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Original Research Article

Implementing Strategic Environmental Assessment in the Global South, a Challenge: Nicaragua as a Case Study

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ABSTRACT

Strategic environmental assessment has been considered significant to the achievement of sustainable transformations and many countries have successfully integrated this instrument in their legal frameworks. Nevertheless, its implementation is influenced by several critical factors, and its strategic nature makes its application a challenge in Global South countries. This paper aims to discuss these factors through the case study of strategic environmental assessment integration and its implementation in Nicaragua. To do this, a literature review regarding success factors for implementation was conducted, and a characterization of the state of implementation in Nicaragua was performed. A series of interviews were conducted with environmental experts and stakeholders was executed a) to develop a social cognitive map, that was used to validate the literature-based strategic environmental assessment characterization. And b) to identify the specific factors contributing to the challenges for its implementation. As a result, it was determined that a total of 32 factors were affecting the successful integration of strategic environmental assessment in plans, programmes and policies. Through the social cognitive mapping, the authors identified the most influential factors and challenges to integrate this type of assessment in Nicaragua. This paper provides indicated potential approaches to overcome obstacles to improve strategic environmental assessment for decision-making and environmental planning.

KEYWORDS

Strategic environmental assessment, SEA, Environmental policy, Environmental framework, Sustainability.

INTRODUCTION

Strategic Environmental Assessment (SEA) is an environmental management instrument that incorporates procedures to consider the environmental impacts of policies, plans and programmes (PPPs) at the highest levels of decision-making processes, to achieve sustainable

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development [1]. It is a proactive, formalized, systematic and comprehensive process of assessing the environmental impacts, and is versatile enough to be applied to a broader scope than environmental impact assessments of individual projects [2]. It further has the adaptability to be able to assess cross-sectoral policies [3]. Globally, governments and development stakeholders have widely recognized SEA as a component of the sustainable development process [4], and it has been highlighted that its strategic nature can be exploited to achieve overarching national [5] and global sustainability goals (SDGs) [6] and sustainability-based transitions [7]. Originating from the United States National Environmental Policy Act in 1969, it has gained global traction, with over 60 countries now implementing it [8].

Despite SEA´s potential as an instrument of environmental management, so far, few initiatives have been successful to integrate this form of assessment into the decision-making of developing countries [9], even though the need for SEA has already evolved more than two decades ago, and the term has been around for more than 40 years [10], [11]. Key principles of SEA include knowledge, integrated decision-making and long-term planning, innovation, precaution, anticipation and prevention, public participation, partnerships, equity, early integration, flexibility, self-assessment, an appropriate level of analysis, adaptability and comprehensibility [2]. Nevertheless, in many developing countries, integration is lost between PPP decision-making procedures and SEA outcomes [3].

One of the biggest constraints when performing an SEA is its strategic nature, which makes its implementation difficult in a context where technical capabilities are scarce and economic resources are not available to decision makers [12]. Another challenge of integrating and implementing SEA is the necessity to tailor a methodology for the specific PPP, so there are many specific factors that can affect the process, and its implementation has proven to be heterogeneous in the world, even among homogeneous legislative regions [10]. Many factors influence the implementation and effectiveness of an SEA; [13] have identified at least 266 critical factors that interact in different combinations at the stages of the SEA planning, implementation and monitoring process and are related mainly to the timing, capacities, resources and participation during the SEA.

As the OECD [14] states, conducting an SEA can help governments to anticipate how the implementation of development plans and policies may impact the environment; its implementation ultimately contributes to integrate environmental considerations into key policy documents, as well as strategies and budgets for key economic sectors. There are few case studies from successful SEA implementation in global south countries, nevertheless, the results of each case is important to a broader understanding of SEA in practice [9]. As [15] remarks, there is a need to fill gaps in SEA research regarding the most important constraints to SEA implementation in different contexts.

It has been the aim of this authors' research to underscore this relevance and contribute to the broader understanding of SEA in Global South countries and the challenges faced for successful implementation. Nicaragua was chosen as a case study for SEA characterization to indicate factors typically influencing SEA integration in the Global South. Through a cognitive mapping for validation, these factors were analysed and discussion on further steps to enhance SEA´s role in decision-making and environmental planning was undertaken. To the authors' knowledge, this is the first time cognitive mapping has been used in a similar context and this is the first academic publication on SEA knowledge in Central America.

LITERATURE REVIEW

The following literature review synthesizes a broad range of studies reviewed for this work. This review brings together work from both developed and developing country contexts, spanning conceptual frameworks, empirical analyses, and case studies. The studies collectively

explore SEA's effectiveness, identify critical success factors and challenges, and offer recommendations for its improved implementation.

The matrix presented below (**Table 1**) organises the literature by summarizing the focus or objectives of each study, the key findings, recommendations or challenges identified by the authors, and the most important factors associated with SEA effectiveness.

Table 1. Literature review main findings

Reference	Key findings	Recommendations / Challenges	Most relevant factors
How may sustainability be advanced through Strategic Environmental Assessment (SEA) in Small Islands? Exploring a conceptual framework [16]	Provides a conceptual framing that argues for the broader application of SEA in small island contexts, emphasizing its potential role in sustainable development.	Suggests the need to incorporate SEA into policy frameworks to drive sustainability and enhance environmental governance.	Integration of environmental considerations, appropriate policy frameworks, and sustainability advancement in local context.
A historical review of the cumulative science in SEA effectiveness [8]	Finds that definitions of SEA effectiveness differ across schools of thought and identifies interlinked factors such as implementation, quality, decision-making impact, governance transformation, and collaborative processes.	Emphasizes grouping and understanding the contingent relationships among these factors for effective SEA evaluation.	Implementation quality, decision-making impact, governance transformation, and collaborative integration.
Factors affecting SEA effectiveness in Estonia [17]	Identifies key factors including cumulative effects assessment, alternatives consideration, public participation, and the need for systematic follow-up; proposes five dimensions of effectiveness.	Calls for improved practices in cumulative assessment and enhanced public involvement, as well as systematic SEA follow-up.	Cumulative effects assessment, alternatives evaluation, public participation, and structured follow-up mechanisms.
What makes strategic environmental assessment successful environmental assessment? The role of context in the contribution of SEA to decision-making [18]	Highlights that SEA success depends on stakeholder consensus on norms/values, certainty in the knowledge base, and openness in decision-making processes.	Recommends tailoring SEA processes to the context of the policy issues, with an emphasis on transparency and stakeholder engagement.	Stakeholder consensus, certainty of the knowledge base, and open, inclusive decision-making processes.
Strategic environmental assessment can help solve environmental impact assessment failures in developing countries [3]	Argues that SEA offers a proactive and broad-based approach that can overcome the shortcomings of conventional EIA in ensuring sustainable development.	Warns that successful SEA requires overcoming challenges like underdeveloped institutions, limited expertise, and weak stakeholder engagement.	Proactive approach, institutional capacity, and comprehensive stakeholder engagement.
Integrating the principles of strategic environmental assessment into local comprehensive land use planning [19]	Emphasizes SEA's potential to foster institutional development and improve planning quality, despite conflicts with short-term development priorities.	Stresses the need for capacity building, clear policy frameworks, and strong political commitment to balance short-term and long-term goals.	Early integration into planning, institutional development, and balancing short-term priorities with long-term sustainability.

