

Urbanization and its environmental impacts in the hydrographic basin of the Ipojuca River-PE, Brazil

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Abstract

In the Ipojuca river basin with its course covering 25 municipalities, there are droughts and floods that hit urban areas or areas from the earliest days of civilization, either by the natural geography of the rivers or by human action. With the disordered occupation of its area, the process of urban expansion and structuring of the basin area is continuous, growing and disorderly influencing in a certain way the environment, where the lack of urban management policy is notorious in the sense of minimizing the resulting impacts. The objective is to identify the environmental impacts of the hydrographic basin of the Ipojuca river - PE, through the processes of urbanization replacing primary activities with secondary and tertiary activities, transforming the city into an urban area to which people, goods, capital and technologies converge. The research is descriptive-explanatory, based on bibliographical surveys, using deductive, analytical, synthesis and dialectical methods. Deforestation of native vegetation has contributed to the high rates of desertification, silting up of rivers, streams, lakes, ponds and contamination of the wells by means of agrochemicals. Disorganized population growth, especially close to water resources, has serious consequences, with great social and environmental damage, which raises the need to manage these areas. It is observed the absence of effective policies, leading to a growing increase in waterborne diseases, causing the suffering of poor populations living with this lack of basic infrastructure. It is concluded that the hydrographic basin of the Ipojuca River is very degraded and the best alternative to reverse this situation is to incorporate participatory methodologies that involve the community.

Keywords: anthropogenic action, planning, expansion and urban structuring, environmental degradation.

1. Introduction

Studies on environmental issues gain prominence in society when imbalances occur and the rate of degradation of the environment, caused by the technological advance and lack of human awareness in the face of natural resources (Brasileiro, 2009).

The increase in globalization has negative consequences for the climate and the population. According to Lundgren et al. (2014), the growth of cities brings with it the increase of areas paved with cement and concrete, so that there is a decrease in the area of absorption of rainwater and vegetation covering which receives solar radiation and favors the thermal condition of the air, softening it. In this aspect, the environmental factors are closely linked to the sensation of comfort, adding also the physiological, personal and subjective factors that are

precursor conditions in the human response to the thermal environment as affirmed by Grandi (2006).

The constant changes in the climate are causing increase in the occurrences of extreme climatic events worldwide. In Brazil, these events occur mainly as floods (heavy rains) and prolonged droughts (Marengo et al., 2010). In the Northeast of Brazil (NEB) the impacts are even greater due to the great variability in the occurrence of precipitation in this region. The main systems responsible for the occurrence of precipitation in NEB are: Intertropical Convergence Zone (ITCZ), High Level Cyclonic Vortex (HLCV), Instability Line (IL), South Atlantic Convergence Zone (SACZ), Terrestrial Breeze and Wave Disorders in the Trade winds (TW) according to the authors Molion et al (2002). El Niño - Southern Oscillation (ENSO) is another mode of climatic variability that influences the occurrence of Northeastern Brazil precipitation.

Melo et al. (2016) identified monthly and annual variations and trends in meteorological variables: maximum and minimum air temperatures, rainfall, relative humidity, number of rainy days, total sunshine, wind intensity and cloud cover in the municipality of Parnaguá - PI. The Weibull distribution was the one that best adjusted the total insolation and relative humidity of the air. The generalized distribution of extreme values was the one that best adjusted the maximum and minimum air temperature. The Beta 4 distribution was adjusted for wind strength and total cloud cover. The results show an increase in the maximum temperature and the minimum temperature, an important condition for the desertification process in the studied area. This condition causes water stress in agricultural crops and consequently low production.

The water consumption has exceeded its renewal and what is currently verified is the lack of fresh water, mainly, in the large urban centers and also the decrease of water quality, mainly due to water pollution by domestic and industrial sewage (Abreu, 2010).

