Industrial brownfield in light of the center-periphery relationship: Marabá – State of Pará

Campo marrom industrial à luz da relação centro-periferia: Marabá-PA

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Abstract

The Marabá Industrial District (MID) is a place connected with the transformation and processing of resources from the perspective of adding value to the iron ore of Carajás (State of Pará). However, local industries have promoted a great spatial transformation, using archaic and polluting techniques and technologies. After an increase in costs and changes in international prices, the areas of these industries were abandoned, indicating a brownfield process under formation in the MID and related areas. This was followed by a process of transhumance, accompanied by cycles of economic contraction and concentration. A mining-industrial periphery condition is perceived in the implementation and conception of the MID, as well as its formation as a brownfield, with spatial, economic, demographic, and environmental repercussions.

Keywords: brownfield; degradation; transhumance; center-periphery; Marabá Industrial District.

Resumo

*O Distrito Industrial de Marabá (DIM) é um local vinculado à transformação e ao beneficiamento de recursos sob uma ótica de agregação de valor ao minério de ferro de Carajás-PA. Porém, indústrias locais promoveram grande transformação espacial com o emprego de técnicas e tecnologias arcaicas e poluentes que, após aumento nos custos e alteração nos preços internacionais, tiveram as áreas abandonadas, indicando um processo de campo marrom (*brownfield*) em formação no DIM e áreas conexas. Seguiu-se um processo de transumância, acompanhado de ciclos de retração e concentração econômica. Verifica-se uma condição de periferia mineroindustrial na implantação e concepção do DIM, bem como a formação como um campo marrom, inclusive com repercussões espaciais, econômicas, demográficas e ambientais.*

Palavras-chave: *campo marrom; degradação; transumância; centro-periferia; Distrito Industrial de Marabá.*

Introduction

The Marabá Industrial District (DIM) is a place whose origins are functionally linked to the transformation and processing of natural resources, from the perspective of adding value to the iron ore exploration chain in the Carajás Mineral Province. According to Santos (2017, p. 1): "[...] foi criado com o intuito de [...] estímulo ao desenvolvimento regional. A partir de 1988 a implantação de indústrias siderúrgicas voltadas para a produção de ferro gusa, aço e ferro-ligas, se transformou na principal estratégia no corredor da estrada de ferro Carajás".

The economy based on mineral resources in the historical context of the implementation of the Grande Carajás Program (PGC) responds to a "deliberate national project" of "conscious state intervention to make viable [a] development project" focused on "industrialization" based on a capitalist economic system (Fonseca, 2015, p. 36). Industrialization in the eastern Amazon would be the option to overcome the old extractive export model "and the enclaves, mining or plantations, as well as to accelerate productivity and the diffusion of technical progress, with repercussions in other sectors of the economy" (Fonseca, 2015, p. 41). It was an import substitution project anchored in a proposal for late industrialization "exporting" archaic technologies to the Brazilian periphery (Brandão; Fernandez; Ribeiro, 2018).

The cyclical periods of the economy, which alter the price and demand for mineral resources on an international scale, have the capacity to bring "protagonism" to resource-based economies (HE et al., 2017).[1] In the case of the periphery, capitalism values areas that were previously of little interest (or not yet chosen for the expansion of capital), within a context of accelerated integration. The Marabá Industrial District, as a "[steel industry] strategy in the Carajás railroad corridor", is seen as yet another venture to finance Brazil's foreign debt, embodying itself as an auxiliary hub receiving "cheap and obsolete" industrial structures dependent on "charcoal", an input that was initially abundant in the region, but linked to a chain of felling of native forest (Grupo Alterosa, 2013) and later in the transformation of babassu coconut into charcoal (Monteiro, 1996). Its peripheral status positions it as a pillar of support for the creation of an industrial park in São Paulo (or in the center-south of Brazil) and to meet the demand for international capital (Brandão; Fernandez; Ribeiro, 2018), all of this using the Amazon integration doctrine as a backdrop (Teixeira de Souza; Silva, 2021). The construction of the Marabá Industrial District was a process announced as an industrializing model for the eastern Amazon, but it did not respond to this measure, including with portions completed in an extremely lethargic manner (Santos, 2017, p. 2), in other cases unfinished or not even started.

The existence of this ferrous metallurgy and steel mill park occurred with a major socio-spatial-environmental transformation and with the use of archaic, degrading and extremely polluting techniques and technologies (Santos, 2017; Costa, 2022) which, after the exhaustion of resources, appears to have been followed by the abandonment of the area without waste treatment and the dismantling and reuse of infrastructures, the genesis of what would be the brownfield process. The brownfield condition fatally affects the well-being of the population, since abandoned industrial infrastructures have the potential for

contamination, impairing the use and reuse of soil, air, water, protein sources and remaining natural resources, also taking into account that some waste tends to become more contaminating and dangerous over the years. Furthermore, the gestation of this brownfield gave impetus to a process of transhumance, as well as the perpetuation of patterns of poverty and inequality (Freudenburg, Wilson, 2002), which resulted in cycles of economic retraction and income concentration.

This article is structured based on a theoretical review for the definition of developmentalism with Prebisch (1949), Brazilian industrialization based on the steel industry with Lessa (1998) and Andrade and Cunha (2002), the peripheral condition in development with Brandão and Fernandez and Ribeiro (2018), the brownfield problem with Vasques (2009) and Teixeira de Souza and Silva (2021), the PGC and the DIM with Santos (2017) and Costa (2022). Initially, the article seeks to explore in greater detail the concepts of import substitution and deterioration of exchanges/ trade. Then, the notions of development and overcoming the center-periphery relationship are reviewed as central elements of the formulations, including the role of the State in modulating sectoral policies in the steel industry. In relation to these concepts, we seek to explore the structuring connections, with a view to revealing their association with the instances of politics and economics of the brownfield phenomenon. Finally, in the last section, we seek to relate the concepts examined with the case study on the DIM.