Does New Regulation Points to an Effective Use of Strategic Environmental Assessment? Lessons from Democratic Republic of Congo [20]	Indicates that while regulations have been introduced, SEA documentation, alternatives development, impact monitoring, and overall process performance still face significant gaps.	Concludes that regulatory reform must be accompanied by improvements in documentation, enhanced public consultation, and a more thorough consideration of alternatives.	Quality of SEA documentation, comprehensive public consultation, and robust alternatives assessment.
Challenges to institutionalizing strategic environmental assessment: The case of Vietnam [15]	Identifies challenges due to a hierarchical bureaucracy, siloed information, limited awareness among senior officials, and resistance to transparency and openness in decision-making.	Recommends reforms to improve inter-ministerial coordination, information sharing, and enhanced training and awareness among decision-makers.	Hierarchical bureaucratic structure, siloed information systems, and the need for increased training and cross-agency coordination.
Studies on Strategic Environmental Assessment in China—implementation and effectiveness [21]	Reveals that SEAs often start too late to influence planning; public participation is weak, and a robust SEA information-sharing platform is missing.	Suggests establishing coordinating agencies, improving data sharing and supervision of SEA documentation, and clarifying legal responsibilities.	Timely integration into the planning process, effective public participation, and structured information-sharing platforms.
From environmental impact assessment to strategic environmental assessment in Bangladesh: Evolution, perspective, governance and challenges [22]	Describes SEA as being in early developmental stages with significant political will, yet hindered by the lack of a legislative framework and coordination among institutions.	Points to the urgent need for formal SEA guidelines, legislation, enhanced capacity building, and better inter-agency coordination.	Emergent implementation phase, need for legislative frameworks, and improved institutional coordination and capacity.
Contextual challenges for implementing strategic environmental assessment in the Global South: insights from a case study in Mexico [23]	Identifies challenges such as limited SEA expertise, low trust in public institutions, and weak capacity of environmental agencies.	Recommends capacity building, strengthening institutional frameworks, adapting SEA to local contexts, promoting inter-agency collaboration, and raising public awareness.	Limited expertise, low institutional trust, and insufficient capacity paired with the need for tailored, collaborative approaches.
Empowering the public in environmental assessment: Advances or enduring challenges? [24]	Finds that despite efforts toward inclusivity and transparency, the linkage between public input and actual decision-making remains weak.	Calls for mechanisms that empower the public beyond mere consultation, ensuring effective integration of public input into decision-making processes.	Effective empowerment and integration of public input, bridging gaps between consultation and actual decision-making influence.
Review of critical factors for SEA implementation [13]	Categorizes factors into those specific to individual SEA stages and general factors such as communication, resources, timing, organisation, and political will/trust among stakeholders.	Emphasizes that addressing communication challenges, resource allocation, timely integration, and building trust are essential for effective SEA implementation.	Communication clarity, resource allocation, proper timing, strong organisational structure, and sustained political will and stakeholder trust.

Strategic environmental assessment performance factors and their interaction: An empirical study in China. [25]	Shows that the decision-making process and policy context directly affect SEA implementation, while factors such as public participation, data sharing, expertise, and SEA institutions influence indirectly.	Highlights the need to improve the decision-making environment and promote inter-sectoral cooperation to enhance SEA effectiveness.	Robust, transparent decision-making processes, a supportive policy environment, and effective inter-sectoral collaboration mediating public participation and expertise.

Thus, the overarching SEA implementation factors can be clustered in the following categories, as suggested by [13], and presented in **Figure 1**.

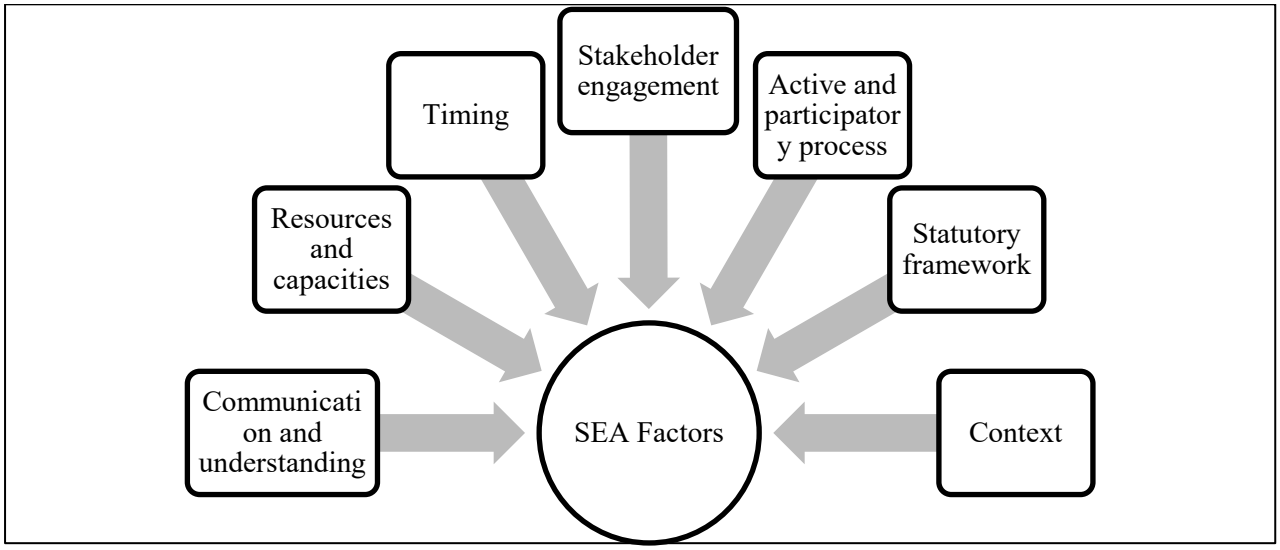

Figure 1. Factors for SEA implementation, summarized [13]

Communication and understanding. Effective communication and understanding among stakeholders, decision-makers, and SEA practitioners are critical for the success of SEA implementation [13]. The complexity of the SEA process can be a challenge in integrating SEA into policy development. Conducting an SEA requires a thorough understanding of the policy-making process and the potential environmental impacts of proposed PPP´s [22].

Resources and capacity. Adequate resources, including time, money, and expertise, are necessary for the successful implementation of SEA [13].

Timing: SEA should be integrated into the decision-making process at an early stage to ensure that environmental considerations are taken into account from the beginning [4].

Stakeholder engagement. Stakeholder engagement is crucial for the success of SEA. It is important to involve stakeholders in the process to ensure that their concerns and interests are taken into account [26], [27].

Active and participatory process. Successful SEA is an active, participatory, and educational process for all parties involved, in which stakeholders are able to influence the decision-maker [27].

Statutory framework. Adopting SEA as a statutory framework in certain countries can ensure that strategic decisions with potentially severe environmental impacts are subject to an SEA [28]. A robust legal framework, thus, is recognized to be a pillar for institutionalisation of SEA [22].

Context specific factors.

- Lack of political will: A lack of political will can be a significant challenge in integrating SEA into policy development [22]. Without strong leadership and support, SEA may not be prioritized in the policy-making process [29].
- Limited stakeholder engagement: Limited stakeholder engagement can be a challenge in integrating SEA into policy development. Without adequate stakeholder engagement, it may be difficult to identify potential environmental impacts and opportunities for enhancing the state of the environment [27].
- Resistance to change: Resistance to change can be a challenge in integrating SEA into policy development. Some decision-makers may be resistant to integrating environmental considerations into policy development, particularly if it requires changes to existing practices [30].

With regards to research gaps and future research, there is limited academic and peer-reviewed literature on SEA in global south countries, hence, there is a need to promote research in this topic, and more specifically in this region, to comprehend more deeply the contextual specificities regarding SEA, its role in sustainability and how to overcome these challenges.

METHODS

The methodology for this research had a mixed method, semi-qualitative, cross-sectional approach. The time period for the context characterization and data collection was three months, from March 2023 to May 2023. Below in **Figure 2** is presented the process that was followed to answer the research question.

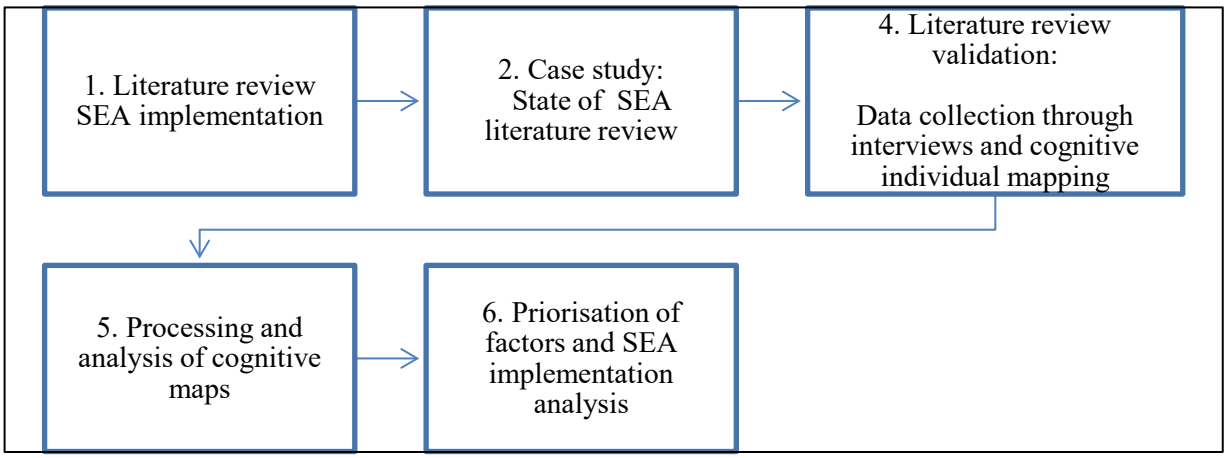

Figure 2. Methods diagram

Literature review

The objective of this first stage was to guide through existing knowledge about SEA integration and the factors that hinder or enhance its implementation. It was of critical importance because it shed light on the current state of SEA research.

