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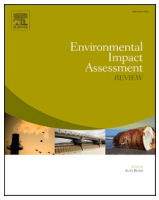

Integrating monitoring systems: Exploring the link between urban planning and environmental assessment

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ABSTRACT

The role of Strategic Environmental Assessment (SEA) in urban planning is becoming increasingly significant, as this tool can be valuable for promoting sustainability in cities, which are increasingly vulnerable to environmental and socio-economic impacts, such as climate change and biodiversity loss. Nevertheless, the practice of monitoring SEA processes and their respective plans remains underdeveloped, and it is primarily focused on narrow thematic approaches or on theoretical frameworks, lacking comprehensive data from real cases. Research that integrates and compares various environmental monitoring instruments across different assessments and plans is limited, with most studies focusing on thematic monitoring of individual SEAs or single plans. This research aims to analyze the relationship between spatial planning monitoring instruments and environmental assessment instruments, with a particular focus on how SEA processes may influence the design and content of spatial monitoring frameworks. Through a comparative analysis of 12 Portuguese municipalities using an analytical framework and content analysis of SEA and spatial planning monitoring reports, the study reveals that monitoring frequency is low, particularly for SEAs, where the practice is almost non-existent. The findings also indicate that the monitoring programs outlined in SEA Environmental Statements directly influence the development of one of the spatial planning monitoring instruments, the Report on State of Spatial Planning, highlighting opportunities to improve integration across environmental management tools. Additionally, this study emphasizes the need for further empirical research to deepen the understanding of challenges in monitoring SEAs within urban planning as in Municipal Master Plan frameworks.

1. Introduction

In urban contexts, Strategic Environmental Assessment (SEA) processes serve as important environmental policy tools to advance urban sustainability (Polido, 2023; Polido et al., 2018). The cities' preparedness to face the escalating impacts of climate change, to which they are particularly vulnerable (Intergovernmental Panel on Climate Change (IPCC), 2023; United Nations Conference on Housing and Sustainable Urban Development (UN-HABITAT), 2017), as well as other environmental and social threats, is enhanced by using SEA.

Given the rapid pace of environmental changes, assessing and monitoring urban environmental conditions have become indispensable for informing sustainable policies (Nakhle et al., 2024). Within SEA, monitoring allows for evaluating whether a plan or program achieves its objectives and verifies whether anticipated environmental impacts align with those observed in practice (Jiricka-Pürrer et al., 2021; Mascarenhas et al., 2012). Monitoring is especially valuable in bridging *ex-ante* and *ex-post* evaluations, facilitating the verification and application of recommendations and measures from SEA (González, 2022). In doing so, it fosters learning from the evaluation of past actions and informs future decisions in environmental management (Waylen et al., 2019b; Waylen et al., 2019a). Sustainability indicators are the primary tool for monitoring, supporting management, assessment, and reporting activities, facilitating more informed decision-making (Ramos, 2019; Ramos and Caeiro, 2010) and particularly important for SEA processes (Donnelly et al., 2007). Furthermore, there are scholars advocating for citizen

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science or "voluntary monitoring" to enhance monitoring reports (Domingues et al., 2018; Ramos, 2019).

Despite the potential role of SEA monitoring stage, the lack of robust monitoring systems is one of the key factors compromising SEA effectiveness (Peterson and Vahtrus, 2019). Environmental and sustainability monitoring of policies and plans remains underdeveloped across various spatial scales, including urban contexts (Rehhausen, 2019; Weiland, 2010). Different challenges hinder effective monitoring implementation, including insufficient collaboration between SEA and Municipal Master Plan's (MMP) professionals (Fernandes et al., 2024), unrealistic or lack sufficient available data, and impractical indicators that may fall outside the purview of the plan's management (González et al., 2019).

The level of abstraction, generalization, and uncertainties at the strategic level (policies, plans, and programs) pose further monitoring challenges in establishing causal relationships between the strategic instruments and their respective real impacts (Mascarenhas et al., 2012). A recommended approach to optimize SEA monitoring involves reinforcing the linkage between SEA requirements of specific plans and existing monitoring activities to reduce redundant efforts (González, 2022; Wallgrenn et al., 2011).

Some studies in the literature propose frameworks to evaluate the effectiveness of monitoring processes in environmental assessments in general, and particularly in the *ex-post* phase of SEA. Recent contributions, present indicator-based approaches to evaluate the effectiveness of SEA process (Therivel and Gonzalez, 2024) or the integration of monitoring with the Sustainable Development Goals (SDGs) (Nakhle et al., 2024). Previously, (Ramos and Caeiro, 2010) have developed a meta-evaluation assessing an evaluation framework used to measure the performance of sustainability indicators, exploring the relevance and integration of meta-evaluation into the assessment and monitoring processes. Santos Coelho et al. (2018), in turn, focus on the evaluation of indicators to assess sustainability, exploring their relevance and integration into monitoring processes, but without necessarily prioritizing practical application in the context of the *ex-post* phase. Baresi et al. (2020) propose a limits-oriented adaptive framework that addresses social and institutional uncertainties in SEA processes, offering valuable conceptual insights but not focusing specifically on monitoring. Chanchitpricha and Bond (2013) present a classic and widely cited framework, establishing categories of SEA effectiveness encompassing procedural, substantive, transactional, and normative dimensions, with a primarily theoretical orientation.

These studies reveal a significant lack of integration between monitoring instruments used in urban planning and SEA. Moreover, they highlight the crucial role of indicators in assessing the impacts of strategic actions (e.g. Mascarenhas et al., 2012; Ramos and Caeiro, 2010; Santos Coelho et al., 2018) and paths to follow, such as integrating the SDGs with monitoring frameworks (Nakhle et al., 2024), citizen science or "voluntary monitoring" (e.g. Domingues et al., 2018; Ramos, 2019) or advocating for the use of adaptive management for transformational change (Baresi et al., 2020). While most studies are primarily conceptual and intended to guide the development of monitoring systems (e.g. Chanchitpricha and Bond, 2013; González, 2022), there remains considerable uncertainty about how to apply these frameworks effectively in practice, particularly when implementing and evaluating operational monitoring systems.