Methodology

The purpose of this article is to review the literature to support the discussion on developmentalism, the peripheral condition in development and the problem of brownfield. Based on the review, the conditions are created to explore the structuring connections of the brownfield phenomenon, with the aim of exposing the consonance between theory and empirical evidence from the case study on DIM. The hypothesis of a greater conformation and overflow of the brownfield problem in a peripheral area can be conjectured, understood and even explained based on the regularities already observed, although the objective of this work is not to compare cases, but rather to test a case of a metal-mineral industry in Marabá-PA, located in a mining and prospecting region where there are notable cases of this type, such as Serra Pelada.

The research on the Marabá Industrial District, a peripheral industrial zone in the Brazilian Amazon, will focus on the key years indicated in its formation as a brownfield, that is, from 2008 to 2016, which coincides with the period of the 2008-2014 international crisis. Authors who contextualize the period mentioned, such as Santos (2017) and Costa (2022), and who already elaborate on the situation of closing down the manufacturing units in this part of the Brazilian territory, will be vital for the analysis of the results and for the discussion of the problem.

From developmentalism to industrialization through the steel industry

According to Prebisch (2000, p. 139), the formation of the world's major industrial centers was preceded by a process of "universal propagation of technical progress", which occurred slowly and irregularly, encompassing small population groups and territorial areas in a continuous movement of expansion and new technical and technological concentration. It forced the periphery of the world-system, which was "vast and heterogeneous" in terms of population and territory, to "participate little in improving productivity". Moreover, within the periphery, technical progress was only available in sectors with low demand for production factors, low spatial diffusion, and low capacity to absorb labor, which was combined with the fact that the vast majority of the population was employed in the production of "low-cost food and raw materials destined for the major industrialized centers" (ibid.).

Prebisch (2000, pp. 142-143) argues that the large industrialized countries achieved "improvement in terms of trade" by "reducing the import coefficient" at a time when the periphery of the world-system was in a phase of economic development in which "imports tend to increase systematically". In addition to this, there was an "abundance of human potential in primary activities" in which such a reserve army of labour served to "continuously put pressure on wages and prices of primary products". Prebisch (2000, pp. 146, 154) argues that the slow pace of this industrialization process in the periphery forced it to give up "part of the fruits of its own progress" through the formation of the international division of labor, because: "The more the periphery strives to increase its productivity, thereby increasing the surplus of its active population, the greater this transfer becomes, provided that other conditions remain unchanged" (ibid. pp. 154-155).

For Prebisch (2000, p. 146), the disparity in the terms of commercial exchange or trade in the international division of labor is observed in the imbalance in the trade balance, since primary products tend to suffer from greater international fluctuations in demand than industrial products. Furthermore, according to Prebisch (2000, p. 151), in the periphery, reproducing the existing terms, in general "salaries [would continue] relatively low, compared to those in force in the centers, even in cases in which there were appreciable increases in productivity". In his study entitled *O desenvolvimento econômico da América Latina e alguns de seus problemas principais* (published in 1949), Prebisch did not acknowledge the problem raised by the Marxist perspective of capitalist development. This perspective argues that there is an unequal exchange at the basis of trade relations between rich and poor territories, in which a transfer of value and surplus value occurs from one pole to another, and that such transfer is based on the exacerbated exploitation of labor by capital. Prebisch states that "there have always been marked differences from one country to another" and that "business organization" and "industrial development" would absorb "the surplus population and tend to implement a relative improvement in wages" (ibid.). Therefore, overcoming the model, in search of development, would involve an industrial development that would import technical progress to the periphery.

The spatial issue of development is based on questioning this process of "spatial reconfiguration of economic activities, transforming and dynamizing certain regions of the planet, while others were doomed to stagnation or decline" (Brasil, 2003, p. 9). In the post-war period, governments began to address the peripheral problem with compensatory development policies, seeking to attract productive capital, with various instruments, to regions considered "less developed". The results, however, were often considered to be less than desirable, with no break with peripheral patterns, increasing income concentration and the deterioration in the quality of life of population (ibid.).

The most basic strategy designed to break this model of terms of trade in the center-periphery of the world system was, according to Lessa (1998, p. 12), to locate, in Brazil, the basic industries in areas with the "presence of natural resources" and with "transportation nodes", in addition to a privileged installation of industrial plants "in incorporable energy sources". Such characteristics were not found in the areas of the cities of São Paulo or Rio de Janeiro, large and well-established national industrial centers, but in peripheral regions of the Brazilian economy. The spatial implications of this strategy in the I (1972-1974) and II National Development Plans (1975-1979), also called I and II NDP, was to launch industrial projects in areas such as the large iron deposits in Carajás/Pará, which would have access to energy from the construction of the Tucuruí Hydroelectric Plant. It is worth highlighting that the II NDP was not the beginning of such expansion towards the periphery, but a consequence of the Five-Year Plans and the Amazon Development Plans, as well as their developments, including the opening of large highways, the implementation of agricultural projects, etc.

