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## TEMPORAL DETECTION OF IMPACTS IN CONFLICTING AREAS AND USE OF WATER RESOURCES IN THE SEMIARID REGION OF PARAÍBA STATE

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### Abstract

The northeastern semi-arid region presents climatic and geomorphological irregularities besides low rainfall, indicating low volumes in its sources. The present work has the objective of showing a qualitative diagnosis of environmental conflicts and the use of water in the county of Monteiro, located in the microregion of Western Cariri of Paraíba, in the high Paraíba River course region. The research was carried out between the years 2014 and 2016, being highlighted the physical and socioenvironmental aspects for identification of the agricultural/agropastoral activities and the contamination of river waters by agrochemicals and household wastes. The agropastoral and agricultural activities in the highlighted years contributed in some way to observing the use of polluting materials, leading to the contamination of the existing water reserves in the region. The conflicts, of anthropic activities, extended more between the East axis where the levels of pollutants totaled an area of 16.1 km in relation to the South axis of the Paraíba River, in 2014. On the other hand, in 2016 the conflicting area had an increase of 22.5 km, close to the Poções reservoir, superficial water source of the region, which is included in the São Francisco River Integration Project, thus increasing the level of contaminations and loss of vegetation.

**Keywords:** Environmental; Water resources; Water pollutants.

### DETECÇÃO TEMPORAL DE IMPACTOS EM ÁREAS CONFLITANTES E USO DOS RECURSOS HÍDRICOS NO SEMIÁRIDO DA PARAÍBA

### Resumo

O semiárido nordestino apresenta irregularidades climáticas e geomorfológicas além da baixa pluviometria, indicando baixos volumes em seus mananciais. O presente trabalho tem por objetivo mostrar um diagnóstico de caráter qualitativo dos conflitos ambientais e do uso dos recursos hídricos precisamente no município de Monteiro, localizado na microrregião do Cariri Ocidental da Paraíba, na região do alto curso do rio Paraíba. A pesquisa foi realizada entre os anos de 2014 e 2016 sendo destacados os aspectos físicos e socioambientais para identificação das atividades agrícolas, agropastoris e da contaminação das águas do rio por meio de agrotóxicos e resíduos domésticos. As atividades agropastoris e agrícolas nos anos

destacados contribuíram de certa forma para observar o uso de materiais poluentes, levando à contaminação das reservas hídricas existentes na região. Os conflitos mais impactantes, das atividades antrópicas, estenderam-se mais entre o eixo leste onde os níveis de poluentes totalizaram uma área de 16,1 km em relação ao eixo sul do Rio Paraíba, em 2014. Em 2016 a área conflitante teve um aumento de 22,5 km, próximos ao açude Poções, manancial da região, o qual está incluído no Projeto de Integração do Rio São Francisco, elevando, portanto, o nível de contaminações e perda de vegetação.

**Palavras-chave:** Conflitos ambientais; Recursos hídricos; Poluidores de água.

## DETECCIÓN TEMPORAL DE IMPACTOS EN ZONAS CONFLICTIVAS Y USO DE RECURSOS HÍDRICOS EN EL SEMIÁRIDO DE PARAÍBA

### Resumen

El Semiárido del Nordeste presenta irregularidades climáticas y geomorfológicas además de las bajas precipitaciones, lo que indica bajos volúmenes en sus manantiales. El presente trabajo pretende mostrar un diagnóstico cualitativo de los conflictos ambientales y el uso de los recursos hídricos en el municipio de Monteiro, ubicado en la microrregión occidental de Paraíba, en la región de Curso alto del río Paraíba. La investigación se llevó a cabo entre los años 2014 y 2016 y se destacaron los aspectos físicos y socioambientales para identificar las actividades agrícolas, agropastorales y la contaminación de las aguas fluviales mediante los tóxicos y residuos domésticos. Las actividades agropastorales y agrícolas en los años destacados contribuyeron de cierta manera a observar el uso de materiales contaminantes, lo que llevó a la contaminación de las reservas de agua en la región. Los conflictos de las actividades humanas, se extendieron más entre el eje este donde los niveles de contaminantes sumaron un área de 16,1 km en relación con el eje sur del río Paraíba, en 2014. En 2016, la zona conflictiva tuvo un aumento de 22,5 km, cerca del manantial Poções, la fuente de la región, que se incluye en el Proyecto de integración del río San Francisco, elevando así el nivel de contaminación y pérdida de vegetación.

