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# Territorial adaptation in peri-urban areas and analytical perspectives on the sustainable development goals in light of the literature

## Adaptação territorial em áreas periurbanas e perspectivas analíticas sobre os objetivos de desenvolvimento sustentável à luz da literatura

*Cristiane Criscibene Pantaleão*[1], *Tatiana Tucunduva Philippi Cortese*[1]

## ABSTRACT

The study aimed to map and analyze the main theoretical frameworks on climate change, extreme climate events, climate mitigation and adaptation, peri-urban areas, and nature-based solutions with a focus on examining how these themes are related to Sustainable Development Goals (SDGs) 11 and 13. In conducting this mapping, the study sought to gather and synthesize existing knowledge, highlighting key gaps and trends found in the literature. The research adopted a qualitative approach, characterizing itself as a theoretical and analytical study based on a literature review, whose data analysis was conducted using the content analysis technique proposed by Laurence Bardin (2016), with support from the ATLAS.ti software. The originality of the work lies in investigating how themes associated with the SDGs have been addressed in the international literature, contributing to the advancement of knowledge in the area. The results indicate that, although most articles examine the SDGs, their engagement tends to lack depth; furthermore, SDGs 11 and 13 appear with low incidence, and are generally linked to discussions about climate change, mitigation, and adaptation. From a theoretical and methodological point of view, the research offers insights to guide future studies and evaluate the presence of the SDGs, especially SDGs 11 and 13, in global urban climate actions, including the incorporation of technologies such as artificial intelligence in data analysis. From a social and environmental perspective, the investigation highlights an alignment between local perceptions and broader climate trends, reinforcing the relevance of local knowledge and the articulation between science, public policies, and community actions.

**Keywords:** climate action; peri-urban areas; Sustainable Development Goals; content analysis; theoretical-conceptual analysis.

## RESUMO

O estudo teve como objetivo mapear e analisar os principais referenciais teóricos relacionados a mudanças climáticas, eventos climáticos extremos, mitigação e adaptação climática, áreas periurbanas e soluções baseadas na natureza, com foco em examinar como esses temas se relacionam com os Objetivos de Desenvolvimento Sustentável (ODS) 11 e 13. Ao conduzir esse mapeamento, o estudo buscou reunir e sintetizar o conhecimento existente, destacando lacunas e tendências-chave presentes na literatura. A pesquisa adotou uma abordagem qualitativa, caracterizando-se como estudo teórico e analítico baseado em revisão da literatura, cuja análise dos dados foi realizada por meio da técnica de análise de conteúdo proposta por Laurence Bardin (2016), com apoio do *software* ATLAS.ti. A originalidade do trabalho reside em investigar como temas associados aos ODS têm sido abordados na literatura internacional, contribuindo para o avanço do conhecimento na área. Os resultados mostram que, embora a maioria dos artigos examine os ODS, o engajamento tende a carecer de profundidade; além disso, os ODS 11 e 13 aparecem com baixa incidência, geralmente associados a discussões sobre mudanças climáticas, mitigação e adaptação. Dos pontos de vista teórico e metodológico, a pesquisa oferece subsídios para orientar estudos futuros e avaliar a presença dos ODS, especialmente os ODS 11 e 13, nas ações globais de clima urbano, incluindo a incorporação de tecnologias como a inteligência artificial na análise de dados. De uma perspectiva social e ambiental, a investigação destaca o alinhamento entre percepções locais e tendências climáticas mais amplas, reforçando a relevância do conhecimento local e a articulação entre ciência, políticas públicas e ações comunitárias.

**Palavras-chave:** ação climática; periurbano; Objetivos de Desenvolvimento Sustentável; análise de conteúdo; análise teórico-conceitual.

[1]Universidade Nove de Julho – São Paulo (SP), Brazil.

Corresponding author: Cristiane Criscibene Pantaleão – Rua Vergueiro, 235/249 – Liberdade – CEP: 01525-000 – São Paulo (SP), Brazil – E-mail: c.c.pantaleao@uni9.edu.br

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## Introduction

Climate change has intensified the frequency and severity of extreme events, such as heat waves, floods, and droughts, thereby increasing urban socio-environmental vulnerability and placing additional pressure on infrastructure urban systems (IPCC, 2022; WMO, 2023). In this context, understanding the relationship between climate change and extreme events is essential for formulating integrated public policies that promote resilient development, risk reduction, and more sustainable cities, in line with Sustainable Development Goals (SDGs) 11 and 13 (United Nations, 2015b; IPCC, 2022; WMO, 2023).

Climate action measures that integrate mitigation and adaptation are essential to address the challenges posed by climate change, contributing to the reduction of greenhouse gas (GHG) emissions and the strengthening of socio-ecological resilience (IPCC, 2022). Climate mitigation involves efforts to reduce the causes of climate change through transition to low-carbon energy systems, preservation of carbon sinks, and reduction of resource consumption, while climate adaptation seeks to minimize adverse impacts and increase the adaptive capacity of communities and ecosystems. These integrated strategies contribute to the achievement of the SDGs, especially SDG 13, which calls for urgent and coordinated action among countries and sectors to respond to global climate challenges (United Nations, 2015b; IPCC, 2022).

Peri-urban areas, located at the interface between urban and rural zones, are an increasingly prominent focus in debates on climate resilience and sustainability, especially within the framework of SDGs 11 and 13 (Allen, 2003; Simon, 2016). These regions function as transition zones that, when well-managed, promote the reduction of pressure on urban centers while supporting the conservation of ecosystem resources, aligning with the goals of SDG 11, which seeks to promote inclusive, safe and sustainable cities, and SDG 13, which emphasizes the need for urgent action to combat climate change and its impacts (United Nations, 2015b; IPCC, 2022).

