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IMPACTS OF THE FLOOD ON LAKE ITAPARICA: SOCIO-ENVIRONMENTAL TRANSFORMATIONS AND GENDER CHALLENGES IN FARM VILLAGES IN PETROLÂNDIA-PERNAMBUCO

Impactos da inundação no lago de Itaparica: Transformações socioambientais e os desafios de gênero nas agrovilas em Petrolândia - Pernambuco

Impactos de la inundación en el lago de Itaparica: transformaciones socioambientales y desafíos de género en aldeas agrícolas de Petrolândia – Pernambuco

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ABSTRACT

The forced relocation caused by major development projects unequally affects men and women's access to land. In the lower-middle region of São Francisco, some municipalities were impacted by the construction of the Luiz Gonzaga Hydroelectric Power Plant, and the municipality of Petrolândia had its population relocated to new areas. The socio-environmental impacts of the flooding of Lake Itaparica on women head of their households were analyzed, considering gender inequalities and access to land in Petrolândia. Therefore, an exploratory and descriptive approach was adopted through documentary analysis, census data to understand the processes of forced migration that occurred in the area, and also using Landsat 8 satellite images to understand the changes in land use and land cover before and after the flooding. Thus, it was observed that in rural areas there is a predominance of the male population due to the land distribution that occurred at the beginning of the migration, and that even with all these changes, women fought for dignified conditions in the urban area and currently have higher literacy rates in the municipality. Through the temporal analysis of land use and cover, a decrease in vegetated areas was verified for the implementation of irrigated perimeters, which contributed to the increase in levels of environmental degradation.

Keywords: Access to Land; Forced Migration; Gender Inequality; Public Policies.

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RESUMO

A realocação forçada por grandes empreendimentos impacta desigualmente homens e mulheres no acesso à terra. Na região do submédio do São Francisco, alguns municípios foram impactados com a construção da Usina Hidrelétrica Luiz Gonzaga e o município de Petrolândia teve sua população realocada para novas áreas. Analisou-se os impactos socioambientais da inundação do Lago de Itaparica sobre famílias chefiadas por mulheres, considerando desigualdades de gênero e acesso à terra em Petrolândia. Assim, adotou-se uma abordagem exploratória e descritiva através de análises documentais, dados censitários para compreensão dos processos de migração compulsória que ocorreu no local e também utilizou-se imagens do satélite Landsat 8, para a compreensão das mudanças ocorridas no uso e cobertura da terra antes e após a inundação. Com isso, observou-se que nas áreas rurais ocorre a predominância da população masculina, devido a distribuição de terras que ocorreu no início do translado, e que mesmo com todas essas mudanças as mulheres lutaram por condições dignas na zona urbana e possuem atualmente maiores taxas de alfabetização no município. Através da análise temporal do uso e cobertura, verificou-se a diminuição de áreas vegetadas para implementação dos perímetros irrigados, o que contribuiu para o aumento dos níveis de degradação ambiental.

Palavras-chave: Acesso à Terra; Desigualdade de gênero; Migração Forçada; Políticas Públicas.

RESUMEN

La reubicación forzada por grandes emprendimientos afecta de manera desigual el acceso a la tierra de hombres y mujeres. En la región centro-baja del condado de São Francisco, algunos municipios se vieron afectados por la construcción de la central hidroeléctrica Luiz Gonzaga, y la población del municipio de Petrolândia fue reubicada en nuevas áreas. Se analizaron los impactos socioambientales de la inundación del Lago de Itaparica sobre las familias encabezadas por mujeres, considerando las desigualdades de género y el acceso a la tierra en Petrolândia. Para ello, se adoptó un enfoque exploratorio y descriptivo mediante el análisis documental y datos censales para comprender los procesos de migración forzada ocurridos en la zona, así como el uso de imágenes satelitales Landsat 8 para comprender los cambios en el uso y la cobertura del suelo antes y después de la inundación. Así, se observó que en las zonas rurales predomina la población masculina, debido a la distribución de la tierra que se produjo al inicio de la migración, y que, a pesar de todos estos cambios, las mujeres lucharon por condiciones dignas en la zona urbana y actualmente presentan mayores índices de alfabetización en el municipio. Mediante el análisis temporal del uso y la cobertura del suelo, se verificó una disminución de las áreas vegetadas debido a la implementación de perímetros de riego, lo cual contribuyó al aumento de los niveles de degradación ambiental.