Besides these frameworks, research examining the relationship between diverse monitoring instruments for land-use and environmental management is limited (Granceri Bradaschia et al., 2024; Hanusch and Glasson, 2008; Mascarenhas et al., 2012), typically focusing either on SEA monitoring schemes developed for a specific plan or on the monitoring already included within the plan itself.

In this sense, the framework developed by Waylen et al. (2019b) offers a particularly practical and integrated perspective, addressing both the implementation of monitoring programs for environmental policies and their connection to decision-making processes. By combining governance criteria, the thematic selection of indicators, and methods for data collection and processing, this framework can be especially relevant for evaluating the performance of SEA monitoring and extracting meaningful information from document analysis.

Within this context this research aims to analyze the relationship between spatial planning monitoring instruments and environmental assessment instruments, with a particular focus on how SEA processes may influence the design and content of spatial monitoring frameworks. It examines *ex-ante* and *ex-post* monitoring programs in terms of their content, execution, and use in decision-making. A comparative analysis across multiple cases from 12 Portuguese municipalities was conducted to achieve this objective.

This focus on the Portuguese context is particularly relevant given the persistent challenges observed in the integration of SEA into municipal spatial planning. Although SEA is formally required for MMPs, studies have shown that the process often begins late, after key planning decisions have already been made, limiting its potential to influence more strategic and sustainable options (Fernandes et al., 2024; Partidario and Monteiro, 2019). Moreover, SEA and MMP processes are frequently carried out by separate teams, with little coordination or mutual influence, resulting in limited integration of environmental considerations into planning decisions (Fernandes et al., 2024). In this context, examining how related monitoring instruments, such as the periodic municipal reports, the Reports on the State of Spatial Planning (RSSPs) analyzed here, may reflect or compensate for these shortcomings is essential to understanding the practical influence of SEA in urban planning and its capacity to support the decision-making process.

Building on this, the study introduces further innovations. It applies and adapts the analytical framework developed by Waylen et al. (2019b), integrating governance aspects, the thematic indicator selection, and data collection and processing methods, to evaluate the performance of SEA follow-up, enhancing the framework's relevance to urban spatial planning contexts. Moreover, the study offers empirical insights into how monitoring is conducted post-SEA approval, considering not only the content of monitoring programs but also their implementation and contribution to decision-making processes.

The article's structure proceeds as follows: after this introduction, the research design section presents the Portuguese regulatory framework to contextualize the research, the selection of case studies, and the analytical framework. The results and discussion section follows this and concludes with a summary of the main points covered and suggestions for improvement and future directions.

2. Research design

To explore and assess the monitoring processes of SEA of Municipal Master Plan's, a qualitative case study was conducted using the context of the Portuguese cities. The study focuses on the *ex-post* phase of the SEA process, which is designed to monitor and verify the predicted impacts of the Plan on the territory, as well as to evaluate the implementation and effectiveness of SEA recommendations, and the overall performance of the monitoring program. To this end, a content analysis focused on the case study SEA monitoring reports was conducted, complemented by broad municipal monitoring reports, such as the Report on the State of Spatial Planning (RSSP), which were included as an addition to the analysis as they present a summary of the implementation of territorial programs and plans at the local level. Therefore, the analysis included both the SEA monitoring reports and the RSSPs when available. The analysis of these reports allows a comparison with SEA monitoring and a broader understanding of how sustainable development is being conducted in the municipalities. The content analysis was developed using an analytical framework adapted from (Waylen et al., 2019b), whose steps are described in detail in the following subsections.

2.1. Case study context: SEA monitoring in Portugal and the relationship with spatial planning

In Portugal, it is a legal requirement for local governments – the public entities responsible for developing Municipal Master Plans – to conduct a SEA of those MMPs. Monitoring it is also mandatory on an annual basis to assess the significant effects on the environment resulting from the implementation of those plans. Both the SEA main reports and the annual results of the monitoring process must be publicly available and sent to the Portuguese Environment Agency, as established by Decree-Law n° 232/2007 (Decreto-Lei n.o 232/2007 Do Ministério Do Ambiente, 2007).

In addition to the SEA monitoring reports, municipalities are required to prepare an additional document for the revision of MMPs or every 4 years, entitled Report on the State of Spatial Planning (RSSP). This report is regulated by Decree-Law no. 80/2015 (Decreto-Lei n.o 80/2015 Do Ministério Do Ambiente, 2015), which establishes the legal framework for spatial management instruments, and it is an important document as it assesses the implementation of spatial plans. It analyses the level of compliance with the objectives outlined in the plans, identifies progress and challenges, and provides justification for the need to revise the plans (see Fig. 1). The RSSP cover various dimensions of Spatial Management Instruments, focusing on economic, social, and environmental aspects.

However, the legal framework for land use planning lacks clear methodological guidelines for preparing RSSPs and establishing a coherent system of indicators (Mourato, 2012). Also, in academia, discussions on RSSP are sparse, with some studies highlighting its limited impact on policy decisions and the challenges in its implementation, such as weak integration across planning scales, and minimal public engagement (Ferrão and Mourato, 2010; Mourato, 2012).

Nonetheless, guidelines were developed for RSSP (CCDRC - Comissão de Coordenação e Desenvolvimento Regional do Centro, 2019), including recommendations on the areas where evaluation indicators should focus. These include objectives and actions defined in the MMP, infrastructure, public facilities, green spaces, land use, urban regeneration, mobility, the definition of new development goals for the municipality, and the identification of sustainability criteria to be adopted. While these guidelines and the structure of the reports are not explicitly framed within the context of SEA monitoring, they align with its objectives by tracking key spatial and environmental dynamics. In this sense, RSSPs could serve as a form of "informal" SEA monitoring, similar to what González (2022) describes in the Irish context. Although not structured as a systematic SEA follow-up, the periodic review of municipal spatial plans through RSSPs compels planners to assess environmental changes, urban transformations, and policy effectiveness. Therefore, examining RSSPs offers valuable insights into how municipalities may be informally integrating environmental monitoring practices, including SEA, into their planning processes.

