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Research Article

Cumulative Impact Assessment of Development Projects Around Campo-Ma'an National Park in Cameroon

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Abstract: This study assesses the extent to which cumulative impacts are considered when evaluating the environmental and social impacts of development projects in proximity to a protected area. The applicability of the Sorensen and Rau method for evaluating these impacts was also investigated. The methodological basis of this study is the content analysis of eight environmental and social impact assessment reports. These reports were assessed using an assessment grid divided into six blocks of questions. This grid was developed on the basis of good practice and implemented through exchanges with key stakeholders. It was also implemented in accordance with the four stages recommended by Sorensen and Rau. The results demonstrate that Block 1, which pertains to the role of the Campo-Ma'an National Park in the study, has a level of consideration of 79%. Block 2, which pertains to the analysis of the impact of the projects on the Park, was considered to a degree of 81%. Block 3, which addresses the consideration of cumulative impacts on the Park, was addressed to a limited extent, at 52%. Block 4, which pertains to public participation, has a compliance rate of 47%. Block 5, which pertains to the integration of the Environmental and Social Management Plan, was considered to the extent of 67%. Block 6 addressed 47% of the cumulative impacts on the park in the Environmental and Social Management Plan. The findings of the Sorensen and Rau method indicate that the component associated with great ape populations remains of significant value, with a criticality score of 19.52. Those components associated with the park's surface area, ecological corridors and habitat remain at an average criticality value of 11.4, 11.1 and 10.22, respectively. This suggests that the park's valued components could suffer from the cumulative effects of the various projects, particularly those associated with great apes. The study revealed that projects do not systematically integrate cumulative impacts due to a dearth of data, and that this shortcoming could be addressed through a combined matrix and network approach. It would be more prudent to consider the digitization of systems in relation to impact analysis at a time when digital technology is optimizing systems.

Keywords: Campo-Ma'an National Park, integrity, cumulative impacts, Sorensen and Rau method

Abbreviations

CIA Cumulative Impact Assessment

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CMNP	Campo-Ma'an National Park
IUCN	International Union for Conservation of Nature
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
VCP	Valued Component on the Park

1. Introduction

Protected areas are designed to conserve, protect and sustainably manage natural, cultural and ecosystem values. In fact, they are the "cornerstones" of national and international conservation strategies. As such, they have been the subject of a special program under the Convention on Biological Diversity since 2004, based on the work and recommendations of the 5th World Parks Congress held in 2003 [1]. The African continent is home to an impressive wealth of flora and fauna. The growing interest in protecting the environment in general and ecosystems in particular has led several African countries to create protected areas on their territory. Cameroon, for example, currently has 30 protected areas covering 8% of its territory. National parks (75%) and wildlife sanctuaries (23%) make up the majority of these protected areas, although some wildlife sanctuaries have also been established. This network of protected areas is complemented by 45 areas of hunting interest and 26 areas of hunting interest managed by communities, covering more than 5.6 million hectares, and three zoological gardens (8 ha) [2-4].

Unfortunately, the integrity of protected areas is sometimes threatened by the negative consequences of so-called "development" activities carried out in and around them [5-7]. This is the case of the Campo Ma'an National Park, which was created on 6 January 2000 to compensate for the negative impact on biodiversity of the Chad-Cameroon pipeline project. This park is one of the priority areas for the conservation of biodiversity in Cameroon and Central Africa, as it has a significant biological wealth. As such, it has been included in the United Nations Educational, Scientific and Cultural Organization's provisional list of World Heritage Sites [2-4]. However, the Campo Ma'an National Park is located at one of the most strategic poles of Cameroon's development and is likely to be affected by current or planned activities. It is therefore necessary to take measures to preserve its integrity.

Environmental and social impact assessment is the almost universal process for limiting or compensating for the negative environmental and social impacts of projects. When properly applied to protected areas, it can make a significant contribution to their protection by addressing upstream the anthropogenic causes of their degradation. Environmental and social impact assessment as a tool for the conservation of protected areas is required by Cameroon's environmental and social regulations, including laws and their relevant implementing texts [8, 9].