Palabras clave: Acceso a la Tierra; Desigualdad de Género; Migración Forzada; Políticas Públicas.

1 INTRODUCTION

The public policies directed to the Brazilian rural environment have come to incorporate the gender perspective, seeking to improve the quality of life for country women and reduce the inequalities to access to land, credit and infrastructure (Farah, 2004; Cinelli, 2013). However, in some semiarid municipalities, as in Petrolândia-PE, these policies have

faced structural challenges arising from the forced relocation processes, deeply transforming the socioeconomic and gender dynamics in these communities.

Between 1986 and 1987, the construction of the Luiz Gonzaga Hydroelectric Power Plant demanded the compulsory relocation of Petrolândias population, as much in the urban areas as in the rural ones, to allow the formation of Lake Itaparica. As part of the resettlement process, the State committed itself to provide plots of land proportional to the families work force and implement a new irrigation system, as well as offer housing in farm villages or in the new reconstructed city (Scott, 2009). However, the distribution of these lands and the implementation of the irrigated perimeters occurred in an uneven way, especially impacting the women head of their households.

The transition to the new intensive agricultural model in the farm villages showed significant challenges. The delay on the installation of the irrigation systems made it that, in the first years after the relocation, many families depended exclusively on the Temporary Maintenance Budget (VMT) to subsist (Melo, Arruda, Sobral, 2015; Mendonça et al., 2023). Besides that, the low fertility of the soil and the environmental degradation caused by the continuous use of the irrigation systems directly affected the economic sustainability of the resettled families (Araújo, 2017). This scenario aggravated the difficulties faced by women in the access to the production resources and in the participation of the agricultural sector, given that, in many cases, the land plots were mostly destined to men, reinforcing social and economic exclusion patterns (Scott, 2009; Carvalho, 2009).

Although there are studies about the socioeconomic impacts of the relocation in Petrolândia (Scott, 2009; Santos, 2019), there are still gaps in the literature about the specific difficulties of the women head of the household in the redistribution of the lands and the agricultural work dynamics after the resettlement. Researches point that the forced migration resulted in a larger concentration of women in the urban area, where they sought income alternatives in commerce and service sectors (Cinelli, 2013). At the same time, the invisibilization of the female work in the farm villages persisted, especially in the planting activities in production gardens and in the care of small animals, that were before exclusively for the women and were incorporated by the men after the relocation (Scott, 2009).

Given this context, this paper has for its main objective to analyse the socioenvironmental transformations occurred by the flooding of Lake Itaparica and its impacts over the families leadered by women in the farm villages of Petrolândia, considering the gender inequalities, access to the land and the socioeconomic conditions after the resettlement.

To achieve this objective, the following specific objectives were established: identify the socioenvironmental and economic changes occurred in Petrolândia after the flood of Lake Itaparica and the creation of the farm villages; examine the way in which the redistribution of the lands and the resettlement process influenced the condition of the women head of their households; and discuss the gender inequalities observed in the productive organization and the access to resources in the rural and urban areas of the municipality.

