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ENVIRONMENTAL LICENSING AND EXPANSION OF AQUACULTURE IN PARÁ: GEOSPATIAL MAPPING AND REGULATORY CHALLENGES

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ABSTRACT

Aquaculture has consolidated itself as one of the most dynamic sectors of animal production in Brazil, registering an average annual growth of 8% between 2004 and 2014. In the state of Pará, this activity is driven by favorable climatic and geographic factors, being mostly composed of small enterprises, with more than 90% of the production units operating in areas of less than 2 hectares. However, regulatory challenges, especially with regard to environmental licensing, directly influence the expansion of the sector. This study

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carried out a geospatial mapping of aquaculture production areas in Pará, with emphasis on the identification of enterprises exempt from environmental licensing. The methodology involved the collection and analysis of data from the State Secretariat for the Environment and Sustainability (SEMAS), in addition to processing this information in the ArcGIS software for a detailed geographic representation.
The results indicate that the exemption from environmental licensing has stimulated the expansion of aquaculture, but also shows weaknesses in the regularization and inspection of enterprises. The absence of adequate technical information and bureaucracy in accessing regularization are significant obstacles. In this way, the study highlights the need to improve public policies, expanding technical training and the dissemination of regulatory information to ensure the sustainability of aquaculture in the state. The implementation of strategic measures, such as incentives for environmental regularization and optimization of the process of granting water resources, is essential for the consolidation of the sector and the mitigation of environmental impacts.

Keywords: Aquaculture in Pará. Aquaculture Environmental Licensing. Sustainable development. Aquaculture Regulation. Public Policies in Aquaculture in Pará.

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INTRODUCTION

Aquaculture has been consolidated as the fastest growing sector in animal protein production in Brazil, registering an average annual increase of 8% between 2004 and 2014, surpassing cattle farming (5.1%), poultry farming (4.1%) and pig farming (2.9%) (KUBITZA, 2015). The sector plays a crucial role in food security, socioeconomic development, and the diversification of the national productive matrix, contributing significantly to the generation of employment and income. Brazil produced about 887,029 tons of fish in 2024, consolidating itself as one of the main aquaculture producers in the world (PEIXE BR, 2024).

In the national context, the state of Pará stands out for its expressive vocation for continental aquaculture, favored by the climatic conditions and the vast availability of water resources, which allow the exploration of freshwater and marine waters in practically all of its 144 municipalities (LEE & SARPEDONTI, 2008). However, despite the high productive potential, aquaculture in Pará is still characterized by small-scale enterprises, which operate predominantly in the domestic market and face regulatory and structural challenges that limit their expansion.

Environmental licensing is one of the main management instruments to ensure the sustainability of aquaculture activity. Regulated by CONAMA Resolution No. 413/2009, this process classifies aquaculture enterprises into nine categories according to their potential environmental impact, determining the requirements for obtaining the license (BRASIL, 2009). In addition, Federal Law No. 6,938/1981 instituted the National Environmental Policy, establishing licensing as an essential administrative procedure for the location, installation, expansion and operation of activities that use environmental resources and that may generate significant impacts (BRASIL, 1981).

In Pará, the State Secretariat for the Environment and Sustainability (SEMAS) is responsible for the inspection and issuance of environmental licenses, following the guidelines of CONAMA Resolution No. 237/1997, which assigns the competence of licensing to the state, federal or municipal agency according to the scope of environmental impacts (BRASIL, 1997). Although the legislation allows the exemption of licensing for small enterprises, there are still challenges in the regularization of many producers, either due to the lack of technical information or the fear of taxation, which generates a scenario of informality and uncertainty for the sector.

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Brazilian aquaculture reflects a global phenomenon in which aquaculture production has become essential to meet the growing demand for fish, since fishing catch has remained stable since the 1980s, with a global production of approximately 90 million tons per year (FAO, 2020). In 2019, aquaculture accounted for 85.3 million tons of world fish, which represents 47.9% of total production and generated a global revenue of US$ 259.5 billion (FAO, 2020). The major aquaculture producers are Asian countries, such as China, India, Indonesia, and Vietnam, while in the West, Brazil and Chile stand out due to continental and marine production, respectively.

In Brazil, aquaculture has maintained continuous growth, reaching an estimated production of 1.6 million tons in 2021, representing approximately 50% of the total fish supply in the country (VALENTI et al., 2021). Fish farming, shrimp farming and malacoculture are the main national aquaculture segments, with emphasis on the production of tilapia and tambaqui. Recent data from the IBGE (2022) indicate that, despite the growth, there are discrepancies in the statistics between official estimates and the numbers reported by industry associations, such as Peixe BR, which point to a significantly higher production than government data.