However, environmental and social impact assessments sometimes fail to cover all the impacts that the environment may be exposed to because they do not sufficiently consider cumulative impacts, which are changes to the environment resulting from a combined action with other past, present and future actions. Several studies have shown that inadequate consideration of cumulative impacts could harm all ecosystems in the vicinity of these projects and pose a significant threat to protected areas [10, 11]. According to Ostoich and Wolf [12], Cumulative Impact Assessment is not carried out systematically due to non-mandatory legal requirements and a limited, unsystematic analysis methodology. To fill this gap, the authors recommend integrating Cumulative Impact Assessment (CIA) at a more strategic level, particularly when carrying out strategic environmental assessments. According to Halpern [13], the lack of data and a common methodological approach hampers the effectiveness of the process of identifying, analysing and assessing cumulative impacts. This idea seems to be supported by [10, 13], and it would be necessary, as Ozcan [14] suggests, to work on developing an approach that integrates specific areas, such as protected areas, in order to improve the way they are taken into account in environmental and social impact assessments. Faced with this situation, the International Union for Conservation of Nature (IUCN) recommended at the World Conservation Summit in Marseilles in 2020 that member states should protect protected areas from the cumulative impacts of development activities around them through mechanisms that help to integrate these impacts when carrying out environmental and social impact assessments. However, several barriers limit this integration, including the lack of appropriate assessment methodologies [10, 12].

This article aims to contribute to the improvement of the implementation of cumulative impact studies in environmental and social impact assessment projects in protected areas, mainly in Cameroon, in order to fill some important gaps in terms of identification, analysis and assessment methodology, particularly in the Campo-Ma'an National Park. The aim of this study is to improve the consideration of the cumulative impacts of development projects on the Campo-Ma'an National Park in the south of the country. Specifically, we evaluate the cumulative impacts considered in the environmental and social impact assessments of existing projects, and then test the application of the combination of the Leopold matrix method and the Sorensen and Rau network method to assess these impacts. The Sorensen and Rau method is one of the recommended methods for this purpose [15].

2. Materials and methods

2.1 *Materials*

The Campo Ma'an National Park is located in the Southern Region of Cameroon, in the town of Campo Ma'an, between latitudes 2°10′ and 2°45′ North, and longitudes 9°50′ and 10°48′ East [4]. Close to the Atlantic coast, Campo Ma'an National Park is accessible by road (Yaounde-Kribi-Campo road, Douala-Kribi-Campo road and Yaounde-Ebolowa-Nyabizan road) and by water (from Equatorial Guinea, crossing the Ntem River and arriving at Campo Beach). Figure 1 shows the location of the Campo-Ma'an National Park and some of the development projects in its vicinity.