Search criteria. For this review, key words were used as a first search criteria on the SCOPUS database, these keywords were: 'Strategic environmental assessment', 'SEA', 'factors' and 'drivers'. The search was limited to only peer reviewed articles and the filters to further narrow down the search were:

- These words must be found in the title, keywords or abstracts.
- The review time frame was 2003 to 2023.
- Titles, key words or abstracts containing only environmental uses for SEA were considered.

Screening criteria. The title, abstract and keywords of 51 articles were read and the one that met these criteria were excluded from the final analysis:

- Only focused on factors within the impact evaluation.
- Proposed specific methodologies to assess indicators or factors, during an SEA process.

These exclusion criteria allowed only those articles referring to factors and drivers influencing SEA integration or implementation at a certain policy level.

Data extraction. The articles were systematized using a data table, which included the approach and data collection techniques used, along with information about the place, main results and factors of implementation.

General factors affecting strategic environmental assessment implementation

The first search yielded 53 documents under these search criteria, which were grouped as follows: Environmental Science (38); Social Sciences (29); Agricultural and Biological (9); Engineering (7); Earth and Planetary Sciences (5); Energy (5); Economics, econometrics and finance (3); others (5), from 26 different countries. After applying the exclusion criteria, this number was reduced to 13.

Case study characterization and validation factors

Literature review on current state of SEA in Nicaragua. This substage consisted in the review of journal papers, grey literature (newspapers, organism webpages, official national reports). This literature review provided the baseline information to understand the legal framework and state of implementation of SEA, comprehending a timeframe of 20 years.

The characterization of the case study was complemented by semi guided open interviews and fuzzy-logic cognitive mapping to validate the findings on the factors of influence found through the literature review. To perform this validation, the following steps were performed:

Fuzzy-Logic cognitive mapping. To validate the factors found in the literature review, this study set to understand how the case study SEA system worked and to identify which critical factors were applicable to the system. To achieve this, FCM was found suitable. An FCM is a participatory method, that uses knowledge and opinions to create a model. These models then, can be used to examine perceptions of an environmental or social problem or to model a complex system where uncertainty is high and little empirical data is available. Through this mapping, individual representations of concepts and causal relationships in social and ecological systems are developed.[32].

Hobbs *et al.* [33] proposed a methodology that relies heavily on input from experts and stakeholders for FCM. This methodology extracts their knowledge and exploits their experience of the model and behaviour of the system. In standard methods of FCM learning, concepts are represented as nodes, and the relationships between them are represented as weighted arcs. Nodes of the graph stand for the concepts that are used to represent the system, and the weighted arcs represent the strength and direction of the causal relationships between the concepts. This substage was fundamental for data collection and later analysis, so it was subdivided into two steps, based on methodologies for information extraction for mental modelling: Open guided interviews as suggested by [34] and selection of stakeholders to be interviewed [15] and the design of the interview, [18].

Selection of interested parties and stakeholders to be interviewed. The first part consisted in selecting the actors for the cognitive mapping. This selection was done considering their knowledge in sustainability, environmental law and their role in the decision-making process on sectorial policies. The recommended minimum of maps to perform this analysis, was two

per type of stakeholder. The actors that were to participate in the data collection process was determined using the method of selecting types of stakeholders; four relevant types were chosen:

1. Independent Organisations: NGO's and consultancy agencies.
2. Government: ANA, MARENA, MAG, MEM, ENATREL.
3. Academia.
4. Environmental legal framework experts, individuals.

Design of instruments for data collection. The instrument was an open interview, which served as a guide for the interviewee to identify the important aspects for cognitive mapping.

The first part of the interview was designed to assess the knowledge in SEA of the actors in environmental policies in Nicaragua, and to achieve the characterization of the case study. This part served as an introduction to the cognitive mapping process and a successful response to both questions, determined if the stakeholder had the knowledge to complete a cognitive map regarding the research.

Individual elaboration of cognitive maps. Each interviewee drew their cognitive map, on paper, following and adapting the methodology recommended by [35].

First, the interviewee was explained how cognitive maps are made and a simple one was drawn as a demonstration. Once the process was understood, they started drawing their own map as follows in **Figure 3**:

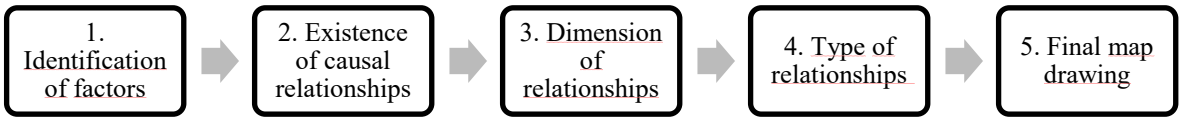

Figure 3. Diagram of cognitive mapping steps, adapted from [36]

The total time for completing the map was established at a maximum of 35 minutes. During this time, the author was present, but in silence. If there was any question regarding the process, they were answered but no input for the factors were given, aside from the ones in the instructions page, as examples. No limit of factors or variables, maximum nor minimum was given.

Processing and analysis of cognitive maps. For the processing and analysis of the individual maps, FCMEXPERT Software [37] was used, which is an open-license FCM design, modelling and analysis software. This phase contained the following subphases, which were based on [35]:

- Map processing in software: Input of cognitive map into software.
- Coding of cognitive maps in matrices. From this analysis, the number of variables obtained, type and weights of the same will be determined.
- Increase of individual cognitive maps by aggregating them to form social cognitive map of stakeholders. This consists of a ponderation of all variables in one single cognitive map.
- Analysis of the structure of individual and social cognitive maps using theoretical index of graphs. This stage determines which of the variables have more effect on the current system, so leverage points can be identified based on those variables.
- Reclassification for types of variables, prioritisation and comparison with literature review results on general factors for SEA implementation. For example: A context specific variable, like: Civil unrest, which is highly specific to some parts of a country or region, would be reclassified to a broader factor, which could be "Contextual factor".

RESULTS

State of SEA integration and knowledge in Nicaragua

SEA was first recognized in Nicaragua by law as mandatory for strategic planning was in 2006, with the development of the first environmental assessment system [38]. In the image below, we can see the evolution of the legal framework regarding SEA in the last 30 years in Figure 4.

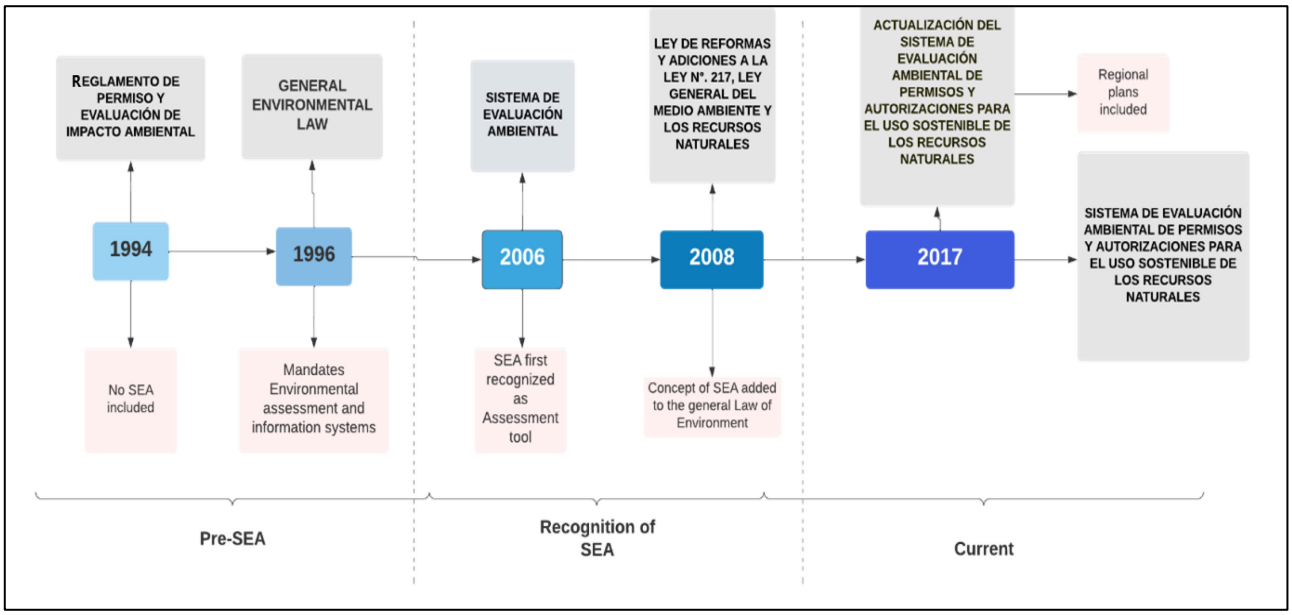

Figure 4. Evolution of SEA legal framework

The scope of SEA within the current Presidential Decree is general, encompassing three categories for Strategic Assessment Process: 1. National, sectoral development plans and programmes, 2. National plans or programmes for land use planning and 3. Regional plans and programme [39]. According to the decree [39], the goal of the SEA is to assess environmentally the above mentioned PPP´s, focusing on investment, national and sectorial development, and with this, to guarantee the inclusion of the environmental factors.