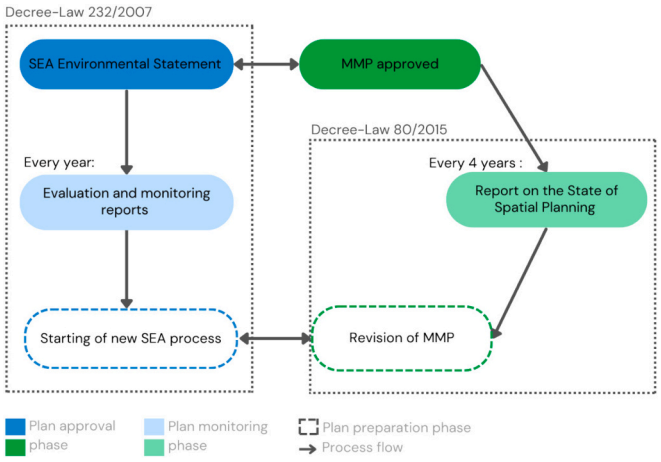

Fig. 1. Overview of the monitoring process flow within the Municipal Master Plan (MMP) and its integration with the Strategic Environmental Assessment (SEA).

2.2. Selection of case studies

The selection of case studies was made based on the following criteria i) Municipality classified as a City by the Degree of Urbanization (DEGURBA[1]) (Eurostat, 2021; Eurostat, 2024; Statistics Portugal, 2022), in mainland Portugal; ii) online availability of the SEA Report and Environmental Statement; iii) balanced distribution across the Portuguese mainland, according to NUTS II regions classification.[2]

A total of 12 case studies were selected: 5 from NUTS II Norte; 3 from NUTS II Centro; and 4 from NUTSII Lisbon Metropolitan Area (AML) (see Fig. 2). The data collection and analysis process occurred between May and July 2024. When available, the documents analyzed were the SEA monitoring reports and the RSSPs. The reports were retrieved from

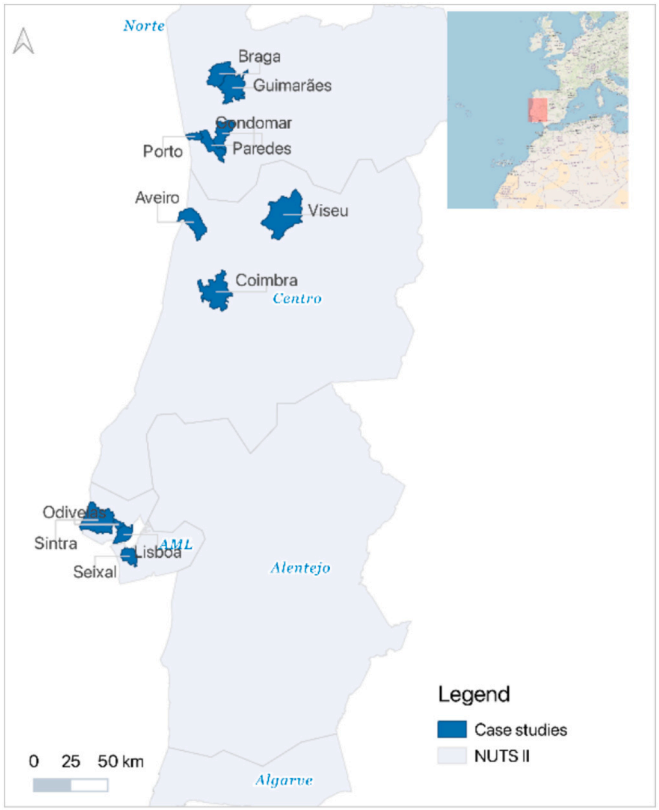

Fig. 2. Spatial distribution of the case studies.

[1] In Portugal, 16 municipalities are classified as "City." Lisbon and Porto are included in this list but encompass, respectively, nine municipalities (Almada, Amadora, Barreiro, Cascais, Lisboa, Loures, Odivelas, Oeiras, and Seixal) and five municipalities (Gondomar, Matosinhos, Porto, Valongo, and Vila Nova de Gaia). However, each of these municipalities develops its own MMP and was therefore considered individually in our selection criteria.

[2] Nomenclature of Territorial Units for Statistics (NUTS) is a geocode standard adopted by European Union for referencing the administrative divisions of countries for statistical purposes. NUTS divides each EU country into 3 levels: NUTS I: major socio-economic regions; NUTS II: basic regions (for regional policies); NUTS III: small regions (for specific diagnoses).

searching the reports online or contacting the Municipalities by e-mail and telephone. The SEA Reports and Environmental Statements of all the cases were also consulted. Table 1 lists the case studies, and the respective documents analyzed. A total of eight documents (one SEA monitoring report and seven RSSPs) from 6 case studies were retrieved and assessed.

2.3. Analytical framework and content analysis

The reports were explored using the content analysis approach (Bardin, 1977; Krippendorff, 2004), a method suited to structured documents like SEA reports, as it enables systematic synthesis of information while reducing subjectivity in interpretation. In addition, this method enabled both a qualitative analysis of the content of the documents and a quantitative study by grouping the indicators into established categories namely, to conduct frequency analysis.

The analytical framework used in this study was adapted from Waylen et al. (2019b), who examined how policy-driven monitoring and evaluation practices across Europe support, or fail to support, adaptive management of socio-ecological systems. Based on nine cases and three major EU environmental policies (Water Framework Directive, Natura 2000, and Agri-environment schemes), the authors developed a comparative framework structured around three key dimensions: what is monitored, how monitoring is carried out, and how its results are used in decision-making (Waylen et al., 2019b, Table 1, p. 376).

This framework offers a structured and operational perspective that is particularly useful for assessing monitoring efforts aimed at informing decision-making. It provides a systematic basis to explore whether and how monitoring systems contribute to learning and inform more sustainable decisions, which is a central objective of SEA. Therefore, this framework was considered suitable for this study as it allows analysis of spatial planning monitoring instruments as well as assess the extent to which these instruments are aligned, interconnected, and potentially influenced by SEA principles.

Some modifications were made to adapt the original framework to the specific context of urban planning and SEAs in Municipal Master Plans, preserving the original methodological structure while adjusting the questions to fit the urban context better.