**Palabras clave:** Conflictos ambientales; Recursos hídricos; Contaminantes del agua.

### 1. INTRODUCTION

The semi-arid northeast faces climatic factors responsible for the variation of other elements that compose it. The scarcity of rainfall makes the processes of soil degradation more and more pertinent when exposed to misuse, making their chemical and physical processes precarious for the adaptation of vegetation. In each environment there is an adequate activity that can be tolerant and less impacting, and should be predicted through the deep knowledge of the relationships that take place in environmental systems or geosystems, according to their potential and vulnerabilities (BERTRAND, 1978). According to Law 9.433/97, the hydrographic basin is defined as the territorial unit for the

implementation of the National Water Resources Policy. The high course region of the Paraíba River, which is included in the São Francisco River Integration Project and of great importance to Paraíba, presents environmental impacts which include environmental degradation, as a result of poor land use, deforestation of vegetation cover, contamination of water reserves and groundwater. Regarding conflicts of water use, these can be classified as: the destination of use, when the water is used for destinations established by political decisions, based on social desires, meeting social, environmental and economic demands, such as the withdrawal of water from an ecological reserve for irrigation; conflicts of qualitative availability, typical situation of water uses in polluted rivers (LANNA, 1997).

Monteiro, municipality of Paraíba, has a hydrography of the dendritic type, that is, surface drainage and some springs, highlighting the Serra de Jabitacá. Among the best known reservoirs, Poções dam stands out, with a maximum capacity of 29,861,562m<sup>3</sup>, which is part of the São Francisco River Integration Project. This reservoir is used for irrigation, but the excessive use of biofertilizers causes degradation and eutrophication processes in the spring, in addition to erosion caused by the removal of riparian forest and trampling of animals.

Anthropization is increasingly causing a major impact in the semi-arid region. The loss of vegetation, quality of life, water, agriculture become problems when it is not known or when there is no commitment to regions where climatic factors interfere with the development process of the municipality, agricultural productivity and the economy. Following the interference of climate factors, deforestation, poor soil management, and deforestation intensify environmental degradation (SILVA, 2012). The erosion of the natural resources of the semi-arid region is perceived when exactly the human population exploits the areas of influence of the Hydrographic Basins in a disorganized manner (MENINO ; CAVALCANTE, 2013). The vegetation cover under exploitation in the world points to a harmful imbalance for the environment, the extinction of important native species of both plants and animals, erosion, soil infertility, brings great consequences and damages (SILVA, 1998). In relation to the Northeast, historically speaking, the population agglomerations in terms of territorial occupation, only justify the reason for the fragmentations that the soil, vegetation and water bodies suffer with great losses of their resources, especially in regions such as the semi-arid that requires attention with regard to low rainfall, the soil largely young and poor in nutrients. Rainfall irregularities influence decision making regarding economic development and its practices (ANDRADE, 1963).

The degradation of an ecosystem consists in the alteration of its natural balance caused by the action of factors that act on natural resources, determining a reduction in the genetic diversity of native flora and fauna, as well as eutrophication in the case of aquatic ecosystems. Such impacts may be induced by anthropic action, through deforestation, the practice of predatory agriculture, the use of plant cover as a source of energy and the incorporation of marginal lands, unfit for agriculture and the production process (FERNANDES, 2008). The use of geoprocessing for image composition and mapping of vegetation areas in different forms and at different times allows the spatial identification of the

misuse of natural resources and landscaping pointing to situations impacting on the environment (BORGES *et al.*, 1993).

The objective of this work was to present a qualitative diagnosis between the years 2014 and 2016 of environmental conflicts and use of water resources precisely in the municipality of Monteiro located in the micro-region of Cariri Ocidental, Paraíba, especially in the high course region of the Paraíba River, highlighting the physical and socio-environmental aspects for the identification of agricultural activities, agropastoralism and contamination of river waters by means of pesticides and domestic waste.

