Periódico Eletrônico
Fórum Ambiental da Alta Paulista
ISSN 1980-0827 – Volume 19, número 1, 2023

Incompatibility in Permanent Preservation Areas and Land Use in the Sanabani River Basin Silves-AM in 2019

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SUMMARY

The objective of the present study was to map and identify the occurrence of legal incompatibilities in land use in the permanently protected areas of the Sanabani River basin in the municipality of Silves-AM. Landsat 8 OLI imagery for 2019 was used to develop the land use and vegetation cover analysis map. The next step consisted in the digital processing of the images, using the software QGIS and SPRING. The delineation of the hydrographic channels of the study area was used to develop the map of the permanent conservation area, we used the digital elevation model of Topodata and satellite imagery available in the Google satellite catalog through the QuickMapServices extension in QGIS to create drainage lines. Land use mapping and vegetation cover were classified as forested, deforested, and water areas. The forested land class covered a total of 617.89 km2, representing 92.99%, while deforested land covered a total of 26.90 km2, representing 4.05%. On the other hand, the water areas had a total area of 19.71 km2, equivalent to 2.97%. The legally defined areas classified as compatible show that 99% of the AAs are preserved. On the other hand, the areas classified as incompatible represent only 1% and are mainly located in the south and southeast of the basin.

KEY WORDS: Conservation Areas. Permanent. Use of the earth.

1 INTRODUCTION

The human intervention associated with the expansion of agricultural frontiers and the increasing demand for food that accompanies economic expansion cause environmental damage, such as the displacement of native vegetation in rural or urban areas. Therefore, the importance of environmental management aimed at protecting and preventing the consequences caused by the expansion and economic exploitation of the same is emphasised. Considering the importance and ecological function of a preserved environment for social and environmental relations and consequently for the economy.

The suppression of native vegetation, such as in areas designated for permanent conservation, are regions that have suffered from the advance of the agricultural frontier, as they are riparian forests that protect the drainage channels of watersheds and the sources of rivers. Silva Neto and Aleixo (2019) state that areas under permanent conservation are highlighted as areas of high environmental vulnerability, in which they are more susceptible to triggering environmental degradation processes.

Law No. 12,651 of May 25, 2012, provides for the protection of native vegetation and establishes in Article 1 general rules for the protection of vegetation, permanent protected areas and legal reserves, forest use, supply of forest raw materials, control of the origin of forest products, and control and prevention of forest fires, and provides for economic and financial instruments to achieve its objectives (BRASIL, 2012).

In its 7th article, it deals with the vegetation located in the Permanent Preservation Area, where the owner of the area, owner or occupant in any title, natural or legal person, under public or private law, has the obligation to keep it protected and preserved.

This law is an important protection instrument for actions aimed at protecting the environment, such as vegetation in a Permanent Preservation Area, avoiding its degradation, because it protects both soil and water. For Santos (2019), the Permanent Preservation Areas are spaces characterized by the untouchability and prohibition of direct economic use, due to their environmental value, strictly related to the maintenance of the quality of water resources. Therefore, the study of watersheds associated with Permanent Protected Areas is necessary because the presence of conflicts between use and occupation and non-compliance with legislation in these areas threatens the quantity and quality of water resources due to river dynamics and surface water flow (PANIAGO et.al. 2019).

The present study aimed to map and identify the occurrence of legal incompatibilities in land use in the areas of permanent conservation of the Sanabani River basin in the municipality of Silves-AM. To achieve the proposed objectives, thematic maps were created using Geographic Information Systems (GIS), as this helps in the rapid identification of permanent conservation areas and areas of environmental conflict through spatial analysis operations and mathematical procedures performed on the geographic database stored in the system in the form of thematic information and tables (STRASSBURGER, 2005).

2 GOALS

Map of areas of compatibility and incompatibility with land use and vegetation cover in areas of permanent conservation in the Sanabani River Basin in the municipality of Silves – AM.