Within the urban context, peri-urban areas are defined as transition zones between consolidated urban spaces and rural territories, characterized by mixed land use, heterogeneous socioeconomic dynamics, and an intense interaction between urban and rural flows. Marked by processes of territorial expansion and fragmentation, they face significant governance and service provision challenges, while simultaneously offering a strategic potential for the supply of ecosystem services and sustainability solutions. Recent studies in the Brazilian context characterize them as hybrid spaces that demand integrated planning approaches and public policies sensitive to their socio-environmental vulnerabilities (Barbosa et al., 2022; Weins et al., 2022).

Peri-urban planning that integrates climate measures and green infrastructure can strengthen adaptation to extreme events and contribute to the fulfillment of SDGs 11 and 13 (United Nations, 2015b; IPCC, 2022). This requires incorporating mitigation and adaptation strategies into the central instruments of municipal management, such as the master and contingency plans for risk reduction. However, studies conducted in Brazilian cities indicate that this integration is still incipient, reinforcing the need for integrated territorial approaches tailored to peri-urban specificities to promote greater socio-environmental resilience (Teixeira and Pessoa, 2021; Villanova et al., 2024).

This study is rooted in the challenge of how cities can effectively contribute to achieving the SDGs through climate change mitigation and adaptation actions, especially in peri-urban areas, whose hybrid character between rural and urban areas requires nuanced approaches. To address this challenge, the overall objective of the research is to map and analyze the main theoretical frameworks related to climate action and peri-urban areas, identifying their connections with SDGs 11 and 13. By doing so, it aims to synthesize existing knowledge, highlighting gaps and trends in the literature.

In a literature review, mapping consists of identifying, organizing, and systematizing the existing body of literature on a given topic. It aims to recognize the key theoretical and conceptual frameworks, recurring themes, analytical approaches and dominant focuses, as well as the temporal and thematic distribution of publications and under-explored research GAPS that are still little explored. Unlike a traditional narrative review, mapping is not limited to describing studies; rather, it contributes to structuring the field of knowledge, enabling the visualization of the relationships between concepts and their evolution over time (Grant and Booth, 2009).

This review was developed in two complementary stages: first, a descriptive mapping of the literature was carried out to identify the main theoretical frameworks and the presence of SDGs 11 and 13 in the studies analyzed; second, a critical qualitative analysis was conducted using the content analysis technique. The latter sought to evaluate the depth and conceptual articulations between climate action, peri-urban areas and the SDGs.

The selection of these SDGs is based on their direct relevance to the research theme. SDG 11 aims to promote inclusive, safe, resilient, and sustainable cities by articulating social justice, resource efficiency and the reduction of socio-environmental vulnerabilities. SDG 13, conversely, guides the adoption of urgent measures to mitigate and adapt to climate change, emphasizing the integration of these actions into public policies, the strengthening of resilience to disasters, and the prioritization of vulnerable populations based on international cooperation and climate finance (PNUD, 2025).

The relevance of investigating themes linked to the SDGs lies in understanding how these issues have been addressed internationally. Mapping concepts, theoretical approaches, and methodologies consolidated in the literature contributes to the advancement of scientific knowledge and enables the identification of gaps, trends, and challenges that remain underexplored. In this context, the proposed analysis seeks to systematize these contributions, providing support and insights capable of guiding future research and strengthening the development of studies in this field.

## Methodological Procedures

This study adopts a qualitative approach, functioning as theoretical research based on a bibliographic review carried out in the Web of Science database. Data analysis was performed using the content analysis framework proposed by Bardin (2016), with the support of the ATLAS.ti software, which facilitated the organization, categorization, and systematic interpretation of the material. According to Bardin (2016), this technique enables the description and interpretation of textual content, producing indicators for analytical inferences. While ATLAS.ti assists in the systematization of data, the definition of categories and the construction of inferences remain under the responsibility of the researcher, guided by the adopted theoretical framework (Silva Junior and Leão, 2018).

In this study, the latest version of ATLAS.ti (25.0.1), released in December 2024, was used. This version incorporates artificial intelligence (AI) features that function as a technological tool to operationalize all stages of Bardin's (2016) content analysis, facilitating the analytical work and promoting the construction of relationships that underpin the treatment and inference of results. AI resources were specifically employed to create summaries, which supported the development of the group of memos — objects used to record notes, descriptions, and other information relevant to the research process.

Table 1 presents the relationship between the classic phases of content analysis and the functionalities of the ATLAS.ti software, highlighting how the technological tool supports each stage of the analytical process. The table illustrates the correspondence between methodological procedures of qualitative analysis and the software's resources, contributing to the systematization, organization, and interpretation of data throughout the research.

## Methodological path of data collection

Given the objective of mapping specific themes, this study adopted bibliographic research and its primary methodological procedure. The international database Web of Science was chosen due to its comprehensiveness and effectiveness in the indexing of scientific publications relevant to the topics analyzed.

Initially, a set of keywords was selected for insertion and search in the database, with the objective of conducting a literature review on the following topics: "climate change", "extreme weather events", "climate action measures", "nature-based solutions (NbS), "peri-urban areas" and "Sustainable Development Goals".

The analysis categories initially adopted matched the terms used in the search strings. However, given the semantic proximity between some concepts, the texts were manually read and coded to evaluate not only the presence of the terms, but also the depth of their treatment, distinguishing between superficial mentions and core discussions in the scope of the articles.

