GREEN LOGISTICS AND GEOGRAPHY SUSTAINABLE STRATEGIES FOR ENVIRONMENTAL TRANSFORMATION

https://doi.org/10.56238/sevened2025.008-026

Breno Bergantini Arantes[1], Adriano Reis de Paula e Silva[2] and Vitor Ribeiro Filho[3].

ABSTRACT

Green logistics has stood out as an essential approach to reducing the environmental impacts of logistics activities, promoting sustainability and operational efficiency. Geographic thinking, in turn, offers a strategic vision to understand spatial interactions and their influences on the environment. The objective of this study was to analyze the relationship between green logistics and geography, demonstrating how the integration of these knowledges can optimize resource management and minimize environmental damage. For this, a methodological approach based on a literature review was used, with the analysis of studies and data on sustainable practices in the logistics sector. The results indicate that the implementation of green logistics, associated with geographical thinking, allows the choice of more efficient routes, the reduction of pollutant emissions and the optimization of transport and distribution processes. In addition, the research demonstrated that the adoption of sustainable practices in logistics is essential to face contemporary environmental challenges, such as climate change and the degradation of natural resources. It is concluded that the combination of green logistics and geography represents a viable strategy to minimize environmental impacts, improve logistics efficiency and contribute to sustainable development.

Keywords: Green logistics. Sustainability. Geography.

[1]Student
State University of Minas Gerais – UEMG
Email: breno.1095746@discente.uemg.br
Work carried out with the support program: INSTITUTIONAL PROGRAM OF SCIENTIFIC AND TECHNOLOGICAL INITIATION SCHOLARSHIPS NOTICE 11/2022 – PAPq / UEMG
[2]Prof. Master
State University of Minas Gerais – UEMG
E-mail: adriano.reis.paula@uemg.br
Advisor professor who has the support: Human Resources Training Program – PCRH, FAPEMIG 04/2024 – Postgraduate Scholarships
[3]Prof. Dr.
Federal University of Uberlândia
E-mail: ribeirofilho.vitor@gmail.com
Collaborating Professor at the Institute of Geography, Geosciences and Collective Health - IGESC

INTRODUCTION

Green logistics has been consolidated as an essential concept in the search for sustainable alternatives in the logistics sector, aiming to minimize the environmental impacts resulting from the transport, distribution and storage of goods. Geographic thinking, in turn, plays a key role in understanding spatial interactions and formulating strategies to optimize logistics flows with less environmental impact. According to D'Agosto and Oliveira (2018), sustainability in logistics involves the adoption of practices that reduce the emission of pollutants, optimize the use of natural resources, and promote energy efficiency in supply chains. Thus, the relationship between green logistics and geographic thinking emerges as a relevant field of study for environmental transformation and sustainable development.

The research problem that guides this study lies in the need to understand how the integration between green logistics and geographic thinking can contribute to the reduction of environmental impacts in the logistics sector. Thus, the central question of the investigation is: how can geographic thinking be applied to green logistics strategies to minimize environmental impacts and promote sustainability? From this problematization, it becomes essential to explore the mechanisms by which geographical knowledge can be used in the formulation of logistical strategies that consider environmental, territorial and socioeconomic factors.

The overall objective of this research is to analyze the intersection between green logistics and geographic thinking, evaluating the main sustainable practices adopted in the logistics sector and how geographic knowledge can contribute to their optimization. In addition, it is intended to identify the challenges and opportunities in the implementation of these strategies, considering variables such as infrastructure, environmental policies and availability of technological resources. The research seeks to demonstrate that green logistics, when integrated with geographic thinking, can result in a more efficient and sustainable model of distribution and transportation of goods.