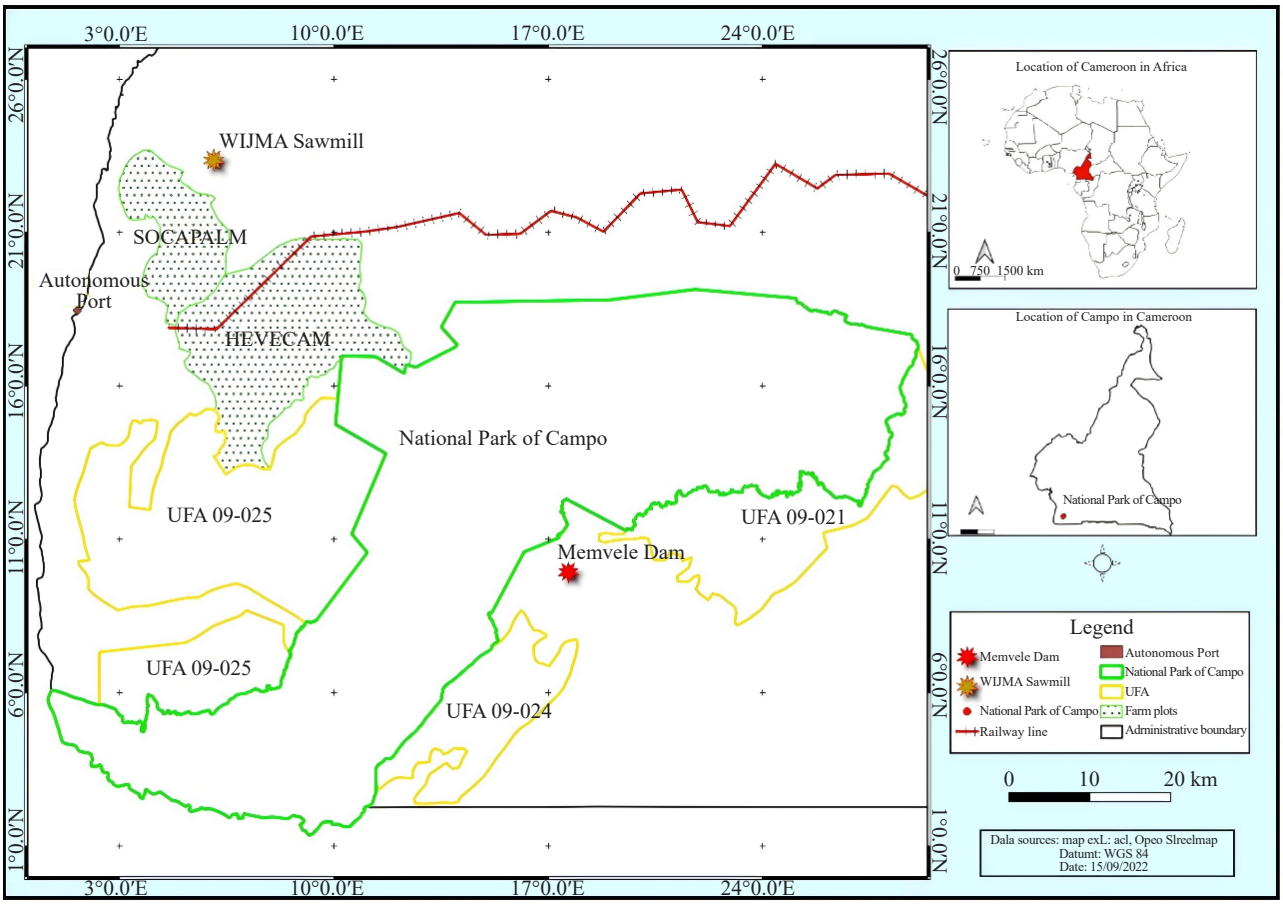

Figure 1. Location of the Campo-Ma'an National Park and some development projects

2.2 *Methods*

A step-by-step approach was adopted to achieve the objectives of this study. Figure 2 shows a synoptic diagram summarizing the methodology of the work carried out.