3 METHODOLOGY

The Sanabani River basin is located entirely in the municipality of Silves, in the state of Amazonas, and has an area of approximately 670 km² (Figure 01). According to Albuquerque (1999), Silves is one of the Amazonian communities founded by missionaries who settled in the Amazon. The municipality was founded in 1660 under the name of Saracá on the Urubu River by Frei Raimundo of the Order of Mercy.

The municipality is located in the Middle Amazon region, about 250 km from the Amazon capital, and the land runs 226 km from the AM-010 road (Manaus-Itacoatiara) and

ISSN 1980-0827 – Volume 19, número 1, 2023

another 127 km from BR -363, bordering the municipalities of Itapiranga, Urucurituba and Itacoatiara (FARIA, 2010). It has an estimated population of 9,171 inhabitants spread over an area of 3,723,382 km² (IBGE, 2019).

Picture 01 - Study area location

Source: IBGE, 2010. Elaboration Bruno Sarkis, 2020.

Landsat 8 OLI imagery was used to create the 2019 land use and vegetation cover analysis map. They have a spatial resolution of 30 meters. The bands used were 4,5 and 6, and the acquisition date was Aug. 30, 2019, orbit/point 230/62.

The images are provided through the United States Geological Survey (USGS) website. The map was divided into 03 thematic classes: forested, deforested, and water bodies.

The next step consisted in the digital processing of the images, for which the QGIS and SPRING software were used. According to Santos et. al (2010), digital image processing techniques can be divided into three steps: Preprocessing, image enhancement and image analysis.

In the QGIS software, the color composition of the red (RED), near infrared (NIR), and mid infrared (IV) bands was elaborated to facilitate the interpretation of the images and to allow the identification of features and objects. Watershed boundaries were used to delineate the study area.

After this step, the images were imported into Spring and image segmentation began with the cropped images, as well as classification by region using the Bhattacharya classifier.

The first step in the classification process is segmentation. According to Santos et. al (2010), the segmentation of an image consists of grouping pixels with similar characteristics in terms of tonality and texture and forming homogeneous regions.

According to Lopes (2005), this process divides the image into regions that must correspond to areas of interest for the application; such regions are a set of contiguous "pixels" that spread in both directions and provide uniformity.

After segmenting the image, the training process was performed, which refers to the detection of patterns in the image divided by region, assigning a specific class to the collected pattern (SANTOS, et. al. 2010).

Classification supervised by region uses the spectral information of each "pixel" and the spatial information related to the relationship between the "pixels" and their neighbors. Such classifiers simulate the behavior of a photo interpreter that recognizes homogeneous image regions based on the spectral and spatial properties of the images (SANTOS, et. al. 2010).

The Bhattacharya classifier is a supervised classification algorithm that, according to Santos et. al (2010), requires the selection of training regions and can use the individual regions during the segmentation process or polygons representative of the regions to be classified.

The post-classification process consists in refining the land use classification and is composed of the extraction of isolated pixels. In the case of the unclassified pixels, depending on a threshold or weighting set by the user, the Spring pattern was used.

The mapping of Permanent Preservation Areas (APP), considering the current legislation, was based according to the criteria established in federal law No. 12,651, DE MAY 25, 2012 (New Forest Code).

In Section I where it deals with the Delimitation of Permanent Preservation Areas, Art. 4 is considered a Permanent Preservation Area, in rural or urban areas, for the purposes of this Law:

I - The margins of each perennial and intermittent natural watercourse, except ephemeral waters, from the edge of the regular bed depression, in a minimum width of: a) 30 meters for watercourses with a width of less than 10 meters; b) 50 meters for watercourses with a width of 10 to 50 meters; c) 100 meters for watercourses with a width of 50 to 200 meters; d)

200 meters for watercourses with a width of 200 to 600 meters; e) 500 meters for watercourses with a width of more than 600 meters.