Ferreira et al. (2016) have shown that floods and droughts in urban areas occur from the earliest days of civilization, either by the natural geography of the rivers or by climatic systems on the globe and / or region or even by anthropic action, as in the case of the municipality of Paudalho - PE. From the disorderly occupation of its area, the process of expansion and urban structuring of the area is continuous and disorderly, influencing the environment to a certain extent, where the lack of policy and urban management is notorious in order to minimize the resulting impacts. The environment is overloaded by human activities and can no longer perform its purifying function. When analyzing the degradation of natural resources in the face of the urbanization process, it is concluded that the lack of sanitation in the cities has generated an unprecedented degradation of the urban environment, with water resources being one of the most affected elements of nature. Devastation of the soil for construction of bricks is another problem that communities have been facing, thermal discomfort and reduction of the relative humidity of the air. Disorganized population growth, especially close to water resources, has serious consequences, with great social and environmental damage, which raises the need to manage these areas.

The accelerated urban development procedure has been studied for the purpose of assessing the dynamics of the landscape, the transformations that have occurred in the last decades in South America from the process of integrating the country's interior regions to the expansion of industry

towards medium and large cities, according to Stamm et al (2010). Urban heating may be influenced by the winds, the variability of humidity and also the rise in sea level. The urban vegetation softens the temperature and provides the population with a better environmental comfort, since the urban centers produce major alterations in the local and regional climate, whereas wooded areas present a differentiated climate and, consequently, a more pleasant one.

According to Abreu et al (2010), cities grow in a disorderly way, which is noticeable in the landscape and in the urban network, and there is no public control over the constructed space.

A disorderly and uninhabitable environment is born, resulting from public, private, unregulated and uncoordinated policies that generate countless and serious economic, social and health problems for the population and the environment. Such activities that involve environmental issues promote the process of environmental degradation that is usually a consequence of the urbanization process that occurs in a random or inadequate way, causing environmental impacts (COMDEPI, 2002).

According to Botelho (2007), man begins to understand the impossibility of transforming the rules of nature and the importance of reformulating his environmental practices, that is, he is aware of the loss of environmental quality. The lack of sanitation and structure in the cities at minimum levels that ensure the well-being of its inhabitants creates a framework of unprecedented urban environmental degradation, with water resources being one of the first elements of the natural resources to suffer such effects. For this reason, water mirrors such as lakes, ponds, streams, rivers, wells, etc., that are close to or inserted in some city always present some type of contamination, being the degree of pollution directly proportional to the population and the level of productive activity of the city.

Numerous sources of pollution contaminate water resources. Effluents resulting from agricultural, industrial and commercial activities, as well as man-made waste, have historically been introduced into the common beds of rivers, streams, lakes and ponds (COMDEPI, 2002).

The objective of this paper is to identify the environmental impacts of the hydrographic basin of the Ipojuca river - PE, through the processes of urbanization of substitution of primary activities for secondary and tertiary activities, thus transforming the city into an urban area to which people, goods, capital, technologies converge.

2. Materials and methods

The basin of the Ipojuca River (BHRI) is located in the state of Pernambuco, between 08°09'50" and 08°40'20" south latitude, and 34°57'52" and 37°02'48" west longitude. Due to its elongated conformation in the west-east direction, this basin has a strategic position in the state, serving as a large waterway connecting the Metropolitan Region of Recife and the backwoods region of the state. The upper, middle and lower parts of the basin are located in the regions of the backwoods (small portion) and

countryside of the State, while the lower stretch has the greatest part of its area located in the Mata Pernambucana zone, including the coastal range of the State which limits to the north with the basin of the Capibaribe river, a group of basins of small coastal rivers and with the State of Paraíba; To the south, with the basin of the Sirinhaém River; To the east, with the Atlantic Ocean; And to the west, with the basins of the Ipanema and Moxotó Rivers and the State of Paraíba (Figure 1).