In addition to text adjustments, the central adaptations made included the following: (i) the inclusion of a question to assess the extent to which the set of indicators proposed in the environmental statement of the SEA was used in the monitoring; (ii) the inclusion of an assessment of the main dimension of sustainable development (socio-economic, environmental, social, economic, and institutional) monitored, based on the indicators grouped by "Critical Decision Factor (CDF)"[3] (main key areas selected to evaluate the strategic effects) of the SEA Environmental Statement; (iii) the inclusion of a question on the existence of follow-up governance frameworks that include monitoring responsibilities, which is crucial for ensuring the effectiveness of both monitoring and SEA recommendations/measures implementation, as discussed by (Monteiro and Partidário, 2017; Partidario and Monteiro, 2019; Polido, 2023); and (iv) the inclusion of a specific question on how monitoring data led to adjustments to the impact predictions conducted in forthcoming SEAs and planning activities proposed in the revision of the MMPs, in line with the logic of adaptive management and the effectiveness of long-term monitoring (Waylen et al., 2019b). The adjustments resulted in Table 2, which outlines the structuring questions on which the analysis was based. The analysis of all the cases is available in the supplementary material, where you can consult the full results.

The set of questions proposed in the analytical framework includes dimensions that are also highly relevant in the context of SEA for spatial plans, particularly considering the broad scope and complexity of land-use planning decisions. These plans encompass multiple sectors and policy areas, from housing and infrastructure to environmental protection and social services, and their implementation often leads to cumulative effects across spatial and temporal scales (González, 2021). As a result, it is essential to consider a wide range of dimensions, including social, economic, and contextual factors, to capture the full implications of planning decisions and their potential trade-offs.

In this way, incorporating social and economic aspects into SEA is essential, especially in the context of spatial planning, where decisions influence not only environmental conditions but also human well-being and local development. SEA has been recognized for its potential to support urban sustainability (Polido, 2023; Polido et al., 2018), which requires attention to multiple, interconnected dimensions. In line with this, Nakhle et al. (2024) emphasize that sustainability involves balancing environmental progress with social and economic goals, as reflected in the SDG framework. Including socio-economic criteria also helps capture external drivers and human–ecosystem interactions that influence the planning system (Waylen et al., 2019b), supporting more adaptive approaches to monitoring and evaluation.

In addition, the broader contextual conditions in which planning and SEA processes unfold must also be considered. Understanding system change requires monitoring not only internal dynamics, but also influential elements of the social, technical, environmental, economic, and policy context (Waylen et al., 2019b). As González (2021) highlights, the effectiveness of SEA of spatial land-use plans is closely tied to how legislation and guidelines are interpreted and applied within specific planning frameworks. So different local contexts inevitably shape the mechanisms and outcomes of SEA implementation.

In this sense, varying levels of performance can often be explained by distinct governance conditions (González, 2021), including both institutional structures and the role of actors, which directly influence how

Table 1
Characterization of case studies and documents retrieved and analyzed (highlighted in grey) (Câmara Municipal de Lisboa, 2015; Câmara Municipal de Lisboa, 2022; Câmara Municipal de Paredes, 2018; Câmara Municipal de Paredes, 2023; Muncípio de Gondomar, 2018; Município de Braga, 2018; Município de Guimarães, 2018).

NUTS II Region	City	Year of Environmental Statement publication	Available monitoring documents and their years[3]	Reference
North	Porto	2021	Not available	-
	Guimarães	2016	Municipal planning evaluation report (2018)	Município de Guimarães (2018)
	Braga	2015	Report on the State of Spatial Planning (2018)	Município de Braga (2018)
	Gondomar	2015	Report on the State of Spatial Planning (2018)	Município de Gondomar (2018)
	Paredes	2014	Report on the State of Spatial Planning (2018); SEA monitoring report (2023)	(Câmara Municipal de Paredes, 2018, 2023)
Central	Aveiro	2020	Not available	-
	Coimbra	2014	Report on the State of Spatial Planning (2023)	(Câmara Municipal de Lisboa, 2015, 2022)
	Viseu	2013	Not available	-
Lisbon Metropolitan Area	Sintra	2020	Not available	-
	Odivelas	2015	Not available	-
	Seixal	2015	Not available	-
	Lisboa	2012	Report on the State of Spatial Planning (2015 and 2022)	(Câmara Municipal de Lisboa, 2015, 2022)

[3] As proposed in the guidelines by Partidário, this terminology reflects what the author usually calls 'strategic-based model' (do Partidário et al., 2007) or 'strategic thinking model' (do Partidário, 2012).

Table 2
Overview of the analytical framework adopted for the content analysis conducted on the selected monitoring documents.

1. Does monitoring take place?	
1.1. Does monitoring take place?	Are the SEA monitoring processes documented through reports that review, synthesize and interpret the data available/collected? Is the monitoring program in the monitoring reports the same as the one proposed by the SEA in the Environmental Statement?
2. What is monitored?	
2.1. Are monitoring programs able to understand environmental aspects of the spatial system?	What environmental aspects are monitored? (proposed and collected) Are there any examples of redundant, repeated or unusable information collected or presented in the monitoring report? (yes/no) Are there any examples where information relevant to the environmental context is available from other sources, but is not used in the monitoring report as secondary data?
2.2. Are social and economic aspects of the spatial system monitored?	What social or economic aspects are monitored? (proposed and collected) Are there any examples of redundant, repeated, or unusable info collected or presented in the monitoring report? (yes/no)
2.3. Does monitoring allow understanding of context?	What aspects of context are monitored (social, technical, environmental, economic, policy)? Are there any examples of redundant, repeated, or unusable info collected or presented in the report? (yes/no)
2.4. Are sustainable development dimensions monitored?	What are the main dimensions of sustainable development most covered by the monitoring program (based on the "Critical Decision Factors" and its indicators)? (proposed and collected)
3. How is monitoring carried out?	
3.1. Are secondary data being used?	Are secondary data being used?
3.2. Are state and non-state actors involved in data collection and evaluation?	Does a governance framework exist within the SEA documents or monitoring reports that define the specific roles of each actor in the monitoring process? Describe Are both state + non-state agencies providing monitoring data?
3.3. Are the data publicly available and accessible?	Is citizen science or "voluntary monitoring" being used to collect, analyze and, or report monitoring data? Baseline raw data associated with the indicators are publicly available through reports, websites, or other platforms? Is there a separate non-technical monitoring report or a non-technical section within the existing monitoring report that highlights key points, using accessible language for the general public?
4. How is monitoring used in decision-making?	
4.1. Are there any publicly documented uses of monitoring data to spatial planning?	Are the spatial planning actions updated or changed? How are monitoring data used to make these changes? Are decisions hindered by a lack of sufficient monitoring data?
4.2. Is there public availability of evaluation processes, and any other uses of monitoring information (including in policy)?	Is there information on how the monitoring program and recommendations were altered? Is there information on how the SEA process and MMP were altered due to the monitoring phase?