Looking specifically at the GCP, the industrial plants were supposed to follow the mineral export route of the Carajás Railway (CR), but located in "urban centers in peripheral regions", such as the large, but never built, Itaqui-State of Maranhão steel mill. The planned Itaqui-State of Maranhão steel mill and all the others that would actually come into operation in the Carajás Logistics Corridor were linked to the National Steel Plan (NSP). This, established by the Presidential Decree No. 2.054, of March 4, 1940, authorized the creation of a commission that would "carry out the final technical studies for the construction of a national steelworks [...] with the participation of State and private capital" (Brasil, 1940), and designed to break the primary-export model to which Brazil was tied. The aforementioned National Steel Plan achieved its greatest initial feat with the creation of the National Steel Company (NSC) on January 30, 1941, and the effective start of operations in 1946. It is worth noting that, at that time, NSC was not designed for a peripheral Brazilian economic zone, but to be installed in Volta Redonda-RJ, a location in a "hinterland" of the two major national industrial centers mentioned above. President Getúlio Vargas classified NSC as a priority for "the nationalization of the exploitation of the country's wealth" (Memorial da Democracia, 2022) in an attempt to reduce the disparity in terms of trade to which the Brazilian economy was forced. NSC was – before any talk of breaking the Brazilian economy's dependence on industrialized nations – a concession of the Washington Accords, made between the

Brazilian and the United States of America (USA) governments. The aforementioned president foresaw the construction of a steel plant that could supply steel to the allies during the World War II (Almeida, 2014, p. 49). Initially, it was not intended to support the development of a national industrial park, although it achieved this purpose during the 1970s (Lessa, 1998, p. 19). NSC could be understood as a technology – largely polluting – "exported" (Brandão, Fernández and Ribeiro, 2018) to a "periphery-Brazil" that had enormous reserves of raw materials and energy, a supplier of cheap and still poorly organized labor, with the capacity to produce at lower costs for the USA market and for a Europe undergoing post-war reconstruction, for abundant capital in the United States, eager to be invested in economies like Brazil's, with idle capacity and little affected by the conflict. Following the same strategy, in the 1950s, the Usinas Siderúrgicas de Minas Gerais (Usiminas) and the Companhia Siderúrgica Paulista (Cosipa) were set up, which, together with NSC and Belgo-Mineira, formed the tetrad of the Brazilian heavy steel and metallurgical industry until the beginning of the 1980s, when the Companhia Siderúrgica de Tubarão (CST) began operating.[2] It is worth noting that, in 1973, a controlling company for the national state-owned steel industry was established, Siderurgia Brasileira S.A. (Siderbrás), to which the shares of the National Bank for Economic Development (NBED) in NSC, Usiminas and Cosipa were transferred. Shortly before Siderbrás, came the Advisory Council for the Steel Industry (Consider), created in 1968 to implement the proposals for reformulation of the NSP by the Advisory Group for the Steel Industry (AGSI), created the previous year. In 1970, Consider became a deliberative council which was named National Council for the Steel Industry (Andrade, Cunha and Silva, 2002). Therefore, before the I and II NDP, the legal and institutional framework was already in place for the implementation of a state-run steel-metallurgical industrial model for import substitution, improving the terms of trade and international commercial exchange and increasing labor income.

Initially, industrialization via steel industry in the 1970s was calculated to be in line with the "change in the Industrialization Pattern" that sought an "expansion of the supply of basic inputs, primarily pursuing national self-sufficiency" for the 1980s. It was based on "investments [that] would create an increased demand for machinery and equipment" in a new national economic direction focused on the "domestic market [...] programmed for the expansion, diversification and technological sophistication of the national capital goods industry" by counting on an institutional framework supported by State financing from NBED and its subsidiaries: Insumos Básicos – Fibase (Lessa, 1998, pp. 16-17), Mecânica Brasileira S.A. (Embramec) and Investimentos Brasileiros S.A. (Ibrasa). The new reformulation of the NSP and the provisions of the Consider in 1974, including a review of the goals of the I NDP to support the II NDP, was carried out by the Economic Development Council (EDC) of the Planning Secretariat (SEPLAN), a higher administrative body created after the downgrading and extinction of the Ministry of Planning, which, among other things, established, as a directive for the steel industry, a leap in production from "5.4 million tons of steel in ingots in 1970" to an installed capacity of 32 million tons in 1980 (ibid., p. 19). According to Andrade and Cunha (2002, p. 27),

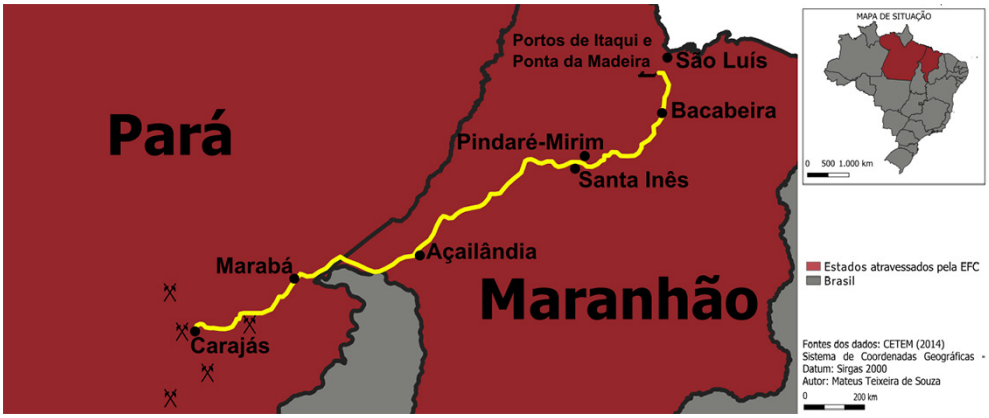
the II NDP directed 35% of the investments programmed for the industrial sector to the steel and metallurgical industries, in addition to setting approximately 15% of the investments in the steel industry for the formation of fixed capital in the Brazilian economy. For the authors (2002), the NBED, by observing the provisions of the NSP:

> [...] established conditions such as, for example, support for companies under effective national control, with basic projects carried out by Brazilian firms, which would hire technical assistance from foreign firms, being 80% is the minimum nationalization rate required for equipment. (Ibid., p. 27)

It can be seen that this was a policy that provided for the "improvement of terms of trade" based on the "reduction of the import coefficient" with a focus on increasing fixed capital and national industrial capacity. As mentioned by Andrade and Cunha (2002, pp. 28-29), it is important to highlight that both in the period of the II NDP and in the period of 1980-1985 and 1985-1989 (respectively III NDP and post-III NDP) financing, instruments were focused on the three large plants controlled by Siderbrás, reaching, in 1980, an installed capacity of 16.4 million tons/year. It corresponded to 51.25% of that predicted in the 1974 NSP review.