The relevance of this study lies in the need to promote a more sustainable logistics development model, aligned with global environmental guidelines and society's growing demands for responsible business practices. According to Barboza, Moori and Madeira (2019), the transport sector is one of the main responsible for the emission of polluting gases, requiring strategic actions to minimize its environmental impacts. Green logistics presents itself as a viable solution to this problem, as it allows the implementation of technologies and processes that reduce environmental degradation without compromising operational efficiency. In addition, geography provides a theoretical and methodological

framework that enables a detailed analysis of logistics flows, territorial dynamics, and socio-environmental impacts of transport operations.

The rationale for conducting this research is based on the urgent need to rethink traditional logistics and transportation models in light of contemporary environmental concerns. The accelerated growth of industrial and commercial activities has intensified the demand for efficient logistics solutions, while aggravating problems such as air pollution, excessive consumption of fossil fuels, and the degradation of natural ecosystems. According to Brito and Silva (2017), the adoption of sustainable practices in logistics is not only a legal requirement, but also a strategic factor for companies that want to stand out in an increasingly competitive market. In this way, understanding the interface between green logistics and geographic thinking can provide subsidies for the formulation of public policies and business initiatives aimed at sustainability.

The methodology used in this study is based on a literature review based on the analysis of academic and scientific sources on the subject, including articles, books and official documents that address the relationship between green logistics and geographic thinking. Studies dealing with the application of sustainable practices in the logistics sector were examined, as well as research exploring the influence of geography on the organization of logistics flows and the mitigation of environmental impacts. In addition, data on pollutant emissions, energy consumption, and environmental policies were analyzed to understand the impact of logistics strategies on sustainability. The research adopts a qualitative approach, seeking to interpret and synthesize the available information to provide a detailed overview of the topic.

The National Common Curriculum Base (BNCC) reinforces the importance of geography in the critical formation of individuals, highlighting its relevance for the understanding of spatial and environmental processes (Brasil, 2018). This knowledge allows logistics professionals to make more informed and sustainable decisions, considering variables such as distances, transport infrastructure, and environmental impacts. Gois and Hora (2019) point out that the implementation of green logistics in cargo transport still faces significant challenges, especially with regard to the adoption of sustainable packaging and the reduction of fuel consumption. These challenges reinforce the need for studies that deepen the relationship between logistics and geography, identifying innovative solutions to minimize environmental impacts.

In view of this, this study intends to contribute to the advancement of knowledge in the area of sustainable logistics, demonstrating how the incorporation of geographic thinking can make logistics operations more efficient and environmentally responsible.

Throughout the work, the main practices of green logistics, its environmental impacts, and the possibilities of applying geography to optimize processes and reduce negative externalities will be addressed. Thus, it is expected that this research will provide subsidies for future investigations and for the implementation of logistics strategies more aligned with the principles of sustainability and socio-environmental responsibility.

GEOGRAPHICAL THINKING AS A TRANSFORMING ELEMENT OF THE ENVIRONMENT

Girotto (2021) emphasizes that geographic reasoning has played a central role in the consolidation of geography as a science and school discipline, having a historical and epistemological trajectory deeply rooted in the development of this area of knowledge. The author points out that this concept not only structured academic geography, giving it a well-defined object, theory and methodology, but also became fundamental for its understanding in formal education. Similarly, Silva (2020) reinforces this perspective by arguing that geography, throughout its evolution, has appropriated geographic reasoning as an essential element for the construction of analytical and critical thinking, allowing individuals to understand the organization of space and the interactions between physical, social, and economic factors.

In the educational sphere, the relevance of geographic reasoning is manifested in the education of students, consolidating itself as a fundamental cognitive tool to interpret spatial processes. According to Oliveira (2019), this type of thinking allows the articulation between different scales and phenomena, stimulating the ability to question and analyze spatial patterns. The author's view converges with that of Girotto (2021), who points out that geographical reasoning is not just an academic construction, but a skill present in everyday life, employed by individuals and communities in the appropriation and transformation of space.