Adapted from Waylen et al., 2019b.

SEA is integrated into planning practice. Then, assessing whether state and non-state actors are involved in data collection and evaluation, and whether the resulting information is publicly accessible, becomes critical. González (2021) highlighted that planning decisions are shaped by negotiations and power dynamics, making inclusive and transparent governance crucial. The active involvement of multiple actors enables co-production, knowledge exchange, and learning (Fernandes et al., 2024), while also enhancing the legitimacy and adaptive capacity of SEA. In this sense, public access to monitoring data is not only a matter of procedural transparency but also a condition for meaningful engagement and accountability within spatial planning. In addition, using relevant secondary data, where available, alongside primary data strengthens the evidence base and makes monitoring more effective (Waylen et al., 2019b).

For all these reasons, the framework aligns closely with the aims of SEA and offers a useful lens to understand not only how SEA monitoring is being carried out, but also how it can support informed and sustainable decision-making.

3. Findings and discussion

3.1. Is monitoring taking place?

Six of the 12 cases were analyzed (Guimarães, Braga, Gondomar, Paredes, Coimbra and Lisbon), as they have a monitoring report (see details in Table 1). Two of these cases are currently preparing their first reports: Porto is working on their SEA monitoring report, and Sintra is preparing their Report on the State of Spatial Planning. The remaining four cases lack any monitoring report for their Municipal Master Plan's during the period studied. Almost all reports collected correspond to the RSSP, except for the municipality of Paredes, which also has a SEA monitoring report. Although the municipality of Guimarães titles its report as the Municipal Planning Evaluation Report, it follows a structure and rationale closely aligned with the RSSPs. Thus, the follow analysis and discussion of the results (including tables) will focus on these six cases with some existing monitoring reports. The full results can be found in the supplementary material, where all the cases are analyzed.

The fact that only one SEA monitoring report was published out of the 12 analyzed cases reinforces the observation by Partidario and Monteiro (2019) that, in Portugal, SEA practice rarely progresses beyond the publication of the Environmental Statement. Furthermore, the failure to extend SEA to the monitoring phase significantly compromises its effectiveness and appears to be a broader issue, not limited to Portugal, as also discussed by González et al. (2019) and Peterson and Vahtrus (2019).

When comparing the monitoring program in the RSSP and the ones proposed by the SEA in the Environmental Statement, we found that Paredes´SEA monitoring report fully implements the follow-up program outlined in the SEA Environmental Statement. Additionally, the reports from Guimarães, Braga, and Lisbon (from 2022) directly reference the SEA documents, partially adapting the indicators and Critical Decision Factors (CDFs) within the RSSPs. The other cases, while not explicitly citing the SEA's monitoring programs, incorporate indicators on topics that align with those proposed by the SEA. This result may align with one of the recommendations made by (González, 2022) to optimize the SEA evaluation process, which is to integrate its requirements with an existing monitoring process to avoid redundancy. In this case,

leveraging the preparation of the RSSP itself to assess SEA outcomes could serve as a feasible alternative. For example, in the municipality of Paredes, alongside the development of the RSSP, efforts began to establish a unified platform for ongoing data collection, indicator processing, and analysis — the Municipal Observatory for Spatial Planning. This tool aims to streamline monitoring municipal plans and land-use policies, assessing trends over time. Given the identified connection with SEA indicators being used to a certain extent to measure spatial planning outcomes, initiatives like the one in Paredes may contribute to more effective SEA monitoring at the municipal level.

It is also noteworthy the fact that the teams preparing the RSSPs consult the SEA monitoring program to define RSSP indicators underscores the need for further collaboration between these professionals throughout all stages of the Plan. This is highlighted by Fernandes et al. (2024) when describing the lack of collaboration between MMP teams and SEA professionals in Portugal during the elaboration phase of the MMP and SEA documents.

3.2. What is monitored?

3.2.1. Are monitoring programs able to understand environmental aspects of the spatial system?

A comparison between the SEA's Environmental Statement proposed monitoring framework and what has been implemented by the two types of monitoring reports analyzed, is explored here to understand the SEA's influence on environmental monitoring practices of the municipalities. This is particularly important because the SEA Directive, as transposed into the Portuguese legal framework, requires the monitoring of significant environmental impacts resulting from the implementation of plans and programmes, including Municipal Master Plans. Despite this, there are no specific guidelines regarding the selection of indicators. Spatial systems are complex, dynamic, and context-specific, which means that identifying relevant indicators and evaluating actual impacts depends on knowing how these systems function and respond to change (Mascarenhas et al., 2012; Reicher et al., 2021).

Most of the frequently addressed indicators, based on the Critical Decision Factors, involve natural resources, biodiversity, risk factors, and environmental quality in urban settings (including noise, air quality, sanitation, and green spaces, among others). Overall, indicators on these themes offer a comprehensive perspective on the potential impacts of land-use plans on the environmental urban contexts. In addition to being directly aligned with Sustainable Development Goals (SDGs) targets and indicators, this set, if assessed robustly, could provide deeper insights into the spatial strategy adopted and whether it relates to sustainable development goals (Nakhle et al., 2024).