IV - The areas around the springs and the perennial water eyes, whatever their topographic situation, in the minimum radius of 50 (fifty) meters.

V - The slopes or parts of these with slopes greater than 45°, equivalent to 100% (one hundred percent) in the line of greatest slope.

The first step for the elaboration of the Permanent Preservation Area map was the delimitation of the hydrographic channels of the study area, using the topodata digital elevation model and satellite images available in the Google Satellite catalog available through the QuickMapServices extension in QGIS for generating drainage lines, in the case of channels with a width of 10 meters or less, the water mass polygons for channels with a width greater than 10 meters, and points for the hydrographic springs.

After the elaboration of the vector layers (points, lines, and polygons) the buffer distance operator was applied to create a zone around a geographic element. In this case of the hydrography, it contains locations that are within a distance specified by the new forest code.

The next step was centered on performing the vector blending procedure, where the software groups all the buffers generated into a single vector file: the APP's information plan.

To elaborate the app's incompatibility map, the vector information plan was transformed into a matrix. Following this procedure, the file was imported into Spring to be correlated with the land use map and vegetation cover.

The procedure used to generate the incompatibility layer of the app with respect to land use can be defined as a logical operation between information plans and was performed in a legal environment where the compatible and incompatible classes were defined by the overlap between the two variables.

The classes of primary and secondary vegetation and water were used as compatible, while the classes of exposed soil and pasture were used as incompatible. The final step was to decompose the information plan created in NtM into thematic sections, assigning the two values resulting from the processing to the corresponding classes.

4 RESULTS

The results of the land use and vegetation cover mapping, the permanent protected areas and their incompatibility areas for the year 2019 allowed the review of human-induced changes in use and occupation in the Sanabani watershed and use mapping and vegetation cover were divided into forested, deforested, and aquatic areas.

The class of forested land covered a total of 617.89 km2, representing 92.99%, while deforested land covered a total of 26.90 km2, representing 4.05%. On the other hand, the water areas had a total area of 19.71 km2, corresponding to 2.97% (Figure 02).

The forested areas are the areas with dense and still preserved primary vegetation, which are mostly arboreal. The deforested areas, on the other hand, belong to the class of secondary vegetation with herbaceous and shrubby plants. Pastures were also identified in these deforested areas, mainly for large animals such as cattle and buffalo.

Agricultural activities have also been identified, where mainly cassava (Manihot esculenta) is cultivated, as well as urban settlement with houses built on the banks of the Sanabani and Itapani rivers and in the municipality of Silves.

Picture 02 - Land Use and Vegetation Cover of the Sanabani River Basin in 2019.

Source: IBGE, 2010. Elaboration Bruno Sarkis, 2020.

As shown in Table 01, of the total area of the Sanabani River Basin of 664 km2, the permanent protected areas account for a total of 149 km2, or 22% of the basin area.