In addition, the geographical understanding of the world precedes its institutionalization as a school subject. According to Santos (2018), long before the formalization of geography teaching, human societies already used geographical reasoning when naming places, tracing routes, interpreting natural phenomena, and adapting to the environment. Such a perspective dialogues with Girotto's (2021) statement when he recognizes that geography was not an exclusive invention of the school or university, but rather a field of knowledge that emerged from the human need to understand and interact with space. In this sense, Almeida (2017) adds that academic geography, by incorporating

this reasoning, has enhanced the capacity for spatial analysis and decision-making, both in the educational context and in territorial planning.

Geographical reasoning, as Pereira (2016) points out, is not restricted to a theoretical structure, but is materialized in human spatial practices. The ability to connect different elements of space and understand environmental and social dynamics has been a guiding principle of geography since its inception. In this context, the logic of connection, highlighted by Girotto (2021), demonstrates the importance of geographic reasoning as a structuring factor of geographic thinking and interpretation of the world, both in the academic sphere and in everyday life.

> We can find it throughout the texts written by Alexander Von Humboldt, especially with regard to the emphasis that the author gives to the spatial connection between phenomena, one of the defining elements of geographical reasoning. In the famous map "Geography of equinoctial plants" it is possible to verify the author's concern with describing, analyzing, and building spatial connections between phenomena such as types of plants, altitude, changes in temperature, atmospheric pressure, etc. (Girotto, 2021, p. 3).

Humboldt, a renowned naturalist and explorer of the nineteenth century, was one of the precursors of geographical reasoning by emphasizing the spatial connection between phenomena, becoming a central figure in the consolidation of geography as a science. According to Santos (2018), the holistic and systemic approach proposed by Humboldt directly influenced the way geographic space came to be understood, integrating physical, biological, and human aspects. The effort to acquire this knowledge over historical time demonstrates the evolution of the capacity for spatial analysis, essential to understand environmental dynamics and the interactions between the elements that make up the planet.

In the contemporary context, geography, as a mandatory subject in basic education, plays a fundamental role in the formation of students' critical thinking. According to Oliveira (2019), the presence of geographic reasoning in elementary school is essential to develop students' ability to interpret spatial reality in a critical and reflective way. In this sense, the National Common Curriculum Base (BNCC), approved in 2017 by the Ministry of Education (MEC), reinforces the importance of this concept by establishing guidelines for its application in education. The BNCC, according to Costa (2020), guides the construction of school curricula, the formulation of pedagogical practices, and teacher training, ensuring that geographic reasoning is used as an essential tool in the education of students.

The BNCC recognizes spatial thinking as an indispensable element for understanding the contemporary world, establishing that geographic reasoning must be stimulated in order to integrate knowledge from various areas, such as Mathematics,

Science, Art and Literature. According to Almeida (2021), this interdisciplinarity makes it possible to solve complex problems related to spatial organization, geographic scales, and the impacts of human action on the environment. In addition, the BNCC emphasizes that geographic education should contribute to the development of skills aimed at the analysis of spatial phenomena, promoting a comprehensive and critical view of the processes of transformation of the territory.

With the rapid social and technological changes of the twenty-first century, society undergoes constant reconfigurations that affect ways of life, interpersonal relationships, and the organization of geographic space. According to Ribeiro (2017), the emergence of new technologies and economic dynamics requires individuals with specific skills, including geographic reasoning and spatial thinking, which are fundamental for understanding and adapting to this new reality. In the job market, the ability to analyze spatial becomes a differential, allowing individuals to understand the processes of urbanization, resource distribution, and environmental impacts in a more strategic and efficient way.

In view of this scenario, it is essential to discuss the teaching methodologies and cognitive processes that enable the acquisition and application of geographic reasoning in basic education. For Lima (2019), the teaching of geography should consider the students' previous knowledge and use innovative pedagogical approaches that stimulate reflection on the organization of space. In recent years, there has been a growing recognition of the importance of this concept in the education of students, especially with regard to environmental education, an area in which geographic reasoning can be widely applied to the understanding of socio-environmental dynamics and the formulation of preservation strategies.