In the North region, aquaculture has benefited from climatic conditions and great water availability, which favors an accelerated growth in production. States such as Rondônia, Pará, and Roraima lead aquaculture production in the region (IBGE, 2022). In the specific case of Pará, aquaculture activity dates back to the 1930s, when the first records of fish farming were made by the Emílio Goeldi Museum of Pará. In the 1970s, marine shrimp farming began its expansion with the construction of the first nursery excavated in Curuçá, where native species of marine shrimp were cultivated (LEE; SARPEDONTI, 2008).

Aquaculture regulation in Pará has evolved to keep up with the growth of the sector. Law No. 10,306/2023 establishes guidelines for state environmental licensing, defining the criteria for authorization and control of activities that use natural resources and may cause environmental impacts (SEMAS, 2023). The State has also implemented digital tools to optimize the licensing process, such as the Municipal Environmental Licensing System (SISLAM), which allows the management and issuance of environmental licenses by electronic means, reducing bureaucracy and improving the inspection of projects (SEMAS, 2023).

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In this context, this study aims to carry out a survey of aquaculture areas in the state of Pará, with emphasis on small enterprises and the impact of environmental licensing on the expansion of the sector. Specifically, it seeks to identify the spatial distribution of the production units, evaluate the situation of the enterprises exempt from licensing and analyze the challenges faced by producers in environmental regularization. The study is based on the collection and analysis of SEMAS data, using georeferencing tools, such as ArcGIS, to map the aquaculture areas of the state.

The relevance of this study lies in its contribution to the formulation of public policies that promote a balance between economic growth and environmental conservation. The regularization of the aquaculture sector in Pará can boost the competitiveness of local producers and expand the supply of sustainable fish, meeting the growing demands of the market. Thus, the study is justified by the need to deepen the knowledge about environmental licensing in Pará aquaculture, providing technical and scientific subsidies for the improvement of regulations and development strategies in the sector.

METHODOLOGY

The present research adopted an exploratory and descriptive approach, using geospatial analysis and documentary review to map small aquaculture enterprises in the state of Pará, with emphasis on those that are exempt from environmental licensing. To this end, secondary data from institutional databases, environmental legislation and georeferencing tools were collected and analyzed. The methodology was structured in five main stages: data collection, elaboration of the geospatial map, analysis of the granting of water resources, survey of the applicable legislation and bibliographic review.

LOCATION OF RESEARCH AND DATA COLLECTION

The study was conducted in the 144 municipalities of the state of Pará, in the northern region of Brazil, with the objective of identifying and mapping small-scale aquaculture enterprises, framed in the exemption from environmental licensing. Data collection was carried out through information made available by the State Secretariat for the Environment and Sustainability (SEMAS-PA), accessed in person at the Department of Fisheries and Aquaculture Management (GEFAP) and online, through the SEMAS Transparency Portal.

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The database used comprised updated administrative records for the first half of 2024, including information on geographic location (latitude and longitude), size of enterprises (up to 5 hectares), cadastral status (active or inactive), in addition to historical records of environmental grants and licensing. To ensure greater accuracy of the data, inconsistencies were found in the information base, cross-referencing with other government sources and previous records.

ELABORATION OF THE GEOSPATIAL MAP

The elaboration of the geospatial map of aquaculture enterprises was carried out using the ArcGIS software, which allows spatial analysis and cartographic visualization of environmental data. Initially, the collected data was converted to compatible formats, such as shapefiles (.shp) and geodatabase files (.gdb), facilitating its integration into the system. Inputs from the Integrated Environmental Monitoring and Licensing System (SIMLAM), made available by SEMAS, which provides detailed information on areas subject to environmental licensing, were used. The cartographic methodology included the import of geographic coordinates of the identified projects, the demarcation of the projects on the geospatial map of the state of Pará, the overlapping of layers of environmental information, including hydrography, protected areas and specific zoning, in addition to the generation of graphic models for the comparative analysis of the distribution of the projects and their relationship with areas of ecological interest.

ANALYSIS OF THE GRANTING OF WATER RESOURCES

Water use is a determining factor for the sustainability of aquaculture, requiring specific regulation to ensure the preservation of water resources. In this study, the criteria and requirements for obtaining the water use permit in the state of Pará were analyzed, as established by the State Decree and SEMAS-PA regulations. The analysis followed steps that included the identification of the current legislation on the granting of water resources in the state, the survey of the technical and documentary requirements necessary for the granting of the grant, the analysis of the challenges faced by aquaculture producers in obtaining regularization and the mapping of water availability in the production areas. The information was obtained through direct consultation of environmental legislation and interviews with experts and regulatory agencies, allowing a detailed view of the procedures required for the regularization of water use in small-scale aquaculture.