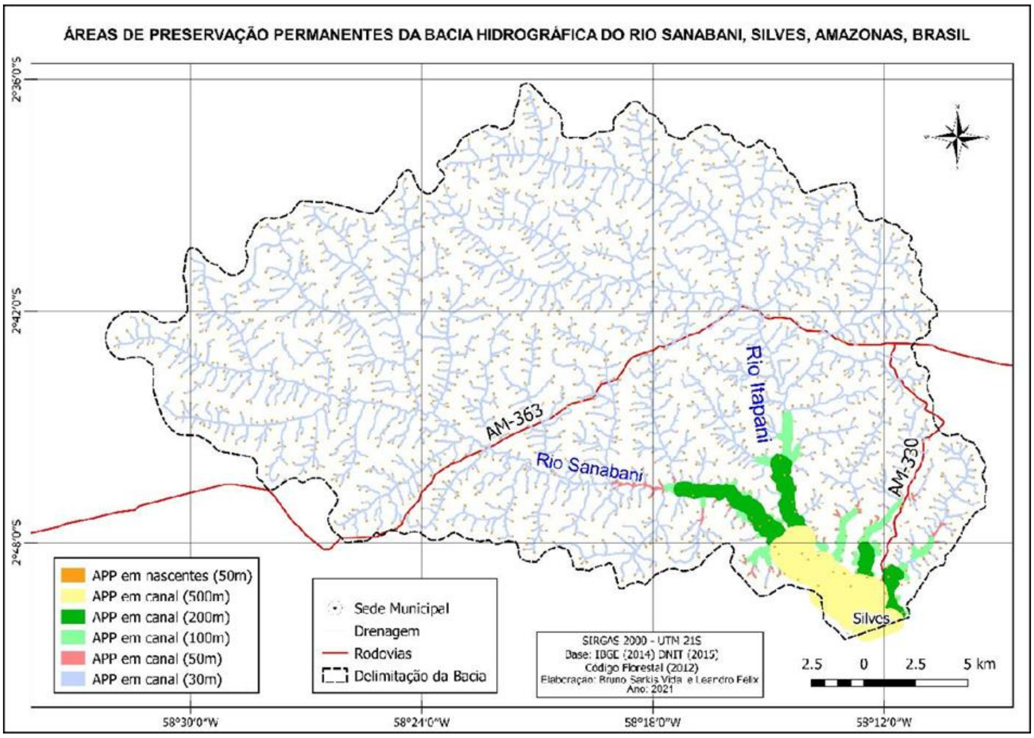
Table 01 - Areas with and without permanent preservation in km2.

Area	Area in km2	Area in %
Total Area with Permanent Preservation	149	22
Total Unpreserved Area of the Basin	515	78
Total basin area	664	100

Source: INPE, 2020. Elaboration: Leandro Félix. 2021.

Picture 03 shows that the Permanent Preservation Areas are mostly in areas of springs, considering the range of 50 meters of vegetation in their surroundings, and in banks of drainage channels with a range of 30 meters wide. The other Permanent Preservation Areas are located on the banks of drainage channels, with a range of 50 meters to 500 meters wide, located in the south and southeast region, closer to the mouth of the basin and in the municipal seat of Silves.

Figure 03 - Permanent Preservation Areas of the Sanabani River Basin in 2019.

