The urbanization process in the largest metropolitan area of Minas Gerais through the rivers and railways paths

Marcelo Maia, Marcela Marajó, Vitória Murata, Matheus Cintra, Nickolas Garcia
Federal University of Minas Gerais

Abstract

The largest metropolitan region in Minas Gerais, Brazil, located between mountainous terrain and the Velhas River Valley, is historically significant. This area connects key urban centers from Brazil's colonial gold era and the 19th-century industrial period. The research emphasizes the historical importance of the Velhas River Valley as a crucial route through the Iron Quadrangle, rich in gold, iron ore, and water. The establishment of the railroad along this valley further cemented its developmental role. The study underscores the significant influence of waterways and railways in forming Minas Gerais's primary metropolitan area, now the third largest in Brazil with over 5 million residents. The paper begins with the colonization and territorial expansion in Minas Gerais, highlighting the natural river routes and strategic railway placements that determined the main urban centers' locations. It then transitions to the Brazilian development era driven by road systems, noting the decline of railroads that once underpinned transportation and growth. This shift not only altered urbanization patterns but also negatively impacted the region's socio-environmental quality. The paper critically evaluates the transition from rail to road, observing the deterioration of socio-environmental cohesion and resulting fragmentation and territorial disorder in the Metropolitan Region of Belo Horizonte.

Keywords
Urbanization process, Railways, Natural systems, Velhas River Valley, Transport planning, Regions and regional planning in history, Cities and the natural environment

How to cite
Marcelo Maia, Marcela Marajó, Vitória Murata, Matheus Cintra, Nickolas Garcia, "The urbanization process in the largest metropolitan area of Minas Gerais through the rivers and railways paths". In Ian Morley and Hendrik Tieben (eds.), *International Planning History Society Proceedings*, 20th IPHS Conference, "The (High Density) Metropolis and Region in Planning History," Hong Kong, 2 - 5 July, 2024, TU Delft Open, 2024.

DOI: 10.7480/iphs.2024.1.7660

INTRODUCTION

The process of urbanization in the Metropolitan Region of Belo Horizonte[1] (RMBH) is investigated, adopting a perspective based on Yuk Hui's cosmotechnics[2] and the concepts of natural systems[3]. Traditionally, the origin of Belo Horizonte has been discussed as a continuation of the history of Ouro Preto, the former capital of Minas Gerais. This hegemonic narrative, which represents the official version of history, leaves in the background the particular techniques of the urbanization process of the region's original communities that developed on the banks of rivers and between mountains. In this study, we have built an analysis centered on the Velhas River and the mountains that shape and design the landscape of its valley. We believe that the river and the mountains are fundamental for discussing landscape and environmental aspects of the RMBH.

Yuk Hui's proposal of cosmotechnics as cosmopolitics is particularly interesting, as it suggests the need to identify processes and techniques based on diverse narratives in order to build a more inclusive and sustainable future. The predominant narrative of the Belo Horizonte Metropolitan Region (RMBH) often highlights a conflict between urban development and waterways and mountains, resulting in the degradation of these natural elements. In contrast to this perspective, and based on the thinking of Yuk Hui, this study seeks to develop a narrative that seeks a technique that integrates rivers and mountains into the urbanization process.

Another reference for our study is the notion of natural systems, which explores the complex interactions that define ecosystems and the importance of keeping these interactions balanced for environmental sustainability. We use the categories of geomorphology to analyze how mountains, rivers and other natural formations shape and are shaped by the societies that settle in them. In this approach, natural systems provide consistent inputs for a methodology of territorial analysis.

In opposition to a technical approach based on natural systems, we have Arão Reis's plan for Belo Horizonte[4]. This type of plan favored orientation and circulation using road axes as a structuring technique, disregarding waterways and relief. Thus, the river, as a planning unit and infrastructural basis for urban development, was discarded, and subsequent urban plans throughout the 20th century reinforced this technique.

NATURAL SYSTEMS AND THE URBANIZATION PROCESS

Geological and topographical features, often studied under the term geomorphology, are essential components of natural systems. By analyzing the forms of the earth's surface and the processes that shape them, geomorphology plays a fundamental role in understanding how these systems function and interact. Natural systems, in the geographical and environmental context, include all the physical and biological elements that interact within a specific ecosystem or environment. Geomorphological features[5], such as mountains, valleys, plains, and other landforms, are integral parts of these systems, as they influence and are influenced by other natural elements and processes, such as hydrology, climate, and biological activities.

Watersheds and watercourses, in particular, are clear examples of natural systems[6]. A watershed encompasses the entire land area where rainwater drains into a main watercourse, such as a river, lake, reservoir or ocean. These systems are dynamic and complex.

In the analysis made in the study presented here, we highlight two categories within the field of study of geomorphology; continuous valleys and slopes.

Continuous valleys play a central role in defining river basins and act as axes of convergence for smaller valleys, notable for their gentle slopes. They are very favorable locations for human settlement and agricultural activities, thanks to the availability of flat land and water resources. Essential for the development of efficient passageways and flows, they naturally support large territorial development infrastructures, giving up their riverbeds for waterways and their banks for railroads. As natural paths of shorter distance, valleys are suitable for becoming main mobility corridors, housing arterial roads and mass transit routes. These valleys go through phases of contraction and expansion, featuring both narrow areas and flat expanses, ideal for activities that require ample space and easy access for cargo vehicles, such as warehouses and industries[7].