During the analysis process, emergent categories were incorporated into the coding stage, such as "the 2030 Agenda", "climate resilience", "ecosystem services" and "ecosystem-Based adaptation (EbA)". The inclusion of "the 2030 Agenda" is justified by the need to contextualize the SDGs within the framework of the United Nations global action plan. The refining of "resilience" into "climate resilience" resulted from the study's emphasis on environmental risks and extreme events, requiring greater conceptual precision. Furthermore, "ecosystem services" and "ecosystem-based adaptation" were incorporated due to their recurrence in discussions on NbS, as they represent specific approaches that leverage ecosystem functions to enhance climate change adaptation.

To map the international literature, the keywords were translated into English and organized into blocks, combined by Boolean operators (*OR* and *AND).* Different arrangements were initially tested in a single string covering all themes; however, the results were unsatisfactory, even after adjustments in the descriptors. Therefore, we decided to adopt two distinct strings in order to expand the scope and relevance of the selected studies. They are:

- String "1": (("climate change" OR "extreme weather events") AND ("sustainable development goals") AND ("climate action measures" OR "climate adaptation" OR "climate mitigation"));
- String "2": (("peri-urban areas" OR "urban fringes" OR "transition zones") AND ("sustainable development goals")).

The strategy adopted, therefore, sought to expand the scope of the research corpus and avoid the exclusion of pertinent studies, acknowl-

**Table 1 – Steps in the search content analysis process*.**

| Phase | Bardin's Content Analysis | Operation / Functionality of ATLAS.ti |
|---|---|---|
| 1 | Pre-analysis (floating read) | Import, organization and reading of documents, creation of memo for reflective notes; selection of the corpus. |
| 2 | Exploration of the material (categorization) | Texts coding and code creation; highlighting and segmentation of relevant snippets; annotation of comments. |
| 3 | Treatment of results | Grouping and hierarchization of codes; creation of networks and concept maps to visualize relationships; analysis of frequency and co-occurrence of codes. |
| 4 | Inference and final interpretation | Use of analytical memos to integrate the categories; export of reports and graphs to support inferences; preparation of a final report. |

*Meaning of "memo": refers to a brief message or note. Meaning of "corpus": refers to a collection or set of documents on a certain topic.
Source: based on Bardin (2016).

edging the theoretical fragmentation identified while preserving the analytical coherence of the mapping and content analysis carried out.

The search was conducted in May 2025 and structured in three stages. In the first stage, the total number of publications retrieved was obtained. In the second, inclusion and exclusion criteria were applied to refine the results. Finally, in the third stage, the abstracts were read to select the publications that effectively demonstrated an alignment with the research theme.

The inclusion criteria, applied through Web of Science platform filters, comprised peer-reviewed full articles, open access texts published in English and Spanish. The selected time frame spanned from 2015 to 2025, contemplating SDGs 11 and 13. The exclusion criteria consisted of books, conference reports, editorials, articles in languages other than those previously specified. Furthermore, grey literature was excluded (government documents, conference proceedings, theses and dissertations, technical and commercial documentation, non-academic documents and materials in general).

The results of this stage were organized in Table 2 for easy visualization, defining in step 3 the number of articles to be analyzed using the ATLAS.ti software, following Bardin's (2016) guidelines.

Using the documents selected in stage 3 (2015–2025), the phases of pre-analysis, exploration, processing, and inference of the data were carried out in ATLAS.ti, enabling the identification of trends and thematic gaps. During the coding process, one additional article was excluded as it was outside of the scope of the study, resulting in a final corpus of 3,535 documents for String 1.

The chosen time frame is justified by the milestone of 2015, the year of the approval of the Paris Agreement and the launch of the 2030 Agenda, which established the 17 SDGs. The Paris Agreement sets forth international commitments to limit global temperature rise and address climate change, while the 2030 Agenda defines an integrated action plan, composed of 17 SDGs and 169 targets, aimed at balancing the economic, social, and environmental dimensions of sustainable development (United Nations, 2015a).

## Results and Discussion

The analysis of the correlation between the SDGs and the research's theoretical frameworks, along with the identification of gaps and trends, provides a foundation for future investigations and for understanding the level of interaction of these objectives in actions aimed at climate change in the urban context. This investigation was based on the incidence of the SDGs, with an emphasis on SDGs 11 and 13, within the articles selected from the chosen database.

Reports and graphical representations were developed to support the inferences derived from the content analysis (Bardin, 2016), and operationalized through the ATLAS.ti software. The process of grouping and categorizing the codes contributed to the systematization and synthesis of the results. The identification and segmentation of relevant passages during the textual analysis enabled a robust theoretical articulation with the findings.

Figure 1 shows the quantitative distribution of articles by search string and year of publication, allowing the visualization of temporal trends in scientific production. It is observed that the themes within String 1 gained greater prominence between 2021 and 2023, peaking in 2023, with a decrease in 2024. In contrast, those of String 2 presented an emerging trend in 2021 and 2023, with minimal incidence in 2019 and 2020. The significant growth in publications associated with String 1, especially in 2022 and 2023, indicates thematic consolidation and a robust research trend during the period analyzed.

The graph and table also demonstrate variations in publication frequency between the different strings analyzed, evidencing a gap in the literature regarding the approach to peri-urban areas, the focus of String 2, compared to the prevalence of studies related to the SDGs and climate change mitigation actions, addressed in String 1.