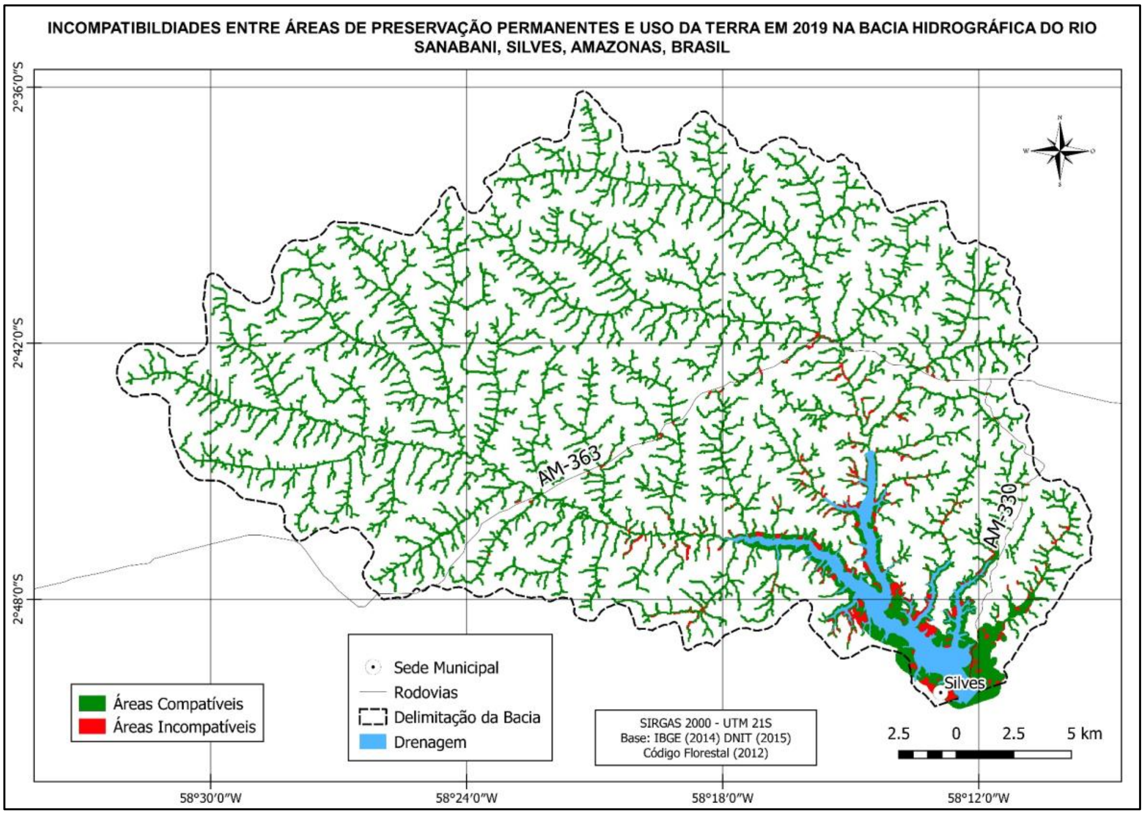


Source: IBGE, 2010. Elaboration Bruno Sarkis, 2020.

The delimitation of the areas of compatibility and incompatibility in Permanent Preservation Areas in the Sanabani river basin was carried out where agricultural, livestock and urban occupation was inadequate with what is provided for by law (forest code). The overlap of land use map information and vegetation cover with permanent preservation areas allowed the identification of areas with incompatibilities.

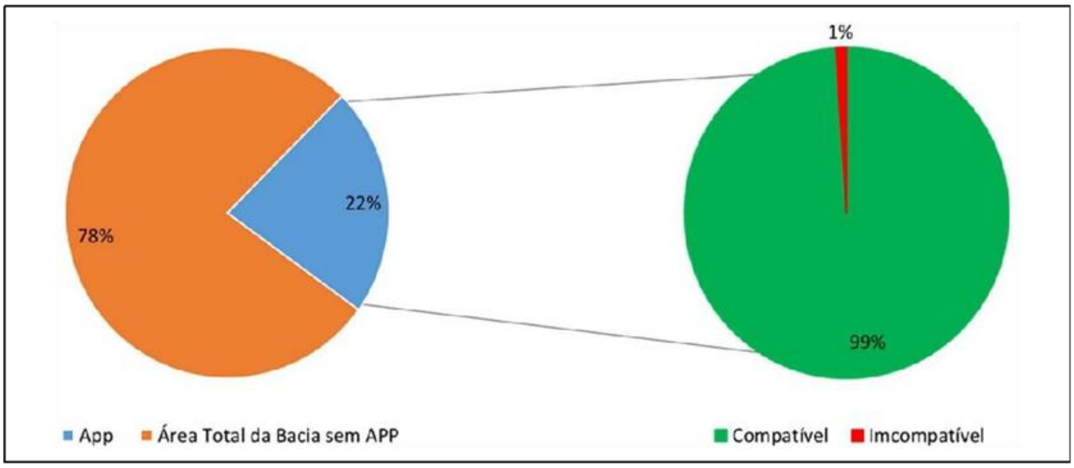
Picture 04 and graph 01 show that areas legally destined and identified as compatible indicate that 99% of THE AAs are preserved. On the other hand, the areas identified as incompatible are only 1%, being located mainly in the south and southeast region of the basin on the banks of rivers and drainage channels of 50 meters to 500 meters towards its mouth and in the municipal place.