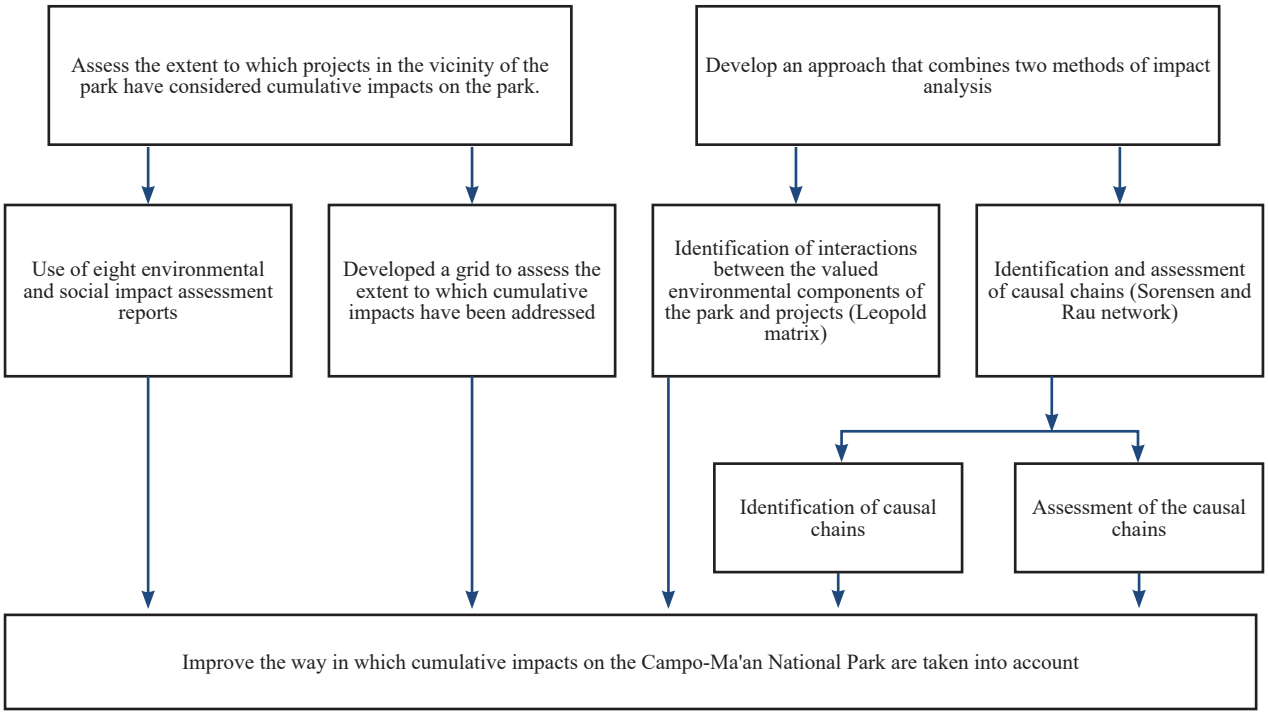

Figure 2. Synoptic approach to the study

According to this Figure 2, improving the way in which the cumulative impacts of projects on the Campo-Ma'an National Park are taken into account involves assessing the extent to which projects take them into account and using an assessment methodology that combines two impact analysis tools.

2.2.1 *Assessment of the level of consideration of cumulative impacts in existing environmental and social impact assessment*

The assessment of the level of consideration of cumulative impacts in the existing environmental and social impact assessment was based on a content analysis of the environmental and social impact Assessment reports and discussions with key stakeholders, including the Curator of the Campo-Ma'an National Park, delegates from the Ministries of Environment, Forests and Wildlife, the environmental departments of the projects concerned, the World Wild Fund (WWF) Cameroon Program Office and local non-governmental organizations.

To support this assessment, a set of 20 questions was selected, taking into account best practices in environmental and social impact assessment, the implications of cumulative impact assessment, the need to preserve the integrity of the Campo-Ma'an National Park, and the views of stakeholders. The 20 questions were grouped into six (06) blocks, namely (i) the first block of questions (1 to 3) sought to determine the place of the Campo-Ma'an National Park in the study under consideration; (ii) the second block of questions (4 to 6) sought to determine whether the Environmental and Social Impact Assessment explicitly addressed the analysis of the project's impact on the Campo-Ma'an National Park; (iii) the third block of questions sought to determine whether the Environmental and Social Impact Assessment explicitly addressed the analysis of the project's impact on the Campo-Ma'an National Park; and (iii) the third set of questions (7, 8, and 21) sought to determine the extent to which the cumulative impacts of the projects on the Campo-

Ma'an National Park had been considered; (iv) the fourth set of questions (9 and 10) dealt with public participation to ensure that park issues were taken into account; (v) the fifth set of questions (11 to 18) dealt with the environmental and social management plan and whether impact management measures had been proposed; and finally (vi) the sixth set of questions (19 and 20) dealt with the inclusion in the environmental and social management plan of any specifics related to cumulative impact management. This question grid was applied to eight (08) existing environmental and social impact assessments of projects adjacent to the Campo-Ma'an National Park.

The level of consideration of cumulative impacts related issues was assessed on a relative scale of 3 levels shown in Table 1.

Table 1. Level of assessment of consideration of cumulative impact related issues

Levels	Correspondence level	Description
Good	70% ≤ level block ≤ 100%	good consideration of cumulative related issues raised in the environmental and social impact assessment and associated environmental and so-l management plan
Moderate	35% ≤ level block < 70%	more or less good consideration of cumulative related issues raised in the environmental and social impact assessment and the associated environmental and social management plan
Low	0% ≤ level block < 35%	virtually no consideration of cumulative related issues raised in the environmental and social impact assessment and associated environmental and social management plan

2.2.2. *Application of the combined Leopold matrix and Sorensen network method*

The combined Leopold matrix and Sorensen and Rau's method proceed by identifying the cumulative impacts on the valued environmental components in four steps: (i) identification of the valued environmental components (ii) identification of past, current and future projects that interact with the valued environmental components, (iii) identification of the causal chains and finally (iv) evaluation of the causal chains.

2.2.3 *Identification of interactions between the valued environmental components of the park and projects (Leopold matrix)*

The content analysis of reports from the Divisional Delegation of the Ministry of Planning, the Park Manager, Environmental and Social Impact Assessments of projects and non-governmental organizations involved in the protection of the park, such as the Cameroon office of the World Wide Fund, the German Society for International Cooperation and the Netherlands Development Organization, allowed the identification of the valuable environmental components of the park and projects, while the Leopold Matrix was used as a tool to identify interactions between projects and valuable environmental components of the park.