In this sense, Castellare and Paula (2020) highlight that the use of geographic reasoning allows for an in-depth analysis of spatial phenomena such as floods, landslides, epidemics, pollution, and migratory flows, themes that directly affect the lives of populations. For the authors, geography, by providing tools to interpret these processes, enables the formulation of more effective public policies and greater environmental awareness. Thus, the application of geographic reasoning in basic education is essential to form critical citizens prepared to deal with contemporary challenges, promoting a broader and more integrated understanding of space and human interactions with the environment.

Geographical reasoning is based on the categories of analysis of geography, such as space, territory and landscape, allowing us to understand the complexities of the world from its spatial organization. According to Santos (2018), this reasoning involves logical principles that enable the identification of spatial patterns, relationships between

phenomena and their socio-environmental implications, being essential for environmental awareness and sustainable practices. Spatial analysis, therefore, enables the interpretation of maps and satellite images, helping to understand the distribution of geographic phenomena and their dynamics.

Location, one of the fundamental principles of geography, plays a central role in the interpretation of reality, as it provides meaning and relevance to spatial phenomena. According to Oliveira (2019), location can be absolute, established by geographic coordinates, or relative, defined by spatial relationships between different elements of the territory. Knowledge about location is essential for urban planning, natural resource management, and sustainable development, as it influences informed decision-making. For Rodrigues e Costa (2021), this principle has been used since primitive peoples, who organized their space based on classification, delimitation, and location, evidencing the need to understand where phenomena occur.

Another fundamental principle of geographic reasoning is scale, which allows us to analyze the interactions between local and global processes. According to Costa (2020), understanding spatial scales makes it possible to identify how external factors influence a given location and vice versa. This relationship between different geographic levels is essential to understand the environmental and social impacts arising from globalization, urbanization, and climate change, contributing to a broader and more integrated view of spatial dynamics.

The connection between geographical phenomena also stands out as an essential principle for understanding space. For Almeida (2021), events that occur in one region can have significant repercussions in others, demonstrating the interdependence of natural and social systems. This understanding enables a more accurate analysis of contemporary challenges, such as environmental disasters, migrations, and socioeconomic crises, favoring the development of mitigation and adaptation strategies.

Spatial differentiation, in turn, highlights the diversity of characteristics present in the territories. According to Ribeiro (2017), geography is dedicated to analyzing the heterogeneity of landscapes, natural and social systems, seeking to understand their specificities and interactions. This principle is essential for territorial planning, allowing the development of public policies adapted to the particularities of each region, promoting sustainable development and the reduction of socio-spatial inequalities.

Geographic reasoning is therefore an essential tool for the critical analysis of contemporary issues such as climate change, urban growth, and migratory flows. According to Lima (2019), the teaching of this concept in basic education is essential to form citizens

capable of interpreting and intervening in reality, making them more aware of the impacts of their actions in the geographical space. In addition, this knowledge enables more informed decisions in everyday life, such as choosing places to live, responsible consumption, and adopting sustainable practices.

The relationship between the development of geographic reasoning and environmental education highlights the importance of geography in raising awareness about the preservation of the environment. According to Castellare and Paula (2020), the analysis of natural and anthropogenic landscapes allows the identification of degraded areas, environmental problems, and ecological imbalances. This approach strengthens the perception of the urgency in environmental protection and the need for sustainable strategies to ensure a balanced future between society and nature. In this way, geography is an essential science for understanding environmental dynamics and for building a more conscious and responsible society in relation to the environment.

Geography contributes significantly to understanding the limitation of goods and services offered by physical environmental systems. According to Santos (2018), geographic reasoning makes it possible to analyze the spatial distribution of natural resources, such as water, fertile soils, and minerals, emphasizing their finitude and the need for sustainable management to ensure their preservation for future generations. This understanding is essential for the formulation of environmental policies that seek to balance the exploitation of natural resources and environmental conservation.