Figure 1 - Outline of the hydrographic basin of Ipojuca River and surrounding municipalities. Source: Adapted Author

The Ipojuca River basin (BHRI) covers an area of 3,435.34 km², corresponding to 3.49% of the area of the State. In this basin 25 municipalities are inserted, among which, 14 have their headquarters inserted in the basin. The course of the Ipojuca River, with about 320 km, is predominantly oriented in the west-east direction, being its river regime intermittent, becoming perennial from its middle course, near the city of Caruaru. Its main affluent, on the right bank, are the streams: Liberal, Taquara and Mel, and, on the left bank, the streams of Coutinho, Mocós, Muxoxo and PataChoca. The Liberal stream, its most important affluent, has its sources in the municipality of Alagoinha. It drains, along its 47 km of extension, areas of the municipalities of Alagoinha, Pesqueira and Sanharó, and flows into the Ipojuca river. Its estuary has been greatly altered in recent years, due to the installation of the Port Complex of Suape. Its main tributaries along the right bank are: Liberal stream, Papagaio stream, Tacaimbó stream, Taquara stream, Cipó stream, Vasco stream, Pau Santo stream, Mocó stream, Pedras stream, Green stream, Caruá stream, Barriguda stream, Machado stream Of Mel, Continent stream, Titara stream, Vertentes stream, Macaco Grande stream, Rocha Grande stream, Silver stream, Cotegi stream, Piedade stream and Minas

stream; And the left bank: Poção stream, Mutuca stream, Taboquinha stream, Maniçoba stream, Bitury stream, Coutinho stream, Mocós stream, Salgado stream, Várzea do Cedro stream, Jacaré stream, Sotero stream, Cacimba de Gado stream, Queimada stream, Manuino stream, Serrote stream, Bichinho stream, Muxoxo stream, São João Novo stream, Suue Creek stream, PataChoca stream, Cabromena stream, Sapocaji stream and Urubu stream.

Land

In the eastern part of the studied area, two distinct forms of land are observed, namely: the coastal plain, with altitudes always lower than 100m; And a set of hill-shaped - "sea of hills" - located on the crystalline surface, with altimetric heights of less than 300m, found near the Borborema plateau (this plateau occupies more than 70% of the basin here studied, beginning in the vicinity of the territorial space of the municipality of Chã Grande). In the areas located on the previously mentioned plateau, between the municipalities of Chã Grande and Belo Jardim, there are more or less flat surfaces, with altitudes varying between 400 and 700m. In the western portion of the basin, in the areas belonging to the municipalities of Poção, Pesqueira, Sanharó and Belo Jardim, there are the oldest and highest surfaces,

already well worked by the erosive process, with altitudes varying between 800 and 1,000m.

Geology

Most of the area of the Ipojuca river basin is represented by pre-Cambrian crystalline rocks, whose dominant lithostratigraphic unit is the Migmatitic-Granitoid Complex - pCmi, where the granites and granodiorites are predominant on the migmatites, Stromal, nebulous and epibolytic. Throughout the entire hydro unit, following the east-west direction, there is an extensive transcurrent fault of the right, called the Pernambuco Lineament. This fault separates the gneisses to the south and the dominant granites to the north, extending westward to areas of Arcoverde. Another massive, granitic-diorite occurs south of the fault, going from the municipality of São Caetano to areas of the municipality of Chã Grande. In small areas, associated to metagrauvacas, quartzites and crystalline limestones, are undifferentiated shales and gneisses - pCAx of the Upper Precambrian, which can be considered as correlates of the Salgueiro Group, of great occurrence in the western region of the State. With respect to the sediments that occur in a small area of this hydrographic basin, it is possible to see that recent alluvial deposits dominate, followed by outcrops of the Cabo Formation, which presents through conglomerates, argillaceous argillaceae with silty matrix, siltstones and clays, besides vulcanites in the form of sills, necks or spills, of acidic constitution (rhyolites) to basic (trachyte and basalt).

Vegetation

The dominant vegetation presents physiognomic differences as a consequence of the edaphoclimatic factors, and can generally be considered as "agrestina" caatinga, characterized by the presence of xerophilous, deciduous species, in large numbers composed of thorns and abundance of Cactaceae and Bromeliaceae. In the higher areas and exposed to the humid winds (the southeastern trade winds), the "elevation marshes" occur (being distinguished as areas of springs), being considered ecosystems differentiated from those predominant in the lower or less exposed areas. In these marshes the presence of the mountainous forest is observed, at the moment with high state of degradation being replaced by the polyculture. In the more humid areas of the basin, the vegetation is of the Atlantic Tropical Perennial Forest type, which today is greatly reduced by the devastating action of men. Mangroves are found on the coast, some in great devastation.