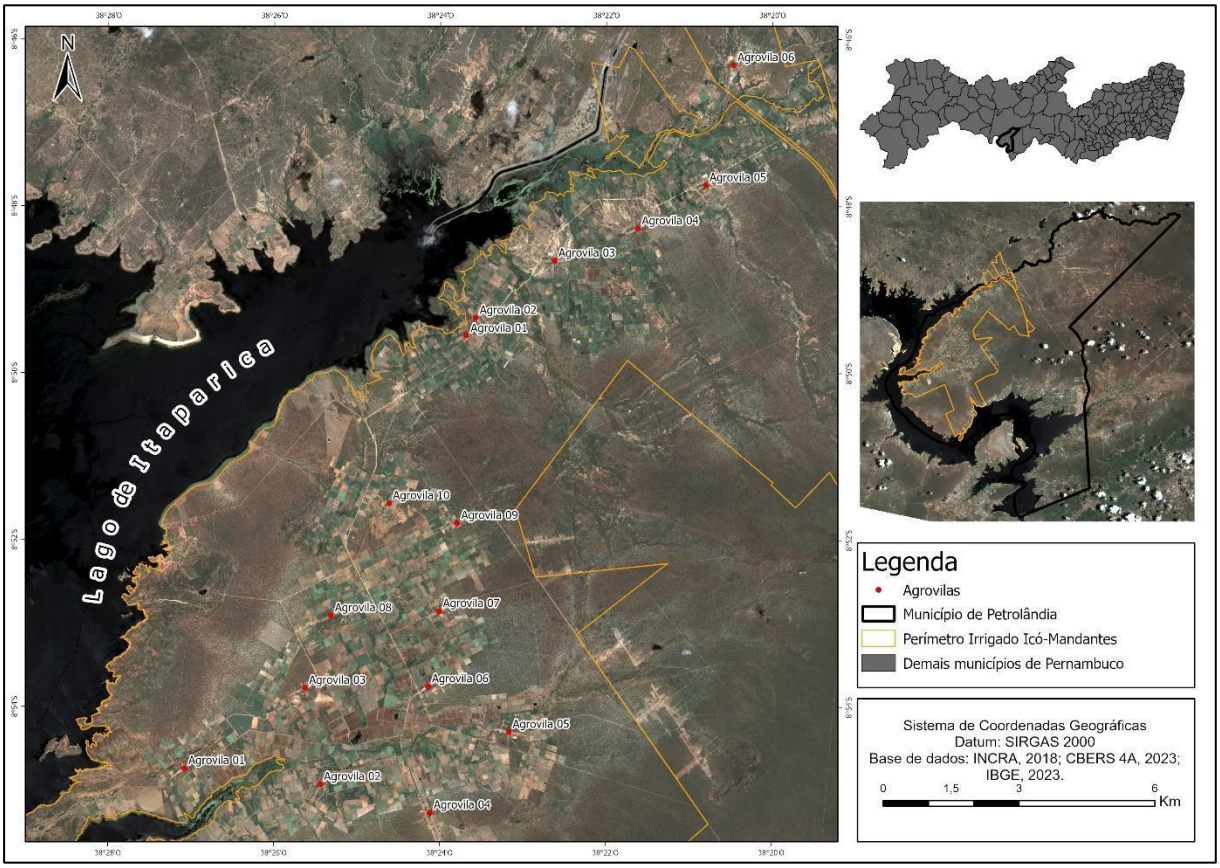
This way, the proposed objectives guide the analysis of the socioenvironmental transformations and the gender dynamics in the resettlement process in Petrolândia, articulating the social, economic and territorial dimensions discussed in the following sections.

2 MATERIALS AND METHODS

For this paper, an exploratory and descriptive approach has been adopted, combining documental analysis, census data collection, remote sensing and bibliographic revision. The choice of this approach is justified by the necessity to comprehend the socioenvironmental impacts of the forced relocation in Petrolândia, with special attention to the gender dynamics and the access to the land by the resettled women (Farah, 2004; Cinelli, 2013).

The research was conducted in the municipality of Petrolândia, Pernambuco, with focus on the irrigated perimeter of Icó-Mandantes and the resettlement blocks of the farm villages of Icó-Mandantes (Blocks 3 and 4), Barreiras (Block 1) and Apolônio Sales. These areas were selected based on three criteria: (i) representativity on the context of forced resettlement promoted by the construction of the Luiz Gonzaga Hydroelectric Power Plant, (ii) expressive presence of women head of households and (iii) direct impact of the irrigated perimeters over the local socioeconomic relations.

Image 01 – Location map of the Irrigated Perimeter of Icó-Mandantes - Pernambuco



Source: INCRA (2018), Authors (2024).

To analyse the impacts of the compulsory migration and the organization of the irrigated perimeters over the families headed by women, scientific articles, dissertations and thesis on forced resettlement and public policies in the semiarid context were analysed. The government reports, including documents from São Francisco and Parnaíba Valleys Development Company (CODEVASF), and studies on the Luiz Gonzaga Hydroelectric Power Plant impacts, were examined to contextualize the local socioeconomics transformations (Brasil, 2010).

The data from the demographic census of the Geography and Statistics Brazilian Institute (IBGE) in 1991, 2010 and 2022 was used to characterize the resettled female population, identifying urban-rural migration and vulnerability patterns. The variables analysed include distribution by gender, participation in the labor market, literacy levels and land access.