The slopes, on the other hand, have varying gradients that directly influence the modes of occupation and use. Although they are generally not ideal for serving as direct passage corridors, they are crucial within the geographical unit in which they are located. A notable characteristic of hillsides is the area immediately above the valleys. This region, because it has a gentler slope, is often developed before the valley due to the difficulties related to sanitation and drainage faced by valleys. Initially, this area is urbanized while the valley remains unexplored. Over time, as the valley is urbanized, these two parallel roads evolve to form a dynamic binomial of activities, integrating commerce, services and other urban functions.

The urbanization process of the Velhas River Valley until the 20th century followed the natural systems, i.e. the infrastructure and location of urban settlements were consequences of the favorable conditions of the natural system. This mirroring of infrastructure with natural systems allowed for an organic and fluid development of the territory. For example, we have the infrastructure of the territory by waterway and railroad, which followed the continuous valleys. The waterway and railroad followed the river valley, connecting urban centers along an axis; these centers, in turn, were located on the hillsides along this axis, allowing immediate and quick access to the transportation system that connected the entire region. The hilltops remained unoccupied, preserving local springs and water sources. When the valleys showed phases of expansion, the nuclei expanded and received larger equipment, including industries, as in the case of the steel mills set up in the region.

Over the course of the 20th century, the development process gradually moved away from natural systems. The waterway, already prevented by the silting up of the river, and the decommissioned railroad were replaced by roads that allowed the tops of the hills to be reached. As a result, the vegetation on the upper slopes and the springs were compromised. The slopes became more prone to erosion and landslides, and the water supply was jeopardized. The automobile allowed access to areas that the railroad and waterway could not reach. This disconnected location from natural systems, when adopted on a large scale, resulted in unnatural urban development processes.

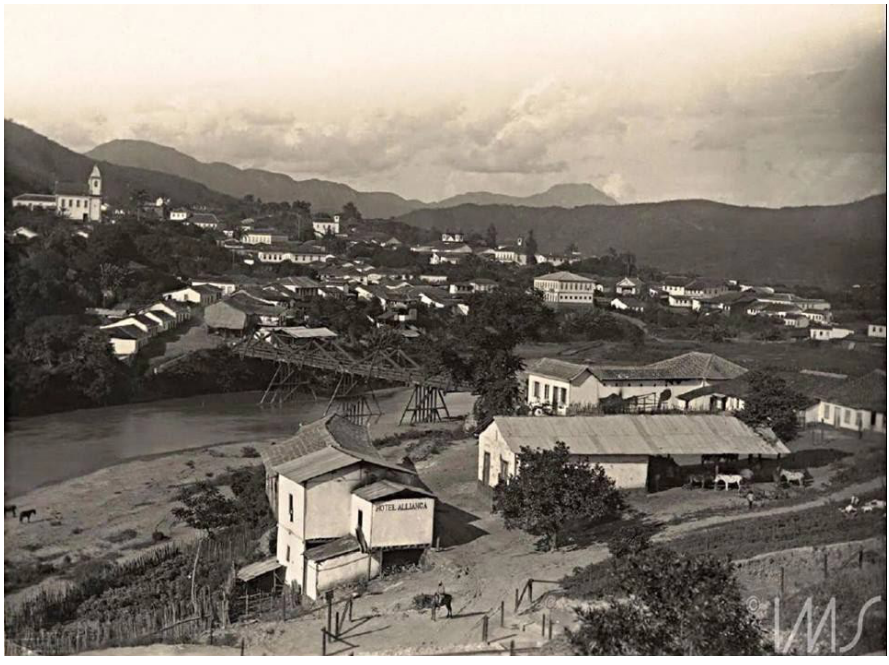

Fig. 1. Sabará, 1880.

BETWEEN RIVERS AND MOUNTAINS

The Velhas River, a tributary of the São Francisco River, flows towards the northeast of Brazil until it flows into the Atlantic Ocean. From the Atlantic, following the São Francisco River and then the Velhas River, you arrive in a mountainous region rich in minerals that became known as Minas Gerais. The place name Minas Gerais was used to indicate a long, continuous and contiguous sequence of mines.

It was exactly at the confluence of the Velhas River and the Sabará River that the urban center of the same name was established (Figure 1). This location was not chosen at random; the area was rich in alluvial gold, found in abundance in the sedimentary deposits of the region's rivers. The alluvial gold, found in the form of powder, fine chips or nuggets, was separated from the sediments using methods such as sieving and gravity[8] separation. Sabará was formed at the meeting of these two rivers and was the first settlement in Minas Gerais, consequently the place where the Metropolitan Region of Belo Horizonte (RMBH)[9] originated. Sabará is also the name of a river, a shortened form of the Tupi term *tesáberabusu*, which means big shiny eyes (*tesá*, eye + *berab*, shiny + *usu*, big), in reference to the gold nuggets that were found there[10].

