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Perceptions of Four Rural Communities Regarding the Largest Hydropower Project in Ecuador: The Case of Coca Codo Sinclair

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Abstract

The global transition towards renewable energy production has increased the demand for new and more flexible hydropower operations. Although hydropower is generally considered environmentally friendly, it can cause environmental and social impacts. As the biggest and most representative hydropower project in Ecuador, the Coca Codo Sinclair hydropower project (CCSHP) provides a relevant case of water use competition between local communities and the country's development. In this study, perspectives of four communities near the CCSHP were analyzed through a survey with 183 responses collected in 52 days through door-to-door household visits in two upstream and two downstream towns. The analysis highlights that limited community participation in project design and insufficient communication strategies have undermined public acceptance, despite government promotion of its national benefits. Survey results reveal that 79% of respondents expressed negative perceptions, primarily about environmental change, displacement, and lack of compensation, while only 15% expressed positive views. It is important to note that the communities had no role in selecting the project location, and their involvement was limited, particularly regarding transportation, environmental changes, and the loss of local species. These findings suggest that project managers should strengthen dialogue with local communities and design participatory mechanisms that can improve trust and long-term project acceptance.

Keywords: Ecuador; energy; communities; hydropower; perception; renewable; survey

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1. Introduction

Ecuador, a small country in South America, historically relied heavily on fossil fuel-based power generation during the early 2000s. According to the Ministry of Energy and Non-Renewable Natural Resources, thermoelectric plants accounted for approximately half of the country's electricity production at that time [1]. However, installed hydropower capacity has increased significantly in recent years. Data from the International Hydropower Association indicate that hydropower represented 40% of Ecuador's energy production in 2006, with an installed capacity of 1640 MW; by 2024, this capacity had risen to 5251 MW, supplying approximately 66% of the national electricity grid [2,3].

The Regional Energy Integration Commission of South America estimates Ecuador's hydropower potential at 23,000 MW. Currently, it has used 23% of the capacity [4]. This demonstrates Ecuador's significant remaining hydropower potential. On the other hand, Figure 1 shows the electricity generation by source based on the data from British

Petroleum [5]. The data reveal that Ecuador's hydropower generation was 4 TWh in 1985, 8 TWh in 2000, 12.5 TWh in 2015, and approximately 23 TWh by 2024.

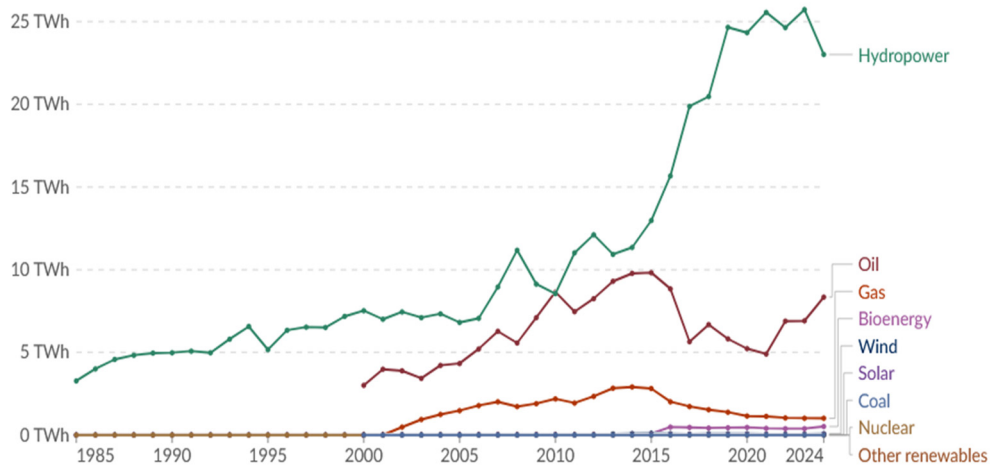

Figure 1. Electricity production by the source of Ecuador [5].

Figure 1 shows that hydropower in Ecuador has generally increased, although growth has varied over time. This generation potential relies on an average annual water flow of 376,018 hm^3 [6]. Thus, within Ecuador's hydropower potential, the Coca Codo Sinclair hydropower plant (CCSHP) was constructed between July 2010 and August 2016, the largest hydroelectric investment in this country, as an emblematic project for being the most representative installed plant with 1500 MW that will play a crucial role in energy generation [7]. The hydropower facility was officially inaugurated on 18 November 2016 by the presidents of Ecuador and China [8]. Moreover, the project was built for a 50-year life span and currently contributes approximately 30% of the energy grid in Ecuador, called the National Interconnected System [9].