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SURVEY OF THE LEGISLATION APPLICABLE TO SMALL-SCALE AQUACULTURE

The environmental regulation of small-scale aquaculture in Pará follows a set of regulations that involve federal, state and municipal spheres. To ensure a complete analysis, a detailed survey of applicable legislation was carried out, including federal legislation such as the Water Law, CONAMA Resolution No. 237/1997 and CONAMA Resolution No. 413/2009, state legislation such as Law No. 10,306/2023, SEMAS-PA regulations and regulations on environmental licensing and use of water resources, in addition to municipal rules that establish specific guidelines for the regulation of local aquaculture. The analysis of these regulations made it possible to describe in detail the process of exemption from environmental licensing for small-scale aquaculture enterprises, as well as the main challenges faced by producers to remain regularized. In addition, possible legal gaps and opportunities to improve public policies aimed at the aquaculture sector in Pará were identified.

RESEARCH METHODS

The present study used qualitative and quantitative methods, combining documentary, geospatial analysis and literature review. The methodology was structured in stages that included a literature review through the analysis of books, scientific articles, theses and dissertations related to aquaculture, environmental licensing and sustainability, in addition to consulting institutional documents and technical reports from environmental agencies. Documentary research was also carried out, with a survey of institutional databases (SEMAS, IBGE, FAO, PEIXE BR) and extraction and cross-referencing of information on aquaculture production, environmental licensing and public policies. The geospatial analysis used GIS tools (ArcGIS) for mapping the aquaculture areas and evaluating the geographic dispersion of the projects in the state of Pará.

The structuring of the methodology of this study was developed in order to provide a comprehensive and rigorous analysis of the environmental licensing of aquaculture in Pará. The combination of document analysis, literature review and georeferencing allowed a detailed mapping of aquaculture activity in the state, providing subsidies for future discussions on sustainability, public policies and environmental impacts of small-scale aquaculture.

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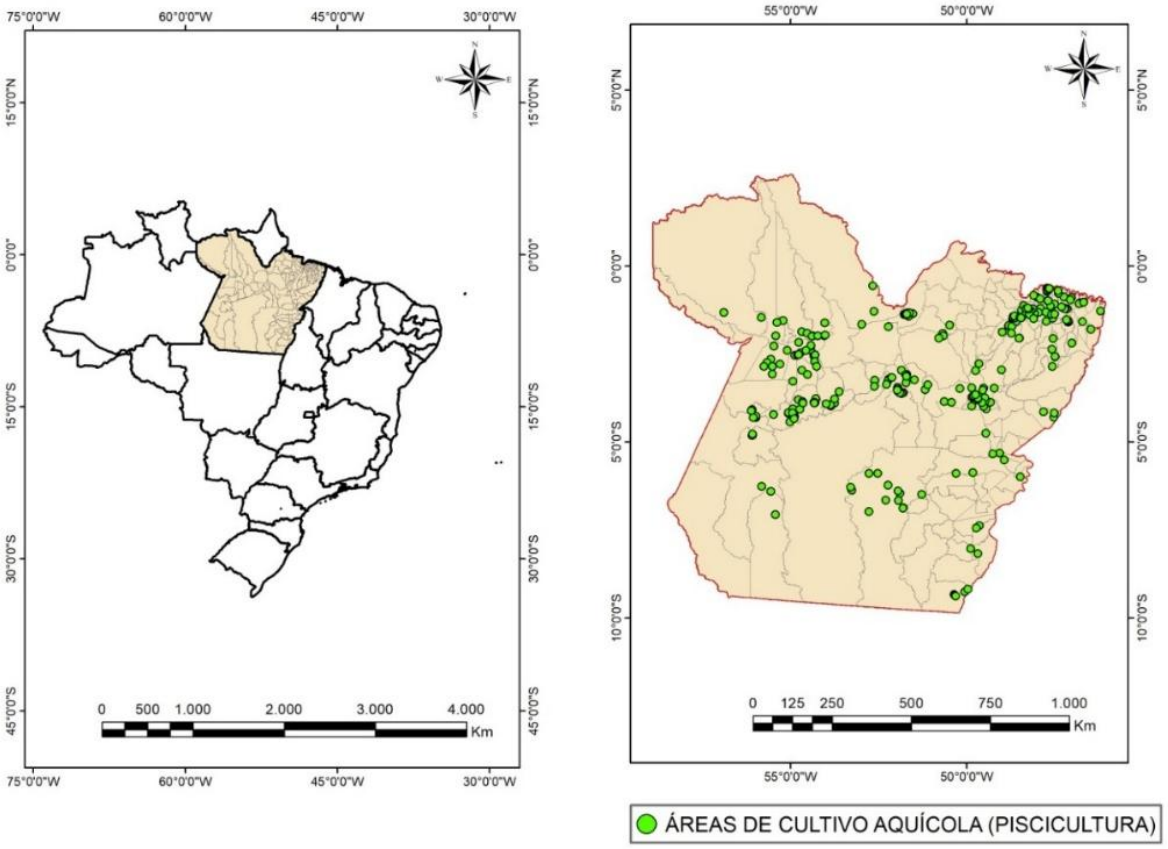
RESULTS