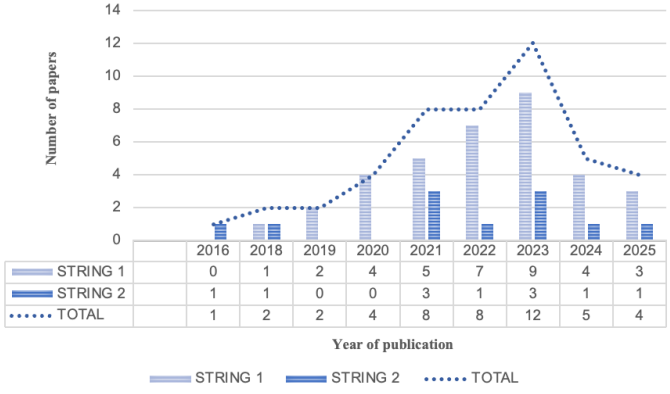


**Figure 1 – Distribution of publications in the period.**
Source: the authors through ATLAS.ti.

**Table 2 – Quantitative results found by search string at each stage.**

| N° | Search string | Number of documents | | |
|---|---|---|---|---|
| | | Stage 1 | Stage 2 | Stage 3 |
| 1 | (("climate change" OR "extreme weather events") AND ("sustainable development goals") AND ("climate action Measures" OR "climate adaptation" OR "climate mitigation")) | 165 | 73 | 36 |
| 2 | (("peri-urban areas" OR "urban fringes" OR "transition zones") AND ("sustainable development goals")) | 37 | 22 | 11 |

The need to employ two search strings stems from how the literature has treated the theoretical frameworks analyzed, which are rarely integrated within the same study. This characteristic highlights a relevant thematic gap in scientific production, identified and discussed as one of the key findings of this research.

Considering the primary objective of this study, to analyze the relationships between the adopted theoretical frameworks and the SDGs, particularly SDGs 11 and 13, the interrelationships identified in the literature were systematized through a co-occurrence analysis presented in Figure 2. This analysis highlights the degree of incorporation of the SDGs in the examined studies, using a chromatic scale to represent different levels of association. Four levels of co-occurrence were defined: light gray, indicating minimal incorporation; light blue, corresponding to a low level; medium blue, representing a moderate level; and dark blue, indicating a high level of articulation between the theoretical frameworks and the SDGs. The absolute frequency is indicated below each code, corresponding to the total number of occurrences in the analyzed works.

As highlighted by Stafford-Smith et al. (2017), the SDGs fulfill only a normative function, but also a structuring one, guiding strategic planning aimed at sustainability. Similarly, Dhanapal et al. (2023) emphasize that robust climate action plans are essential to meeting the requirements of the Paris Agreement and for the effective incorporation of the SDGs into public agendas. These studies, identified in the corpus analyzed, corroborate the results presented in Figure 2, which show high connection frequencies between the SDGs and the concepts of "climate change", "climate mitigation" and "climate adaptation", noting, however, that such articulations remain predominantly at the conceptual level. Following these, with considerably lower frequency, "2030 Agenda" and "NbS" stood out.

Regarding SDG 11 specifically, the most recurrent concept was "climate change", followed by "climate mitigation" and "climate adaptation".