However, before the construction of the CCSHP, the Coca River and its tributaries played a fundamental role in supporting the livelihoods and ecological balance of the region. Local communities primarily used the river for fishing, small-scale irrigation, transportation, and recreational purposes, while the surrounding basin maintained high levels of aquatic and terrestrial biodiversity. The riverine ecosystem hosted native fish species of subsistence value, diverse riparian vegetation, and habitats that sustained both wildlife and ecotourism activities [10,11]. These conditions represented the baseline environment upon which the hydroelectric intervention was superimposed, and they remain central to understanding the current perceptions of the local population.

Research on this project has opened the discussion on how large-scale hydropower plants ($\geq$500 MW), such as the Coca Codo Sinclair, not only motivate renewable energy development but also create disputes over natural resources with repercussions and transformations in different aspects [12]. According to an investigation by The New York Times in December 2018, the hydropower project was being carried out despite several studies and warnings about unfavorable geological conditions. Specifically, in the area near there is an active volcano (El Reventador in Spanish) subject to earthquakes and a zone with erosion, affecting the river flow [13].

Jiménez (2019) determines that the generation capacity of the Coca Codo Sinclair Hydroelectric would be affected by the reduction of 222 m^3/s in the contribution to 2040 due to the water future uses in nearby cities that would consume a total of 19.4 m^3/s, and the flow entering the CCSHP would be reduced by up to 11%, thus affecting electricity generation. Therefore, an efficiency plan for the plant is necessary [14].

At the same time, a phenomenon of regressive erosion in the Coca River has been observed, a process that has accelerated since the plant's construction. Experts have noted in recent years that the project's infrastructure has contributed to the disappearance of the San Rafael waterfall and led to land subsidence, with significant impacts on downstream communities [10]. This situation highlights the complex interplay between Ecuadorian large-scale energy infrastructure, environmental integrity, and social well-being [15].

Nonetheless, the expansion of large-scale hydropower, while promising from a natural resource perspective, must also be understood through the lens of community perceptions that emphasize participatory approaches, local engagement, and principles of energy justice [16]. Understanding how communities perceive the impacts and institutional responses to such projects is essential to promote fairness, recognition, and transparency. Employing surveys and qualitative methods to capture these insights supports socially inclusive and responsible hydropower development, ensuring that the exploitation of Ecuador's considerable hydrological potential aligns with sustainable outcomes.

The Coca Codo Sinclair serves as an ideal case study for such an investigation, given its central role in Ecuador's current and future energy landscape. The perspectives of nearby communities, surveyed in the post-implementation phase, offer valuable insights for analysis and evaluation. Community impressions are understood here as the transmission of lived experiences and observations, shaped by daily interaction with their surrounding habitat and familiar environments.

Beyond the national energy narrative, the Coca Codo Sinclair project illustrates a clear socio-environmental research problem: the competition for water resources between state-led energy development and the daily needs of surrounding populations [17]. Communities reported not being consulted during project location decisions while experiencing disruptions in transportation, loss of agricultural lands, and environmental degradation. These outcomes underscore that hydropower development cannot be evaluated solely on technical or economic criteria but must also account for social legitimacy [18].

Although discussions regarding the disadvantages and challenges of hydropower have been limited on a global scale, even fewer studies have focused on the socio-environmental impacts of specific projects [19]. Thus, the novelty of this research lies in its focus on community perceptions, particularly within the context of participatory approaches to energy planning, using Ecuador as a case study. Consequently, future investment decisions concerning hydropower infrastructure should be informed by empirical evidence drawn from existing projects [20].

Moreover, as energy transition pathways from fossil fuels to renewables are evaluated through various approaches, Dall-Orsoletta (2022) emphasizes the fundamental importance of incorporating social considerations into energy system models, advocating for greater citizen participation and transparency to support more effective decision-making processes [21]. A recent study that links hydropower development with the principles of energy justice emphasizes procedural extent beyond conventional environmental assessments. Studies in the Brazilian Amazon, at the Belo Monte dam, illustrate how communities downstream experience multitemporal injustices, as perceptions of inequity evolve until the operation phases [22]. Within the European and Turkish contexts, hydropower has also been examined as both an enabler and a challenge for equitable energy transitions, where migration, energy poverty, and access inequalities intersect [23]. These insights frame hydropower not only as a technical system but also as a social arena of justice and distributional trade-offs, which this study seeks to analyze through community perceptions surrounding Ecuador's CCSHP.