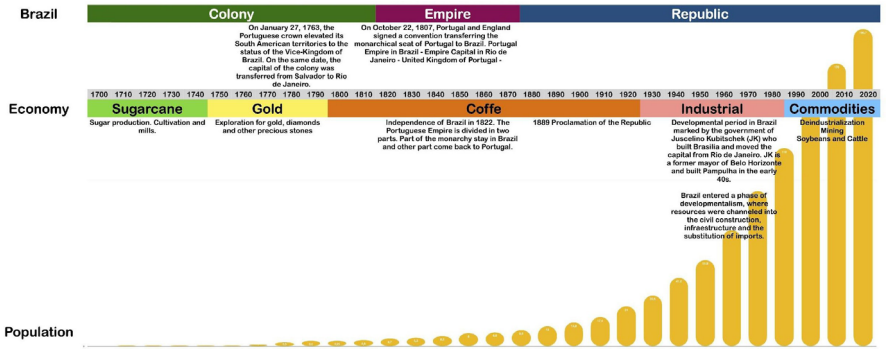

Fig. 2. Timeline of Brazil's historical, economic and population context.

To discuss a specific urbanization process, it is essential to place it in a historical context, highlighting the events that defined the periods in question and the economic aspects that drove the territory's development. The diagram shown in figure 2 offers a timeline that covers important moments in Brazil's history: the colonial period, the empire and the republic. It also provides an overview of the main economic cycles along this historical trajectory, superimposed on a graph showing the growth of the Brazilian population.

We have structured the analysis into four routes that represent a synthesis of the four historical moments that marked the process of urbanization in the region (Figure 3). The first route, coming from the interior of the country, was navigable by the Atlantic rivers as far as Sabará. With the discovery of gold, the move of Brazil's capital and the clearing of mountains and forests, a connection was established between Minas Gerais and the coast, highlighting the first confrontation between man and natural systems. This route was difficult and represented a struggle against the natural systems that had previously provided the infrastructure for territorial connectivity and urban expansion. In the third period, railway routes emerged, creating a basis for the process of industrialization and consolidation of regions, especially in the Zona da Mata.

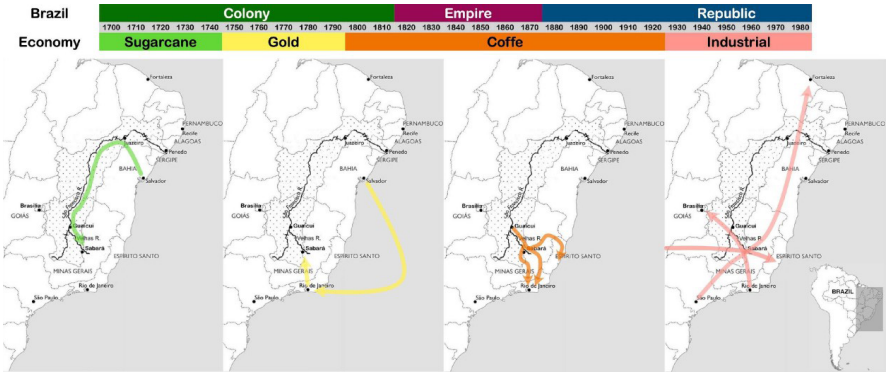

Fig. 3. Four routes that represent a synthesis of the four historical moments. Fonte: Elaborado pelo autor.

This period represented a return to natural systems, restoring rivers as axes of development and regional connectivity. In the fourth and final moment, the RMBH is cut off by national highways, experiencing its greatest economic and population expansion, again disconnected from the development axes provided by natural systems. These routes tear up the territory and create a rupture in the pre-existing urbanization process. The BR-040, for example, does not follow the Velhas River Valley as the Central Railroad did, but crosses the top of the mountains and arrives in Belo Horizonte from above, viewing it from above, crossing large viaducts over rivers, original urban centers and railroads.

THE FIRST ROUTE: THE RIVER

Rivers, as the pulsating veins of the Earth, have always played a crucial role in the expansion of human occupation, serving not only as sources of water, but also as natural pathways for exploration and the establishment of human settlements. The journey of the indigenous tribes across the American continent vividly illustrates this role. Starting from the north, these ancient travelers found refuge in caves along rivers, such as the middle Velhas River, in the heart of Brazil[11]. This river proved to be an archaeological landmark, with the unearthing of the oldest human fossil found in the Americas, Luzia[12], a few kilometers from its banks. As time progressed, the Velhas River not only housed the first human settlements, but also guided Portuguese explorers in their search for riches. Coming from the northeast, these explorers followed the course of the São Francisco River[13] and, later, the Velhas River, penetrating the center of Minas Gerais. Notably, the first gold nugget was found in 1677 near Sabará on the banks of the Velhas River[14] and in 1695 gold mines[15].

The city of Sabará stands out both for its historical references and for its unique location. Situated along the course of the Velhas River, the city is positioned where the river crosses a remarkable geological formation: the mountains that frame the south of the RMBH. This crossing takes place on a winding route between very steep slopes called gorges[16]. After this gorge, the river follows a less winding, slower course on a bed that was navigable[17] for many years.