Despite being included in the country's environmental assessment system for over twenty years, its application has not been instrumentalized and no official reports of SEA were found to be performed by any of the responsible organisms. In the most recent environmental assessment decree [39], it is stated that SEA should be administered by the central Environment and Natural Resources Ministry (MARENA), through the General Directorate of Environmental Quality, with the participation of other relevant state sectors, nevertheless there is no complimentary administrative nor legal instrument that establish the guidelines for performing one nor government portal that provides information about SEA implementation.

Furthermore, during the search for cases of SEA in Nicaragua, general or specific regional, sectoral, there were no peer reviewed papers nor grey literature referencing implementation of SEA, making this study the first to analyse the state of SEA in an academic setting.

One of the interviewees from a ministry was part of the committee that developed the first Environmental Assessment System and stated that there was doubts as to how they were going to achieve the operationalisation of the SEA, because they knew that many countries before in Latin America had tried to incorporate it into their practices but had no success performing an SEA. The driver for the incorporation of the SEA as an instrument in the National Environmental Law and later in the first decree for Environmental Assessment in 2006 was to standardise the regulatory framework with other countries of the region, as part of the Agreement for the Strengthening of Environmental Impact Assessment Systems in Central America, signed by the Ministers of the Environment of Central America Region [40]. This

situation, alongside with the lack of further technical norms or manuals on how SEA is supposed to take place, suggests the inclusion of instruments without considering the available expertise nor its practicality to achieve its implementation.

This was validated in the data collection stage, all the interviewees knew the concept of SEA, and acknowledge the importance of undertaking one with any PPP, but they were not aware of the procedures regarding how to integrate SEA into decision-making nor had they been part of an SEA group. Methodologies to integrate it, implement it, monitor or evaluate the processes of an SEA were also unknown to the interviewees.

Overall, there was a lack of information regarding SEA at any level of implementation integration. There were no previous scholarly publications, academic works or thesis that covered the general topic of SEA. No scientific publications regarding the factors that affect the implementation, neither in Nicaragua nor elsewhere on Central America. Nevertheless, a case study [41] discussing SEA pilot experiments process in 10 municipalities in Honduras was found and reviewed. This case study shone a light on the potential of SEA in similar countries as Nicaragua: authorities were committed to support the process and resources were invested, particularly in trainings and the result was overall positive, nevertheless, a political crisis in 2009 stopped these processes and no further information about any attempt of continuing the practice was found [41].

All the previously mentioned circumstances suggest that this is the first exploratory research in Nicaragua and Central America to evidentiate the factors of SEA implementation.

Validation of Literature review: Factors affecting strategic environmental assessment implementation in Nicaragua

Three individual cognitive maps were used to determine the factors for SEA in the case study. The results of those individual maps are available in the Appendix (**Figure A1**. Individual cognitive map 1: Interview of public ministry official, 30 years of experience in environmental policies; **Table A1**. Factors influencing SEA integration, results individual map 1; **Figure A2**. Individual cognitive map 2: Interview of environmental consultant, specialty environmental permisology, 10 years of experience in environmentalmanagement; **Table A2**. Factors influencing SEA integration, results individual map 2; **Figure A3**. Individual cognitive map 3: Interview of environmental law expert; **Table A3** Factors influencing SEA integration, results individual map 3; **Table A4**. List of total factors affecting SEA in case study, social cognitive map; **Figure A4**. Screening criteria according to EU Directive, flowchart based on [44]).

From the augmented social mapping and the interviews, there are a total of 32 factors that can be influencing the implementation of SEA in PPPs in Nicaragua, **Figure 5** (see list of factors and their classification on Appendix **Table** A4). The more frequent type of factors were: Contextual factors (10), Resources and capacities (8) and statutory framework (6).

Through the cognitive social mapping, prioritisation of types of factors were done by weight of influence on the system, according to the final map (**Figure 6**). This prioritisation allowed to identify which types of factors were the most relevant, given that some of the factors were very specific to the experiences or the sectors in which the stakeholders had focused.

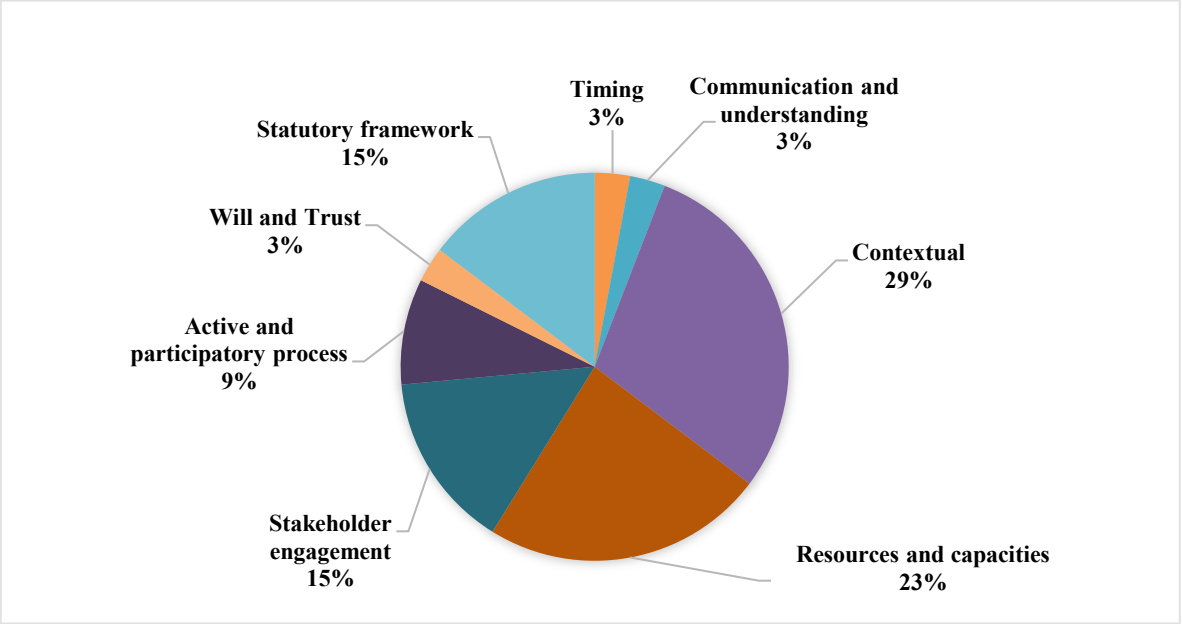

Figure 5. Factors affecting the implementation of SEA in case study, based on **Table A4**