In light of this background, the present study issues the data gap from communities and integrates these findings with scientific argumentation to critically discuss; thus, this

paper aims to address the perceptions of four distinct population groups residing near the CCSHP in Ecuador, employing a survey-based methodology to contribute empirical evidence to the ongoing discourse on sustainable energy development.

2. Materials and Methods

Expanding the benefits and impacts of hydroelectricity, this study adopts an experimental methodology, collecting primary data from surveys in four communities, which were then processed, analyzed, graphed, and transformed into interpretable findings.

For the data acquisition, a survey is used from household interviews, and then the observations of the living conditions in the areas and the people's impressions are tabulated. As a significant research contribution, the results can indicate the future evolution of the impacts of hydroelectric plants and the expected improvements in other projects [24].

The mathematical analysis of the survey data classified according to result groups is accomplished using statistical methods, primarily descriptive statistics. These methods enable the summarization of responses through central and dispersion measures while also clarifying the distribution and key characteristics of the data [25]. To further illustrate patterns and trends, graphical representations such as bar charts are employed, offering a quantitative visualization of survey outcomes [26].

Finally, with the defined methodology, the application place of the samples was selected (the study location) in the four communities surrounding the Coca Codo Sinclair plant, and a standard finite population sampling formula was applied to determine the necessary surveys, as indicated in the following sections.

2.1. Study Area

The Coca Codo Sinclair hydropower project is situated between the provinces of Napo and Sucumbíos in northeastern Ecuador, approximately 150 km east of Quito, the nation's capital, as illustrated in Figure 2. The main nearby cities in these provinces are El Chaco in Napo and Lumbaqui in Sucumbíos, while the closest rural towns include San Luis and San Carlos. These four communities collectively constitute the sample population from which information was gathered for this study.



Figure 2. Coca Codo Sinclair in Ecuador—study area and the location of surveys [27].

The Coca Codo Sinclair hydropower project is in a tropical area with an annual average temperature of 18 °C and an overall rainy climate. The river describes a curve with a drop of 620 m and provides an average annual flow of 287 m^3/s for hydropower generation using a compensation dam and tunnel connection to the powerhouse [28]. For better understanding, Figure 3 shows a schematic representation of the area studied.

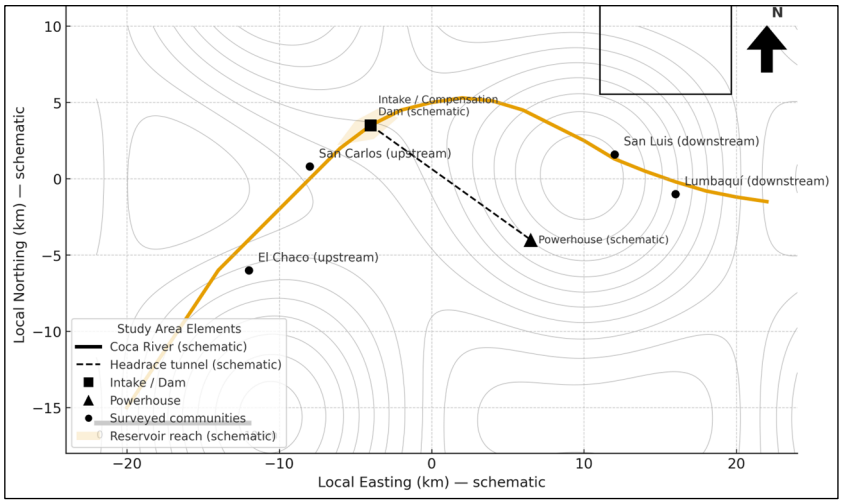

Figure 3. Coca Codo Sinclair and the surrounding study area in a schematic map [27].

2.2. Data Analysis and Collection

Field data collection was conducted using a quantitative approach to examine the current expectations and observations of the residents close to the CCSHP. The information represents actors' impressions at different levels and areas of society, with answers that will evaluate the environmental and social perception from their location [25].

The data were collected by conducting a questionnaire survey for each household in early 2024 over 52 days in the first trimester. The purposive sampling technique was used to randomly sample households to capture the socio-economic and demographic diversity of the communities [29].