## 2. METHODOLOGY

The collection of the points was done through Garmin 78S GPS, according to Figure 1, which allowed to identify, through a plotting done on Google Earth, the areas of environmental conflict through the actions and anthropic activities, in the east and south axes and later imported to the GPS Track Maker software for data acquisition.



Figure 1 - Plotting of the conflicting sections in the studied area. Data source: Google Earth (2019). Elaboration: Author (2019).

For the on site diagnosis, six stretches were divided in 2014, the rainy season in the region, which allowed the identification of the use of degradation materials in the river through the accumulation of domestic (stretches 1 and 2) and agricultural (stretches 3 and 4) pollutants, mainly in the eastern axis. Regarding the southern axis, agropastoral activities were identified (stretch 5), close to the margins of small water bodies, degrading the soil and native ciliary vegetation existing in the area (stretch 6). A table was made in which inappropriate activities by the local community, such as accumulations of domestic and agricultural waste, water contamination due to inadequate use of pumps, removal and burning of vegetation and inappropriate agricultural activities were highlighted in the conflicting zones of the east and south axes of the Paraíba River in a percentage of 100% for each impact found, across the area in km. For the year 2016, only the eastern axis was studied, identifying on site the

same degradation processes found in 2014. The stretches from 1 to 4 were analyzed.

## 3. RESULTS AND DISCUSSION

The study was conducted in the municipality of Monteiro, which comprises the largest municipal territory of the Paraíba River basin, precisely in the upper river basin, totaling an area of 986,370 km<sup>2</sup>, located between coordinates 7°53'20" S of latitude and 37°07'12" O of longitude. This stretch currently includes the São Francisco River Water Integration Project, where the canal is located on the project's eastern axis. The recharges vary due to the oscillating flow that is released by the channel, which contributes to the supply of the local community and region presented in Figure 2.



Figure 2 - Location of the PISF channel, highlighting the stretch that begins in the municipality of Monteiro and extends to the municipality of Boqueirão, presenting the reservoirs that are included for receiving the waters of the São Francisco River. Data source: Author (2019). Elaboration: Author (2019).

The São Francisco River watershed has an area of approximately 640,000 km<sup>2</sup> covering 7 federal units (Alagoas, Bahia, Federal District, Goiás, Minas Gerais, Sergipe, in addition to 507 municipalities (CBHSF, 2015). The PISF project, east axis, implemented in the High Course of the Paraíba River, upstream of the Boqueirão reservoir, the largest in extension of the Cariri Paraíba, brought to the localities of Monteiro and other neighboring cities, the perennialization of the Paraíba River in addition to the transposition of the waters that flow through the river with flows granted by ANA (CBHSF, 2015). Monteiro is located at an altitude of approximately 600m. The region of Paraíba presents a predominance of reliefs that provide through the altitude, winds that promote the occurrence of orographic rains allowing the perennialization of some rivers in soil regions in processes of erosion (RODRIGUES, 2012; CARVALHO, 2014). The predominant vegetation in the municipality of Monteiro is of the Caducifólia espinhosa type, with undergrowth, very common in the caatinga of the semi-arid region (PEREIRA JUNIOR, 2012; COSTA and ARAÚJO, 2016).

The region's climate is semi-arid with hot summer rainfall, according to Köppen's classification, with approximately 600m altitude and average rainfall is 431.9 mm/year (AESAs, 2016). The vegetation is low, Caatinga, typical of the semi-arid region. Although there is vegetation such as cactaceous, the development of these plants is characterized by developing in areas with low rainfall and few water sources (SOBRINHO and FALCÃO, 2006). The stretches analyzed in May 2014 and December 2016 are located between the coordinates (753'15.6" S; 37° 06'23" O) for the eastern axis, near the Poçoões dam, and the southern axis (7 54'03.5" S; 37°07'20") near a local community, limited by highways PB 264 and BR110. In order to identify the existing impacts on the stretches, the physical and socio-environmental aspects were highlighted for the identification of agricultural activities, agropastoralism and contamination of river waters by means of agrochemicals and domestic waste.