To examine changes in the usage and coverage of the land, were utilized satellite images from Landsat 8, processed in the Arcgis Pro software. A supervised classification of maximum verisimilitude was applied to identify the expansion of the irrigated perimeters

and degradation of the soil between 1985 and 2022 (Souza Jr., 2020). The data was integrated into the analysis to evaluate the transformations in the land use that occurred from the compulsory migration.

The census data was handled using descriptive statistics, seeking to identify vulnerability and migration patterns. The satellite images were analysed through supervised classification to detect changes in the land usage.

The results analysis was conducted through interpretative comparison between the demographic census of 1991 and 2010, which made possible the comprehension of the changes in the populational distribution and the gender dynamics in the municipality. The integration between census data, bibliographic revision and satellite images allowed the identification of relevant socioenvironmental patterns and tendencies, even without the graphic presentation of maps or tables, ensuring a descriptive and analytical reading of the transformations occurred between the rural and urban environments.

3 RESULTS AND DISCUSSION

The flooding of the Petrolândia municipality and the consequent relocation of the families resulted in the redistribution of the population between the urban and rural areas. The data from the 1991 and 2010 Demographic Census showed a significant change in the gender distribution between the urban rural spaces (Table 01).

Table 01 – Living population in the municipality of Petrolândia in 1991 and 2010.

Year	Gender	Rural	Urban
1991	Men	9.336	6.859
	Women	9.308	7.460
2010	Men	4.642	11.305
	Women	4.229	12.316

Source: Demographic Census (IBGE, 1991 and 2010)

It's been observed that after the resettlement, there was a significant growth of the female and male population in the urban centers, as a way of reconstruction of the local urban center, however in a broad way it also occurred a reduction of the population from the rural areas to the urban area between the years of 1991 and 2010, (Table 1). The significant reduction of the female population in the rural areas after the transfer, which is already

naturally smaller due to the work conditions offered, reduced even more as a result of the access to the land to this fraction of the population. This phenomenon can be explained by the fact that, due to the unequal distribution of the land and the agricultural plots, many of the women were excluded from the productive process and sought economic alternatives in the cities. Although the male population had remained numerically superior in the rural areas, its absolute contingent was reduced by half between 1991 and 2010.

According to Scott (2009), the women head of their households in that transfer represented a small fraction of the population. For the land plots receival criteria, it was necessary a specific amount of male and female children. Unlike the men head of their households, the land plots were calculated by work strength in the household, making him the receiver of a much superior part of agricultural land when equated to the women.

Given this context, in 1991 the new urban center in the municipality already showed better work and income conditions in the local markets and commerce. Throughout the years and with the improvement of the urban and educational infrastructure, the city came to be a welcoming place to the people who were invisibilized in the agricultural areas, with access to education for their children, and better opportunities of improvement in the quality of life of the women head of their households.

In the farm villages that had residences near the agricultural plots, small yards were built, as a way to expand the production process. However, after the displacement of the families, the irrigation systems were not installed in the plantations, making it difficult for the start of the production process mid 1988-1989. The families in the rural area were monthly compensated after the non installation of the irrigation systems with the Temporary Maintenance Budget (VMT), making it the only means of subsistence for the residents until the first harvest after the installation of the irrigation systems (Scott, 2009).

However, the farmers before the flooding, produced during the whole year at the margins of the river and the yards were exclusive responsibility of the women of the house. After the relocation, with the land plots not ready for production, the male residents occupied themselves with the production yards, which were also exclusively for the women, invisibilizing the work and the income that was obtained through the specific fruit growth and small animals, such as birds and goats. (Scott, 2009; Carvalho, 2009).

From Table 1 is possible to visualize the predominance of women in the urban centers since the period of the families relocation. Actively contributing in some social segments, as in schools, health centers, unions, making the people from this gender with

better opportunity and access to education, different from the people in the countryside, who sometimes need to take a long route to attend school daily (Scott, 2009).

The migration from the countryside to the city contributed to amplify the access to better work and education opportunities, especially within the resettled women, who came to have more presence in the urban centers and school spaces. This movement favored the increase of the female literacy rates in the municipality (Araújo, 2020).