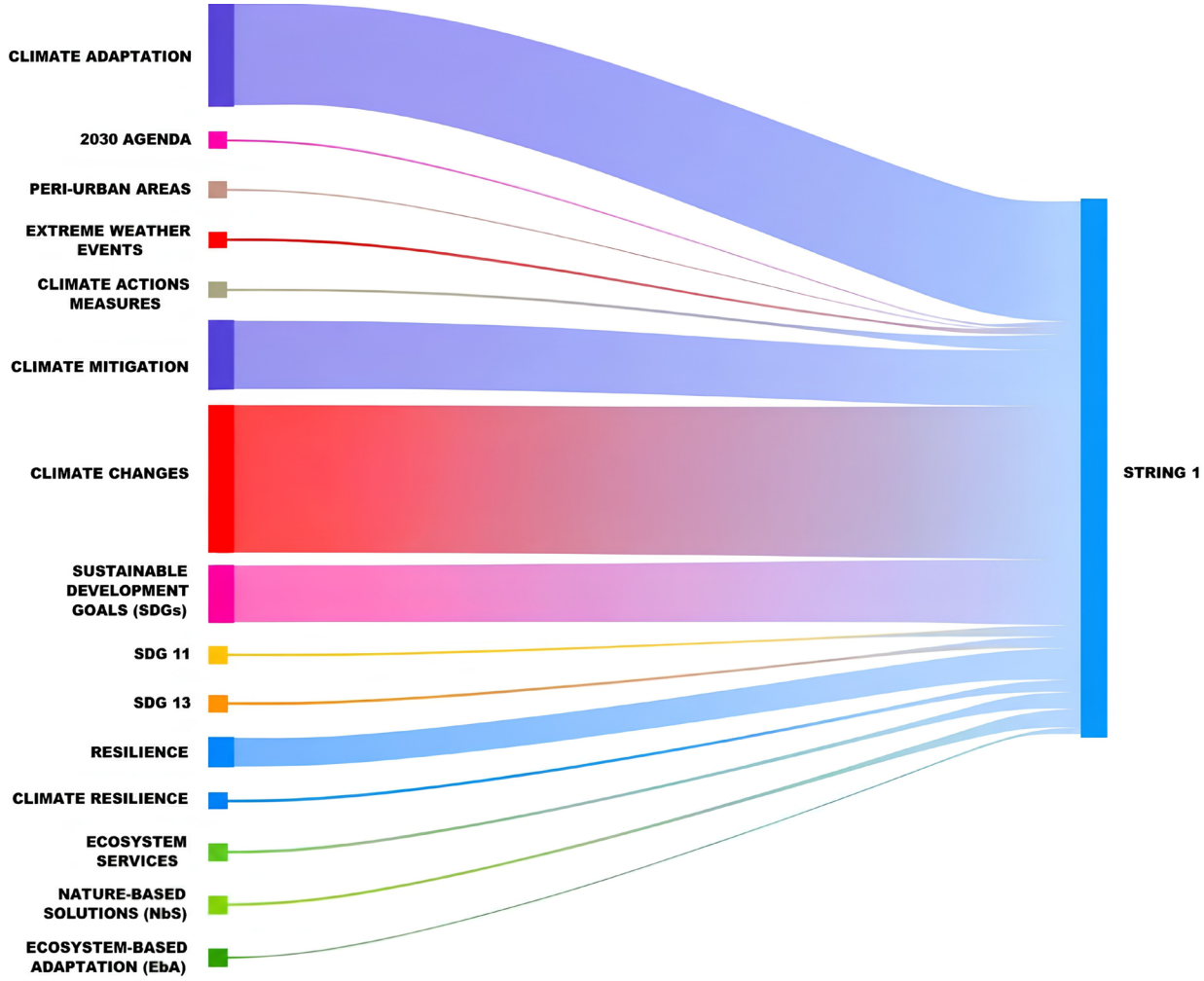


**Figure 2 – Sankey Diagram – Code x Document – String 1.**
Source: the authors through ATLAS.ti.

In turn, "2030 Agenda" presented the same number of occurrences as "climate adaptation", being followed by the concepts of "resilience" and, with only one occurrence each, "peri-urban areas" and "climate action measures". Concerning SDG 13, the concept of "climate change" was also more prominent, followed by "climate mitigation" and "climate adaptation". Subsequently, the concepts of "resilience", "climate action measures" and, with a single occurrence, "climate resilience" emerged.

The classification presented in Table 3 represents one of the key findings of the research, as it demonstrates the predominance of superficial associations and the limited conceptual integration of SDGs 11 and 13 in the literature analyzed. Studies indicate that the 2030 Agenda has incorporated disaster risk reduction into climate action (SDG 13) to promote resilient communities (SDG 11) and strengthen the national capacities, especially in developing countries (Uchiyama et al., 2021). However, the absence of specific action plans aimed at the SDGs — especially SDG 11 — remains significant in several countries (Zhang et al., 2020).

The results from both strings were integrated using Sankey diagrams, shown in Figures 2 and 3, which present the intensity of the associations between codes based on the thickness of the represented flows (Riehmann et al., 2005). Figure 2 (String 1) shows a predominance of the themes "climate change", followed by "climate adaptation" and "climate mitigation", while "peri-urban areas", "the 2030 Agenda" and "ecosystem-based adaptation" show a low incidence. The reduced frequency of SDG 13 is also noteworthy, despite its direct relationship with the core concepts analyzed. This pattern converges with the literature that points to the marginalization of peri-urban areas in urban planning and the persistent gap in integrating climate action, SDGs, and specific territorial contexts (Lima et al., 2022).

Figure 3, regarding String 2, indicates "peri-urban areas" as the theme with the highest incidence, followed by "2030 Agenda" and "sustainable development goals". "Nature-based solutions" and "ecosystem services" are also highlighted, showing the recurrent association between green infrastructure and peri-urban contexts. This result aligns with the literature that recognizes the multifunctionality of these areas and their strategic role in providing ecosystem services. Furthermore, it advocates the more effective incorporation of NbS in territorial planning as a means to enhance sustainability and socio-environmental resilience (Verdú-Vázquez et al., 2021; Lima et al., 2022; Malekpour et al., 2023).

On the other hand, there is a low incidence of the themes "climate action measures" and "SDG 13", the latter being directly related to action against climate change. Although the code referring to "SDG 11" is more frequent than "SDG 13", its presence in the analyzed studies is still limited, representing a significant gap in the literature. This absence is particularly relevant given that SDG 11 deals directly with sustainable urbanization and, specifically, its target 11.a explicitly identifies peri-urban areas as a priority for integrated urban planning policies.

Figure 4 presents three diagrams that compare the frequency and distribution of SDG approaches in the two strings analyzed. Although the SDGs appear broadly associated with the topics investigated, this relationship occurs predominantly is a generic way. Despite their direct connection to the study's object, SDGs 11 and 13 demonstrate a low interaction with other codes, evidencing a thematic correlation gap. Since the qualified incorporation of the SDGs in scientific production is fundamental to implementing their goals, this highlights the critical role of science in identifying challenges, formulating evidence-based solutions, and monitoring the progress of the 2030 Agenda.

As a strategy for synthesis and visual communication of the results, Figure 5 presents a bar graph quantifying the incidence of the themes by code, organized according to their respective color families. This representation consolidates the total number of occurrences identified in the analyzed articles, allowing a comparative and integrated reading of the frequency of the mapped concepts and highlighting predominant trends in the literature.

It is observed that "climate change" is the theme with the highest incidence, grouped in the same chromatic family as "extreme weather events". Although the first presents a high recurrence, the second appears less prominently, suggesting that, despite the growing recognition of the intensification of extreme events, this dimension is still not explored proportionately to its centrality of the climate debate. In the dark blue family, the codes "climate action measures", "climate mitigation" and "climate adaptation" reveal a marked asymmetry: while mitigation and adaptation are widely mentioned, the integrated treatment of climate action measures is less developed. This result aligns with recent literature, which recognizes mitigation and adaptation as foundation strategies for addressing the impacts of climate change, but points to the need for greater integration between the two in territorial planning (Schipper et al., 2024).