Picture 04 - Incompatibility between Permanent Preservation Areas and Land Use in the Basin Sanabani River in 2019.



Source: IBGE, 2010. Elaboration: Bruno Sarkis, (2020).

Graph 01 - Incompatibility of land use in the Permanent Preservation Areas in the Sanabani River Basin in 2019.



Elaboration: Leandro Felix, (2020).

The main types of incompatibility identified quite common in the Sanabani basin are deforestation for activities such as agriculture and livestock, which do not respect what is provided for by law, in relation to the preservation of these areas (Figure 05).

Figure 05 - Land use incompatibility in APP's. Banks of the Itapani River.

Source: Leandro Felix, (2020).

In areas destined for agriculture, one can observe agricultural practices in strands with very marked slopes, with cultivation, and deforestation for new planting areas (picture 06).

Picture 06 - Deforestation for cassava cultivation in strand with marked slope

Source: Leandro Felix, (2020).

Another problem observed in THE App's is related to solid waste disposal, which according to Alves (2020), the municipalities of Amazonas State do not comply in their entirety, which is advocated by the National Solid Waste Policy through Law No. 12.305/2010 and the State Solid Waste Policy of Amazonas State through Law No. 4.457/2017 regarding the final disposal of municipal solid waste, therefore, no municipality in Amazonas State has a landfill.

In view of this, during the field research, it was possible to observe that all solid waste generated at the headquarters of the municipality of Silves and collected by the city is deposited in the open air in a permanent storage area located near a valley bottom with a steep slope and outside any standards established by current legislation (Figure 07).

Picture 07 - Disposal of solid waste in the open dump.

Source: Leandro Felix, (2020).

At the site of solid waste dumping, some environmental problems have been observed, such as the spread of vectors that transmit diseases, such as rats and flies, the lack of an adequate sewage network for rainwater, incineration and landfilling as a strategy to reduce the amount of waste that contributes to air pollution and contamination of the subsoil. On site, it is noted that there are no controls regarding the entry and exit of vehicles or people.

In the Sanabani watershed, degraded areas such as deforestation and exposed soils promote not only erosion processes but also increased surface runoff, increased sediment transport into the drainage channels, and can lead to siltation of the channels and certain parts of the watershed. Regarding the garbage in the areas under permanent preservation, it is noted that there are no control and protection measures necessary for such irregularities to protect the environment and public health.

5 CONCLUSION

The mapping of the Sanabani River basin made it possible to identify incompatible land use areas that do not comply with the legal provisions, thus creating socio-environmental conflicts, especially in relation to permanent protected areas.

Permanent protected areas represent 22% of the total area of the basin and are legally designated for environmental protection. In these areas, only 1% incompatibilities were found, which are not in accordance with the Forest Code 2012. Although they are almost inconclusive, they show areas that are mainly used by pasture and agriculture, are located on the banks of rivers with accentuated gradients and are urban areas.

Another very critical issue regarding incompatibility in APPs is related to the destination or inadequate disposal of solid waste. This situation does not comply with the recommendations of the National Solid Waste Policy through Law No. 12,305/2010 and the State Solid Waste Policy of Amazonas through Law No. 4,457/2017, regarding the final disposal of municipal solid waste.

The mapping of land use and vegetation cover of the Sanabani River Basin in 2019 allowed the identification of forested areas with a total area of 617.89 km2, equivalent to 92.99%, while deforested areas have a total area of 26.90 km2, equivalent to 4.05%.

Currently, the types of use in the basin are mainly represented by economic activities of the primary sector, where agriculture with the cultivation of cassava and cattle raising with cattle breeding stand out, where the municipality of Silves stands out with the 26th place in Amazon Cattle by Herd In head.

Agricultural occupation was also verified in more vulnerable areas of the relief, and permanent preservation areas such as very steep slopes. On the banks of the main rivers of the basin, the Itapani and Sanabani, there is an intense cultivation of pastures for the practice of livestock.

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