THE SECOND ROUTE: THE MOUNTAINS

In Brazil's colonial history, when sugar cane production was the main economic activity, the colony's capital was Salvador. From Salvador and the Northeast, up the São Francisco River, you could reach Minas Gerais. The network of overland routes would only experience some progress after the discovery of the gold[18] deposits, driven by the need to create a faster connection to the coast and, consequently, to Portugal. This led to the emergence of new routes through the mountains across the Serra da Mantiqueira. Following this dynamic, the capital of the colony was transferred from Salvador to Rio de Janeiro, closely controlling the access routes to Minas Gerais from the coast. The Velhas River and the São Francisco River gradually lost their prominence, as did the entire economic cycle that moved the Brazilian Northeast and the former capital Salvador[19].

The journey to Minas Gerais at the beginning of the 18th century was extremely challenging, especially through the Serra da Mantiqueira, known as the "weeping mountain" due to its numerous springs and streams. During the rainy season, the crossing became even more arduous, with fog, constant rain and slippery trails. Mules and bales often fell into the gorges, while the trail turned to mud. The people of São Paulo used to say that "Minas begins where the roads end", and many didn't reach their destination, succumbing to the steep slopes, treacherous forests and precipices of the Mantiqueira[20]. This mountainous and wooded region is known as the Zona da Mata of Minas Gerais.

THE THIRD ROUTE: THE RAILROAD

One of the foundations of urban development near the Velhas River is the implementation of a railroad infrastructure, which is responsible for connecting the towns that surround it, allowing the movement of people, goods and services. The proposal of a route for the railroad that crosses this part of Minas Gerais was based on the physical characteristics of its watershed. In this sense, when observing Brazil's railway heritage, the paths of the tracks often coincide with watercourses. This can be explained by the need for a flatter topography for the railroad superstructure, as locomotives are not able to move on tracks with steep gradients. In river basins, the bed of a watercourse - the path of the river - is the portion with the lowest altimetry and least slope, and is therefore the most favorable location for building such a superstructure. The railroad installed near the river catalyzed new settlements and connected regions that were territorially distant[21].

The implementation of rail transport began in imperial Brazil, after a decree was issued in 1852 that introduced a guarantee of interest on the capital to be used in the construction of rail lines. This decree created the D. Pedro II Railroad, which connected the capital of the Empire to the capital of the province of Minas Gerais, Ouro Preto[22]. This railroad later became the Central Railroad of Brazil (*Estrada de Ferro Central do Brasil* - EFCB). Ouro Preto, located at the source of the Velhas River, along with Sabará, Caeté, Santa Luzia, Raposos, Nova Lima, Rio Acima and Itabirito, all historic urban centers along the Velhas River Valley, were connected by the EFCB. Later, in 1835, a law was passed authorizing the government to grant the right to one or more companies to build railways linking the capital of the Empire to the provinces of Minas Gerais, Rio Grande do Sul and Bahia. This law made it possible for coffee and sugar cane producers in the Zona da Mata to invest in railroads, creating a network of branches for the EFCB[23]. The railroads expanded and occupied the river valleys, creating a very efficient logistics network. The EFCB made possible the transition of the Zona da Mata from an agricultural economy to an industrial economy, and enabled the emergence of the steel industry in the Velhas River Valley, the cradle of the Brazilian steel industry. The Velhas River Valley reaffirmed its natural vocation of being the axis connecting the urban centers that originated in the gold cycle and made it possible for new urban centers to emerge with the expansion of the railroad, especially in the Zona da Mata.

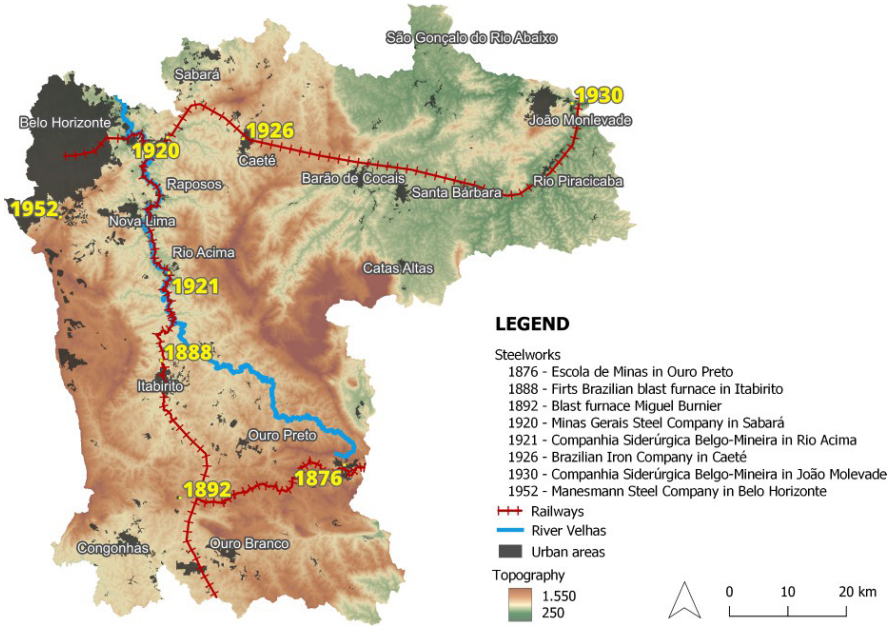

Fig. 4. The Velhas River Valley, the Central Railway of Brazil and the origins of the Brazilian steel industry.