Observing the entire study conducted on the stretch of the Paraíba River and its drainage branches, and identifying the data and main impacts referred to in Table 1, there is a considerable negative contribution from residents living close to the river banks, using inadequate means of agricultural activities and disposing of domestic waste without unfortunately receiving any educational action from the region's managers and a lack of environmental awareness. Alves *et al.* (2012) when studying the degrading impacts on the municipality of Caraúbas, identified, along the stretch of the Paraíba River that cuts through the municipality, several solid waste discharged near the drainage networks of the Paraíba River, resulting in a worrying impact due to the incidence of contamination.

Table 01 – On site identification of the impacting elements on the Eastern axis, held in May 2014. Source: Author (2019).

Study stretch	Main impacts	Area (km)	Percentage (%)
1	Household waste	5	31
2	Domestic waste, leftover hydraulic materials.	4.7	29
3	Agricultural waste (irrigation)	2.8	18
4	Agricultural waste (toxic products)	6.6	32
<b>Total</b>		16.1	100

Table 2 shows the most striking elements observed on the southern axis. It was possible to identify a concentrated removal of native vegetation cover, in an area of 7.3 km, a situation that impairs and increases siltation of the river bed that receives the PISF waters. It was observed several paths made by local residents, where the vegetation already fragmented was trampled by animals and in some points of the stretch, burned.

Unfortunately without any sustainable conservation for that ecosystem, damaging the resilience. Regarding the trampling of animals, an impact that impoverishes and destruct the soil, Marchão *et al.* (2009), when studying soil compaction in western Bahia, analyzed that animal trampling seriously aggravates the soil because the vegetation becomes pasture, damaging its root system, as well as the decrease of infiltration. The authors also point out that excessive trampling causes compaction, a situation that complicates for cases of soils with low humidity (MARCHÃO *et al.*, 2007).

The vegetative cover of the studied site, mainly the ciliary vegetation, of the riverbed, besides presenting a shrubby and creeping aspect is well damaged, showing that the lack of cover accelerates the erosive processes caused by man. The authors Correia *et al.* (2009); Pereira (2013); Wick *et al.* (2000) point out that changes in vegetation and soil in semi-arid environments, through animal and human activities, further accelerate the degradation of the Caatinga.

Table 02 -Identification in loco of the impacting elements on the southern axis, held in May 2014. Source: Author (2019).

Study stretch	Main impacts	Area (km)	Percentage (%)
5	Agropastoral activities	6	27
6	Removal of riparian vegetation	7.3	73
<b>Total</b>		13.3	100

In addition, in Table 2, the agropastoral activities were identified due to the use of animals for transportation of materials and trampling tracks, in addition to the removal of native ciliary vegetation that covers some stretches of small water bodies identified at the site, which demonstrates on the part of the community the misuse of natural resources that exist, contributing to a possible silting up of these water sources, and soil degradation leaving it vulnerable to erosion, consequently infertile for possible replanting. This corresponds to the position of Donadio *et al.* (2005), where he states that the low coverage of native vegetation provides the carrying of large quantities of soil, organic matter and agricultural inputs to the riverbed in the rainy season, contributing significantly to the increase in the concentration of solids and nutrients in the water sources. Researchers such as MMA (2016) and Ganem (2017) point to the exploitation of vegetation removal, overgrazing and a decrease in water quality of semiarid springs due to siltation and loss of biodiversity.

The greatest impact was observed in stretch 4, with a percentage of 32% in relation to the area of (stretch 2), where accumulations of domestic garbage and remains of hydraulic materials were identified, probably used for water collection,

Figure 3. Domestic waste thrown into silted up rivers, and especially in hydrographic basins in processes of degradation only increases the consequences of those who inhabit the riverbeds, because in addition to not following sustainability practices, they lose their space for pollution, emphasizes the authors Barbosa (2014) and Silva *et al.*

Regarding the consumption of this source of water, the quality, due to the contamination of the pollutants found, becomes inappropriate since there is not even a measure to preserve the water reserve, which corresponds to Conama Resolution No. 357 of March 17, 2005, which aims to preserve the natural balance of aquatic communities in general.