2.2.4 *Identification and assessment of causal chains (Sorensen and Rau network)*

Identification of causal chains

The identification of causal chains involved the identification of branches from projects, through initial and final conditions, to the cumulative impacts they may have on valued environmental components of the park. The initial conditions are the project activities, while the final conditions are the consequences of the implementation of these activities. The resulting cumulative impact of the branches affecting the park's environmental components is the cumulative impact of the projects involved on the park's valued environmental components.

Assessment of the causal chains

The assessment of the causal chains consisted of quantifying the cumulative impacts of the branches in the form of the index per branch (equation 1) and the resultant of the cumulative impacts of the branches on the valued environmental components of the park in the form of the Grand Index (equation 2)

$$BI = \sum_{n=1}^{N} I(n) \cdot P(n) \quad (1)$$

Calculation of the Branch Index [16].

With *n*: represents the activity; *I*: the absolute importance of the impact; *P*: the probability of occurrence; *BI*: Branch Index.

The absolute importance of the impact was estimated using a rating of 1 low to 5 high, based on the intensity, duration and extent of the impact [17]. The probability of occurrence of the impact was estimated on a scale of 0 unlikely to 1 certain.

$$GIB = \sum_{n=1}^{N} BI(n) * ai \quad (2)$$

Calculation of the Grand Index for each valued environmental component of the park [16].

Where *ai* represents the probability of occurrence of each branch index on the valued environmental components of the park; *GBI*: Grand Index for each valued environmental; *BI*: Branch Index.

A rating of the criticality of cumulative impacts based on the value of the Grand Index is given in Table 2.

Table 2. Criticality of cumulative impacts according to the grand index

Large index	Criticality of cumulative impacts
≥ 15	Major
≥ 10	Moderate
≥ 5	Minor
< 5	Negligible

3. Results

3.1 *Level of consideration of cumulative impacts on Campo-Ma'an national park in existing environmental and social impact assessment*

The level of consideration of cumulative impacts on Campo-Ma'an national park related issues in the existing environmental and social impact assessment s and associated Environmental and Social Management Plans of the projects studied is summarized in Table 3.

Table 3. Level of consideration of cumulative impact issues in environmental and social impact assessment considered

Question blocks	Environmental and social impact assessment of projects								
	Hevecam	Port Earthworks	Sinosteel	Camiron Railway line	Port Construction	Memve'ele Dam	Biocam	Wijma	Total
I	Moderate (67%)	Moderate (67%)	Moderate (67%)	Good (100%)	Moderate (67%)	Good (100%)	Good (100%)	Moderate (67%)	79%
II	Good (79%)	Good (83%)	Good (83%)	Good (83%)	Good (96%)	Good (88%)	Good (88%)	Moderate (46%)	81%

Table 3. (cont.)

Question blocks	Environmental and social impact assessment of projects								
	Hevecam	Port Earthworks	Sinosteel	Camiron Railway line	Port Construction	Memve'ele Dam	Biocam	Wijma	Total
III	Moderate (67%)	Low (33%)	Low (50%)	Moderate (67%)	Moderate (67%)	Moderate (67%)	Low (33%)	Low (33%)	52%
IV	Low (0%)	Low (25%)	Good (100%)	Good (100%)	Low (25%)	Low (25%)	Moderate (50%)	Moderate (50%)	47%
V	Good (100%)	Moderate (67%)	Moderate (67%)	Good (83%)	Moderate (67%)	Moderate (67%)	Good (83%)	Low (0%)	67%
VI	Moderate (50%)	Good (75%)	Good (75%)	Low (0%)	Good (75%)	Moderate (50%)	Moderate (50%)	Low (0%)	47%
Total projects	61%	58%	74%	72%	66%	66%	67%	33%	62%

The table above shows that for block 1, in the place of the Campo-Ma'an National Park in the study, the level of consideration is 79%. Block 2, on the analysis of the impact of the projects on the Campo-Ma'an National Park, has been considered to the extent of 81%. With regard to block 3 on the level of consideration of cumulative impacts on the Campo-Ma'an National Park, the level of consideration is 52%. With regard to block 4 on public participation, the level of compliance is 47%. Block 5, on the integration of environmental and social management plan measures, has a compliance rate of 67%. Finally, block 6, on the consideration of cumulative impacts on the Campo-Ma'an National Park in the Environmental and Social Management Plan, has been taken into account to a level of 47%. Thus, the overall level of consideration of the Campo-Ma'an National Park in the various environmental and social impact assessment projects is 62%.