The impact of the extraction and excessive use of natural elements is also a relevant aspect. For Rech (2020), ecosystems play a fundamental role in providing indispensable environmental services, such as the supply of water, air, food, and raw materials. However, their degradation and uncontrolled consumption of these resources result in ecological imbalances and exploitation beyond sustainable limits. The author's vision dialogues with the need to establish exploitation practices that respect nature's capacity for regeneration and minimize environmental impacts.

Another essential factor in the study of geography is the identification of socio-environmental inequalities. According to Oliveira (2019), geography enables the analysis of the direct relationship between social and environmental inequalities, showing how political and economic factors influence unequal access to natural resources. Pollution, scarcity of drinking water, and vulnerability to natural disasters are issues that most intensely affect vulnerable populations, making the search for environmental justice a crucial element in the formulation of public policies and territorial planning.

Geography also provides subsidies to understand the interconnection between events that occur on the earth's surface. For Ribeiro (2017), geographic thinking allows us to reflect on the implications of human activities on the environment and the consequences of natural phenomena for society. Disorderly urban growth, the expansion of agriculture and accelerated industrialization are processes that directly impact ecosystems, requiring planning that reconciles economic development and environmental preservation.

In addition, geographical reasoning plays a key role in environmental planning and management. According to Lima (2019), the use of tools such as the mapping of sensitive areas and the identification of preservation zones enables more informed and accurate decision-making to ensure the protection and functioning of environmental systems at different scales. In this way, geography contributes to sustainable planning, promoting practices that minimize environmental impacts and ensure the maintenance of biodiversity.

GREEN LOGISTICS

Green logistics proposes to perform logistics functions, especially the movement of products, minimizing environmental impacts and reducing the energy consumption associated with these processes. According to Morais et al. (2022), the growing pressure from society and environmental regulations has led companies to adopt sustainable practices, including the proper management of waste from the products they sell. This move towards sustainability not only meets regulatory requirements, but also strengthens the corporate image by presenting companies as ecologically responsible.

Barboza et al. (2019) highlight that the transport sector represents a significant portion of CO2 emissions, being one of the main concerns of organizations seeking strategies to mitigate them. The adoption of green logistics allows not only the reduction of these impacts, but also promotes the conservation of resources, the efficient use of energy, and the reduction of waste along the supply chain. Brito et al. (2017) and Yu et al. (2021) corroborate this perspective by emphasizing that reducing carbon emissions will continue to be a challenge in the coming years, driving companies to seek more energy- and environmentally efficient solutions.

Minimizing the emission of polluting gases, such as carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), is one of the main objectives of green logistics. According to D'Agosto and Oliveira (2018), practices such as reducing the consumption of fossil fuels in logistics transport, the conscious use of natural resources and the proper management of solid waste become fundamental for the sustainability of the sector. In addition, strategies

such as recycling, responsible disposal of materials, and innovation in the energy matrix are essential to mitigate the environmental impacts of logistics operations.

The study by Gois et al. (2019) presents 28 practices aimed at transporting cargo in order to minimize environmental damage. However, the authors point out that most of these initiatives do not directly address the impact of packaging and the materials used in its manufacture, which directly influence the weight of loads and, consequently, fuel consumption. Santos et al. (2015), when analyzing 137 articles on the subject, highlight the relevance of "green packaging", which proposes the minimum use of packaging materials, ensuring functionality without compromising sustainability.

In the face of climate change and worsening global environmental conditions, green logistics emerges as an essential field of study to mitigate the negative effects of logistics activities. As Morais et al. (2022) point out, this approach is not restricted to the organizational scope, but has significant social implications, encouraging responsible and environmentally conscious practices. The search for sustainable solutions in the logistics chain represents, therefore, a strategic need for companies and a commitment to the environmental future of the planet.