The concepts "resilience" and "climate resilience", although directly related to SDGs 11 and 13, showed a low incidence, suggesting that the debate on urban adaptive capacity does not yet occupy a central position in the theoretical analyses examined. Similarly, "peri-urban areas" showed a reduced presence in the corpus, despite its relevance to target 11.a of SDG 11, which emphasizes the strengthening of economic, social, and environmental links between urban, peri-urban, and rural areas (United Nations, 2015b). This gap reinforces the theoretical fragmentation identified in the literature and underscores the need for more territorialized approaches to climate action.

The green family, comprising "nature-based solutions", "ecosystem services" and "ecosystem-based adaptation", showed a lower incidence than expected, considering its potential as an integrated mitigation and adaptation strategy, especially in peri-urban contexts. Although these concepts are recognized as effective instruments for reducing vulnerabilities and increasing socio-environmental resilience (IUCN, 2022), their articulation with the SDGs and urban planning remains limited in the studies analyzed.

**Table 3 – Co-occurrence analysis of the concepts codified in ATLAS.ti.**

| | ECOSYSTEM-BASED ADAPTATION (EbA)) Gr=8 | CLIMATE ADAPTATION Gr=391 | 2030 AGENDA Gr=31 | PERI-URBAN AREAS Gr=53 | EXTREME WEATHER EVENTS Gr=27 | CLIMATE ACTION MEASURES Gr=47 | CLIMATE MITIGATION Gr=347 | CLIMATE CHANGES Gr=522 | RESILIENCE Gr=131 | CLIMATE RESILIENCE Gr=32 | ECOSYSTEM SERVICES Gr=69 | NATURE-BASED SOLUTIONS (NbS) Gr=76 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ECOSYSTEM-BASED ADAPTATION (EbA) Gr=8** | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 2 | 2 | 0 |
| **CLIMATE ADAPTATION Gr=391** | 1 | 0 | 3 | 0 | 3 | 5 | 55 | 98 | 35 | 5 | 9 | 9 |
| **2030 AGENDA Gr=31** | 0 | 3 | 0 | 7 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 3 |
| **PERI-URBAN AREAS Gr=53** | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 6 | 3 |
| **EXTREME WEATHER EVENTS Gr=27** | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 7 | 1 | 0 | 0 | 0 |
| **CLIMATE ACTION MEASURES Gr=47** | 0 | 5 | 0 | 0 | 0 | 0 | 5 | 9 | 3 | 0 | 0 | 0 |
| **CLIMATE MITIGATION Gr=347** | 0 | 55 | 0 | 0 | 0 | 5 | 0 | 125 | 5 | 1 | 2 | 12 |
| **CLIMATE CHANGE Gr=522** | 4 | 98 | 1 | 1 | 7 | 9 | 125 | 0 | 30 | 2 | 8 | 9 |
| **SUSTAINABLE DEVELOPMENT GOALS (SDGs) Gr=234** | 0 | 29 | 11 | 2 | 0 | 8 | 34 | 48 | 6 | 1 | 4 | 10 |
| **SDG 11 Gr=52** | 0 | 3 | 3 | 1 | 0 | 1 | 3 | 5 | 2 | 0 | 0 | 0 |
| **SDG 13 Gr=38** | 0 | 5 | 0 | 0 | 0 | 2 | 5 | 11 | 2 | 1 | 0 | 0 |
| **RESILIENCE Gr=131** | 0 | 35 | 2 | 0 | 1 | 3 | 5 | 30 | 0 | 0 | 2 | 5 |
| **LIMATE RESILIENCE Gr=32** | 2 | 5 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 3 |
| **ECOSYSTEM SERVICES Gr=69** | 2 | 9 | 0 | 6 | 0 | 0 | 2 | 8 | 2 | 1 | 0 | 3 |
| **NATURE-BASED SOLUTIONS (NbS) Gr=76** | 0 | 9 | 3 | 3 | 0 | 0 | 12 | 9 | 5 | 3 | 3 | 0 |

Source: based on data from ATLAS.ti.