The survey of aquaculture enterprises in the state of Pará revealed that more than 90% of aquaculture enterprises have less than 2 hectares of water depth, characterizing them as small (LEE & SARPEDONTI, 2008). The analysis carried out through the records of the State Secretariat for the Environment and Sustainability (SEMAS) identified 364 aquaculture enterprises that fall under the exemption from environmental licensing. For a better visualization, Figure 1 presents the map of the geographic location of the regularized enterprises in the state of Pará.

Map of the geographical location of regularized small-scale aquaculture cultivation areas.



Source: Authors

The geospatial analysis showed that some municipalities concentrate a significantly higher number of aquaculture enterprises, indicating the importance of the activity for the local economy. To detail this distribution, Figure 2 illustrates the 10 municipalities with the highest number of regularized aquaculture enterprises.

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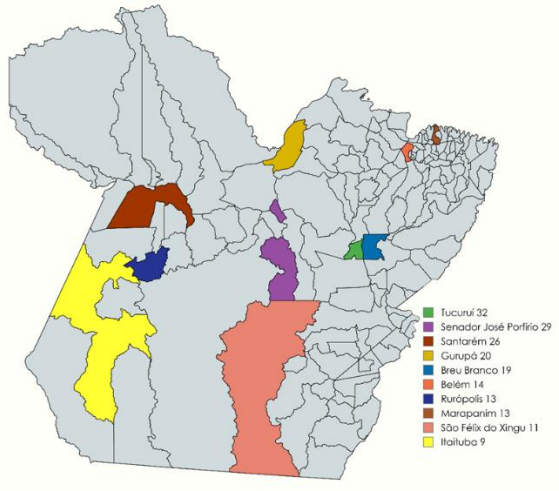
Map of the municipalities that have the largest number of enterprises with active licensing exemption.



Source: Authors

The data showed that the municipality with the highest number of regularized aquaculture enterprises is Tucuruí, with 32 enterprises. The presence of the Tucuruí Hydroelectric Power Plant contributes to the high availability of water resources, favoring aquaculture. Next, Senador José Porfírio, with 29 enterprises, and Santarém, with 26, both benefiting from favorable geographical characteristics and local policies to encourage aquaculture, stand out. Gurupá appears with 20 projects, reinforcing the importance of the hydrographic network in structuring the activity in the state.

Other municipalities relevant to aquaculture activity include Breu Branco (19 enterprises), Belém (14), Rurópolis (13), Marapanim (13), São Félix do Xingu (11) and Itaituba (9). Figure 3 shows a graph with the percentage of regularized aquaculture enterprises in the main municipalities of Pará.

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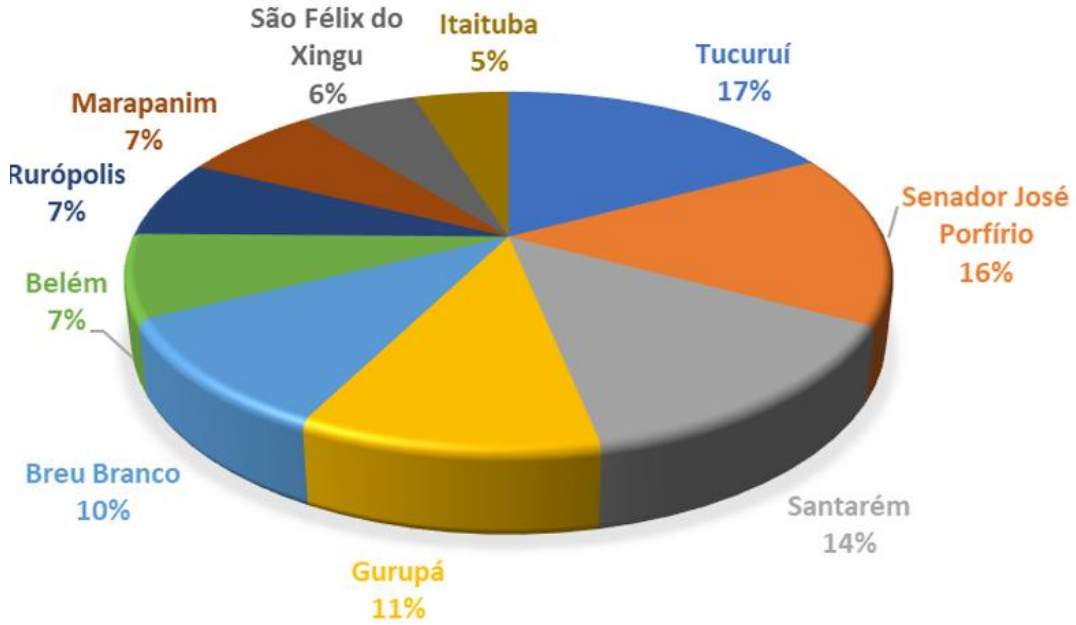
Graph of the percentage of municipalities with the highest number of regularized aquaculture enterprises with active licensing exemption in the state of Pará.