Nonetheless, the new steel mills for the Carajás Logistics Corridor would be designed for a third stage and reformulation of the NSP, which set targets for pig iron production and installed capacity geared towards exports. In the mid-1980s, after the III NDP, the steel and metallurgical strategy for the Carajás Logistics Corridor had already moved beyond the initial conception on the coast of Maranhão and was being installed in the interior of the Legal Amazon, initially in the cities of Marabá-State of Pará and Açailândia-State of Maranhão, with later units in the cities of Santa Inês, Bacabeira[3] and Pindaré-Mirim, in Maranhão (Santos, 2015, p. 37). Unlike Siderbrás/NSC and the NBED/Fibase/Ibrasa ventures, with huge contributions of public capital, the new projects were being implemented with private capital, already reflecting the end of the stage of Brazilian developmentalist thinking in the 1980s. For Lessa (1998, p. 35), the viability of a steel park for transforming Carajás iron ore would depend on the materialization of other projects designed for the national territory. Besides, "the whole would only be possible if the economy maintained its dynamism". Not only the implementation of a railway, the surrounding agricultural projects, the mineral extraction (or rather: the steel industry in the GCP would be the one to depend on this project), the Tucuruí Hydroelectric Plant, the communication and logistics systems would be sufficient, but it would also depend on the "reciprocal articulations between the oil programs, nuclear energy, Itaipu projects, the Albrás-Tucuruí complex, Carajás, Itaqui, Aço Railway, etc.", which would include the "association [between the projects] and financing that were supposed to be articulated and implemented" (ibid., p. 35).

Figure 1 – Map of the Carajás Railway (yellow), the main component of the Carajás Logistics Corridor, highlighting the locations of Marabá, Açailândia, Santa Inês, Pindaré-Mirim and Bacabeira, where the PGC steel plants are located



Source: elaborated by the author based on the "Mapa das Localidades com Presença de Indústria Siderúrgica no Corredor Ferroviário da EFC", 2023. IBGE (2010)

Steel industry and brownfield in the Amazon

The Marabá Industrial District (MID): conception, genesis and apex

When the MID was conceived, the industrializing developmental model was at its point of exhaustion. The NSP, the policy formulating the industrialization strategy through the steel industry, also underwent a reformulation and a new vision that space was of interest as a reflection of the dominant economic relations, which shape the main vectors of transformation (Theis and Galvão, 2012, p. 60). The notion of economic space began to be focused on the internationalist neoliberal dynamics and market globalization (Brandão, Fernández and Ribeiro, 2018, p. 75), defined by the strong presence of "points or poles of development", which would concentrate "resources" and "endowments" of the "fractions of capital" (Theis and Galvão, 2012, p. 60). According to Theis and Galvão (2012, p. 60):

> The most capable [productive] units increasingly reinforce their positions over the others, in a world in which market structures and competition patterns are closer to oligopolistic models. The economy of the development poles is guided, here, by carrying out processes of capital accumulation and social reproduction concentrated in the territory.

In this new neoliberal perspective that breaks with developmentalism, capitalist companies and financial capital "gain autonomy to locate and relocate themselves according to conditions that are more or less favorable to generating profits", representing a loss of control by State over the development of the

territory itself. In this sense, companies impose an uneven pace on the growth of economies and "decree the inclusion and exclusion of regions in the global economic dynamics" (Brasil, 2003, p. 9).

In addition to this ideological reorganization of the national steel sector, the Brazilian foreign debt accumulated after the end of the 1964-1985 Military Dictatorship contributed to the "imbalance" of the Brazilian State. It forced "adjustments" in the "external/internal financial articulation" and required a "sequence of measures to contain imports" and expand exports. Likewise, the continuation of the II and III NDP programs proved unfeasible according to market logic in the face of a scenario of debt crisis and stagflation in the late 1970s and throughout the 1980s (Lessa, 1998, pp. 78-79). Andrade and Cunha (2002, p. 29) add that in the

> [...] so-called "lost decade" [...] the external debt crisis caused a decline in domestic demand for steel. The resulting excess capacity forced steelmakers to export with lower returns, in order to guarantee placement on the international market and maintenance of production. Profits and investments suffered a significant drop, due to the lower availability of external credit and low prices, both external and internal - these caused by price controls, the result of government policy to combat inflation.

Furthermore, they also point out that:

> In 1988, Consider was extinguished. Siderbrás had serious financial problems, [being] prevented from obtaining financing from the NBED. The crisis in the Brazilian State prevented investments from being made in the modernization of the industrial park, increasingly distancing it from international standards of quality, productivity and competitiveness. Investments in the steel industry fell significantly, from an average of US$52.3 billion annually in 1980-83 to around US$500 million in 1984-89. The national steel sector had very dispersed production, but acted on the principle of self-sufficiency in all steel articles, at any cost; in this way, it presented a certain vulnerability, as the globalization of the market was already beginning. It became imperative to open the market and streamline the steel industry, a sector that seemed to be entering a process of stagnation (Ibid.).