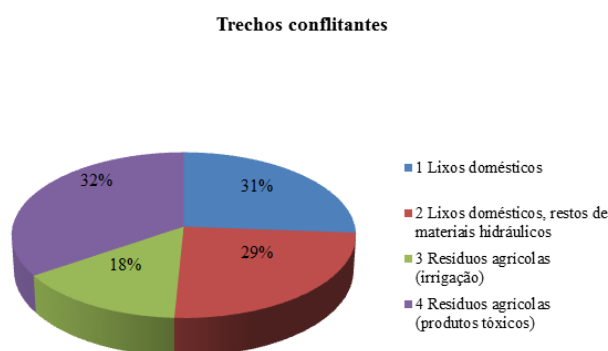


Figure 3 - Representation of the conflicting stretches identified in Table 1, Paraíba River region in 2014. Source: Author (2019). Elaboration: Author (2019).

For the year 2016, Table 3 shows a small increase in the impacting elements, mainly the removal of riparian vegetation and agricultural residues, on the eastern axis, observed in Figure 4. This corroborates the text of Federal Law 9433/97 of the State Water Resources Plan, in which it guides that water supply in rural areas should be guaranteed through guidelines on how to obtain good quality water that has a descending sanitary exhaustion, using, for example, septic tanks. Besides supporting the idea of availability and efficient use of water due to the semiarid region suffering the evaporation processes and climatic variations that affect the semiarid region. Andrade and Souza (2018) when studying the erosion processes in the riparian vegetation that covers the sub-basin of the lower Jaguaribe, in Ceará, point out that the vegetation of the bed is of great value for the river margins, because they slow down the erosion processes, since a large part of the area studied by the authors presented retreats of riparian vegetation approximately 2m per year. Water resource management policies in semi-arid regions are a challenge when it comes to implementing conservative practices to mitigate the force of drought and improve water use systems. According to Garjulli (2003), the history of participatory policy in the semi-arid region has tried in the past to strengthen adequate drought controls, but the lack of initiative on the part of some

managers does not ensure sustainability. The use of agrochemicals in plantations along riverbeds and streams is common in subsistence agriculture in a disorganized way. The eastern axis presented these residues in 2014 and were still found in 2016, a situation that further aggravates the waters of the Paraíba River, characterizing a gradual and continuous impact. Spanghero *et al.* (2017); Santos *et al.* (2018) highlight the concern about irregular occupations in places of preservation and waste disposal, especially in the Paraíba medium River, Alagoas, increasing the impacts on the watersheds, accelerating the contamination of non-perennial water bodies.

Table 3 -Identification in loco of the impacting elements on the Eastern axis, held in December 2016. Source: Author (2019).

Study stretch	Main impacts	Area (km)	Percentage (%)
1	Household waste	7	33
2	Domestic waste, leftover hydraulic materials	7.6	34
3	Agricultural waste (irrigation)	4.9	22
4	Agricultural waste (toxic products)	3.0	20
<b>Total</b>		22.5	100

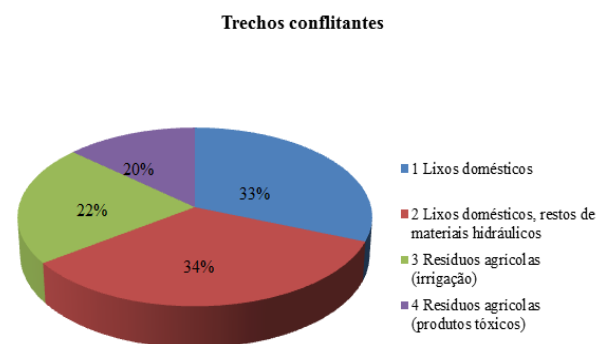


Figure 4 - Representation of the conflicting stretches identified in Table 3, on the eastern axis in the Paraíba River region in 2016. Source: Author (2019). Elaboration: Author (2019).

An increase of 6.4km more can be observed in relation to 2014, proving the deficiency in the environmental orientation on the part of local managers, besides the constant search for water,

both for irrigation and animal dedentation, not least because it is an area included in the São Francisco River Water Integration Project. This stretch, due to the PISF, is already being completed for a future inauguration in the following year, which also worries the authorities about the increase in demand for water for consumption and its withdrawal for use during irrigation. Pagano (2012) stresses the need for participatory policies due to the distribution of water for irrigation with the water demand already regularized. According to the IPEA (2018), the government's plans for the semi-arid Northeast are still precarious when it comes to mentioning the potential for degradation of watersheds, as well as low water levels for irrigation practices.