On the other hand, in the rural areas, the truancy remained elevated. Many young boys left school prematurely to assist with the family income, which compromises the continuity of the schooling and maintains high illiteracy rates within the male population. This reality reflects the regional inequalities on the access to basic education and the structural limitations faced by the rural communities in the semiarid.

The exclusion of the women who live on the irrigated perimeters contributed to their economic vulnerability, leading to higher inequality in the access to work and education rates (Carvalho, 2009). Table 02 presents the literacy data by gender in the municipality, according to the Demographic Census of 2022.

Table 02 – Literacy rates in the municipality of Petrolândia

Literacy Rate		
	Men	**Women**
Literate	10.324	11.805
Illiterate	1.933	1.583

Source: Demographic Census (IBGE, 2022)

It is observed that the women show a slightly higher rate of literacy than the men (IBGE, 2022). However, despite this educational advancement, their insertion on the agricultural job market remained restricted, once that the ownership of the lands and the decision over the use of the plots were concentrated with the men. This pattern is similar to the one observed in studies on the rural resettlements in other parts of Brazil, in which the traditional work division limits the economic opportunities of the women in the production sector (Siliprandi, 2009; Santos, 2023).

In this context, the public policies have relevancy in fights over the female inclusion in agricultural sectors, as much in the reduction of the school dropout rates, as in becoming fundamental for the conduction of analysis facing the local and global contexts (Brasil, 2010;

Silva; Santos, 2023). It's worth noting that female empowerment in the rural environment doesn't restrict itself only to access in the formalization of rights, it also seeks strengthening in the autonomy of the production and organization processes (Siliprandi, 2009).

In the municipality of Petrolândia, one of the main struggle milestones along with the participation of the women, is the local union, that owns many important achievements since the relocation of the population, such as the VMT payment (Scott, 2009). However many challenges persist, such as the unequal redistribution of the production resources and also the cultural barriers that limit the full equity. For these obstacles to be overcome, some studies suggest the introduction of intersectional policies that equally respect gender, race and class (Brasil, 2010; Silva; Santos, 2019; Santos, 2023).

Since the beginning of the transfer, the union center had as one of its main fights the new lands appropriation process, defending the rights to the land and guaranteeing that a large part of the producers had their plots installed with irrigation systems. Making this institution directly responsible for intermediation on the negotiations between companies and farmers affected by the Itaparica constructions, having its headquarters located in Petrolândia until the current days (Scott, 2009).

In current times, the union seeks to perform an active role, collaborating in meetings with some federal government representatives, in search to find effective solutions for the challenges faced by the residents of the irrigated perimeters. In the same way, it sought out an elevated commitment to more sustainable implementations of production through solar power for the producers.

Araújo (2020), affirms that with the passage of the years and with the intensification of the inappropriate management of the soil, associated with the continuous usage and the poorly efficient fallow strategies, intensified the degradation process, limiting the agricultural production levels in the municipality. This way, it is emphasized by Araújo (2017), that the public policies should also be aimed at the recuperation of the soils fertility and technical training for a better understanding of sustainable practices, as the deforestation of new areas.

Additionally, alternatives such as agroecology can offer more sustainable and culturally diverse alternatives, reducing the usage of chemical inputs. According to Siliprandi (2009), agroecology shows positive results in sustainability and social empowerment, including the women in the improvement of these practices.