By the end of the 1980s, the NSP – and its regulatory instrument, the Consider – were ineffective and dismantled, and the steel sector was turning to a globalizing logic far from the self-sufficiency of the theory of industrialization on a national scale, reduction of the import coefficient and improvements in the terms of trade and international commercial exchange that Prebisch (2000) predicted. The MID emerged as a result of the creation of the GCP,[4] which followed the new political--economic-industrial guideline of expanding exports with the aim of financing the Brazilian debt, overcoming the crisis in the domestic market and, secondarily, exporting obsolete structures to a zone of low production costs. The industrialization of the eastern Amazon through "processing of minerals, agriculture and logging" (Santos, 2017, p. 2) would become the alleged, albeit secondary, objective.

According to Santos (ibid.), the option was to offer tax incentives to attract private capital to build steel plants in the MID, including

based on the precepts of the National Policy for Regional Development (NPRD), which applied tax incentives for "tax reduction", the "application of part of the tax [...] in deposits for reinvestment", and tax exemptions granted "to companies established [in the Legal Amazon]" (Brasil, 2003, p. 18). Nogueira (2019, p. 49) goes further and states that tax and credit incentives were even a factor in the future downfall of the MID, as they ended up attracting "technologically outdated enterprises in an attempt to make them competitive". In this context, the District was formally established in 1987 through the Pará Industrial Development Company (IDC) in an area of almost 2 thousand hectares in the urban expansion zone of Marabá (Costa, 2022, p. 74). According to Santos (2017, p. 2), in 1988, it emerged:

> [...] in this context, Pará Steel Company – Cosipar and Marabá Steel Plant – Simara. By 2008, a period that represents the peak of steelmaking activity in the municipality, eleven enterprises for the production of pig iron, steel and ferroalloys had already been established, specifically in MID.

It is worth noting that the first impetus for the installation of steel mills/pig iron plants was limited to the two plants already mentioned. The other nine plants only began to be built in 2002, outside the scope of the GCP, which was extinguished in 1991 (Costa, 2022, p. 30). The new "steel-pig iron" units were attracted by tax incentive policies from the municipal government of Marabá, the state government of Pará, and even the federal government (ibid.).

The MID reached its peak between 2006 and 2008, when the structures were fully operational: 25 furnaces, 2.556.720 tons/year of production, 3.058.720 tons/year of installed capacity, and 3.295 direct jobs generated (Costa, 2022, p. 76; Santos, 2017, pp. 2-3), reaching 8.600 jobs counting indirect jobs (Andrade, 2020, p. 13; Fetim-BA, 2015), a direct industrial mass relatively better paid and organized than in most of the Amazon territory. Along with this, there is the negotiation of Simara, in 2006, which, transformed into the Siderúrgica Norte Brasil (Sinobrás) steel mill, became "one of the largest integrated steel mills in the region, producing rebar, trusses, column mesh, slab mesh, and annealed wire" (Costa, 2022, p. 77). Of the eleven steel mills, in addition to the steel mill already mentioned, nine were producers of pig iron, and one, of ferroalloys (ibid., p. 79). This so-called metalworking hub at the MID in Marabá generated great economic dynamism in the city based on the transformation of metals (Andrade, 2020, p. 13; Costa, Carvalho D. and Carvalho, A., 2011, p. 23).

The crisis in MID: is a brownfield forming?

Santos (2017, p. 3) mentions that the crisis in the MID had its origins in the 2008 capitalist economic crisis related to subprime loans in the United States of America. It impacted the real estate market and the country's financial system. The American steel sector was the largest buyer of pig iron from Marabá, using it to produce steel. Despite the global crisis, Vale's pricing policy was already being identified as one of the main factors in the sector's "disaster" by charging "Brazilian pig iron industries the same price used for export", added to the mining company's dependence and lack of its own ore, which interfered in costs and

production policy in the medium and long term (Grupo Alterosa, 2013). Moreover, Santos (2015, pp. 117-118) highlights, as factors, "the price", the "low quality of the ore" supplied by the mining company Vale, as well as the "changes in Environmental Legislation" and the tightening of inspection by environmental agencies which, upon verifying illegalities in the charcoal production chain, applied successive embargoes and fines to steel mills in the MID.

The price of iron ore was the determining factor not only in the closure of nine of the eleven projects, but also in the continuation of operations of the other two, precisely because they did not use the raw material supplied by the mining company Vale. Another important factor in the composition of costs that differentiated the industrial operation was the energy source, with the two remaining in operation by using electric energy to keep their furnaces lit. In this perspective, it is worth noting that the production costs generated by the pricing policy of the mining company Vale, a clear competition between inter-industrial capitals, may have led to a process of spatial differentiation caused by the divergent platforms of corporate operation. In this regard, the mining company chooses to sell at higher prices to international markets, following the fluctuation of iron ore prices, while the industrial plants of the Carajás Logistics Corridor – obsolete and costly in their essence – have production costs much higher than their capacity to remain in operation. Vale's pricing policy and the costs of production factors for maintaining obsolete industrial plants have made some areas productive and others condemned to economic stagnation. In fact, this apparent explanation of the formation of brownfields through the competitive path of capital, and not only through location, is more robust theoretically, but it still leaves room for discussion based on central-peripheral elements even in a context of capital competition.[5]

The closure of many of Marabá's huge industrial plants accentuated social and regional inequalities. It triggered migratory flows, a factor exacerbated by the launch of Aços Laminados do Pará (Alpa) by Vale – a project to expand the metalworking hub of southeastern Pará, including the start of construction of a river port in Marabá and the infrastructure of the Tocantins Waterway, via the Tucuruí locks (the latter being the only completed project) –, which had its construction started in 2009, but was abandoned. A very large flow of people moved to Marabá at the height of the MID and later with the launch of ALPA. heading to the urban edges and peripheries of Marabá areas lacking infrastructure and minimal public facilities (Costa, 2022). In these places, there was an intensification of social and urban land conflicts, in addition to the intensification of pressure on social policies and municipal planning.