Specifically, it was found that 3/8 of the projects' Environmental and Social Impact Assessments considered the Campo-Ma'an National Park as an issue for consideration, and that all projects' Environmental and Social Impact Assessments addressed issues related to the Campo-Ma'an National Park during consultation meetings and public hearings. However, only 3/8 of the Environmental and Social Impact Assessments explicitly addressed the cumulative impacts of the projects on the Campo-Ma'an National Park and laid the groundwork for improving the consistency of the other projects' strategies for integrated management of impacts on the park. As a result, relatively few project environmental and social impact assessments as consider cumulative impacts, which is a weakness given the complexity of the interface between the Campo-Ma'an National Park and other projects.

3.2. *Cumulative impact assessment on the Campo-Ma'an national park by sorensen and rau*

3.2.1 *Interaction between projects as cause of impacts and the valued environmental components of the Park*

The following valued environmental components of the park were considered: conservation of Great ape populations, conservation of the area of Campo-Ma'an national park, preservation of ecological corridors, and preservation of habitats. Projects considered and some of their interactions with the valued environmental components of the park are presented in Table 4.

Table 4. Some interaction between projects and the valued environmental components of the Campo-Ma'an national park

Code	Projects \ Valued Components on the park	Corridors	Habitats	Great apes	Area
A	Forest Management Unit 09 021	X	X	X	
B	Forest Management Unit 09 024	X	X	X	
C	Forest Management Unit 09 025	X	X	X	
D	HEVEA CAMEROON (HEVECAM) SA			X	
E	Cameroon Palm Company (SOCAPALM)			X	
F	WIJMA Sawmill A Dutch company active in forestry in Cameroon			X	
G	Cameroonian Society for the Industry and Exploitation of Wood (SCIEB)			X	
H	Cameroon Iron company (CAMIRON) Rail wall		X	X	X
I	Port			X	
J	China Steel SA (SINOSTEEL)		X	X	X
K	Cameroon wood exploitation company (BIOCAM) SARL		X		
	Total of projects interactions	03	06	10	02

X: Interaction

Table 4 shows that 10 out of 11 projects interact with the VCP Great apes, 6 out of 11 with the VCP Habitats, 3 out of 11 with the VECP Corridors and 2 out of 11 with the VCP Area.

3.2.2 *Causal chains of cumulative impacts*

Table 5 illustrates the causal chains of cumulative impacts on valued environmental components of the Campo-Ma'an National Park.

Table 5. Causal chains of cumulative impacts on valued environmental components of the Campo-Ma'an National Park

Projects	Initial condition	Final condition	Impacts of the branches	Branch number	Valued Components on the park
A B C	Creation of wood yards	Storage of felled trees in timber yards	Corridor fragmentation	1	Corridors
A B C D E F G H	Uncontrolled population growth	Pressure on wildlife	Increased poaching	2	Great apes
H J	Development of mining industries	Nibbling away at the space occupied by the park	Decrease in the size of the park	3	Area

Table 5. (cont.)

Projects	Initial condition	Final condition	Impacts of the branches	Branch number	Valued Components on the park
A B C	Selective logging	Reduction in natural regeneration potential	Habitat Fragmentation	4	Habitat
A B C F G J K	Opening of the cross-country trails	Increase in vehicle traffic	Habitat Fragmentation	5	Habitat
H J	Excessive clearing	Loss of vegetation cover	Permanent loss of habitat	6	Habitat
A B C K	Accidental introduction of new animal and plant species	Destruction of native animal and plant species	Altered habitat quality	7	Habitat
A B C	Creation of log yards	Obstruction of Great Apes corridors	Self-flagellation due to the cramming of clans into a small area	8	Great apes
A B C J	Deforestation	Keeping animals away	Permanent exile of wildlife and Great apes	9	Great Apes

From Table 5, it can be seen that Branch 1 refers to the Corridor valued environmental components of the park, Branches 2, 8 and 9 to the Great ape populations, Branch 3 to the area, and Branches 4, 5, 6 and 7 to the Habitat.

3.2.3 *Assessment of causal chains of cumulative impacts*

Table 6 gives the branch indexes.