The samples consisted of families in the four communities closest to the hydropower plant. According to data from the National Institute of Statistics and Censuses of Ecuador (INEC by acronym in Spanish), the total number of families in these communities is approximately 3108, as indicated in Table 1 [30,31]. In addition, due to the irregularities of the area and the access difficulty (some places are very hard to enter), 70% (2176) of the households were considered for the study.

Table 1. Population information of the communities.

No.	Community Surveyed	Location	State	Households
1	El Chaco [a]	Upstream	Napo	1107
2	San Carlos [a]	Upstream	Napo	387
3	Lumbaqui [b]	Downstream	Sucumbios	1189
4	San Luis [b]	Downstream	Sucumbios	425
	Total population (TP) in households [c]			3108
	Population near the principal roads (70%) [c]			2176

Source: a. [32]; b. [33]; c. [30,31].

As shown in Table 1, the final selected population consisted of 2176 households. A sample size of at least 8% of these households was chosen because, for medium-sized

populations (≤5000 units), it is common practice to collect data from 5% to 10% to ensure representativeness [34]. Based on the authors' judgment, data were collected from 8% of the population, resulting in a minimum sample of 174 households (2176 × 0.08). The sampling methodology applied aligns with procedures used in other studies examining the livelihoods of populations impacted by hydropower systems [35].

The 8% sample corresponds to a total of 183 surveys, a conservative figure established considering the difficulties in accessing widely dispersed households located in remote regions characterized by challenging terrain and frequent rainfall. Furthermore, strict ethical protocols were observed for each survey, with respondents being fully informed about the academic purpose of the study and informed consent participation [36].

In addition, a final sample of 183 respondents was obtained, exceeding the minimum required sample size of 5% with a 95% confidence level (174 × 1.05) [37]. The demographic profiles of respondents were analyzed using descriptive statistics. The survey questions were formed by considering the implications of developing large-scale infrastructures within natural ecosystems. Thus, they are relevant to the current literature, as they can reveal the perceptions that will help in future hydropower plants and for policymakers.

As Figure 4 shows, the questionnaire consisted of nine multiple-choice questions and one open-ended question, each designed to capture specific aspects of community perceptions. The multiple-choice items addressed respondent profile (gender, age, occupation, and residence time), job opportunities related to the project, communication of objectives and goals, and the support provided by the operator company, while the open-ended question optionally invited participants to share additional observations in their own words.

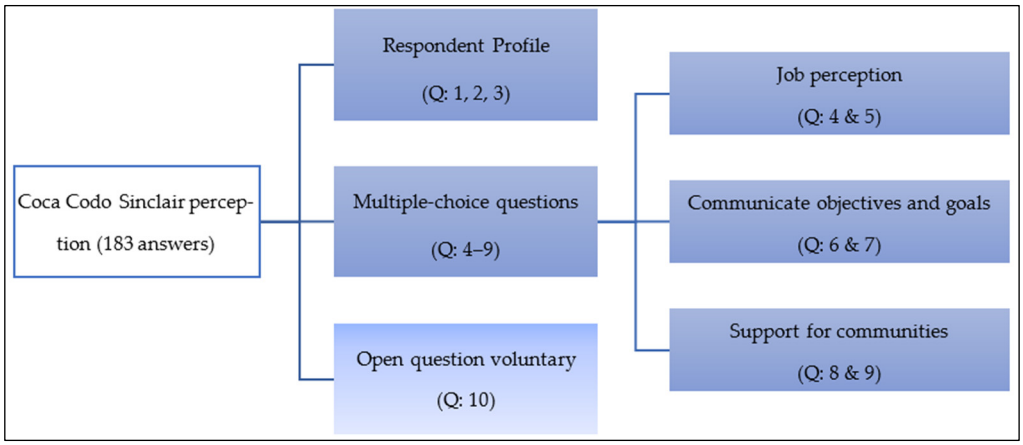

Figure 4. Topic classification of the questionnaire survey.

In addition, each household member's information was collected face-to-face; the participants gave their opinions on the impacts or benefits of the Coca Codo Sinclair project. The survey was in Spanish, the official language of Ecuador, and the participants completed the survey in 10–20 min. Moreover, Table A1 in Appendix A contains the ten questions for determining the impressions.

The questions were deliberately crafted using clear, accessible language tailored to the comprehension level of the target population, primarily rural farmers with limited formal education. This approach was essential to maximize respondent understanding, minimize ambiguity, and promote accurate data collection [38]. Designing the questionnaire with linguistic simplicity and contextual relevance thus facilitated meaningful engagement with the communities, allowing the study to capture authentic perceptions of the hydroelectric plant's social and environmental effects. This methodology aligns with best practices in participatory research and survey design in rural or low-literacy settings, ensuring that the

questions not only reflect expert knowledge but also resonate with and are comprehensible to local stakeholders [39].