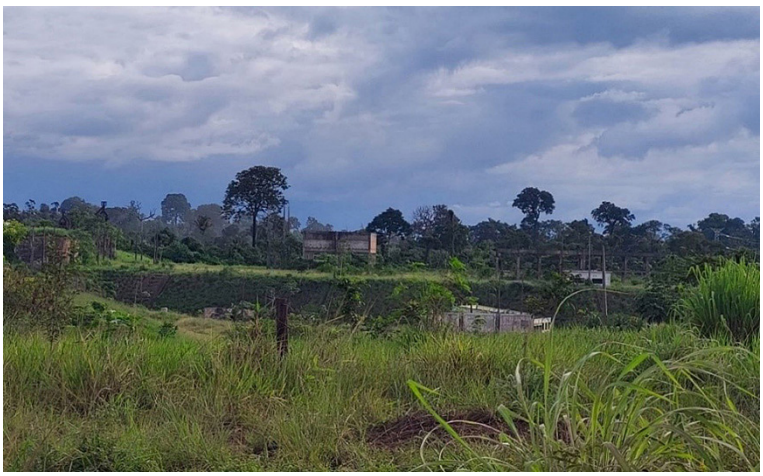
The MID, in this configuration, was, at a given moment, a space chosen by capital, which was part of the set of essential points of the so-called capitalist enterprise. The global and local scalar logic of accumulation turns previously vital areas into dispensable areas, and essential areas into obsolete and uninteresting or unrelated areas. Brownfields (or "brownfield land") were areas that were previously fundamental in capitalist expansion and reproduction (to a greater or lesser degree or scale), which gradually became degraded, obsolete and abandoned (Souza, 2023).

For Vasques (2009), brownfields lost their productive functions after the cessation of economic activities, which, in most cases, have a strong impact on socio-environmental-

-economic aspects in a territory and, through overflow, to adjacent or attached areas. Brownfields are dead zones (or in the process of "death") in the capital accumulation process, which "ceased" to be "essential points" (Santos, 2001). Their means of production and capital are transferred to another space, without first leaving the marks of the process in the form of obsolescence, abandonment, ruins and degradation (Vasques, 2009).

In a mining-industrial site,[6] the formation of a brownfield is preceded by a process of depletion of sources of raw materials and resources, and is generally followed by a process of overflow of the demographic problem. In the mining-industrial case, environmental damage and economic costs increase over time, especially in more fragile sites. These fragile sites, discussed by Magdoff (2013),[7] allow us to refer to the problem of the center-periphery relationship, in which the latter generally finds itself lacking in means and technologies, as well as organization to resist a process that is imposed on it. Technologies from the center, which flow to the chosen and singular spaces located on the periphery, accelerate processes. Prices of minerals abroad, high demand for resources and projects to set up logistics corridors for transport are, in fact, the result of a fierce search by international capital (and even by the Brazilian central region, which is basically made up of São Paulo and, to a lesser extent, the rest of the center-south of the country) to reproduce itself, even at the cost of economic strangulation not linked to regional integration into the capitalist system and overcoming the situation of dependence on a periphery (ibid.). The periphery will begin, from the economic strangulation, the path towards its formation as a brownfield, since the maximization of

Figure 2 – Abandoned industrial structure overgrown with vegetation in MID, in 2022



Source: own authorship, 2022.

short-term profits in these spaces far from the core areas does not prepare the territories for the ecological and socioeconomic problems resulting from the way capitalism works and the economic decisions made (ibid.). When the process of destruction and depletion is at its most advanced stage, there will occur, according to Magdoff (2013, p. 19), a "dispute, often violent, for control of the remaining resources". It results in the weakening of the social element, the relaxation of environmental control and the acceleration and deepening of the formation of the brownfield. The cyclical periods of the economy, which alter the panorama of price and demand on an international scale, have the capacity to dismantle peripheral economies dependent on mineral resources (He et al., 2017). In the case of this mining-industrial periphery, capitalism values areas that were previously of little interest (or not yet chosen for capital expansion). It happens within a context of accelerated integration in order to finance Brazil's external debt, to establish the São Paulo industrial park and to meet the demand for international capital, all of this using the Amazon integration doctrine as a backdrop. It is clear that it was a process that sought to be carried out in a timely manner, and, not responding to this measure, some of its portions were left unfinished later, which results in an eventual brownfield and transhumance process (Teixeira de Souza and Silva, 2021), causing the demographic problem to overflow (Souza, 2023).

Figure 3 – MID area under occupation process and dispute over land ownership, in 2023

Source: own authorship, 2023.

Figure 4 – Signage of a movement in favor of agrarian reform in the foreground in the MID area, behind the Marabá Mineral Cargo Railway Station, in 2022

Source: own authorship, 2022.

No brownfield (and its consequences) arises suddenly. Rather, the territory has been plundered to such an extent by the capitalist system, that speculates on land, forces migrations and segregates areas, establishing a pattern of formation and conformation of a relationship of dependence of the periphery in relation to the center. Migrations are generally the key point for the transhumance process of a periphery (Magdoff, 2013). This transhumance process, as an overflow of the demographic problem in peripheral economies, is related to the limited capacity for fixation and development of technologies, in a linearity towards a basically export-based economy (Teixeira de Souza and Silva, 2021). For this very reason, the MID crisis also exposes the difficulties of innovative articulations to overcome obsolete patterns sustained by the industrialist export rationality, a fact that imposes limits on the induction of locally based innovative dynamics (Monteiro, 2022). Furthermore, the heterogeneity of interests and objectives of economic agents imposes significant barriers to promoting economic and social development (ibid.). The social bases of workers, peasants, and populations are exposed to environmentally harmful technological trajectories (ibid.), such as the felling of forests for charcoal production. Industrial structures

are abandoned in a state of scrap, a symbol of expropriation and overexploitation of labor. Such structures, with their waste and equipment that are harmful to the environment, are abandoned. It poses a risk of contaminating soil, groundwater, and protein sources.