Soil

In the upper, middle and sub-middle stretches of the BHRI, the Planosols (PL), Regosols (RE), Yellow and Red-Yellow Podzolic (PA and PV) and Littoral Soils classes (R) predominate. Significant areas of Rocha Outcrops (AR). In these stretches, other classes of soils are also found, such as Alluvial Soils (A) and Latosols (L), but in areas of lesser expression. The Regosols (RE) are very characteristic of the environment conditions of the agrestine region, poorly developed, sandy (often gravel), deep to medium deep, porous, with "fragipã" commonly located just above the rock, predominantly soft undulating land. Its drainage is basically related to the depth where the "fragipã" and the rock are, and can vary from moderately to excessively drained. Despite their sandy texture, they are fairly well cultivated. Planosols (PL) are generally moderately deep to shallow, imperfectly drained, low permeability and very susceptible to erosion, occurring in lower and predominantly smooth, flat, undulating areas. Yellow and Red-Yellow Podzolic (PA and PV) appear frequently; Present varying depths and textures, mostly deep to shallow, with presence of gravel or gravel. In general they occur in raised relief, which represents one of the greatest restrictions to their exploitation, due to the impediment to agricultural mechanization and the severe erosion risks. Due to the low natural fertility and the high degree of acidity, they are soils that require fertilization and liming for their agricultural use. Coastal Soils (R) are poorly developed, shallow, in general its depth is estimated to be less than 50 cm. In the lower section of the basin, which is located entirely in the Zona da Mata (wood zone) and in the coastal strip, the pattern of occurrence of the soils is quite different, besides the Yellow and Red-Yellow Podzolic, the significant presence of Latosols and Gleysols. The Podzolic found in this region are generally similar to those described for the same class found in the "agrestina" region, with some differences such as the depth, generally larger, varying from deep to very deep, the generally clayey texture, the busiest relief, oscillating between wavy, strong wavy and mountainous. They are not common to be found with gravel, and with "fragipã" and plinth, characteristics more common in the "agrestina" region. The Latosols are clayey, very deep and porous, very permeable and well drained. The Gleissolos develop in lowland areas, depressed areas and alluvial plains, that is, lowland sites, linked to the abundance of water; Are mineral soils, hydromorphic, poorly drained, whose morphological characteristics result mainly from the influence of excess moisture, permanent or temporary. Another occurrence to be recorded is the less developed Alluvial Soils, formed by recent fluvial depositions,

deep to moderately deep, of medium and clay texture and commonly imperfect or moderate drainage.

According to Köpper's climatic classification for the BHRI area, the AS-type climate, followed by the Am and BSh types, occurs most frequently.

The rainy season begins in February with pre-season rains (rains that precede the beginning of the rainy season), with its ending occurring at the end of August and may last until the first fortnight of September. The rainy trimester focuses on the months of May, June and July and its driest months occur between October, November and December. The factors that cause rainfall in the municipality are the contribution of the Intertropical Convergence Zone (ZCIT), the formation of high level cyclonic vortices (VCAS), influence of the contribution of the northeast trade winds in the transport of steam and humidity, formations of the lines of instabilities, the orography and its local contributions forming clouds and provoking moderate to strong rainfall according to Medeiros (2016).

The bibliographical and cartographic information was collected in public institutions and government agencies, located in the state of Pernambuco and in the municipalities that are inserted in the area surrounding the basin. This way, information was obtained regarding the geographical location of the basin, the historical, socioeconomic and environmental aspects of the twenty-five municipalities included.

For the analysis of the potential factors of degradation of water resources, relationships were established between the natural aspects of the physical environment and the conditions of use and occupation of the soil. Also in the present study, the direct and indirect impacts of anthropic origin on the surface water resources of the basin were analyzed.

3. Results and discussion

The phenomenon of urbanization has generated important changes in the urban scenario and in the structures of consumption, income and culture of the population (CEPRO, 2003). It is accompanied by population growth, as many people begin to seek the infrastructure of the city. Urbanization is, therefore, population growth without urban planning and is responsible for the emergence of multiple social problems such as crime, unemployment, pollution, destruction of the environment and emergence of sub-housing (CEPRO, 2003). The rapid growth of urban populations also puts severe pressures on natural resources, especially on water resources, because of their susceptibility.