However, an analysis of the Reports on the State of Spatial Planning (RSSPs) reveals that the adaptation of the monitoring scheme proposed by the SEA statement has typically resulted in a reduction of the environmental aspects being monitored, compared to what was originally proposed, particularly regarding natural resources. Notably, two exceptions are the municipalities of Guimarães, which retained the same thematic focus (CDFs) proposed by the SEA, with nearly the same number of indicators—only omitting surface water quality—and Paredes, which being subject to SEA monitoring in the report, maintained the same set of indicators as the SEA.

The most monitored environmental aspect in the RSSP is environmental quality-related topics. Sometimes, this aspect overlaps with the social dimension of sustainable development and focuses on the relationship between human activities and the environment, particularly in urban areas. This pattern aligns with the observations of (Nakhle et al., 2024), who emphasize the prevalence of indicators centered on urban environmental quality, such as air and water quality and noise pollution, often incorporated into monitoring systems aligned with the SDGs. According to those authors, these indicators are particularly applied in urban areas to assess human activities' impacts.

Conversely, there remains a notable absence of indicators addressing other critical sustainability topics. Critical issues such as the National Agricultural Reserve and the National Ecological Reserve, key national land-use policy instruments that significantly influence Municipal Master Plan's, despite being included in most of the monitoring programs proposed by the SEA Statements, are monitored in only two cases: Guimarães and Gondomar. In contrast, Coimbra describes both the National Agricultural Reserve and the National Ecological Reserve within the municipality but does not assess their changes over time or the impacts they have experienced. Another example is the forest fire indicator, which was included in the SEA statements in almost all cases, except in 2015's Lisbon report, but is only actively monitored in Guimarães, Gondomar, Coimbra and 2022's Lisbon report.

Across the RSSPs, there is minimal repetition in the environmental indicators, such as presenting the same information in both graphs and tables, or redundancy, where indicators with different names convey similar information, except for Coimbra and 2022's Lisbon report. Two cases, Gondomar and RSPP's Paredes, relied exclusively on secondary data; Coimbra predominantly used secondary data, supplementing with primary data for only one indicator (trees planted); Lisbon primarily used primary data, while complementing with external sources in both reports; and the remaining cases, Guimarães and Braga, demonstrated a balance between the use of primary and secondary data.

3.2.2. Are social and economic aspects of the spatial system monitored?

All the case studies address social and economic dimensions within their monitoring programs, either through the Critical Decision Factors defined in the SEA statements or within the RSSP frameworks. In addition to topics that intersect both dimensions, such as land use planning, some cases, such Braga and Lisbon, also incorporated issues related to the institutional dimension, particularly governance, into the SEA.

When comparing the proposed monitoring framework established by the Environmental Statement with what was monitored by the RSSP, it becomes evident that only Paredes' reports fully maintained (even with some adaptations) the social and economic themes initially defined, following the SEA's established monitoring methodology. However, this consistency is not mirrored in the other two cases that also used the SEA's monitoring program (Braga and 2022's Lisbon report). For instance, in Braga, landscape and cultural heritage are the topics related to the social dimension in the SEA statement, while in the RSSP framework, this dimension is covered by mobility and accessibility topics. Overall, these findings suggest that the monitoring approach defined in the SEA Statement may have had a limited influence on RSSP design in these dimensions.

Another distinction between what was outlined in the SEA and what was monitored in the RSSP is the inclusion of indicators related to demographics and population, which are present in five of the eight reports analyzed (Gondomar, Paredes, Coimbra, and Lisbon – both reports). While Guimarães and Braga do not directly include these indicators, both address the issue within the contextual sections of the reports, as will be discussed in the following section. This underscores the importance attributed to this topic by the municipalities when evaluating their Municipal Master Plans, even in cases where it is not explicitly part of the SEA's proposed monitoring framework.

It is worth noting that, just as municipalities prioritize population data, this data is also among the most frequently repeated or redundant across the indicators, occurring in five reports mentioned above. In addition to demographic data, indicators related to economic activity, public facilities, buildings, and urban planning also feature redundant information across these cases.

3.2.3. Does monitoring allow understanding of context?

The most frequently addressed contextual aspects in the monitoring reports were geographical, administrative, and legal. All reports frame in some way these factors, emphasizing their importance in understanding the setting in which the plans were implemented. Regarding

geographical and administrative aspects, no significant changes affecting plan implementation were noted, except in the case of Lisbon. This municipality underwent an administrative reform in 2012, altering its boundaries and administrative map, which reduced the number of parishes and consequently impacted data analysis in the monitoring reports, particularly the 2015 report. In terms of legal aspects, changes in the legislative framework were mentioned whenever they influenced municipal spatial planning policies and the application of spatial management instruments.

Guimarães and Braga are the cases that did not include population and built environment indicators in their monitoring programs and added a socio-demographic characterization and data on the built environment to the initial framework section of the report. Notably, these municipalities followed the pattern of others by presenting repeated or redundant information when addressing these issues. Furthermore, Guimarães added a section on economic activity, including data on companies by sector, alongside its Critical Decision Factor on value creation linked to the economic dimension. The only case that did not include any context-related indicators was Paredes's SEA monitoring report. Nevertheless, it did include a section updating strategic plans, which could have influenced the SEA's implementation during the evaluation period.

3.2.4. *Are sustainable development dimensions monitored?*

By grouping the different Critical Decision Factors, from Environmental Statement monitoring programs, according to sustainable development dimensions (Table 3), it is evident that the dimensions of sustainable development are present across all monitoring programs proposed by the SEA, with a particular emphasis on the environmental dimension, which contains the highest proportion of indicators in almost all cases. Exceptions to this pattern include Guimarães, which has an equal proportion of indicators for both environmental and social dimensions.

When examining what was monitored in the RSSP and the SEA monitoring report, in cases where it was possible to calculate the proportion of indicators, the environmental dimension maintained its prominence in Guimarães and Paredes. However, in Braga, the social dimension overtook the environmental one, becoming the most prominent in this context.

This result aligns with the findings of Nakhle et al. (2024), who stated that although indicators based on the SDGs are designed to assess all three dimensions, there is an imbalance, especially when monitoring urban areas. In this sense, the social and economic dimensions are less prioritized in monitoring practices to the detriment of the environmental dimension.

Table 3
Proportion of indicators grouped by sustainable development (SD) dimensions.