Final considerations

In a brownfield, the depletion of raw material and resource sources is the driving force behind its formation process. If the pricing policy of the mining company Vale continues to condition the resumption of pig iron plants in Marabá, the supposed objective of "industrializing part of the Eastern Amazon" (Santos, 2015, p. 2) from the MID becomes more distant; hence, it reinforces the mineral-export pattern to which the regional economy is linked, since it increases the cost (depletes) of raw material sources for maintaining pig iron activities. The MID was hit by the international crisis of 2008-2014, and remained in this scenario until 2016, when some furnaces were resumed. It was again affected by the recession caused by the Covid-19 pandemic between 2020 and 2021. It is important to highlight, however, that even though it attempted to recover between 2016 and 2020, in the pre-pandemic period, MID never returned to its 2008 operating capacity.

In relation to MID, it can be seen that the process of forming a brownfield meets the basic requirements listed by the theory. The main ones are:

(1) socio-environmental damage, initially caused during the maximum operation of the MID, with the economy of charcoal extraction from the forest and, later, from babassu coconut (Monteiro, 1996), followed by the abandonment of the huge industrial plants with the risk of depositing waste in the soil, air and water. Without the intention of delving into the socio-environmental aspects, even if they instigate rich research on this subject in the case of the MID as a brownfield, it is worth mentioning that the industrial transformations planned for Marabá already raised socio-spatial-environmental concerns at least since the 1970s, it means, before the first pig iron plant was installed in the city. Monteiro and Tarifa (1977 apud Furtado, 2004, p. 6) observed the possibility of "air pollution problems" due to the geography of the Peripheral Depression of Southern Pará, where Marabá is located, with calmer air circulation and the presence of a "heat island" (Furtado, 2004, p. 9). It warns of the risk of "installation of industries" using archaic and extremely air-polluting techniques and technologies.[8] The study named *Perspectivas para o meio ambiente urbano: GEO Marabá*, published in 2010, also pointed out that:

> Mineral extraction projects, pig iron production industries [...], among others, in addition to their potential for degradation and pollution, have been causing – through migration – a considerable population increase. The use and occupation of unstructured areas leads to soil, water and air pollution, with the latter situation being aggravated by industries and gas emissions from motor vehicles. (Raiol, 2010, p. 95)

In a 2018 report entitled *PA – Perversidades sociais e ambientais no caminho da Estrada de Ferro Carajás*, the Map of Conflicts on Environmental Injustice and Health in Brazil, citing the agronomist and social scientist Raimundo Gomes da Cruz Neto, points out that:

> The production of pig iron can emit a series of gases and waste, such as 'suspended solids, cyanide, phenol, ammonia, oils, greases, blast furnace slag, coal fines, gas wash mud and balloon dust. These pollutants can cause intoxication, circulatory and respiratory problems, and other very serious problems'. (Mapa de Conflitos, 2018)

Additionally, Repórter Brasil and Sanchez and Pérez (2022, p. 8), citing the same Conflict Map report, add that "'the spaces of mines, steel mills [...] production and burning of coal' confine and isolate local populations, making their livelihood difficult and attacking their way of life". Multiple socio-environmental damages are observed in a territory weakened by the aggressive search for capital accumulation;

(2) depressed municipal and regional economy, caused by the closure of industrial structures and the dismissal of direct and indirect workers, which reduces the previously abundant (Nogueira, 2019) sources of revenue and financing for the municipality of Marabá in a historical stage of great demographic explosion and demand for public services;

(3) impact on social relations, with the overexploitation of labor and the demobilization of the working class caused by the threat of unemployment, by the "drama experienced by employees" due to layoffs and terminations without guarantees of "money to pay compensation" allegedly due to the accumulation of debts and by the legal proceedings for the bankruptcy of the pig iron factories (Fetim-BA, 2015), in addition to the precariousness of work and exposure of the population to environmentally deleterious technological trajectories, such as the option for "using scrap in the production process and reducing the proportion of pig iron necessary for the formation of the metal alloy" (Nogueira, 2019, p. 51). In this context, it exposes a portion of the working class, which was previously employed in direct and indirect industrial jobs of reasonable quality, to work with industrial waste in an attempt to survive;

(4) urban repercussions, with the population swelling in Marabá, followed by a land speculation process causing an exponential increase in the value of land, rents and construction materials. It forces occupations and invasions on the outskirts of the city and even in the MID area itself since at least 2010 (Mello, 2023), in places without sanitation, schools, health centers, access to transport and communications networks, responding to the "processes of capital accumulation and social reproduction concentrated in the territory" (Theis and Galvão, 2012, p. 60) even though it is totally devoid of infrastructure and resources to support the mass of workers vital for the functioning of the industrial hub;

(5) widening inequalities due to income concentration and the impoverishment of the working class, whose income has been affected by the crisis in the pig iron sector. It is worth remembering that the MID 3,295 direct workers employed in 2008 (Santos, 2015, pp. 2-3; Costa, 2022, p. 76), a number that fell to 250 direct workers employed in 2015 in the only pig iron plant in operation (Grupo Alterosa, 2015), a reflection felt in steel industry jobs which – disregarding the other sectors of the municipal and regional economy supported by indirect jobs linked to pig iron –, with a greater supply of unemployed and qualified workers available, forced wage squeezes;