Table 6. Branch index

Branch	Value of the initial condition	Value of the final condition	Impact value	Branch index
1	6.3	2.4	2.4	11.1
2	20.4	3.6	4	28
3	5.6	2.8	3	11.4
4	5.1	1.5	2	8.6
5	10	2.1	2.8	14.9
6	3	2.4	2	7.4
7	3.9	1.2	2	7.1
8	4	1.2	2	7.2
9	2	2.4	1.2	5.6

Table 6 shows that branch 2, associated with increased poaching, has the greatest cumulative impact with a branch index of 28, followed by branch 5 with a branch index of 14.9. Branch 1, associated with the fragmentation of corridors, and 3, associated with the reduction in the size of the park, have average cumulative impacts with Branch Index values of around 11.

Table 7 provides the grand index or cumulative impact values associated with valued environmental component of the Campo-Ma'an National Park considered.

Table 7. Grand Index for valued environmental component of the Campo-Ma'an National Park considered

VCP	Branch	Branch index	Branch probability	Criticality of the branch	Grand index for VCP
Corridors	1	11.1	1	11.1	11.1
Great ape Populations	2	28	3/5	16.8	19.52
	8	7.2	3/10	2.16	
	9	5.6	1/10	0.56	
Area of the Park	3	11.4	1	11.4	11.4
Habitat	4	8.6	1/5	1.72	10.22
	5	14.9	7/20	5.215	
	6	7.4	3/10	2.22	
	7	7.1	3/20	1.065	

Table 7 shows that, with a Grand index of 19.52, the criticality of cumulative impacts on Great ape populations is major, while it is moderate for the other valued environmental component of the park.

4. Discussion

The results of this study show that the level of consideration given to cumulative impacts on the park is fairly average, due to the fact that most of the projects are identified as part of the Campo-Ma'an Technical Operational Unit. This fact could be an opportunity to improve the studies and facilitate the implementation of the idea proposed by Sandfort et al. [18] to improve environmental and social impact studies by digitizing procedures and data. However, as far as CIA itself is concerned, practically no study has been carried out that would lead to the same conclusions as Leduc and Raymond [16], Sandham et al. [19] and Wanda et al. [11], according to which CIA is a rather exceptional procedure in environmental and social impact assessment.

In terms of the implementation of the combined Léopold matrix and Sorensen and Rau network approach, the results show that the approach is fully consistent with the principles set out by Canter and Ross [20], who talk about good practice in terms of considering cumulative impacts. This means that the approach can easily address the concerns raised by Goodale and Milman [21] regarding the origin of the data needed to integrate cumulative impacts. In addition, this study responds to Roudgami's [22] call for a change in procedures and approaches to ensure the improvement of impact assessment, particularly in the vicinity of protected areas.

Sorensen and Rau's method shows that among the park's valued components, those associated with great ape populations remain high, with a criticality of 19.52, indicating a non-negligible threat to them. Although this study is proactive, it supports the findings of Young et al. [23], which operationally show that human activities put pressure on protected areas, their components and their habitats. Our study shows that the component related to the area of

the park has a criticality of 11.4; that related to the great ape populations has a criticality of 19.52 and 10.22 for the component related to the habitat; therefore, we note that the criticality of 11.4 related to the area of the park represents a moderate criticality for the park, contradicting the operational results obtained by Salomon et al. [24], according to which anthropic pressure is the cause of the reduction of the forest area of a zone. This discrepancy can be explained by the fact that the study was not carried out in a protected area and, consequently, certain protection, prevention and control mechanisms were not applied. This approach is similar to that used as a land-use planning tool by Yang et al. [25] and Cooper [26]. In addition to matrix methods, there are also methods based on the carrying capacity concept and the global change concept of Tremblay and Gariépy [27]. The choice of an approach or combination of approaches must take into account the context in which they are applied. The Sorensen and Rau approach seems appropriate for assessing the cumulative impacts of development projects on the Campo-Ma'an National Park. In summary, we report that several studies have been carried out to highlight the different cumulative impacts of development projects; Table 8 below presents literature reviews of similar studies.