REVERSE LOGISTICS AS AN ORGANIZATIONAL STRATEGY

According to Kumar and Tan (apud Sato, Carbonare, Moori (2006)), organizations have been forced to use LR as a strategy, namely: Environmental legislation, product life cycle, new distribution channels and market forces.

GREEN LOGISTICS AND GEOGRAPHY: SUSTAINABLE STRATEGIES FOR ENVIRONMENTAL TRANSFORMATION

Green logistics emerges as an essential approach to mitigating the environmental impacts caused by logistics activities. Its application is directly related to geographic thinking, which allows us to understand spatial interactions and their influences on the environment. According to D'Agosto and Oliveira (2018), sustainable logistics represents an advance in supply chain management, as it enables the optimization of processes in order to reduce the waste of resources and minimize pollutant emissions. The relationship between logistics and geography becomes evident when considering that decisions about transportation, distribution, and waste management are strongly influenced by spatial organization and available infrastructure. Thus, incorporating geographic thinking into logistics strategies allows for a more efficient and environmentally responsible approach.

Geography, by providing fundamental concepts for understanding spatial relationships, contributes significantly to green logistics. As highlighted by Castellar and Paula (2020), spatial thinking is a fundamental tool in the analysis of the distribution of resources and environmental impacts resulting from human activities. Geography makes it possible to identify spatial patterns that affect the distribution of cargo, the location of logistics centers, and the choice of more efficient routes. This is reflected in the need for integration between geographical knowledge and logistics practices to minimize environmental impacts and promote more sustainable development.

The National Common Curricular Base (BNCC) highlights the importance of geography in the critical education of students, emphasizing its relevance for understanding the interactions between society and the environment (Brasil, 2018). This knowledge allows future professionals to act more consciously in logistics management, implementing strategies that reduce the ecological footprint of operations. Geography, by addressing the interdependence between natural and social systems, provides a solid foundation for understanding environmental dynamics and for formulating sustainable solutions in green logistics.

Green logistics seeks to minimize environmental impacts, especially those related to CO2 emissions. According to Barboza, Moori and Madeira (2019), the transport sector is one of the largest responsible for the emission of greenhouse gases, requiring effective solutions to reduce these pollutants. Among the alternatives adopted, the use of electric vehicles, the optimization of routes, and the implementation of alternative fuels stand out. The application of geographic thinking in this context is fundamental, as it allows the analysis of spatial conditions and the best strategies to reduce energy consumption and pollutant emissions.

The relationship between green logistics and sustainable development is widely discussed in the literature. Brito and Silva (2017) argue that green logistics can be seen as a strategic component in companies' decision-making, since it contributes to the reduction of operating costs and the improvement of corporate image. This approach reinforces the need to integrate geographic knowledge in the definition of logistics strategies, allowing for more efficient and sustainable planning. In addition, geographic thinking makes it possible to analyze the location of companies in relation to consumption and production centers, contributing to the optimization of logistics chains.

Implementing green logistics practices in cargo transportation has been a challenge for many companies. Gois and Hora (2019) identified 28 good practices in this sector, but point out that many of them still do not address the issue of packaging and the type of

material used. Geography, in this sense, plays an essential role in providing information on the spatial distribution of solid waste and on the best practices for its management. The correct disposal of logistics waste can minimize environmental impacts and promote a more efficient circular economy.

The benefits of reverse logistics are also widely recognized in the literature. Morais, Maria and Oliveira (2022) highlight that this strategy allows the reuse of materials, reducing the need to extract new resources and reducing waste generation. Geography contributes to this process by providing information about the spatial flows of waste and the best locations for recycling centers. The application of geographic thinking in reverse logistics can optimize the return of products and reduce the environmental impacts of production chains.