(6) overflow of the demographic problem, with the transhumance (or expulsion) of the exploited working class to the territories adjacent to and close to Marabá due to the high cost of access to land and rents, replicating demographic and land access problems on a macro-regional scale, an effect of the dispute for control of the remaining resources, including urban land, income and public budgets. Melo (2016, p. 188) states that the region ends up presenting "a large migratory flow considering this development model, which forges the migratory processes" from the expulsion of this working class – who eventually become underemployed – marginalized and housed on the outskirts of Amazonian cities. According to Loureiro (2004, apud Melo, 2016, p. 188), this high migratory flow in the Legal Amazon, greater than in the rest of the country, is due to enclave economies, which is precisely the case of the GCP, which mobilizes immense amounts of labor. Melo (2016) even points out that the GCP and its projects (including the steel and metallurgical industries of Marabá and the CR logistics corridor) may have influenced, from 2011 onwards, the demographic flow towards Altamira-PA and Vitória do Xingu-PA for the construction of the Belo Monte Hydroelectric Power Plant, the Belo Sun mineral project and the agricultural projects of the Trans-Amazonian Highway. It is worth noting that there was also an expansion of mineral production and a demographic explosion towards Parauapebas, Ourilândia do Norte, Curionópolis, and Canaã dos Carajás, all located in Pará, in a period coinciding with the standstill and unemployment in the pig iron sector of Marabá.

The discussion and study of the formation of a brownfield in Marabá is far from being exhausted. The panorama encourages us to move beyond the key years indicated in the formation as a brownfield, that is, from 2008 to 2016. There is room for studies to delve deeper into the brownfield condition and its evolution during the following years, until 2021 or 2023, in which the city experienced new cycles of mineral and steel valorization, as well as transhumance as an overflow from the Marabá brownfield towards the mineral zones, large energy and agricultural projects in the Amazon. There is also an opportunity to establish comparisons with the other steel and metallurgical locations of the CR, that is, Açailândia, Bacabeira, Pindaré-Mirim, and Santa Inês, also affected by the closure of the pig iron ore mines during the 2008-2016 sectoral crisis.

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Notes

(1) In the article “Shrinking cities and resource-based economy: The economic restructuring in China's mining cities”, published in 2017, the authors Sylvia Y. He, Jeongwoo Lee, Tao Zhou and Dan Wu describe that, in resource-based economies, there is a tendency for urban shrinkage/depopulation to occur as resources are exhausted. In the research *A Formação de um Campo Marrom à Luz da Teoria da Periferia Mineral Amazônica: Serra Pelada*, published in 2021, the authors identify this phenomenon more broadly in mining areas, as an “overflow” of the demographic problem, since it disperses the unemployed working class to new areas of economic expansion, which highlights the potential to reproduce the phenomenon in an equal or expanded manner and in huge portions of the territory.

(2) According to Andrade (2020, pp. 111-112), these five companies were the pillars of the heavy steel industry in Brazil during the 20th century, but they did not inaugurate the Brazilian steel-metallurgical era. The author indicates the year 1557 as the founding date of the first “metallic iron factory” located in the city of São Paulo, a company owned by Afonso Sardinha. During the 19th century, the “Royal Factory of São João de Ipanema”, the “Royal Factory of Morro do Pilar” and the famous “Ponta d'Areia Foundry and Shipyard Establishment” began to operate. The Belgo-Mineira Steel Company emerged in 1921, forming the first national steel complex, which would later be surpassed by the colossal NSC – which was already within the developmentalist thinking.

(3) Sometimes, the city of Rosário-State of Maranhão is mentioned instead of Bacabeira-State of Maranhão. Less than 4 km separate the two cities. So, they are conurbated centers.

(4) The program was officially launched in 1982. It was regulated by the Decree-Law No. 1.813, of November 24, 1980, and by the Executive Decree n. 85.387, of November 24, 1980, which created the GCP interministerial council to oversee the program. Loureiro (2004, apud Melo 2016, p. 117) went so far as to consider the GCP a project “aimed at implementing a large steel hub in the Amazon”, although it is currently considered a “commoditized” economic enclave sustained by exports with little or no processing, mainly of iron, manganese, bauxite, copper, and nickel.

(5) Souza (2023, p. 99) states that “It is in the competitive pattern that the best bases are found […] to support the formation of the brownfield […].”. Teixeira de Souza and Silva (2021, p. 41) say that “[…] the more pronounced peripheral condition […] more quickly defined exhaustion and subsequent abandonment with socio-environmental liabilities” and that exhaustion is a “basic process for the formation of a brownfield” in a peripheral economy based on non-replicable or divisible resources.

(6) No clear definition was found for the term “mining-industrial”, but it would be vaguely defined as an extractive-transforming complex that would encompass areas of mineral deposits with industrial plants, where the mineral activity would be responsible for the “production of raw material” for the aggregation of industrial value in final or semi-benefiting plants on site or nearby (Distrito Federal, 2019).

(7) The article “Global Resource Depletion: Is Population the Problem?”, published in 2013 by Fred Magdoff, deals specifically with the peripheral mineral industry and not with the mineral processing industry in the periphery, which is one of the objects of this work. Therefore, the author’s use should be considered for his extremely important contribution to the problem of the center-periphery relationship related to the shrinkage/depopulation of urban peripheries, with care taken to consider the scales, which are sometimes very divergent, in the categories mentioned.

(8) Instead of being archaic, Nogueira (2019, p. 53) classifies pig iron as “an already outdated technology” that “[clashed] with the reality of the transformations of the globalized world and lost the little competitiveness” it could have had due to its proximity to mineral sources, the logistics corridor for transportation and the cheap regional labor force.

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