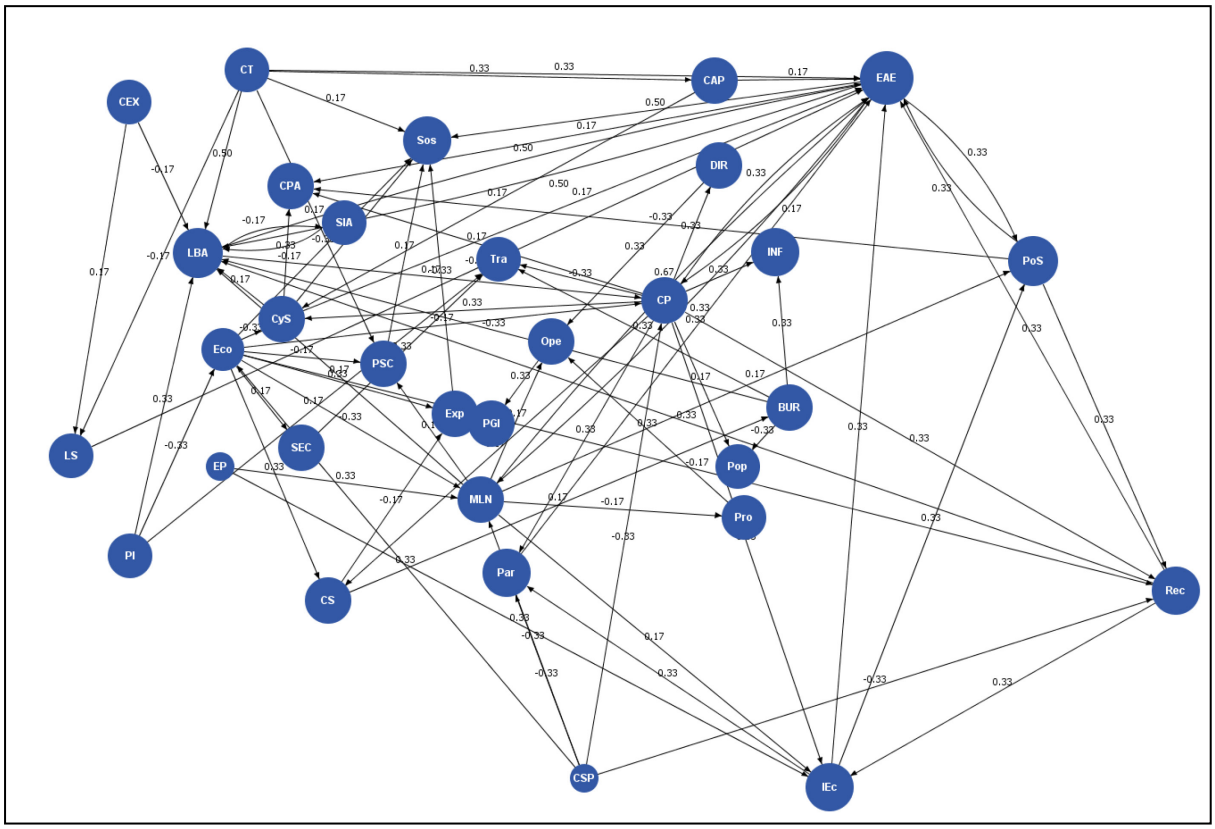

Figure 6. Social cognitive map, augmented from individual mapping

The priorities resulting from this grouping were:

Table 2. Prioritisation of SEA influencing factors

Priority	General Factor Group	Impact on the system
I	Contextual factors	More change in the system, given by the overarching political, social, cultural and economic situation of the country.
II	Statutory Framework	More regulatory related. These factors are needed for the system to function and change, even though their existence does not guarantee their application in the current state. Their implementation depends strongly on the contextual factors.
III	Resources and capacities.	Frequent drivers of change, yet directly dependent on statutory framework and the contextual factors.

As can be seen in the table, contextual factors represent the most powerful drivers of change in the system, as they played a role in changing the weight in SEA integration and implementation, resulting in direct influence in compliance in legal framework, stakeholder participation and communication. Change in any of these group of factors, proportionally to their priority, would mean a significant change in the weights of the overall system, and the fixed state of the system would be shifted to "more integration and better implementation of SEA". This leads to the main challenge of how to modify contextual factors. The following were identified in the case study:

1. Socio-political and economic situation,
2. Transparency,
3. Bureaucracy,
4. International pressure,
5. Centralised decision-making.

As seen above, these factors are the ones that do not change easily and cannot be modified readily from within the system. Nevertheless, the existence of the base regulatory framework in Nicaragua, where the legal basis is already laid out for SEA should be used as a leverage point to focus on more operational factors, such as Knowledge and understanding. Any strategy to start integrating SEA should be aimed to complement via capacity building and stakeholder involvement; and should draw lessons from previous successful experiences in the same context to learn and adapt it to Nicaragua´s specific need.

Scenario analysis through fuzzy logic (FCM) cognitive mapping modelling

Through the cognitive social map, prioritisation of types of factors were done: this prioritisation allows to identify which types of factor were the most relevant as a whole, given that some of the factors were very situation-specific. For example, the factor number 9 code "SIA", represents the inexistence of Environmental Information System called SINIA as stated in the Environmental Law [42], so this was grouped with general factor "Resources and capacities", to simplify the analysis and to have a more general view of the system and how it could change by shifting factors. The priorities resulting from this grouping are presented in **Table 3**.

Table 3. Factor priorities for scenario analysis

Priority	General Factor Group	Impact on the system
I	Contextual factors	More change in the system, given by the overarching political, social, cultural and economic situation of the country.
II	Statutory/ legal framework	Regulatory related. These factors are needed for the system to change, even though their existence does not guarantee their correct application in the current state. Their implementation depends strongly on the Contextual factors.
III	Resources and capacities.	Frequently mentioned, yet directly dependent on statutory framework and the contextual factors.

As can be seen in the table, contextual factors represent the most powerful drivers of change in the system, because they are the sole decision-making approach that answer individual interests, and they are the symptom of a more overarching problem. After doing this prioritisation, the likely scenarios were selected, as an inquiry: e.g. *What will happen to the system if 1. "Contextual factors such as Political Will and Sociopolitical crisis are decreased",* this allowed identify three scenarios (**Figure 7**):

1. Scenario 1. Factors classified as contextual such "Political will" and "Sociopolitical crisis" played a role in changing the weight in SEA integration and implementation, with more compliance in legal framework, stakeholder participation and communication.
2. Scenario 2: Factors "Explicit legal framework" and "Procedures and regulations" were the second most influential variables in the system.
3. Scenario 3: Factors "SEA operations and directives" were the third most influential factors.

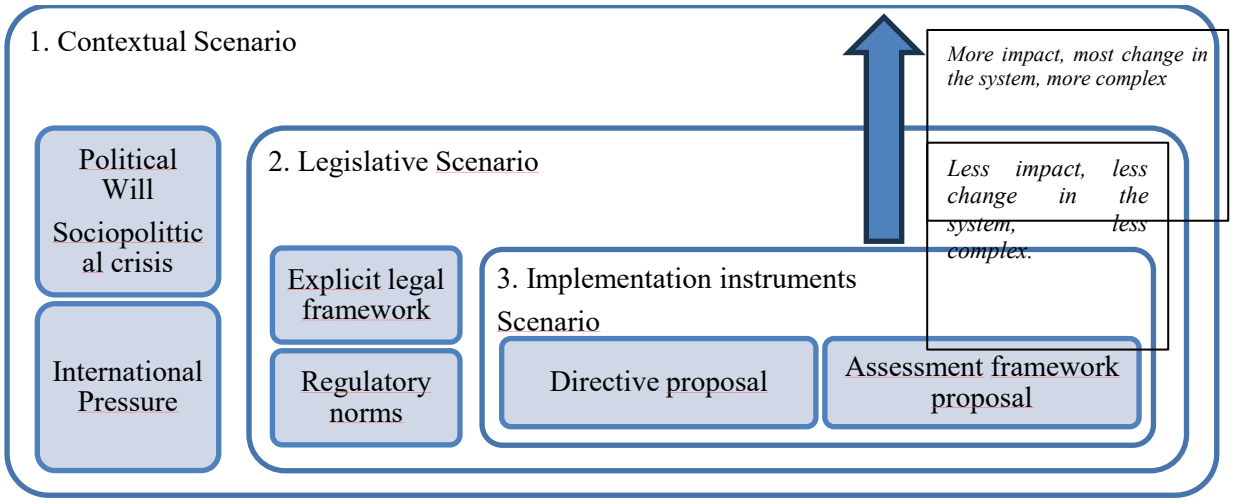

Figure 7. Scenarios for SEA integration, based on FCM results

Strategies for the integration of SEA focused on agricultural policies

Taking the results of the more influential scenarios, strategies were prioritized. Since the contextual factors, by nature, are resistant to change, this thesis work will not cover strategies relating to scenario number 1, even though it is emphasized that these factors are the real drivers of change for SEA integration. Because of the technical impossibility to change a factor such as corruption with one specific strategies, the proposed strategies were prioritized based on scenarios 2 and 3 using the specific factors as leverage points, which were identified as the more direct way of changing the system, tiering also on previous initiatives.

The more impact the scenario has on the system, the more change there is, and the more opportunities to improve. Three strategies are proposed to integrate SEA in those scenarios, presented in **Table 4**.

Table 4. Summary of proposed strategies for integration of SEA

Strategies	Strategy 1 Regulatory annex or amendment to current degree	Strategy 2 Additional instruments or additional SEA Directive	Strategy 3 Policy development framework
Objectives	To promote the regulatory decree for the current assessment systems.	To propose a series of instruments for a new SEA directive in Nicaragua.	To propose a conceptual framework to assess the need for SEA in Nicaragua.
Feasibility	Very likely to be updated with regulatory parts. SEA must be included.	This would need to have the first strategy as a prerequisite, very likely after the addition of regulations to the decree.	This would need to have the first strategy as a prerequisite, less likely.
Factor to develop	Explicit regulatory framework Tiering	Understanding of SEA Tiering Will and Trust	Technical capacities Transparency and communication Economic resources for baseline
Resources	Strong political will and SEA understanding	EU directive as a model	Specialization in SEA. Other conceptual frameworks can work if the context is analysed.