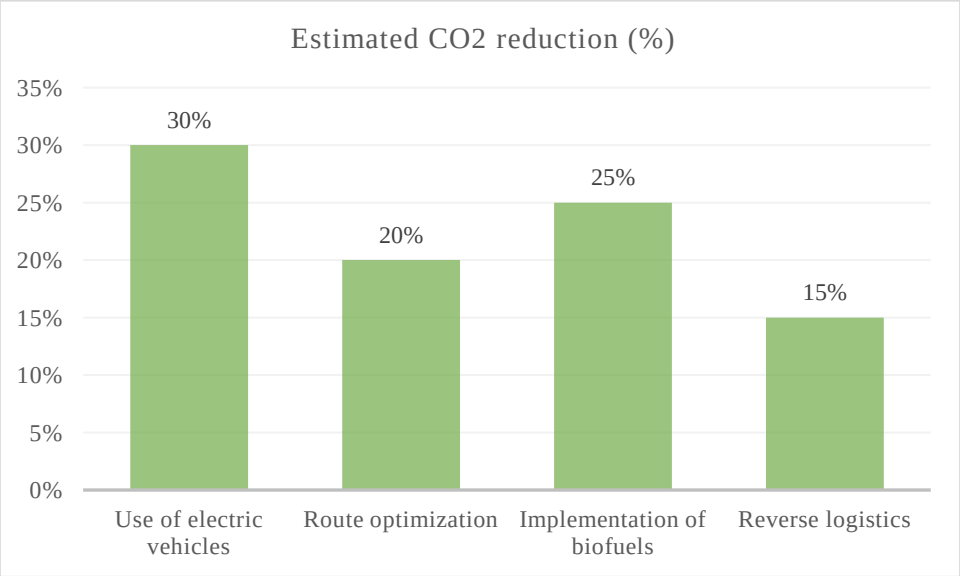
Public policies also play a key role in promoting green logistics. Santos et al. (2015) point out that environmental regulation has become increasingly strict, pressuring companies to adopt sustainable practices. Geography assists in the formulation of these policies by analyzing the spatial distribution of environmental impacts and identifying priority areas for intervention. This integrated approach between logistics, geography, and regulation can contribute to building a more sustainable and socially responsible economic model.

Another relevant aspect of green logistics is the reduction of dependence on fossil fuels. Yu, Zhu, and Tian (2021) highlight that the transition to renewable energy sources is essential for the sustainability of the logistics sector. Geography contributes to this process by providing analysis on the feasibility of deploying sustainable energy infrastructure, such as distribution networks for electric vehicles and biofuels. In addition, green logistics can benefit from identifying more efficient logistics corridors, reducing energy consumption and pollutant emissions.

The application of geographic thinking in green logistics allows for a holistic view of the environmental and social impacts of these activities. Rech (2020) highlights that artificial intelligence can be an ally in the analysis of this data, allowing the formulation of more accurate and effective strategies. The integration of advanced technologies with geographical knowledge can provide more sustainable and efficient logistics, reducing environmental impacts and promoting more balanced development.

To illustrate the impacts of green logistics on reducing CO2 emissions, the following is graph 1 with data on the main practices adopted by companies and their environmental effects:

*Graph **1**. Impact of green logistics practices on reducing CO2 emissions*



Source: From the authors, with data from Yu, Zhu and Tian (2021); Barboza, Moori and Madeira (2019); Santos et al. (2015); Morais, Maria and Oliveira (2022).

The relationship between green logistics and geography is essential to promote a more sustainable development model. Geographic thinking allows for the integrated analysis of logistics processes, contributing to the reduction of environmental impacts and the improvement of operational efficiency. In the face of climate change and growing regulatory requirements, the adoption of sustainable practices in logistics becomes a strategic necessity for companies and society. In this way, the combination of green logistics and geography represents a promising path for building a more sustainable and balanced future.