The origin of the industry along the Velhas River Valley is deeply intertwined with the discovery and exploitation of iron ore in the central region of the Captaincy of Minas Gerais. This narrative begins in the mid-18th century, particularly in the city of Ouro Preto, where the Velhas River originates, and extends through the cities of Itabirito, Rio Acima, Sabará, and Caeté (Figure 4). In 1795, the potential for industrial growth in this region was recognized due to the abundance of high-quality iron ore and natural resources for charcoal production. Governor D. Rodrigo José de Meneses requested permission from the Court to establish new metal production factories to support mining issued a decree prohibiting the establishment of new iron-producing factories[24] and ordering the deactivation of existing ones[25].

The establishment of the Escola de Minas in Ouro Preto in 1876 provided the necessary educational foundation for advancing mining and metallurgical techniques in Brazil. The late 19th and early 20th centuries witnessed substantial industrial expansion along the Velhas River Valley. In 1888, the Usina Esperança in Itabirito marked the establishment of the first Brazilian blast furnace, stimulated by research from the Escola de Minas. The subsequent creation of additional units, such as the one in Miguel Burnier, highlighted the growing industrial capabilities of the region[26]. In the late 1920s, Companhia Siderúrgica Mineira was established driven by former students of the Escola de Minas, marked a significant milestone. Located in Sabará, the company benefited from the region's resources and infrastructure. Under the nationalist government of Arthur Bernardes, further efforts were made to secure the future of the steel sector. This included the transformation of Compan-

hia Siderúrgica Mineira into Companhia Siderúrgica Belgo-Mineira in 1921, following King Albert of Belgium's visit, which played a pivotal role in securing international investment[27]. The construction of the João Monlevade unit in the 1930s and the subsequent operations of new rolling mills in 1940 established Belgo-Mineira as the largest steel producer in Latin America. During World War II, the company took on the critical task of producing rails for Brazil's railway network. The equipment used was entirely built at the Monlevade and Sabará units. The production of the first rail occurred in 1943 and was the first in the history of Belgo-Mineira, Brazil, and also Latin America[28].

THE FOURTH ROUTE: THE VIADUCT

According to Pereira and Lessa[29], since 1930, the Brazilian government has invested heavily in land transportation infrastructure, mainly roads, promoting policies that have intensified the use of the national road network. In 1934, the Vargas government formalized the General National Road Plan[30], which, although

superficial in terms of road policy, served as the basis for national transport coordination. Continuing with the road transport policy, in 1944 the Getúlio Vargas government created the National Road Plan (*Plano Rodoviário Nacional* - PRN), prioritizing the economic use of the existing road network and proposing the construction of 27 federal highways, subdivided into three axes: the first, consisting of six longitudinal highways (north-south direction); the second, consisting of 15 transverse highways (east-west direction); and the third, consisting of six connecting highways. The classification of highways into longitudinal, transversal and link[31] served as the basis for classifying highways in subsequent plans.

Fig. 5. Viaduto Vila Rica, 1957. Originally named the Viaduto das Almas, this viaduct spans the Córrego das Almas, a tributary of the Velhas River. Located on the BR-040 highway, connecting Rio de Janeiro to Brasília, it is 50 km from Belo Horizonte and has a length of 262 meters..

Fig. 6. Inauguração Viaduto Vila Rica, 1957.

In the 1950s and 1960s, Juscelino Kubitschek's government consolidated the preference for road transport as a support for industrial development, particularly with the automobile industry. The Plano de Metas (Target Plan), as reported by GEIPOT[32] in 2001, was a strategy by the government of Juscelino Kubitschek to concentrate investments in transportation infrastructure in order to support the development of industrial parks and agricultural and agro-industrial projects in Brazil. This plan placed particular emphasis on road infrastructure, which became the main mode of transport and received the lion's share of investment, with the emphasis on a five-year road works plan. The construction of Brasilia, the implementation of major roads and agricultural modernization were some of the main projects that boosted the national economy.

The expansion of the road system and Brazilian industry took place during the same period in which the city of Belo Horizonte grew. The new capital experienced timid growth for a few years, but from the 1930s onwards, the city began to expand rapidly. Belo Horizonte was crossed by three major highways of Vargas' NRP: a transversal one (east-west direction), connecting the central-west to the coast; a longitudinal one (north-south direction), connecting São Paulo to the northeast; and a connecting one, connecting Rio de Janeiro to the new capital of Brazil, Brasília. These three important roads converge in Belo Horizonte in a Ring Road.

Connected nationally by this system, Belo Horizonte industrialized and grew along its Ring Road and the highways that came to and from it. Throughout the 20th century, the RMBH grew and consolidated along these highway routes, which literally pass over rivers, valleys

and railroads, leaving the original urban development axes out of sight and out of mind. The new highways flow over the mountains, with their infrastructure overlapping the natural systems. introduced to prioritize the economic use of the existing road network, with the proposal to build 27 federal highways organized along three axes. The Joppert Law of 1945 further strengthened the expansion of highways by reorganizing the DNER and creating the National Highway Fund, which would finance the construction and maintenance of federal, state and municipal highways, as well as encouraging the creation of State Highway Departments (Departamento Estadual de Estradas e Rodagem - DEER). This legislation represented a milestone in the institutionalization of road transport policy in Brazil.