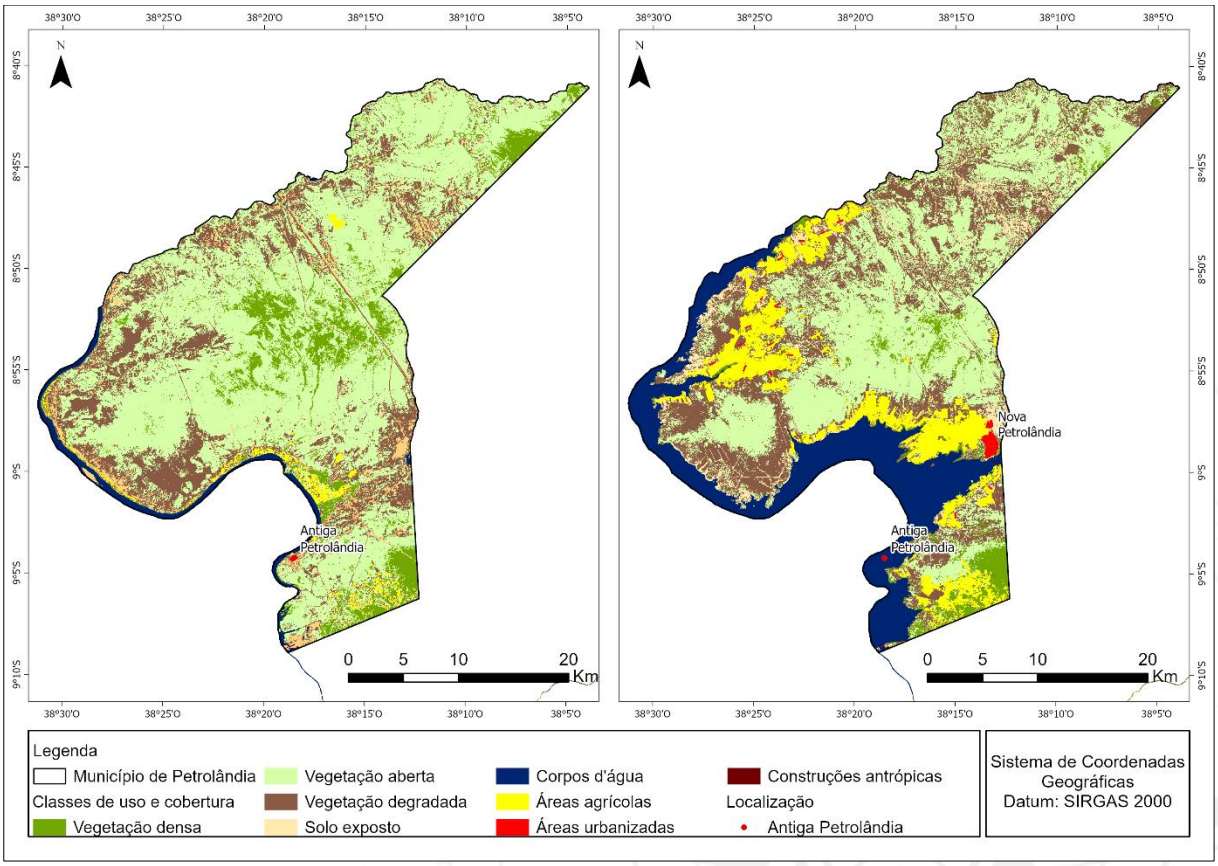
In the documentary "Earth is water: business of the semiarid" it is emphasized that, due to the high value of the fertilizers and the ongoing presence of pests in the plantations,

resulted in the sale of plots to producers with higher purchasing power and abandonment of the lands in locations with high levels of unproductivity (Araújo, 2020). The new owners, with more resources, invested in improvements through the use of fertilizers inaccessible to small producers.

The introduction of the irrigated perimeters boosted the local economy, turning Petrolândia into one of the main fruit production centers in the state. However, the intensification of the agricultural activity resulted in environmental and production problems, such as the loss of soil fertility and accelerated eroding processes, as evidenced by Araújo (2017) and Silva et al. (2024).

When doing an analysis with the years 1985 before the flooding and 2022, the most recent period, it is noted that the deforestation rates are high, from the creation of the areas with irrigated perimeters or even after the relocation, and the issue of the soil erosion (Image 2). As also the construction of urbanized areas surrounding the farm villages contributed to the reduction of the areas with vegetation (Lima et al, 2024).

Image 2 – Temporal analysis of the usage and coverage of the land in the years of 1985 and 2022



Source: Landsat 5 (1985), Landsat 8 (2022). Authors (2025).

The analysis showed a significant increase of the deforested areas and the expressive growth of the irrigated terrains. However, this process was not accompanied by efficient soil management policies, resulting in environmental degradation and the increase of the production costs for the small farmers. The absence of technical assistance also contributed to the vulnerability of the resettled families, who face difficulties in the sustainable use of the land (Araújo, 2020).

It is emphasized that the municipality of Petrolândia is one of the biggest producers of coconut water of the region, due to the irrigated farming area of implementation after the flooding, that presented high expressivity in the municipality, corroborating with Araújo (2017), that comprehends the expressivity of the location in the productions of other fruits such as mango.