FINAL CONSIDERATIONS

In view of the analyses carried out, it is verified that the objective of the work was achieved by demonstrating the relationship between green logistics and geographic thinking as essential tools for environmental transformation. The research showed that the integration of these areas enables the adoption of sustainable practices in logistics management, contributing to the minimization of environmental impacts and the optimization of the use of natural resources. In addition, the data presented reinforce the importance of geography in understanding logistics flows and in the formulation of strategies that reduce pollutant emissions, promote the reuse of materials and favor the sustainability of production chains.

The research problem was answered by proving that green logistics, when associated with geographical knowledge, allows a more efficient planning of the spatial distribution of logistics processes. This approach makes it possible to reduce energy

consumption, improve waste management and optimize transport infrastructure. The challenges faced by companies in implementing these practices were also discussed, underscoring the need for more effective regulations and investments in sustainable technologies.

However, some limitations of the study should be considered. The complexity of logistical processes and variations in environmental policies in different regions may make it difficult to generalize the results. In addition, the lack of specific data on the adoption of sustainable practices in some geographic areas represents a limitation for a more accurate diagnosis of the environmental impacts of green logistics.

It is recommended that future studies deepen the analysis of the impacts of green logistics on specific sectors of the economy, as well as the influence of public policies on the adoption of these practices. In addition, more detailed research on the role of artificial intelligence and digitalization in logistics optimization can contribute to the expansion of knowledge about sustainability in the sector.

Thus, it is concluded that green logistics, combined with geographic thinking, represents a viable way to minimize the environmental impacts of logistics activities. Incorporating sustainable strategies into these operations not only reduces environmental degradation but also promotes a more efficient and balanced economic model. In the face of growing global concern about climate change and sustainability, the adoption of these practices becomes essential for a more sustainable and responsible future.

REFERENCES

1. Barboza, S., Moori, R. G., & Madeira, A. B. (2019). Fatores que colaboram para o desenvolvimento da logística verde nos operadores logísticos. REUNIR: Revista de Administração, Contabilidade e Sustentabilidade, 9(2), 20–29.

2. Brasil. Ministério da Educação. (2018). Base Nacional Comum Curricular. MEC.

3. Brito, M. F., & Silva, J. L. G. (2017). Logística verde: uma ferramenta estratégica na tomada de decisão. Revista Espacios, 38(18).

4. Castellar, S. M. V., & Paula, I. R. de. (2020). O papel do pensamento espacial na construção do raciocínio geográfico. Revista Brasileira de Educação em Geografia, 10(19), 294–322. https://doi.org/10.46789/edugeo.v10i19.922

5. D'Agosto, M. A., & Oliveira, C. M. (2018). Logística sustentável: vencendo o desafio contemporâneo da cadeia de suprimentos. GEN/Atlas.

6. Girotto, E. D. (2021). Qual raciocínio? Qual geografia? Considerações sobre o raciocínio geográfico na Base Nacional Comum Curricular. GEOgraphia, 23(51), 1–12. https://doi.org/10.22409/GEOgraphia2021.v23i51.a45460

7. Gois, L. E., & Hora, I. M. A. (2019). Aplicação da logística verde no transporte de cargas. Brazilian Journal of Production Engineering, 5(5), 117–128.

8. Morais, M. O., Maria, D. F., & Oliveira, L. M. de. (2022). Percepção dos benefícios da logística reversa e logística verde nas organizações. Journal of Technology & Information, 2(3).

9. Rech, A. (2020). Inteligência artificial, meio ambiente e cidades inteligentes. Educs.

10. Santos, J. da S., Bortolon, K. M., Chiroli, D. M. G., & Oiko, O. T. (2015). Green logistics: conceptualization and directions for practice. Revista Eletrônica em Gestão, Educação e Tecnologia Ambiental, 19(2), 314–331.

11. Yu, Y., Zhu, W., & Tian, Y. (2021). Green supply chain management, environmental degradation and energy: evidence from Asian countries. Discrete Dynamics in Nature and Society. https://doi.org/10.1155/2021/5179964