FINAL CONSIDERATIONS

In addition to its importance for exploration and settlement, the Velhas River also facilitated navigation and the construction of infrastructure, such as railroads, which made it possible to found the first Brazilian steel mills and facilitate the exploration and export of iron ore. These natural routes were fundamental to economic development and regional integration. Rivers, exemplified here by the Velhas River, are infrastructures of natural systems that have led humanity through its historical journey, shaping civilizations and cultures along the way.

Throughout the 20th century, a series of policies beginning with the National Road Plan (1944) resulted in the double abandonment of the Velhas River, leaving it literally on the sidelines (southeast) of the development of the RMBH. Over the years, the river suffered environmental neglect and lost its leading role as a regional infrastructural axis. These two processes - urban underdevelopment and the degradation of its bed and banks - occurred simultaneously. In the second half of the century, already relegated to the underdeveloped area in the southeast of the RMBH, the river began to receive sewage from Belo Horizonte. The place that used to attract crowds to extract gold from its banks, the origin of Minas Gerais' urbanization and the source of its wealth, is now a sewer.

Considering the analysis made, we identified that occupying continuous valleys and areas close to rivers, from a technical point of view, is not a bad alternative when it comes to environmental issues. Occupying areas far from valleys does not impede the flow of natural systems; in fact, water ends up flowing into these areas, taking pollution and waste with it. Therefore, being far from the river does not result in a disconnection from it. Being close to the river has the advantage of technically integrating the river landscape with the urban development process. In practical terms, the impacts are visible and immediate. On the other hand, occupying regions far from rivers has a major disadvantage: occupying hilltops causes irreversible environmental damage, such as the loss of springs and the pollution of water sources.

Stopping development and occupying river valleys is not an effective alternative for preserving rivers; on the contrary, it can result in a profound disregard for them. This story shows us that if what lies beneath is not seen, it produces no memory and tends to be forgotten and neglected in development plans.

REFERENCES

Abreu, Maurício de Almeida. *Evolução Urbana do Brasil*. Rio de Janeiro: Instituto Pereira Passos, 1999.

Almeida, T. 2011. "Berço de Ouro." *Revista Mineração*. Accessed May 21, 2024. https://revistamineracao.com.br/2011/11/01/berco-de-ouro/.

Arquivo Nacional. *Estrada de Ferro D. Pedro II*. 2016. Accessed May 21, 2024. http://mapa.an.gov.br/index.php/menu-de-categorias-2/317-estrada-de-ferro-d-pedro-ii.

Brasil Escola. "Mineração no Brasil Colonial." Accessed May 21, 2024. https://brasilescola.uol.com.br/historiab/mineracao-no-brasil-colonial.htm.

Capra, Fritjof. *The Web of Life*: A New Scientific Understanding of Living Systems. New York: Anchor Books, 1996.

CBH Rio das Velhas. "História - CBH Rio das Velhas." Accessed April 18, 2024. https://cbhvelhas.org.br/historia/.

CDE Group. "Mineração de Ouro de Aluvião." Accessed May 21, 2024.

https://www.cdegroup.com/pt-br/aplicacoes/outras-aplicacoes/mineracao-e-minerio-de-ferro/mineracao-de-ouro- de-aluviao.

Constantino, N. R. T., F. M. Foloni, and K. G. Biernath. "Rios e Ferrovias: Conexões e Identidade entre a Cidade e a Paisagem." In *Patrimônio, Paisagem e Cidade,* edited by Marta Enokibara, Nilson Ghirardello, and Rosio Fernández Baca Salcedo, 59-82. Tupã, SP: ANAP - Associação Amigos da Natureza da Alta Paulista, 2016.

Accessed May 21, 2024. https://www.researchgate.net/publication/318140612_RIOS_E_FERROVIAS_CONEXOES_E_IDENTIDADE_ ENTRE_A_CIDADE_E_PAISAGEM.

Empresa Brasileira de Planejamento de Transportes – GEIPOT. Caminhos do Brasil. Brasília: GEIPOT, 2001. Fausto, Boris. *História do Brasil*. São Paulo: Edusp, 2013.

G1. "Minas do Ouro que Chamam Gerais." Minas 300 Anos, March 26, 2020.

https://g1.globo.com/mg/minas-gerais/minas-300-anos/noticia/2020/03/26/minas-do-ouro-que-chamam-gerais.gh tml.

Grandi, Guilherme. 2022. "Transportes e Planos de Viação no Brasil Imperial". Revista USP, nº 132 (abril): 101-24. https://doi.org/10.11606/issn.2316-9036.i132p101-124. p.104

Gregory, Kenneth J., and Andrew S. Goudie, eds. The SAGE *Handbook of Geomorphology*. London: SAGE Publications Ltd, 2011.

Governo do Estado de Minas Gerais. Secretaria do Planejamento e Coordenação Geral. Superintendência de Desenvolvimento da Região Metropolitana. *Plano de Ocupação do Solo da Aglomeração Metropolitana de Belo Horizonte*. PLAMBEL - Região Metropolitana de Belo Horizonte. 1976.

Hui, Yuk. The Question Concerning Technology in China: An Essay in Cosmotechnics. Falmouth: Urbanomic, 2016.