Strategy 1. Regulatory annex to current degree

A good legal framework is important as a basis for SEA. This strategy focuses on adding explicit procedural information to the current decree. This can be achieved with a normative decree; as was done with the National Water Law. This strategy aims at stablishing SEA procedures that provide guidance on how to conduct an SEA, including the scope of the assessment, the methods to be used, and the roles and responsibilities of stakeholders.

That means that capacity development is also required for law-drafting experts. It is recommended that this addition to the current system be an informed decision and based on legislation from other countries and encouraged to consult with other countries in their region when drafting the proposal, to encourage discussion about successes and misses in integrating SEA. Some recommendations regarding the current decree are:

- a requirement to make an early start of SEA mandatory for all plans, linking the timing of SEA to the initial stages of planning.
- a requirement for a scoping report that must be approved and adopted by both the development and environmental authorities, as a way of strengthening cooperation and consultation between development and environment agencies.
- clear standards aimed to improve the quality and timing of the public's involvement. These suggestions have all implications for skills and training **[43]**.

Strategy 2. Nicaraguan SEA directive as an Instrument

An SEA directive is a binding document stating the procedures during an SEA process, from early stages to monitoring and assessment. This strategy is linked to Strategy 1; these directives must be explicitly mentioned in the assessment system to have legal binding value.

Many countries have derived their national directives from the analysis of the European Union, the EPA from the United States or the Chinese assessment system [1]. These directives have a minimum of:

1. Clear objectives for SEA implementation,
2. Scoping and screening criteria.

An example of screening criteria, based on the EU Directive, and used widely, with adaptations in other countries is expressed in the flowchart contained in **Figure A4** in Appendix.

Strategy 3. Policy development framework

Policy development frameworks could inform decision makers and experts in why and how the SEA would be integrated in the policy. The objective of this strategy is to fill the gap in technical capacities, while understanding of SEA and methodological knowledge to simplify policy development. Providing simplified policy-making models can help to ensure that SEA provides environmental input throughout the stages of policy development; for this capacity should be built to communicate SEA information in language that is understood by decision-makers and that there is enough stakeholder engagement to contribute to the planning process.

Some authors refer to frameworks for policy development and integration of environmental factors, to achieve this simplification of policy making. The proposed decision support framework by [45] is a good example of functional SEA complimentary tools to help the process of integration. Adapting the following flowchart will allow professionals, government officials and stakeholders in Nicaragua to comprehend the background for environmental assessment on PPP level.

Implementing SEA in Global South countries

Any SEA is situated within a specific cultural context of decision-making, where the specific way decisions are conducted impacts the ability of SEA to accomplish its objectives and contribute value to the decision. This, in turn, dictates the effectiveness and success of the SEA. Furthermore, the characteristics of the decision-making context are directly connected to how SEA is approached and the extent of its coverage. The individuals involved, the institutional framework, and political strategies shape how a process like SEA is perceived by policymakers and decision-makers. Additionally, SEA itself functions as a tool of public policy inseparable from the realm of politics and the broader governance environment, as it both wields influence over and is subject to influence from the components comprising that environment.

The OECD [9] states that three pillars are required to institutionalize SEA in a country: 1. SEA expertise, 2. legal and financial basis to be in place and 3. clear institutional structure. By analysing the case study, we see how these pillars interact and are influenced by specific context within a very complex governance system.

[16] and [23] discuss in their research on challenges of SEA in Global South countries, this may be due to many factors: the economic problems typical of a developing country (inequality, poverty, corruption) and the lack of political will, lack of trust in government, which are mirrored in arising problems in environmental governance.

In their systemic-context specific broad analysis of SEA effectiveness in China, highlighting the shortcomings in the SEA integration of a previously poor country, in which the challenges where similar, but in a bigger scale than Nicaragua´s, Bina [43] discusses that the main difference between SEA successful and unsuccessful implementation is the kind of governance that shapes the system.

In effect, as seen in this exploratory research, governance context and SEA cannot be completely discussed as separate matters, as [46] argue in their analysis, emphasizing the need to prioritize more research on governance in SEA as an integrated system, instead of analysing single aspects of governance (e.g. public participation, monitoring and follow-up, capacity-building, decisions transparency or accountability).

As [47] discusses, SEA implementation can be very advantageous because it ensures the early systematic assessment of advantages and disadvantages of the decision-making process while promoting the democratization of planification and the decision-making process through participatory discussions, that ultimately lead to transparency and greater public acceptance. Then, SEA must be included, and demanded, as a requirement for government policy proposals and must be established in local municipalities and implemented by local authorities regularly.

Capacity building as a general strategy could ensure that the SEA expertise pillar is achieved, but as all factors, this is a matter of political will and if there are no state structures supporting the process environmental planning, SEA in the Global South will continue to be a solution just in theory.

DISCUSSION

Nicaragua has a broad framework of environmental legislation, with policies and strategies to guide environmental management towards a successful implementation. However, this is an aspect that has not yet been taken advantage of, since the application of all environmental regulatory instruments throughout the last three decades has evolved slowly. Because of the numerous challenges that are tied to the context of the case study country, the "factors for implementation" identified through the interviews were almost synonymous with "difficulties for performing an SEA". This is probably related to the negative connotation of public decision-making for environmental protection and sustainability.

The state of the art on SEA emphasizes the need of stakeholder involvement and participation as the main factor to achieve a successful implementation, as it is a building block of the principles for SEA. Nevertheless, it can be observed in the maps that it played a secondary role in causality for the integration of SEA for one of the interviewees, while another one mentioned it indirectly through factors such as "centrality in decision-making" and "no cooperation between ministries". The one remaining did not even contemplate it. Two reasons can be deducted from this result:

1. The first one is the representativity of the maps: The limited number of maps limit the understanding of the system, as it cannot be said that the whole national system can be determined by a small sample.
2. The second one could be the type of stakeholders interviewed: The three maps represented in this analysis are in some way related to being in a position of policy – maker, rather than being the stakeholder affected by the decisions. As such, it can be supposed that representatives from different sectors would lean into a more participation based, social and economically oriented system.

The main limitation with this research was the limited participation in interviews due to political issues and fear of retaliation. There was a reluctancy to participate in the interview process, even though the author assured confidentiality. Out of the 12 representatives of stakeholder groups selected for interviewing, only three responded; two of them did the mapping, while the remainder wanted to perform an informal talk instead of an interview, without participating actively in the mapping process.

Thus, data collection was limited due to the inability of actors to partake in independent research without previous authorization from the central government. It is expected that the results are biased because of these challenges regarding data collection and validation. Although the use of FCM is broad in socio-environmental decision-making, studies have not

focused on the analysis of the framework for SEA. This could be due to the participatory nature of the topic and the method, which, as seen with the case study, hindered the analysis.

Other limitation was the scope of the research, as its conception departed from the supposition that there were some considerations of strategic planning in PPP development. As found through the data collection, there are many context-specific circumstances which make the analysis of the practice of SEA in sectoral policies not possible.

Future research regarding SEA integration and implementation in sectoral success factors can be drawn from a more specifically designed methodology using SEA experts' panels, such as the one conducted by [48]. Fundingsland Tetlow & Hanusch [10] discuss at their state-of-the-art review, that SEA is an instrument many decades since its conception, yet there are still unknowns regarding the success and the translation into action due to the high strategic component; methodologies are not a "one-size-fits-all" recipe, so there is still many gaps in research regarding this topic.

Climate change and sustainability transitions are emerging as the future research of SEA as [7] point out, in line with pressing global environmental crisis accelerate, and with this, the necessity of SEA to keep up to ensure its function and it follows that there must be a way to ensure the integration and implementation on Global South countries.

CONCLUSIONS

Nicaragua, in Central America, is a Global South country and its legislative framework contemplates the use of SEA to ensure sustainability. nevertheless, there are no indications that there are any voluntary nor mandatory SEA successfully implementation efforts in any public PPP.

In theory, SEA poses an effective way to ensure participation, transparency and optimal resource allocation; but as we have seen, it is very difficult to witness it working successfully in practice in nations of the Global South, because a sturdy governance is needed to avoid resources waste, bureaucracy and meaningless procedures, to be able to fill the gaps in environmental governance. As seen with the case study in Nicaragua, these gaps are common in Global South nations, and it is not easy to overcome the challenges regarding political and social issues and economic development.