Table 8. main contributions

No	Main contributions
1	The study by Cooper and Sheate [10] analyzed the level of consideration given to cumulative effects in study reports in general, and did not take protected areas into account. The results showed that cumulative effects analysis is far from operational due to the lack of a common definition of the concept of cumulative assessment.
2	The study carried out by Wanda et al. [11] analyzed the extent to which cumulative impacts were taken into account in study reports in a general way and did not take protected areas into account. The results show that the analysis of cumulative effects is far from operational due to the lack of a common definition of the concept of cumulative assessment.
3	The study by Ostoich and Wolf [12] analyzed the integration of cumulative effects assessment in EIA reports, using an assessment questionnaire. However, the study did not take protected areas into account, and concluded that cumulative effects analysis is not systematic and has methodological limitations. The study recommends the use of GIS to identify pressures and manage data.
4	Ozcan and Strauss [14], in their study, establish links between projects near protected areas and impact studies, and provide a conceptual framework for their use.
5	Leduc and Raymond [16], define the general framework of environmental assessments and the main tools for their implementation.
6	The main limitation of the study by Sandfort et al. [18] is that it does not sufficiently integrate the cumulative aspect and approaches the question of protected areas in a global manner.
7	The study by Sandham et al. [19] analyzed impact assessment reports for projects in South African national parks. The approach was to examine the various aspects advocated by the regulations. The study concludes that, on the whole, the issues are addressed, but that some park-related issues are not adequately dealt with, and that issues relating to cumulative impact analysis are not systematically addressed.
8	The study by Canter and Ross [20] analyzed specific aspects and studies related to the identification and assessment of cumulative impacts, provided considerations on areas for improvement and proposed a six-step approach for the systematic integration of cumulative impacts into environmental assessments.
9	Goodale and Milman [21], in their studies, have proposed an approach to cumulative impact analysis in the context of the implementation of wind energy projects. It leads to the development of a model and is specific to the marine environment. However, it does not address the issue of protected areas.
10	Roudgarmi [22] reports that environmental assessment practitioners find it difficult to identify and assess cumulative effects due to inadequate frameworks and a lack of methodology, and the authors conclude that the approach should be improved to make environmental assessments more effective.
11	The study by Young et al. [23] puts into perspective the fact that all the planet's ecosystems are threatened by human activities, and the associated causes, consequences and vulnerabilities.

Table 8. (cont.)

No	Main contributions
12	The study by Salomon et al. [24], shows the cumulative impact on adjacent forest ecosystems of human activities planned for a community and their evolution over time. This study shows that activities in the vicinity of protected areas can have an impact, hence the importance of anticipating their implementation, particularly during environmental impact studies.
13	Yang et al. [25] propose in their study a framework for assessing cumulative impacts on bay ecosystems and define a clear approach to impact identification and assessment. The approach is based on GIS and Pearson analysis, the latter being based on data relating to the evolution of specific factors.
14	Cooper's study [26] presents network methods, such as those used to identify impacts, and proposes an approach that highlights causal chains on the values of ecosystem services that we wish to conserve.
15	Tremblay and Gariépy [27], in their study on the prospects for integrating the cumulative impacts of tourism projects in protected areas, set out the main avenues to be explored to better take them into account.

This literature review shows that the issue of cumulative impacts of development projects adjacent to protected areas is very poorly documented, which could lead to the management objectives of protected areas not being achieved. Nevertheless, both the environmental assessment of protected areas and the integration of cumulative impacts into conventional environmental assessments have been the subject of some, albeit isolated, reflection to date. This study therefore brings together several of the isolated results on the consequences of taking into account the cumulative impacts of development projects on protected areas, leading to their loss of value, in the light of operational results obtained in the context of monitoring.

5. Conclusion

The objective of this study was to contribute to a better consideration of cumulative impacts on the Campo-Ma'an National Park in Cameroon. Located in Cameroon, in the Environmental and Social Impact Assessment and associated Environmental and Social Management Plan of projects that may interact with the park. The result is that relatively few environmental and social impact assessments and associated environmental and social management plans of projects consider the cumulative impacts associated with the interface of the Campo-Ma'an National Park with other projects. This reduces their ability to ensure that the integrity of the Campo-Ma'an National Park is maintained. Sorensen and Rau's methodology highlighted the criticality of cumulative impacts on the park's valued environmental components, which could lead to the loss of some, such as the great apes. It is important to strengthen the consideration of cumulative impacts in environmental and social impact assessments and associated environmental and social management plans of projects as a means of preserving the integrity of protected areas such as the Campo-Ma'an National Park. In short, this study has shown that cumulative impact assessments are not systematically carried out for development projects near protected areas, both because past and current projects are not taken into account and because of a lack of appropriate methodologies. The combined approach could therefore be a starting point for improving practices at a time when digital technology offers the prospect of improved systems and processes. Further studies could then be undertaken to digitize practices and ensure that the cumulative impacts of development projects are systematically considered in environmental and social impact assessments to maintain the integrity of protected areas.

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Conflict of interest

The authors declare that they have no conflict of interest.

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