The model of civilization that generated the environmental crisis we are experiencing is the result of the demystified and utilitarian relationship between man and nature, which had its predecessors in post-medieval Europe, and later spread to the colonized world, which compared living systems. The simple biological machines, similar to a clock, were made possible to know them completely by the analysis of its parts, in a deep reductionist vision and incapable to reach the systemic matrix in which all nature is inserted. This misguided form of approach has allowed barbarism in man's relationship with the natural environment and the consequent unbridled exploitation of natural resources, culminating in modern consumer society (Pelizzoli, 1999).

The area of the basin studied has a high pollution index when compared to its industrial park, because it is small. Its situation is troublesome in the face of its deterioration over the years. There are already places with critical points where there are several releases of river galleries, where various wastes are thrown into the river without any kind of treatment.

In response to this new reality of the urban landscape, there was a confusing urban land use planning, as Silva (1993) puts it, although the state started investing in infrastructure, it did so to serve the interests of national and foreign capital, placing it at the margin. This is the main problem, which is the adequacy of the urban landscape to meet the needs of the population and its increase (Silva, 1993). The construction and implantation of residential neighborhoods, the so called housing complexes, in the search to try to overcome this problem, failed to reach the full contingent, much of it is still excluded from the formal labor market, even to a point of being excluded from their reference of citizenship.

The problems of flooding and landslides occurring seasonally lead to a recurrent public calamity, as residences and dwellings do not conform to a habitability pattern, being constructed with inappropriate materials and, in an emergency manner, to give precarious shelter to who cannot afford to pay rent or build decent housing. The river does not have any work of containment or control of floods, despite being the extensive watershed passing through lands.

Its main environmental impacts include deforestation of riparian forests and floodplains, burning, deposition of domestic, hospital and industrial sewage, pollution, use of agrochemicals in areas near its banks, silting and burial, mainly from the sources.

Deforestation of the riparian forests results in silting up of the river, since the main function of the riparian forest is to protect the soil against erosion, which leaves the soil unprotected and is subjected to

erosion. With the rain, the earth is worn, going to the river, which becomes silted, tending to become increasingly shallow.

The fires are an old agropastoral or forest practice that uses fire in a controlled or uncontrolled way to enable family or slave farming or to renew pastures. And the hydrographic basin area of the Ipojuca river has been suffering from intense fires caused by agriculture and the disorderly agribusiness.

The deposition of domestic, hospital and industrial sewers when they are not collected in nets or adequately treated in the treatment plants, being exposed or released in the raw state in the water courses, generating a series of social and health problems. When they are released without treatment in the water courses, a characteristic feature of the sewage, whether domestic or otherwise, is the oxygen consumption of the water from these sources, causing damages to fish and raising the cost of water treatment for consumption.

Although environmental laws to control water pollution have evolved over time, this has not prevented the constant release, often "*in natura*", of huge volumes of industrial, hospital, agricultural and domiciliary waste in the environment and, consequently, in the water courses, which had its water quality compromised and its uses limited.

4. Conclusion

One of the solutions to the recurring problem that plagues the riverside populations located near the water resources of BHRI and its tributaries is through housing management, through a basic sanitation program and the relocation of the population to areas of better infrastructures, which improvements must be carried out to guarantee a better quality of the water resources and the preservation of the riverside areas, generating improvement of the quality of life and of the environment.

The environment is overloaded by anthropogenic activities and can no longer perform its purifying function. When analyzing the degradation of natural resources in the face of the urbanization process, it is concluded that the lack of sanitation in the cities has generated unprecedented urban environment degradation, with water resources being one of the most affected elements of nature.

Deforestation of native vegetation has contributed to the high rates of desertification, silting up of rivers, streams, lakes, ponds and the contamination of well water by means of agrochemicals.

Disorganized population growth, especially close to water resources has serious consequences with great social and environmental damage, which raises the need to manage these areas.

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