It is important to note that this research was conducted exclusively through voluntary surveys and non-intrusive observational methods, focusing solely on the perceptions and opinions of adult participants. In accordance with Ecuadorian regulations, studies based on anonymous surveys that do not involve physical, psychological, or social risks are classified as "low risk" and are therefore exempt from full ethics committee review. For this reason, formal approval by an ethics committee was not required. Nonetheless, the study adhered to the ethical principles of the Declaration of Helsinki (1975, revised in 2013), and informed consent was obtained from all participants prior to their participation in the survey.

3. Results

For the analysis of survey results, descriptive and graphical statistics are employed, as the data are summarized through quantitative measures and visualized using bar charts. The results identify the main topic addressed by the accumulation of tendencies, since each question offered four options: yes, no, a little, and do not remember.

From the survey's main results, the respondents' average age was 30–49 years, with 58% (range 20–80 years); 52% were men, and 48% were women (Question 1; Table A1). In addition, the median of occupation data is 61% of those interviewed were farmers (Question 2).

Seventy-two percent of respondents (Question 3) indicated that they had lived more than ten years near the CCSHP, indicating they were familiar with the place before the project intervention. The data collected by the National Institute of Statistics and Censuses of Ecuador reveal that in the two states, Napo and Sucumbios, most of the population is considered indigenous and has agricultural activities as their occupation because the four communities surveyed are rural areas [40].

By contrast, as Figure 5 shows (Question 4), 53% of the respondents' work was related to the Coca Codo Sinclair project since its construction, either directly or through a family member's job. Furthermore, (Question 5) 84% of the respondents did not receive capacity-building programs from the Coca Codo Sinclair hydropower operator company. In comparison, 14% received some training activities, but only introductory workshops provided by the company, some related to the benefits of hydropower.

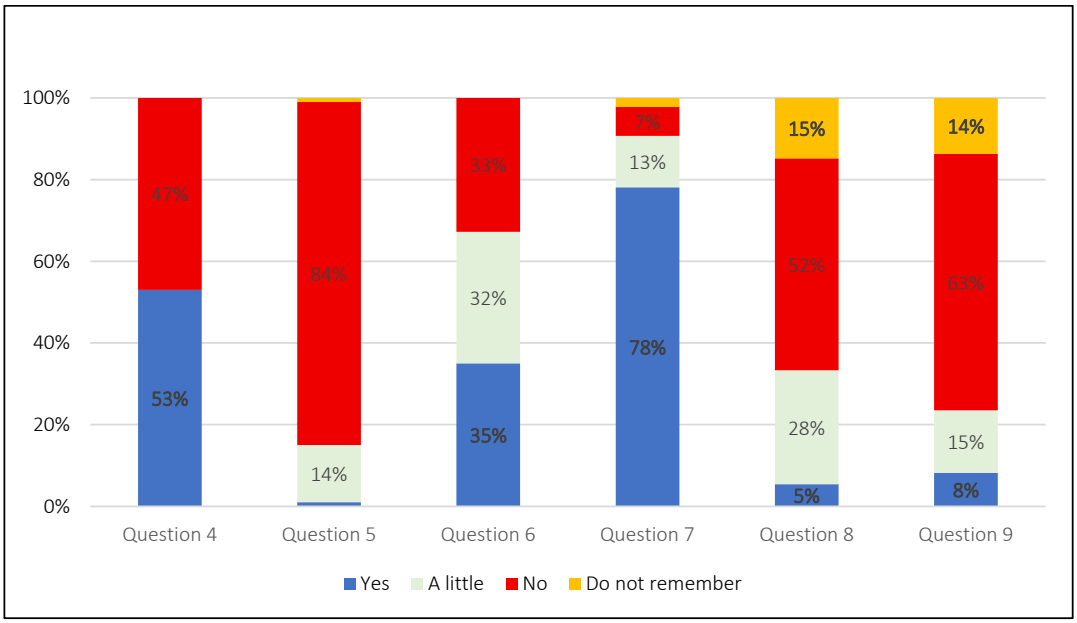

Figure 5. Job perception, goals, and community support (Questions 4 to 9).