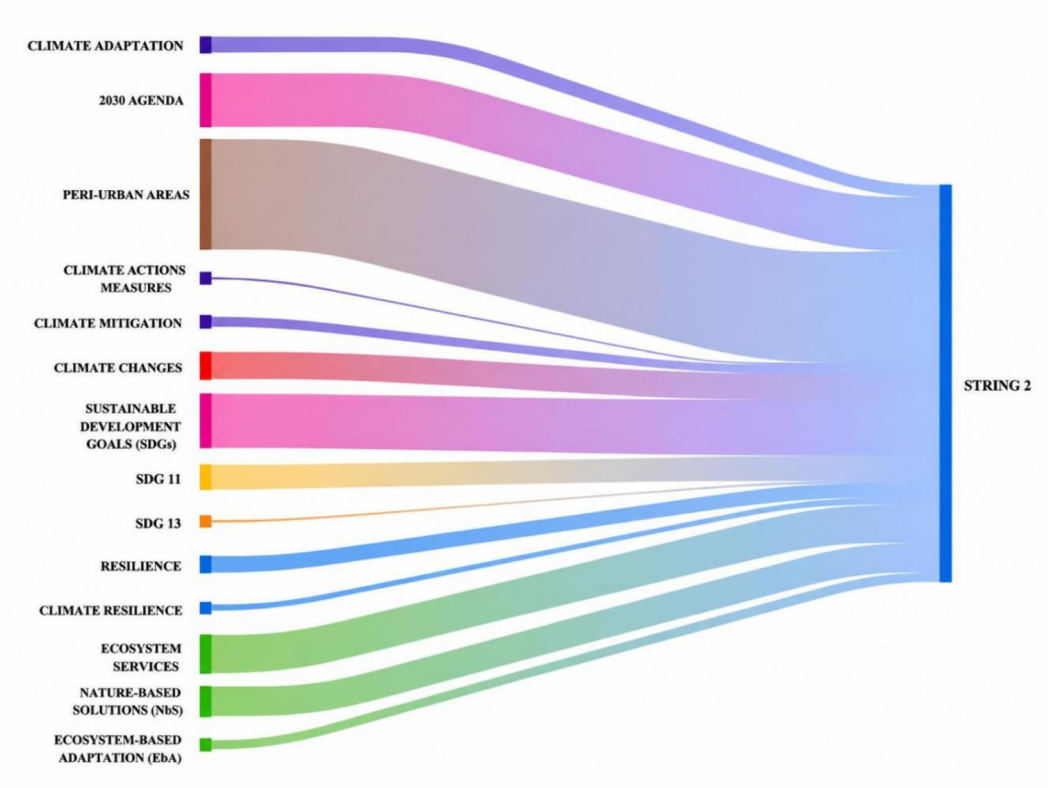


**Figure 3 – Sankey Diagram – Code x Document – String 2.**
Source: the authors through ATLAS.ti.

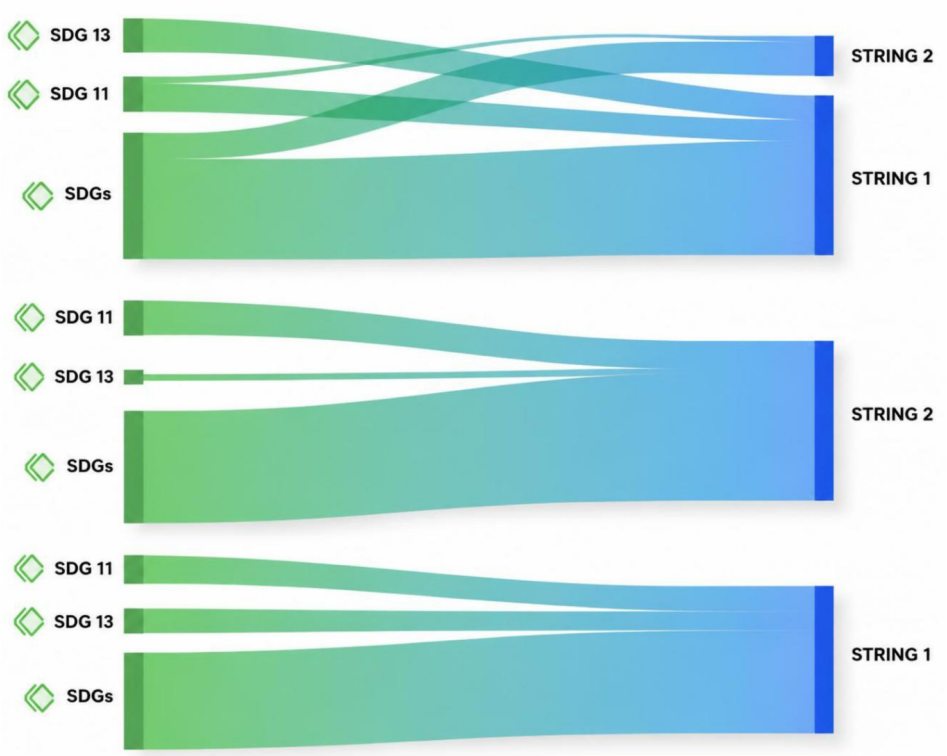


**Figure 4 – Sankey Diagram – Code x Document – ODS x Strings 1 e 2.**
Source: the authors through ATLAS.ti.

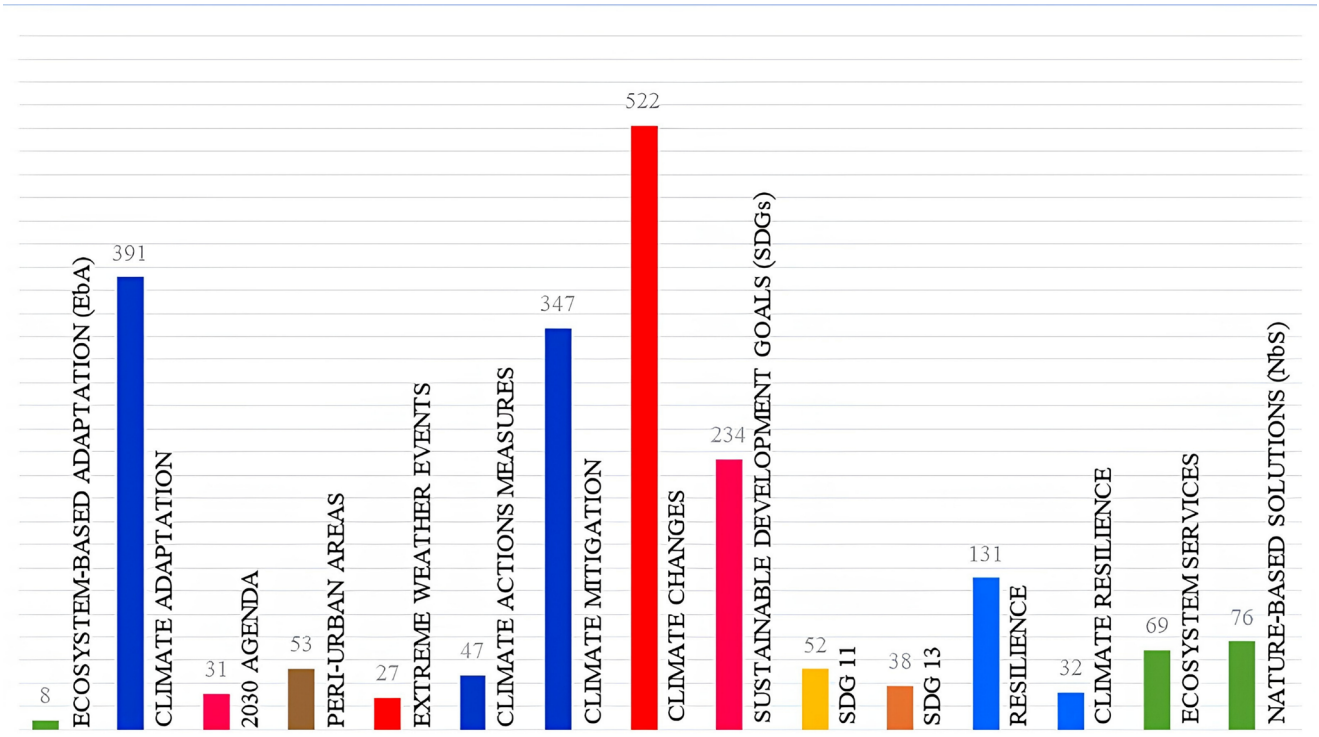


**Figure 5 – Integrated code quantification.**
Source: the authors through ATLAS.ti.

Regarding the terms related to the 2030 Agenda, "Sustainable Development Goals" occurs relatively frequently when treated generically, while "the 2030 Agenda" appears only sporadically. Specifically, "SDG 11" and "SDG 13" demonstrated a low direct articulation with the theoretical frameworks investigated, one of the most relevant findings of the research. This result suggests that, although the SDGs are present in academic discourse, their analytical incorporation remains superficial, indicating a mismatch between the normative centrality of the 2030 Agenda and its effective integration in debates on climate action and peri-urban areas.

In summary, the consolidated results reinforce the existence of a significant thematic gap, characterized by fragmented approaches and limited integration among climate change climate change, peri-urban planning, and SDGs 11 and 13. This highlights the need for more integrated and territorially sensitive research agendas.

## Conclusions

The results demonstrated that the proposed objective — to map the main theoretical frameworks and analyze their relationships with SDGs 11 and 13 — was achieved, allowing for a systematization of the state of the art and the identification of relevant trends and gaps in the literature. The analysis indicates the need to deepen discussions on mitigation, adaptation, and urban resilience, particularly within the scope of SDG 13, as well as to strengthen the articulation between SDG 11 and debates on peri-urban areas, urban-rural interactions, and multiple urban scales.

The identification of gaps in the literature, understood as missing information, theoretical inconsistencies or dimensions that are still little explored, is essential for the advancement of scientific knowledge. Such gaps highlight the explanatory limits of existing production and indicate opportunities for further investigation, especially in contexts in which certain phenomena remain insufficiently understood or lack more integrated theoretical approaches.

The findings highlight significant gaps in the literature, notably the low incidence of studies that simultaneously integrate climate action, peri-urban areas, and SDGs 11 and 13. There is a predominance of fragmented approaches, with a greater focus on climate change and less attention to peri-urban areas, climate resilience and, crucially, SDG 13. Although the SDGs are frequently mentioned, their incorporation occurs in a generic way and poorly aligned with their goals and the theoretical frameworks analyzed, revealing limited conceptual and territorial integration. These gaps underscore the need for more integrated research, capable of connecting peri-urban planning, urban resilience, and effective implementation of the 2030 Agenda.