To use the satellite image, band 3 of the CBERS4 satellite was used, monochrome MUX sensor, highlighted and under contrast, which guaranteed the identification of exposed soil stretches due to vegetation loss, observed in Figure 5. Crispin (2016), using the composition of the visible and infrared bands of the TM sensor of LANDSAT5 and the 8, in a region of high environmental fragility, in Quixadá, Ceará, was able to identify, through enhancement techniques, the possible areas of agricultural practices and exposed soil spots, concluding that these combinations resulted in identifying the most degraded areas of the studied site. For Dantas *et al.* (2018) the combinations of orbital images for the processing and classification of Soil Use in Cerro Corá, Ceará, brought quite significant responses for precisely revealing areas of Soil Exposed due to existing agriculture, indicating degradation.

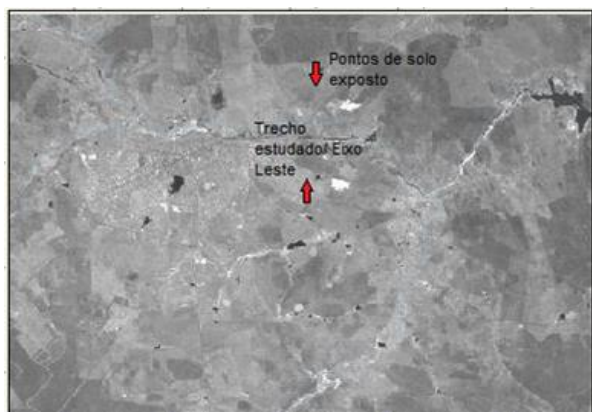


Figure 5 - Grayscale representation through the image of band 3 of the MUX sensor of the CBERS 4 satellite in Monteiro, Paraíba. UTM projection, Sirgas 2000, zone 24S. Source: Author (2019). Elaboration: Author (2019).

The clear shades near the margin of the Paraíba River, indicated in the image of band 3, show that there is an increase of exposed soil both in the studied area and its surroundings. It was also possible to observe that the constant and bad use of the soil is provoking even more the increase of erosion and with this an uncontrolled exploration of this studied area is reached which provides losses of area for the plantation due to the impoverishment of the soil making it even more saline. And in this area we found materials that are used for irrigation, household

waste, which proves the lack of adequate management for irrigation practices by local residents. A situation that becomes worrying in relation to the preservation of the riverbed, the vazante vegetation and all its extension, due to the lack of orientation on the part of the managers of the municipality.

#### 4. CONCLUSIONS

The municipality of Monteiro is considered the largest municipal territory in the Paraíba River basin, with an area of 996.88 km<sup>2</sup>, and is part of the São Francisco Integration Project, where the region of the high course of the river is located, which is already operating.

The Brazilian Northeast has a history of environmental impacts in terms of losses of large arable areas and even of preservation when it comes to ensuring better use of soil and water. The existing resources are limited and need to be preserved under conditions of sustainable practices. Especially in areas of semi-arid regions where rainfall rates are consequently low, water availability for the improvement of physical and morphological conditions of the soil as well as the use of water for consumption are often precarious and do not supply the plans of those who survive or trade in such environments.

The fragmentation of the ebbing vegetation as well as the riparian vegetation increases and compromises the decomposition of the whole structure of the river bed due to the removal, burning, and passage of animals, reaching extreme points of total loss due to silting up and decrease in the flow.

The conflicting areas observed in the main stretches studied, between the years 2014 and 2016, showed negative responses, especially the east axis, increasing the area from 16.1 to 22.5 km, due to several and constant inappropriate anthropic practices, such as the misuse of water reserves found in the stretches, such as the use of hydraulic pumps without any study and analyze the accumulation of domestic waste generating water and soil contamination, the trampling of animals in areas that could be preserved, especially on the banks of water bodies. It is necessary a better deepening in terms of research to observe the quality of the water in the region and how far pollution can be reached.

Since the Paraíba River is very important for the region of Cariri, and for the semi-arid region of Paraíba, it is up to the authorities to reflect on a more efficient plan for the management of these natural resources, which are increasingly being exploited, to seek mitigating measures of preservation and educational actions for the proper use of this ecological environment.

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