CITY	Indicators in the SEA environmental statement (no.)	Proportion of indicators by SD dimensions (%)	Indicators in the Reports on the State of Spatial Planning (no.)	Proportion of indicators by SD dimensions (%)
Guimarães	32	Environmental (31 %)/Social (31 %)	16	Environmental (38 %)/Socio-economic (38 %)
Braga	154	Environmental (34 %)	36	Social (36 %)
Gondomar	40	Environmental (65 %)	Not calculated, as the monitoring program was not based on the SEA.	Not calculated, as the monitoring program was not based on the SEA.
Paredes	54	Environmental (51 %)	57	**RSSP:** Not calculated, as the monitoring program was not based on the SEA. **SEA monitoring report:** Environmental (51 %)
Coimbra	56	Environmental (59 %)	Not calculated, as the monitoring program was not based on the SEA.	Not calculated, as the monitoring program was not based on the SEA.
Lisboa	39	Environmental (46 %)	Not calculated, as the monitoring program was not based on the SEA.	Not calculated, as the monitoring programms was not based on the SEA.

3.3. *How is monitoring carried out?*

3.3.1. *Are secondary data being used?*

For this study, secondary data is considered as any data not originating primarily from the Municipality and its departments. Thus, even indicators that incorporate data from other state agencies are not considered primary sources. Secondary data are prevalent in the composition of indicators across all case studies, except Paredes's SEA monitoring report, which lacks information regarding data sources.

Waylen et al., 2019b emphasize the value of secondary data in addressing certain informational gaps. However, in this study, we found that reliance on secondary information for monitoring can compromise indicator evaluation, as some sources, such as the National Statistics Institute, release data at intervals that do not align with the evaluation cycle of the indicators, resulting in data gaps. Many RSSPs published in 2018 (e.g. Guimarães, Braga, Gondomar, and Paredes) present indicators based on outdated data, such as the 2011 Census. This lag can hinder timely decision-making during plan implementation, limiting its effectiveness. Moreover, the assessment of spatial state or SEA outcomes is compromised, as the indicators no longer accurately reflect current conditions at the report preparation time. This may originate from limitations experienced in earlier phases of the SEA process, as noted by Fernandes et al. (2024) and Pereira and Polido (2025) and can substantially hinder a thorough understanding of SEA effectiveness.

3.3.2. *Are state and non-state actors involved in data collection and evaluation?*

Considering all the case studies, nine of them (Porto, Gondomar, Paredes, Aveiro, Coimbra, Viseu, Sintra, Odivelas, and Lisbon) established a governance framework during the SEA process (either in the Environmental Statement or in the Environmental Report). Of these, six (Porto, Gondomar, Paredes, Coimbra, Viseu, and Odivelas) determine monitoring as one of the stakeholders' responsibilities in the governance framework.

However, when analyzing the RSSP, no reference was identified to the governance framework or the participation of the different stakeholders in the collection and evaluation of monitoring data, in contrast with what is advocated by Gachechiladze-Bozhesku (2011) and Domingues et al. (2018). A sustained stakeholder engagement process throughout SEA implementation is needed to track evolving priorities, support informed feedback on strategy and SEA follow-up, and promote learning for more sustainable practices Gachechiladze-Bozhesku (2011).

Although all the cases used different sources of information to establish the indicators, the reports show no evidence that the entities providing the data were actively involved in the process. This suggests that although governance is recognized as a key component in monitoring SEA documents, its practical implementation remains limited. Two issues corroborate this result. First, it is assumed that monitoring is conducted by state agencies, relying predominantly on data from governmental sources, although in some cases (such as Guimarães, Braga, Gondomar, and Lisbon), data from non-governmental agencies were also incorporated. Second, neither the RSSP nor SEA monitoring report mentioned the use of citizen science or voluntary monitoring with the involvement of stakeholders in data collection and/or evaluation. These findings point to a disconnect between the governance frameworks envisioned in the SEA, which aim to engage both governmental and non-governmental actors, and their effective involvement in environmental monitoring practices.

We posit that these issues may reflect the SEA preparation process in Portugal, where public participation is minimal, typically occurring late after essential decisions have been made, primarily to fulfil legal requirements (Fernandes et al., 2024). Consequently, it is unsurprising that the monitoring phase mirrors this approach, even if not formally part of SEA, with low public engagement and limited evidence of collaboration among stakeholders.

3.3.3. Are the data publicly available and accessible?

The availability and accessibility of data and information are one of the most vulnerable aspects of the monitoring processes. This is largely due to the lack of clear references or effective mechanisms for accessing the databases and information systems used by municipalities to store, analyze, and report the monitoring indicators. In addition, there is no inclusion of specific topics or the preparation of non-technical reports that make it easier for the general public to understand and use this information. This gap undermines both the transparency and effectiveness of monitoring actions, as discussed by Waylen et al. (2019b) and Fernandes et al. (2024), while also limiting the participation of civil society and other interested stakeholders, restricting the potential positive impact of such data on the development of local environmental and sustainability policies and informed decision-making.

3.4. How is monitoring used in decision-making?

3.4.1. Are there any publicly documented uses of monitoring data to revise management?

The structure of the RSSP reveals that the final and concluding chapters present a summary of the assessment carried out, along with recommendations for amending or revising the MMP. Among the reports analyzed, only Braga, Paredes's SEA monitoring report, and the 2015 Lisbon report do not include suggestions of this nature. The case of RSSP of Paredes, although also not including any explicit recommendations, presents a table suggesting specific adaptations to the MMP regulations, which, according to the report, was already in the process of being implemented.

In cases where recommendations are present, they generally address social, environmental, and economic aspects, based at least partially on the spatial assessment. These recommendations cover adjustments to the plan's regulations, changes in land use to align with current legislation, the implementation of policies (housing, urban regeneration), urban infrastructure, and green spaces, to name a few. However, despite offering some direction for future action, these recommendations do not specify which indicators or aspects of monitoring contributed to their rationale. While some reports highlight challenges and key factors for change (such as Gondomar) or offer a synthesis that appears linked to monitoring (such as Coimbra and 2022's Lisbon report), it remains unclear how the system of indicators was employed to draw conclusions and formulate recommendations. This finding aligns with the study by Waylen et al. (2019b) and Reicher et al. (2021), where it was unclear whether and how management actions within the environmental policies analyzed were influenced by monitoring data. One reason for this ambiguity is that data evaluation and related decision-making processes are rarely documented publicly (Waylen et al., 2019b).