The identification of trends is a fundamental step in understanding the state of the art of a thematic field and guiding the direction to pos-

sible directions of scientific production. By evidencing emerging patterns and conceptual transformations, trend analysis adds a dynamic dimension to the literature review, moving beyond a simple descriptive synthesis toward an evolutionary interpretation of knowledge.

Strengthening the integration between NbS, SDGs (especially SDGs 11 and 13) and peri-urban planning requires the adoption of conceptual and methodological guidelines that promote coherence between global agendas and local territorial instruments. In this sense, it is recommended to incorporate NbS as a structuring pilar in master plans and contingency plans, explicitly linking them to SDG targets and measurable indicators of climate mitigation, adaptation, and resilience. Methodologically, the use of integrated territorial analyses, the mapping of ecosystem services and the assessment of socio-environmental vulnerabilities are suggested as a basis to inform decision making. In addition, the promotion of multilevel governance and qualified social participation can ensure that the strategies adopted reflect the specificities of peri-urban areas. These propositions aim to transform NbS from normative concepts into operational instruments capable of guiding territorial interventions aligned with the 2030 Agenda.

As an agenda for future research, it is suggested that the analytical scope be expanded to other international databases, such as Scopus, which encompasses a broader set of journals, including regional publications that may reveal different approaches to the theme. In addition, methodological improvement of search and analysis strategies is recommended by disaggregating broad themes, for example, distinguishing specific types of climate adaptation, such as green infrastructure, planned retreat, or disaster warning systems, as well as by conceptually differentiating between categories often treated in aggregate, such as ecological resilience versus social resilience. Another relevant advance involves creating metrics to assess the depth of SDG incorporation in research, for example, distinguishing between superficial mentions, contextual use, or application as an analytical basis. Such strategies will foster more refined and comparable analyses, allowing a more precise understanding of how these concepts have been mobilized in the scientific literature.

## Authors' contributions

**Pantaleão**, C.C.: conceptualization; methodology; software; formal analysis; investigation; data curation; writing – revision, and editing. **Cortese**, T.T.P.: project management; supervision; validation.

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