Source: Authors

In addition to the active projects, 15 projects were identified with inactive licensing waivers. The main factors associated with downtime include economic hardship, logistical challenges, and changes in local regulations. The distribution of these inactive enterprises is shown in Figure 4, highlighting Gurupá as the municipality with the highest number of inactive enterprises (4). Other affected municipalities include Belém (2), Breu Branco (1), São Félix do Xingu (1), Mãe do Rio (1), Alenquer (1), Bragança (1), Placas (1), Anapu (1), Tucuruí (1) and Uruará (1).

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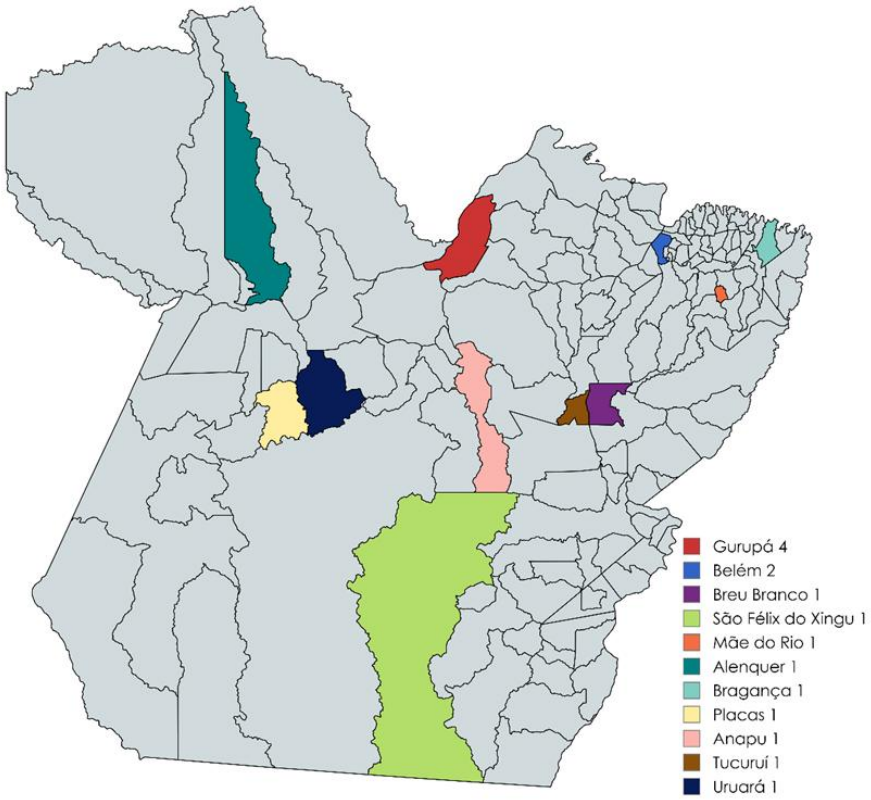
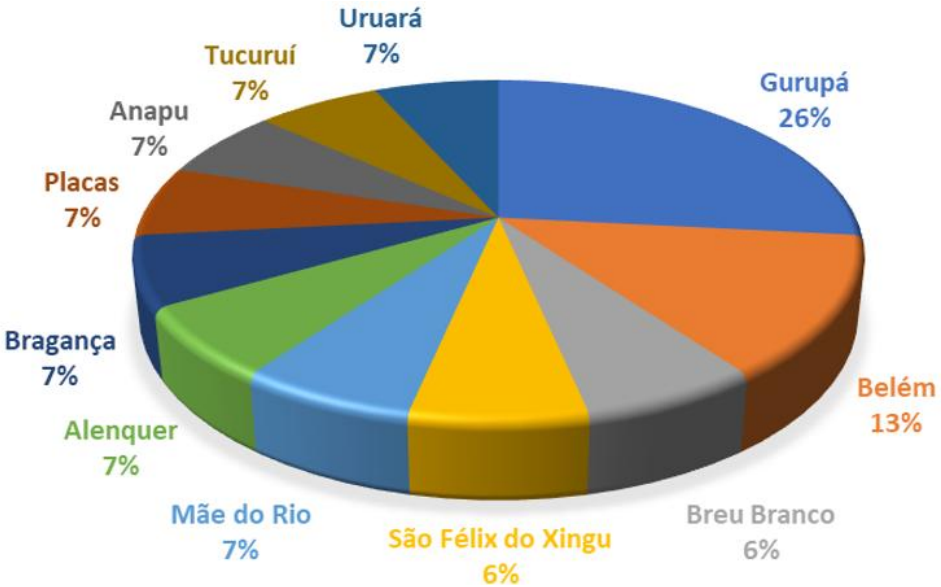
Map of municipalities that have enterprises with inactive licensing waiver.