The majority of successful experiences and case studies found are those from the global north, where directives such as the European and USA have been implemented in national, regional and sectoral policies. As was presented, there is a strong link between economic development, democracy and successful SEA integration for sectoral policies; the drivers of effective SEA implementation are commonly not present in Global South countries, still struggling to ensure human rights and fair allocation of resources.

Existing studies on SEA in Global South countries and discuss contextual challenges such as limited knowledge and experience with SEA, low trust in public institutions, and limited institutional capacity of environmental agencies. Limited resources can be a challenge in integrating SEA into policy development. Conducting an SEA requires resources, including time, money, and expertise, which may not always be available. As seen with the case study, the sociopolitical background plays an important role in environmental decision processes.

Through this analysis, 32 factors that influence SEA integration or implementation in the case study were identified, with the contextual ones being the most relevant to ensure integration, though they are most difficult to modify; this validates previous research on SEA implementation and gives an outlook of the challenges a typical Global South country need to address in order to keep up with international established practices, such as SEA.

To the authors' knowledge, this study is the first to analyse this topic in Nicaragua and Central America. It provides an outlook on the current state of understanding of SEA implementation in Global South and highlights the importance of prioritising the research to understand environmental decision-making in countries such as Nicaragua, and to propose strategies that are

aligned with the specific issues of the country and the framework for environmental policies. While the three cognitive maps utilized in this study do not comprehensively represent the entire system's function, they offer a preliminary understanding of the situation, especially given the limited participation due to political sensitivities. In contexts where data collection is constrained, disseminating such findings is essential to inform both national and international audiences about the challenges in implementing SEA in Nicaragua. This contributes to the broader discourse on environmental governance in similar contexts.

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NOMENCLATURE

Abbreviations	
ANA	Autoridad Nacional del Agua
BCIE	Banco Centroamericano de Integración Económica
BID	Banco Interamericano de Desarrollo
ENATREL	Empresa Nacional de Tranmisión Eléctrica
IFC	Fuzzy-Logic Cognitive Mapping
MAG	Ministerio de Agricultura
MARENA	Environment and Natural Resources Ministry
MEM	Ministerio de Energía y Minas
NGOs	Non-Governmental organisations
PPPs	Plans; Programmes and Policies
SDGs	Sustainable Development Goals
SEA	Strategic Environmental Assessment

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APPENDIX

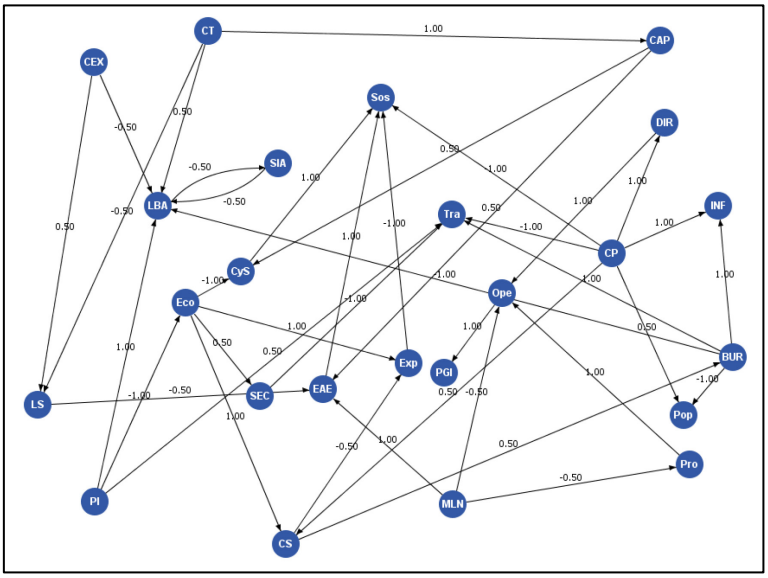

Figure A1. Individual cognitive map 1: Interview of public ministry official, 30 years of experience in environmental policies

Table A1. Factors influencing SEA integration, results individual map 1

Number	Code	Factor or variable
1	EAE	Integration or implementation of SEA (sectorial or regional)
2	CP	Politic will or compromise
3	MLN	National legal framework
4	LBA	Environmental baselines
5	Sos	Sustainability
6	Eco	Economic interests
7	CS	Sociopolitical crisis
8	CT	Existence of technical capabilities at the national level
9	CyS	Capacities for monitoring and control for environmental PPPs
10	Exp	Exports
11	PI	International pressure from development banks and international cooperation such as BCIE, BID, JICA
12	SIA	Inexistence of environmental information systems
13	SEC	Corporate secrecy
14	Tra	Transparency
15	Ope	Lack of SEA operationalization
16	PGI	Inexistence of integrated management of resources programmes or plans
17	DIR	Unclear directives and functions in institutions
18	INF	Information not shared between institutions, only by upper level authorities (central government)
19	CAP	Existence of ministry capacities for leadership in SEA practice
20	CEX	Preference for foreigner consultants; no understanding of national contexts
21	BUR	Need for central government to allow information flow, bureaucracy and vigilance
22	Pro	Inexistence of procedures nor guidelines for SEA
23	Pop	Delayed decisions due to populist interests (assurance of followers for voting)
24	LS	Unavailable social baselines

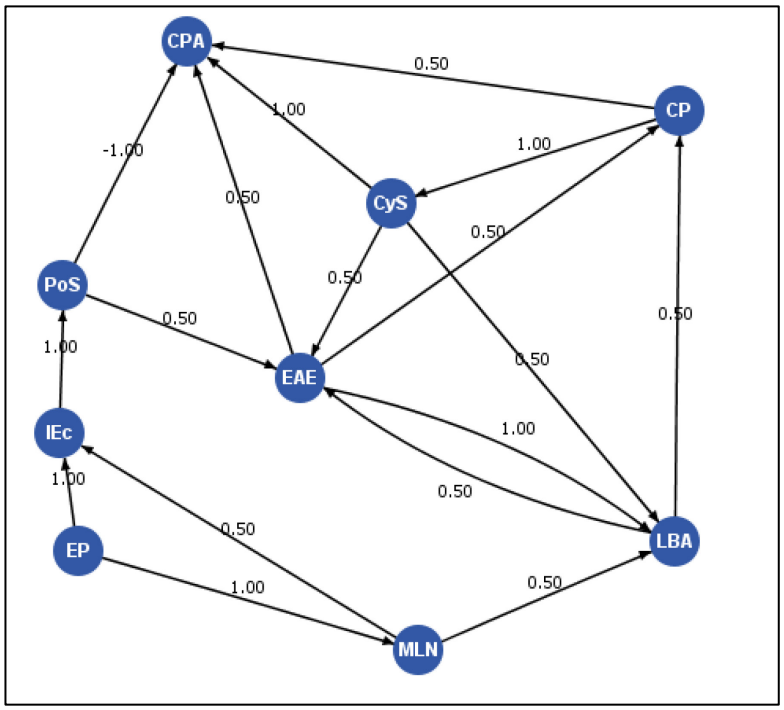

Figure A2. Individual cognitive map 2: Interview of environmental consultant, specialty environmental permisology, 10 years of experience in environmentalmanagement

Table A2. Factors influencing SEA integration, results individual map 2

Number	Code	Factor or variable
1	CyS	Capacities for monitoring and control for environmental PPPs
2	EAE	Integration or implementation of SEA (sectorial or regional)
3	CPA	Environmental protection and conservation
4	CP	Politic will or compromise
5	EP	Politic stability
6	MLN	National legal framework
7	LBA	Environmental baselines
8	IEc	Economic incentives
9	PoS	Sectorial policy development