Instituto do Patrimônio Histórico e Artístico Nacional (IPHAN). "História - Sabará (MG)." Accessed May 21, 2024. http://portal.iphan.gov.br/pagina/detalhes/1825/.

Moholy-Nagy, Sibyl. *Urbanismo y Sociedad: Historia Ilustrada de la Evolución de la Ciudad*. Barcelona: Blume, 1970.

Navarro, Eduardo de Almeida. *Dicionário de Tupi Antigo: A Língua Indígena Clássica do Brasil*. São Paulo: Global, 2013.

Neves, O. R., and M. M. Camisasca. *Aço Brasil: Uma Viagem pela Indústria do Aço*. Belo Horizonte: Escritório de Histórias, 2013.

Pereira, L. A. G., and S. N. Lessa. "O Processo de Planejamento e Desenvolvimento do Transporte Rodoviário no Brasil." Caminhos de Geografia 12, no. 40 (2011). Instituto de Geografia, Universidade Federal de Uberlândia. Accessed May 21, 2024. http://www.ig.ufu.br/revista/caminhos.html.

Projeto Manuelzão. 2015. "A História da Ocupação Humana da Bacia do Rio das Velhas." Universidade Federal de Minas Gerais. Accessed May 21, 2024.

https://manuelzao.ufmg.br/a-historia-da-ocupacao-humana-da-bacia-do-rio-das-velhas/.

Oliveira, L. 2012. "Conheça o Barco a Vapor Pioneiro das Águas em Minas Gerais." Estado de Minas, December 8.

https://www.em.com.br/app/noticia/gerais/2012/12/08/interna_gerais,335440/conheca-o-barco-a-vapor-pioneiro- das-aguas-em-minas-gerais.shtml.

Rangel, C. H. 2016. "Barcos a Vapor no Rio das Velhas e São Francisco." Proteus Educação Patrimonial, September. http://proteuseducacaopatrimonial.blogspot.com/2016/09/barcos-vapor-no-rio-das-velhas-e-sao.html.

Wikipedia. "Luzia (fóssil)." Accessed May 21, 2024. https://pt.wikipedia.org/wiki/Luzia_(fóssil).

IMAGE SOURCES

Figure 1 Marc Ferrez. Moreira Salles Institute Collection.
Figure 2 Prepared by the author. Figure 3: Prepared by the author. Figure 4: Prepared by the author.
Figure 5 Laboratório de Fotodocumentação Sylvio de Vasconcellos da EAD/UFMG.
Figure 6 Arquivo O Cruzeiro, Estado de Minas. "Inauguração Viaduto Vila Rica, 1957.

ENDNOTES

1. The Metropolitan Region of Belo Horizonte, located in the state of Minas Gerais, Brazil, is the third-largest metropolitan area in the country, comprising Belo Horizonte and 33 other municipalities. This region has a population exceeding 5,8 million and is a significant economic and cultural hub. Belo Horizonte, the capital of the state of Minas Gerais, is a city of great significance to Brazil due to its position as one of the country's main economic, cultural, and educational hubs. With a diversified economy, the city stands out in the sectors of services, commerce, and industry, as well as being an important center for technology and innovation. Culturally, Belo Horizonte is known for its vibrant arts scene, music festivals, and rich gastronomy, reflecting the diversity and cultural richness of Minas Gerais. Additionally, the city is home to some of Brazil's leading universities and research centers, significantly contributing to the country's scientific and academic advancement.
2. Chinese philosopher Yuk Hui's cosmotechnics proposes a pluralistic approach, considering technologies as cultural practices rooted in specific contexts and not as neutral or universal entities. Yuk Hui proposes cosmotechnics as a cosmopolitics, suggesting the need to discover and integrate a diversity of techniques originating from different cultural narratives in order to build a more inclusive and sustainable future. From this perspective, we investigate urbanization techniques that could harmonize the coexistence between urban development and natural elements such as rivers and mountains. Cosmotechnics allows us to question the hegemonic narrative that often presents urban development in opposition to the environment, and to look for alternatives that integrate waterways and topography into urban planning. In: Hui, The Question Concerning Technology in China.
3. The natural systems approach focuses on the complex interactions that define ecosystems and the importance of keeping these interactions balanced for environmental sustainability. We use the categories of geomorphology to understand how mountains, rivers and other natural formations influence and are influenced by human societies. We analyze the RMBH considering natural systems as the basis for a territorial analysis methodology that incorporates the interactions between biotic and abiotic elements.
4. Arão Reis was the civil engineer and architect responsible for the original urban plan for Belo Horizonte, the new capital of Minas Gerais, inaugurated in 1897. In: Abreu, Evolução Urbana do Brasil.
5. Gregory and Goudie, The SAGE Handbook of Geomorphology.
6. Moholy-Nagy, Urbanismo y Sociedad.
7. Governo do Estado de Minas Gerais, Plano de Ocupação do Solo.
8. CDE Group, "Mineração de Ouro de Aluvião."
9. IPHAN, "História - Sabará (MG)."
10. Navarro, *Dicionário de Tupi Antigo*, 596.
11. Projeto Manuelzão, "A História da Ocupação Humana."
12. Wikipedia, "Luzia (fóssil)."
13. The São Francisco River is one of Brazil's most important watercourses and the fourth largest river in the country and in South America. With a length of 2,863 kilometers, its watershed covers an area of approximately 641,000 square kilometers, connecting states in the Southeast and Northeast regions of Brazil.
14. Almeida, "Berço de Ouro."
15. Fausto, *História do Brasil*, 98.
16. In geography, a gorge refers to a deep, narrow valley, often with steep sides, created by the erosion of a river. This term is suitable for describing landscapes where the river has carved a narrow, winding path through rocky or mountainous formations.
17. The Velhas River was navigated and integrated into the most extensive waterway network that has ever existed in Brazil. At the end of the 19th century, the state of Minas Gerais founded the Companhia Viação Central do Brasil with the aim of promoting river transportation in the São Francisco river basin. The steamer Saldanha Marinho was at the head of the company to carry fabrics and cotton, traveling as far as Juazeiro. This small steamer was a pioneer in the navigation of the São Francisco basin, traveling from Sabará to Guaicuí during periods of high water and from there, all year round, to Juazeiro, the northern terminus of navigation on São Francisco River. Guaicuí, or Barra do Guaicuí, is the place where the Velhas River flows into the São Francisco River. The name Guaicuí (in Tupi language) means "river of the velhas",