Source: Authors

The percentage ratio of inactive enterprises by municipality is shown in Figure 5, showing the challenges faced by each locality to keep their aquaculture activities in operation.

Graph of the percentage of municipalities with inactive aquaculture enterprises with the exemption from licensing.



Source: Authors

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The data indicate that the exemption from environmental licensing has been a crucial factor for the expansion of aquaculture in Pará, allowing the formalization and operation of small entrepreneurs. However, the existence of inactive enterprises demonstrates that regularization is not enough to guarantee the continuity of activities, and technical and financial support is needed to strengthen the sector.

DISCUSSION

Aquaculture in the state of Pará stands out for its significant concentration of small-scale enterprises, with more than 90% having less than 2 hectares of water depth (LEE & SARPEDONTI, 2008). This scenario reinforces the relevance of the activity in the regional economy and the need for public policies aimed at environmental regulation and strengthening the sector. The identification of 364 regularized aquaculture enterprises shows that the exemption from environmental licensing has been a fundamental mechanism for the formalization and growth of aquaculture in the state.

The growth of aquaculture in Pará is compatible with what is happening at the national level. According to Peixe BR (2024), Brazil has registered a continuous increase in aquaculture production, consolidating itself as one of the world's leading producers of fish. This panorama confirms the importance of the activity, but also points out challenges, such as the need for environmental regularization and technical support for small producers. However, Costa and Costa (2022) point out that state legislation is more rigid than federal legislation, creating barriers to the regularization and formalization of aquaculture in the state. This regulatory misalignment harms small producers, making it difficult to access credit and making investments in the sector unfeasible.

The data from this study indicate that the highest concentration of regularized aquaculture enterprises is in the municipalities of Tucuruí (32), Senador José Porfírio (29) and Santarém (26), while Gurupá stands out with 20 enterprises. These results corroborate the analyses of Lee & Sarpedonti (2008), which already pointed to the favorable geographical distribution of aquaculture in Pará due to water availability and appropriate climatic conditions. In addition, Da Silva et al. (2024) point out that family aquaculture in Marajó and Northeast Pará is mainly characterized by low-tech production systems, in which limited infrastructure and restricted access to technical assistance directly influence the sustainability and productivity of the activity. These factors may justify the greater concentration of enterprises in places where there is institutional support and more

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adequate infrastructure, favoring the regularization and permanence of aquaculture farmers in the sector.

Another essential factor for the maintenance and expansion of aquaculture in the state is access to rural credit, which is essential for the modernization of enterprises and improvement of production conditions. According to Araújo et al. (2015), between 2000 and 2010, only 0.93% of the resources of the Constitutional Fund for Financing of the North (FNO) allocated to the agricultural sector were invested in aquaculture in Pará, evidencing the low financial incentive available to aquaculture producers. The difficult access to credit, associated with the bureaucracy to obtain environmental licensing, compromises the sustainable expansion of the activity, making it difficult to invest in infrastructure, purchase inputs and access to technologies.

The absence of financial support directly impacts the productive structure of small aquaculture farmers, as demonstrated by Zacardi et al. (2017), who analyzed urban aquaculture in Santarém. The study identified that most producers operate in extensive systems, with low technology and family labor, using the activity as an income supplement. The lack of technical assistance and knowledge about financial management were also pointed out as challenges for the development of the sector. These factors reinforce the need for public policies that facilitate access to credit and promote technical training to ensure the sustainability of aquaculture in the state of Pará.