Santos, Gomes and Sobral (2022), emphasized that the increase in the production of fruit growing contributed for the more modern machinery demand in the field, contributing with the urban centers development, through the commercial establishments aimed at this sector. Throughout the years, as the small producers sold their plots, a need arose for the adaptation to the urban centers to the new dynamic production ways in the field.

The new relations of power, economy and techniques that were improved in the countryside and in the city after the flooding, contributed to an ongoing transformation. And Milton Santos (2008), emphasizes that the geographic space is part of a historical and social construction that is in constant change, making the space transformed by the society through time, and also with value systems interconnected with each other.

This development in the municipality's urban center contributed in the promotion of more gender equality, allowing the women to have more work opportunities in the commercial establishments, and more income generation for the whole population. Beyond that, it opened a variety of work options, not only in commerce, but also in factories, through the fresh coconut water bottling, destined to the local commerce.

The bigger diversification of economic activities in the urbanized centers became a reflection of the transformations that occurred in the territory, through the sociospacial reconfiguration caused by the flooding, and that generated positive impacts in the local economy. However, all the plantations in this municipality depend on the irrigation systems, due to the semiarid climate with lack of rain, and that were installed by Chesf (Image 03).

Image 03 – Coconut plantation in the irrigated perimeter of Icó-Mandantes.

Source: Field work carried out by the authors (2022).

Another positive milestone, after the flooding of the municipality for the construction of the hydroelectric power plant, is that the residents received specific plots of land for each family and before this entire process, a significant part of the population did not own farming land.

Therefore, it is observed that the sociospacial changes occurred in the relocation process to new areas contributed to the local commerce expansion, more work opportunities for the women head of their households, despite the gender equity challenges faced throughout the entire relocation process.

4 FINAL CONSIDERATIONS

This paper analysed the impacts of the compulsory migration caused by the construction of Lake Itaparica over the population of Petrolândia-PE, with emphasis on the gender inequalities and the socioeconomic vulnerability of the women head of their households. The results indicated that, although the irrigated perimeters implementation had boosted the local economy, the unequal redistribution of land limited the female participation in the production sector, reinforcing historical patterns of economic exclusion.

The analysis showed that, after the resettlement, there was an expressive relocation of the female population to the urban centers, where they sought income alternatives in commerce and in service sectors. This reality highlights the need for public policies that promote more equity to the land access, ensuring that the resettled women can integrate themselves to the agricultural economy more actively.

Besides that, it was verified that the intensification of the irrigated agriculture brought significant environmental challenges, such as soil degradation and increased production costs. To mitigate these impacts, it is necessary the strengthening of sustainable soil management programs and technical assistance aimed at family farming, with special attention to the farming women.

The research contributed to the debates of forced migration, gender and rural development inequality, offering a detailed analysis on the challenges faced by the resettled women of Petrolândia. Unlike the previous studies, this paper highlights the female exclusion in the land redistribution process and its consequent economic vulnerability, appointing ways to more inclusive public policies.

Although this paper has offered comprehensive panorama on the forced migration impacts, some limitations must be recognized. The absence of qualitative interviews with resettled women prevents a deeper subjective analysis on their daily challenges. This way, future studies could incorporate qualitative methodologies, such as interviews and focal groups, to complement the quantitative findings presented in this paper.

The results of this research suggest that governmental measures must be improved to guarantee more equity to the land and rural credit access. Some possible actions include: technical assistance programs specific for farming women, aimed to trained them in sustainable management of farming plots; rural financing lines adapted to the needs of the resettled women, promoting more economic autonomy; and environmental recuperation projects for the irrigated perimeters, ensuring the farming production feasibility in the long term.

Moreover, the observed transformations in Petrolândia provide concrete evidence to the theory that the space is a social relations materialized instance, being permanently produced and reproduced by human actions. The forced migration, the farm villages reorganization and the urban expansion configured new uses to the territory, resulting in a spatialization of the gender and socioeconomic inequalities. In this context, the irrigated rural and emerging urban spaces constitute expressions of the new economic and social

dynamics imposed by the state intervention and by the adaptation strategies of the resettled population.

The forced migration significantly altered the socioeconomic structure of Petrolândia, especially impacting the women head of their households. This way, the implementation of effective public policies is essential to reduce the inequalities, strengthen the family farming and ensure decent conditions to the resettled populations.

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