Additionally, several municipalities, including Guimarães, Braga, Coimbra, and Lisbon, directly cited difficulties in obtaining data for indicators, particularly regarding access to more current and reliable data to feed the indicators and analyze spatial conditions. It is important to highlight that the lack of explicit mention of these difficulties in other cases (such as Gondomar and Paredes) does not imply their absence. Although the reports do not conduct a meta-evaluation of the indicators or the monitoring process, we may infer that these challenges arise from unrealistic, excessively general or complex, or simply irrelevant indicators, as discussed by (González et al., 2019). While it is not possible to determine precisely whether these challenges have hindered decision-making, we know that the lack of up-to-date data can lead to a limited understanding of spatial realities, ultimately compromising the effectiveness of strategic decisions, in line with what is argued by Pereira and Polido (2025). These findings are consistent with González (2022) recommendations, which highlight the necessity of coordinating the collection and centralized provision of relevant environmental monitoring data, including spatial information.

3.4.2. Is there public availability of evaluation processes, and any other uses of monitoring information (including in policy)?

The monitoring programs established in RSSP, as already discussed, were established according to the realities of each municipality. In some cases, the indicator sets defined in SEAs were incorporated into RSSP. However, the updates and adaptations observed in these systems do not result from a meta-evaluation of indicators, but rather from persistent difficulties in obtaining data. This limitation compromises not only the evaluation of the effectiveness of SEA Pereira and Polido (2025), but also the capacity of to evaluate the consequences of the implementation of the MMPs (Reicher et al., 2021).

Of the cases analyzed, only one Braga demonstrated a clear link between the monitoring program established in the RSSP and its direct application in the revision of the Municipal Master Plan. In this example, the monitoring program outlined in the 2018's RSSP was adopted in the first phase of the SEA, which began in the same year, as part of the MMP review process. This demonstrates a rare but significant example of the intersection between ex-post monitoring and policy-making in the field of spatial planning.

The availability of evaluation processes and the use of monitoring information remain limited, this is in line with what González (2022) found. Although RSSPs are publicly accessible, when prepared by the responsible authority, the absence of a continuous evaluation of indicator systems and the reliance on hard-to-obtain data weaken the consistent use of this information for reviewing and adjusting spatial policies. To overcome these shortcomings, it is recommended to promote citizen science for the collection of data (Domingues et al., 2018; González, 2022) and enhance the use of available technology (González, 2022).

4. Conclusion

This article aimed to analyze the relationship between spatial planning monitoring instruments and environmental assessment instruments, with a particular focus on how SEA processes may influence the design and content of spatial monitoring frameworks. Using an analytical framework adapted from Waylen et al. (2019b), the study focuses on 12 case studies from Portuguese municipalities. The results of this exploratory research offer several significant insights:

In four cases, the monitoring programs outlined in the SEAs' Environmental Statements influenced the preparation of RSSPs. This suggests a strong potential for integrating both monitoring processes, thereby avoiding redundancy, an approach also advocated by González

(2022) and Wallgrenn et al. (2011).

The frequency of monitoring remains generally low and, in the case of SEAs for MMPs, is almost non-existent, indicating a clear non-compliance with legal requirements. The absence of a monitoring phase in SEA substantially limits its potential impact. This issue is not limited to Portugal, as referenced by González (2022).

The most commonly used indicators focus on environmental aspects and are generally aligned with the broader dimensions of sustainable development. However, key sustainability indicators, such as those related to the National Ecological Reserve, are notably missing from the monitoring systems. There is an emphasis on urban environmental quality, which is typical in urban contexts (Nakhle et al., 2024). To ensure more comprehensive and context-sensitive assessments, SEA practitioners and planners should reconsider the selection of indicators to better reflect the specific territorial characteristics.

Outdated data are often used in the preparation of the monitoring process, and practitioners face limited access to relevant databases, which undermines the quality and relevance of monitoring outcomes. This may stem from constraints also encountered in earlier SEA phases, as pointed by Fernandes et al. (2024) and Pereira and Polido (2025), and significantly hinder a full understanding of SEA effectiveness. As discussed by Domingues et al. (2018), citizen science may help address this issue, alongside the need for policy-makers' commitment to ensuring compliance with SEA monitoring requirements (González, 2022).

The monitoring process is also marked by weak collaboration across stakeholders and low levels of public participation. Even though a governance framework is established, there is no evidence that different stakeholders are involved in the data collection, nor that agencies responsible for collecting data are involved in the process. This represents a missed opportunity to enhance SEA effectiveness. As advocated by Gachechiladze-Bozhesku (2011), stakeholder engagement and collaboration throughout monitoring processes are key to adapting priorities and fostering sustainable practices.

It is unclear how the monitoring processes are used to inform and guide future planning decisions. There is a lack of transparency regarding the mechanisms through which this data influences policy adjustments, strategic changes, or the adaptation of plans. Understanding how monitoring feedback translates into concrete actions is crucial for assessing the effectiveness of SEA and ensuring that environmental considerations are meaningfully integrated into ongoing and future planning efforts.

Future empirical research could usefully build on these findings, helping to understand the dynamics at play. Thus, future research should provide insights into the effective integration of monitoring systems and examine the underlying causes and challenges that hinder their implementation, with a particular focus on identifying the key factors contributing to the limited application of monitoring in SEA and planning processes. It should also investigate the potential contributions of citizen science and sustained stakeholder engagement in strengthening monitoring efforts within SEA processes. Such investigations could contribute meaningfully to the growing discourse on improving monitoring systems by integrating environmental and planning monitoring systems.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the author(s) used ChatGPT and Grammarly to improve the text and spelling. After using this tool/service, the author(s) reviewed and edited the content as needed and take (s) full responsibility for the content of the publication.

Declaration of competing interest

The authors declare having no competing interests that could influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.eiar.2025.108195.

Data availability

Data will be made available on request.

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