Despite the advancement of aquaculture formalization, there are significant challenges, especially in relation to inactive enterprises. 15 projects were identified with inactive environmental licensing waiver, indicating structural and economic difficulties. Almeida (2010) highlights that technical training and access to technologies are determining factors for the sustainability of the sector. The lack of information on regularization and financial incentives may be one of the factors that contribute to the inactivity of part of the enterprises. In addition, Costa (2022) reinforces that bureaucracy and the high costs of environmental licensing are limiting factors for the continuity of aquaculture activities, especially for small producers who do not have specialized technical support.

The relationship between exemption from environmental licensing and environmental impacts also deserves attention. According to Capez (2019), the absence of strict regulation can lead to adverse environmental impacts, if compensatory measures and sustainable practices are not adopted. This concern is shared by Moraes (2020), who

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suggests the need for continuous monitoring and adoption of preventive policies to avoid the degradation of natural resources. In the context of family aquaculture, Da Silva et al. (2024) point out that informality in the sector often prevents the adoption of good management practices and limits the sustainable development of the activity.

Another essential factor for the sustainability of the activity is the granting of the right to use water resources, a regulatory instrument that ensures balance in the use of water. According to Federal Law No. 9,433/97, the grant aims to guarantee the multiple use of water and avoid conflicts between users. In Pará, the process of applying for the grant is regulated by the State Secretariat for the Environment and Sustainability (SEMAS), being an indispensable requirement for the regular operation of aquaculture enterprises. However, as observed by Costa (2022), the lack of clarity in the concession criteria and the delay in analyzing the processes are obstacles that make it difficult for small producers to adhere to this regulation.

The survey also indicates that, despite the ease provided by SEMAS's Integrated Environmental Monitoring and Licensing System (SIMLAM), many small producers still face difficulties in the regularization process. The efficiency of the system is directly linked to the training of users and the continuous support of environmental agencies. In this sense, Costa and Costa (2022) argue that the digitalization of environmental licensing processes represents an advance, but warn that the digital exclusion of small producers can be an obstacle to the regularization of aquaculture in the state.

Based on the results obtained, it is possible to say that the exemption from environmental licensing has been a determining factor for the expansion of aquaculture in Pará, allowing small producers to regularize their activities and contribute to the development of the sector. However, challenges related to the lack of technical information, access to financing and sustainable environmental management still need to be addressed to ensure the continued growth of the activity.

CONCLUSION

The analysis of the geographical distribution of aquaculture enterprises in the state of Pará revealed that most of the production units are located in municipalities with easy access to water bodies, basic infrastructure and local technical support. This pattern of concentration demonstrates that aquaculture is a relevant economic activity in these regions, where the exemption from environmental licensing has allowed small producers to

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enter and remain in the sector, encouraging the formalization of the activity and the growth of aquaculture production in the state. This reality demonstrates not only the expansion of the sector, but also the need for efficient management to ensure that growth occurs in a sustainable way, respecting environmental regulations and promoting productive inclusion.

Environmental regularization has proven to be a determining factor in strengthening aquaculture, providing legal certainty to producers and encouraging the adoption of more sustainable practices. However, the challenges faced by small fish farmers, such as limited access to technical training and information on environmental regulations, reinforce the need for continuous public policies and institutional support. Investments in specialized training and technical assistance are essential for producers to be able to adapt to legal requirements and optimize their production responsibly.

The granting of the right to use water resources has emerged as an essential instrument to ensure the rational use of water and avoid conflicts between users. Its implementation, in accordance with the principles of the National Water Resources Policy (Federal Law No. 9,433/97), plays a crucial role in regulating the capture and use of water resources, ensuring a balance between environmental preservation and the growth of aquaculture. The research revealed that the environmental licensing platform of the State Secretariat for the Environment and Sustainability (SEMAS) of Pará has been an efficient tool, but its full use depends on the training of users and continuous support by the regulatory agency.

The results obtained reinforce that the exemption from environmental licensing for small enterprises has been a facilitating mechanism for the formalization and expansion of the aquaculture sector. However, for this strategy to be sustainable in the long term, it is necessary for producers to have access to technical information, financial incentives and government support. The inclusion of small aquaculture farmers in environmental regularization programs must be accompanied by incentives for innovation and the promotion of technologies that optimize production, ensuring lower environmental impact and greater production efficiency.