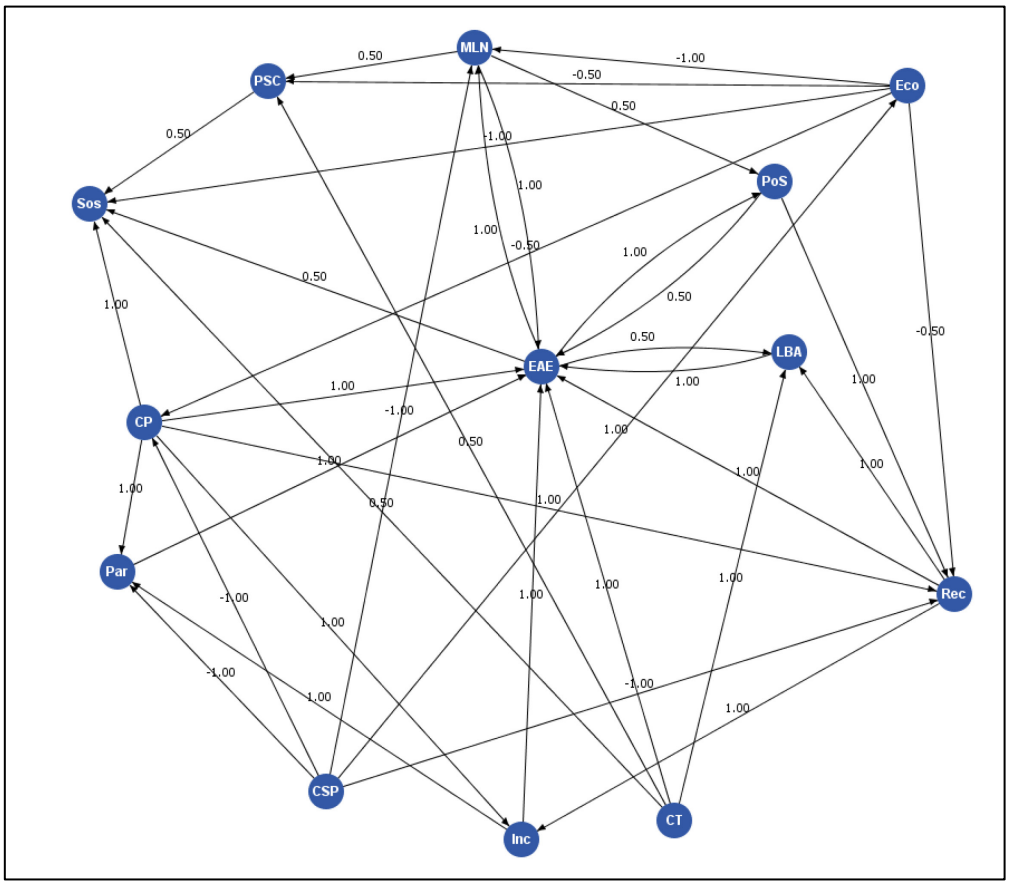

Figure A3. Individual cognitive map 3: Interview of environmental law expert

Table A3. Factors influencing SEA integration, results individual map 3

Number	Code	Factor or variable
1	EAE	Integration or implementation of SEA (sectorial or regional)
2	CP	Politic will or compromise
3	MLN	National legal framework
4	LBA	Environmental baselines
5	PoS	Agricultural policies development
6	Sos	Sustainability
7	Eco	Economic interests
8	CS	Sociopolitical crisis
9	Par	Stakeholder participation
10	IEc	Economic incentives
11	Rec	Economic resources availability
12	CT	Existence of technical capabilities at the national level
13	CSP	Sustainable agricultural or sectorial practices

Table A4. List of total factors affecting SEA in case study, social cognitive map

Number	Code	Factor	Re-Classification of concept or factor
1	EAE	Integration or implementation of SEA (sectorial or regional)	Communication and understanding
2	Sos	Sustainability	Context
3	CyS	Capacities for monitoring and control for environmental PPPs	Resources and capacities
4	Eco	Economic interests	Context
5	Exp	Exports (International drivers)	Context
6	CS	Sociopolitical crisis	Context
7	PI	International pressure from development banks and international cooperation such as BCIE, BID	Context
8	LBA	Environmental baselines	Resources and capacities
9	SIA	Inexistence of environmental information systems	Resources and capacities
10	SEC	Corporate secrecy	Stakeholder engagement
11	Tra	Transparency	Active and participatory process
12	CP	Politic will or compromise	Will and Trust, context
13	CT	Existence of technical capabilities at the national level	Resources and capacities
14	CAP	Existence of ministry capacities for leadership in SEA practice	Resources and capacities
15	CEX	Preference for foreigner consultants; no understanding of national contexts	Resources and capacities
16	LS	Unavailable social baselines	Resources and capacities, active and participatory process
17	MLN	National legal framework	Statutory framework
18	Ope	Lack of SEA operationalization	Statutory framework
19	Pro	Inexistence of procedures nor guidelines for SEA	Statutory framework
20	DIR	Unclear directives and functions in institutions	Stakeholder engagement
21	PGI	Inexistence of integrated management of resources programmes or plans	Statutory framework
22	BUR	Need for central government to allow information flow, bureaucracy and vigilance	Active and participatory process
23	INF	Information not shared between institutions, only by upper level authorities (central government)	Context
24	Pop	Delayed decisions due to populist interests (assurance of followers for voting)	Timing
25	CSP	Sustainable sectoral practices	Context
26	Par	Stakeholder participation	Stakeholder engagement
27	IEc	Economic incentives	Stakeholder engagements
28	Rec	Economic resources availability	Resources and capacities
29	PoS	Policy development	Statutory framework
31	CPA	Environmental protection and conservation	Context
32	EP	Political stability	Context

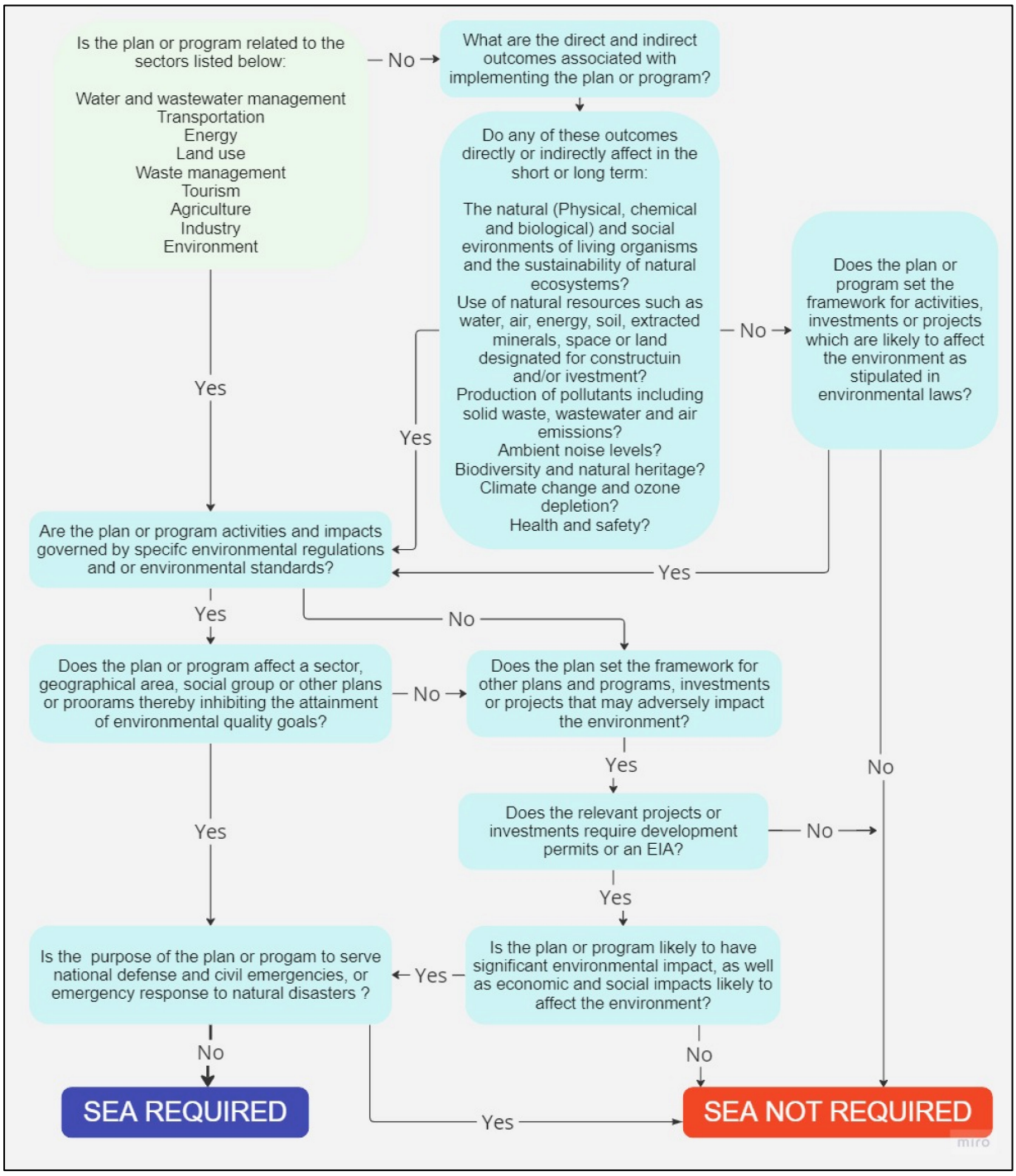

Figure A4. Screening criteria according to EU Directive, flowchart based on [44]

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