and "velhas" means old women in portuguese. Juazeiro is a Brazilian municipality in the interior and north of the state of Bahia. It was from the port of Juazeiro that the vessels known as steamers departed. It was the most important port on the São Francisco river and communicated with other riverside municipalities in Bahia and directly with the state of Minas Gerais. The steamboat Saldanha Marinho began operating on the Velhas River in 1871. Its construction was attributed to Henrique Dumont, Santos Dumont's father, near Sabará. In: Rangel, "Barcos a Vapor."; Oliveira, "Conheça o Barco a Vapor."

18. The gold cycle was a period in the 18th century, during colonial Brazil, when Brazil held half of the world's gold production, attracting many immigrants from Portugal and significantly increasing the colony's population. The gold cycle connected various regions, promoted the urbanization of the country and laid the foundations for Brazil's independence, which took place a few decades later.
19. Brasil Escola, "Mineração no Brasil Colonial."
20. G1, "Minas do Ouro."
21. Constantino, Foloni, and Biernath, "Rios e Ferrovias," 59-82.
22. Arquivo Nacional, *Estrada de Ferro D. Pedro II*.
23. Grandi, "Transportes e Planos de Viação no Brasil Imperial," 104.
24. [24] Neves and Camisasca, *Aço Brasil: Uma Viagem pela Indústria do Aço*, 28.
25. [25] This was a strategic move to ensure the colony remained focused on ore extraction and basic activities, leaving the more profitable processing and manufacturing to be conducted in Portugal. The prohibition was lifted in 1799 with the Royal Charter that encouraged the creation of iron processing factories. This led to the establishment of small iron forges using the African "crucible" method, a technique brought over from gold mining practices. The arrival of the Royal Family in Rio de Janeiro in 1808 further accelerated the development of the Brazilian steel industry. Tax exemptions on raw materials for metallic iron production and pioneering initiatives, such as the one led by Intendant Câmara in Morro do Pilar, marked the early attempts at industrializing the region.
26. Neves and Camisasca, *Aço Brasil: Uma Viagem pela Indústria do Aço*, 44.
27. Ibid, 53.
28. Ibid, 71.
29. Pereira and Lessa, "O Processo de Planejamento."
30. This plan initially supported the creation of the National Department of Highways (*Departamento Nacional de Estradas e Rodagem* - DNER) in 1937, which had a broad role in organizing, building, maintaining and regulating national roads. The DNER was also responsible for the creation of two major roads that would connect the South to the Northeast and North of Brazil. In 1944, the National Road Plan was
31. GEIPOT, Caminhos do Brasil. |
32. Ibid.

ACKNOWLEDGEMENTS

We would like to thank FAPEMIG for supporting the development of the Intelligent Urban Transport System research (universal demand APQ-02852-18), which provided subsidies for the study of the transport system in the Belo Horizonte Metropolitan Region. We would also like to express our gratitude to the MAPAS Project - Mapping, Analysis, Prognosis and Sustainable Actions, the result of the Partnership for Research, Development and Innovation (PPD&I) between VLI Multimodal S.A, the Federal University of Minas Gerais (UFMG) and the Federal Institute of Education, Science and Technology of Minas Gerais (IFMG) and its team, which contributed to the research and development of this study. The MAPAS Project is an initiative to develop innovative solutions to tackle the historical occurrence of irregular occupations at risk on the railway tracks operated by the concessionaire of the Brazilian railway system.

DISCLOSURE STATEMENT

The authors declare that there are no financial interests, competing interests, or institutional affiliations that could have influenced the research and its outcomes. The authors have no conflicts of interest to disclose.

NOTES ON CONTRIBUTOR(S)

Marcelo Maia is a Professor in the Department of Urbanism at the School of Architecture, Federal University of Minas Gerais (UFMG). His primary focus is on lecturing and researching the digital urbanization process, technology, landscape planning, territorial planning, and urbanization processes. Marcela Marajó, Vitória Murata, Matheus Cintra and Nickolas Gracia are undergraduate Architecture and Urbanism students at the School of Architecture of the Federal University of Minas Gerais.