In view of the scarcity of in-depth studies on the reality of aquaculture in Pará and its relationship with environmental licensing, this work contributes significantly to the understanding of the theme, offering subsidies for future research and formulation of more effective public policies. The continuity of investigations on the challenges faced by small aquaculture farmers, combined with the search for solutions to optimize environmental

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regularization and the sustainable use of water resources, will be essential to consolidate aquaculture as a strategic sector for economic and environmentally responsible development in Brazil.

Finally, this study highlights the need for greater integration between regulatory agencies, the productive sector and research institutions, with a view to creating mechanisms that promote the professionalization of aquaculture and increase its competitiveness in the market. The strengthening of the sector involves encouraging technical training, disseminating information on good management practices and formulating public policies that ensure the sustainability of the activity. In this way, aquaculture in the state of Pará can consolidate itself as an efficient, sustainable production model in line with contemporary environmental and socioeconomic requirements.

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REFERENCES

1. Almeida, C. (2010). Capacitação técnica e acesso a tecnologias na aquicultura. Revista Brasileira de Aquicultura, 12, 34–45.

2. Araújo, J. G. de, Santos, M. A. S., Rebello, F. K., Oliveira, C. M., & Costa, A. D. (2015). Crédito rural para aquicultura: Uma análise do Fundo Constitucional de Financiamento do Norte no estado do Pará. Revista Eletrônica em Gestão, Educação e Tecnologia Ambiental, 19(3), 553–562. https://doi.org/10.5902/2236117018996

3. Brasil. (1981). Lei Federal nº 6.938, de 31 de agosto de 1981. Dispõe sobre a Política Nacional do Meio Ambiente.

4. Brasil. (1997). Resolução CONAMA nº 237, de 19 de dezembro de 1997. Dispõe sobre o licenciamento ambiental.

5. Brasil. (2009). Resolução CONAMA nº 413, de 26 de junho de 2009. Dispõe sobre o licenciamento ambiental da aquicultura.

6. Capez, F. (2019). O impacto da legislação ambiental sobre o desenvolvimento sustentável. Revista de Direito Ambiental, 23, 45–67.

7. Costa, R. (2022). O marco regulatório da aquicultura e sua influência sobre o desenvolvimento da atividade no estado do Pará. Revista Brasileira de Meio Ambiente, 18, 22–35.

8. Costa, R., & Costa, A. (2022). Legislação e aquicultura no estado do Pará. Revista de Gestão Ambiental e Sustentabilidade, 15, 89–104.

9. Da Silva, P. R., Almeida, C. M., & Santos, F. (2024). Caracterización de la acuicultura familiar en las mesorregiones Marajó y paraense noreste. Revista Ibero-Americana de Aquicultura, 25(3), 55–72.

10. Food and Agriculture Organization of the United Nations. (2020). Fishery and aquaculture statistics 2018: Meeting the sustainable development goals. FAO.

11. Instituto Brasileiro de Geografia e Estatística. (2021). Panorama da aquicultura. https://panoramadaaquicultura.com.br/wp-content/uploads/2022/11/Screen-Shot-2022-11-16-at-11.25.03-PM-768x425.png

12. Kubitza, F. (2015). Aquicultura no Brasil: Principais espécies, áreas de cultivo, rações, fatores limitantes e desafios. Panorama da Aquicultura, 150, 10–23.

13. Lee, J., & Sarpedonti, V. (2008). Diagnóstico, tendência, potencial e políticas públicas para o desenvolvimento da aquicultura. In Diagnóstico da pesca e da aquicultura no Estado do Pará. Universidade Federal do Pará / Núcleo de Altos Estudos Amazônicos.

14. Moraes, J. (2020). A importância das medidas compensatórias no licenciamento ambiental. Revista Brasileira de Meio Ambiente, 15, 55–70.

15. Peixe BR. (2024). Anuário da piscicultura brasileira 2024. Associação Brasileira da Piscicultura. https://www.peixebr.com.br/anuario-2024/

16. Secretaria Estadual de Meio Ambiente e Sustentabilidade. (2023). Lei nº 10.306, de 2023. Governo do Estado do Pará. https://www.semas.pa.gov.br/legislacao/img/ods14.png

17. Valenti, W. C., et al. (2021). Panorama da aquicultura. Panorama da Aquicultura, 30(182).

18. Zacardi, D. M., Lima, M. A. S. de, Nascimento, M. M., & Zanetti, C. R. M. (2017). Caracterização socioeconômica e produtiva da aquicultura desenvolvida em Santarém, Pará. Acta of Fisheries and Aquatic Resources, 5(3), 102–112. https://doi.org/10.2312/ActaFish.2017.5.3.102-112