On the other hand, as Figure 5 shows (Question 6), only 35% of respondents acknowledged that the objectives and goals of the project were shared with them, and 32% needed to remember the details of the intervention stage. Furthermore, (Question 7) 78% of the respondents lacked encouragement and participation from the Coca Codo Sinclair hydropower operator company to gather their ideas for improving the care and communities' development.

Likewise, as shown in Figure 5 (Question 8), 52% of the respondents revealed that the Coca Codo Sinclair administration did not provide support regarding care to the communities. In addition, (Question 9) 63% of the respondents revealed that the operator company did not provide financial, social, and environmental support. Of the respondents, 15% mentioned that this support exists partially, and 14% do not know or remember such activities.

Response to a Voluntary Open Question (Additional Observations)

After the multiple-choice interrogations, the respondents answered an open-ended question (Q.10) designed to capture additional comments on the CCSHP. The open-ended responses were not audio-recorded. Instead, participants' statements were documented as written notes during the interviews. These notes were later translated, organized into three main categories (positive remarks, negative considerations, and recommendations), and systematically reviewed to identify recurring themes and patterns of perception.

From this optional question, eighty-one comments were collected; 64 (79%) were negative considerations, 12 (15%) were positive remarks, and 5 (6%) were recommendations. A particular clarification is that the answers were edited to provide native English expressions of the original sentences (translation from Spanish). Regarding negative remarks, the following main topics were compiled from the survey collected.

Environmental impacts were the most prominent concern among respondents. The Coca Codo Sinclair hydropower project significantly altered the natural flow of the Coca River, leading to the disappearance of the San Rafael waterfall and causing notable declines in aquatic and terrestrial biodiversity. These changes not only disrupted local ecosystems but also severely affected tourism, as landscape modifications made river navigation difficult and diminished the area's appeal for adventure tourism and conservation.

Construction-related issues further compounded local dissatisfaction. While the project initially provided some temporary employment during the building phase, these jobs were short-lived and did not translate into stable, long-term opportunities for the community. Additionally, the construction process led to flooding of upstream lands, displacement of residents, and insufficient compensation for those affected, exacerbating social tensions and mistrust toward the project.

Regarding other parameters, respondents highlighted that large-scale infrastructure development resulted in significant land-use changes, with virgin lands converted to roads and other facilities, causing environmental damage and offering few local benefits. Criticisms were also directed at government accountability, with many perceiving that the project prioritized political interests over community welfare. Overall, the survey reveals a pattern of environmental degradation, social disruption, and governance shortcomings, with little perceived advantage for the nearby population.

On the other hand, the positive remarks include the provision of sports facilities for general use, support for the school's construction, and basic training for interested individuals. Economic aid has been granted to complete parks under construction, along with equipment and books provided to the libraries of El Chaco and Lumbaqui. Additionally, work on the hydropower plant supports national energy development, and the donation of four buses facilitates student transportation to schools and high schools. Secondary roads have been built to improve residents' mobility and assist in the transfer of materials and equipment for the hydropower construction and reservoir compensation. As observed,

these twelve positive reflections focus on the tangible infrastructure and benefits provided by the Coca Codo Sinclair project administration.

Finally, communities recommend that the government conduct a study on the positive and negative impacts of the building and operation of the hydropower project. This report should be published and made accessible to the surrounding populations and for future reference and actions required for possible corrections, if applicable. The consolidated recommendations mention how it can rectify the social and environmental changes caused by hydropower construction. Among the suggestions collected, people's impressions suggest that more studies are required to understand specific affectations. Moreover, the government should consider reducing taxes in the intervention area for the use of natural resources.

4. Discussion

At the beginning of 2016, when the CCSHP was inaugurated, the government programs widely publicized the project's advantages, promulgating the most significant construction in Ecuador after the railroad; approximately 7000 people were directly employed [41]. However, since 2019, some problems have appeared, including structural failures in the hydropower plant and regressive erosion in the catchment area [42].

As background, before Coca Codo Sinclair was developed by a Chinese company with more than 3 billion dollars, Ecuador's energy policy faced difficulties of political and economic [43]. Thus, as a small oil producer and exporter, Ecuador decided to finance the energy grid (Coca Codo Sinclair) using the oil payment [44]. Nevertheless, all this structural framework demonstrates that Ecuador faces the dilemmas of energy policy common to resource-rich developing countries, where political, economic, social, and financial objectives often diverge.

Teräväinen (2019) determines that the Coca Codo area functions as an ecosystem with rich biodiversity, and the government saw it as a source of local income for energy and regional development, but it did not, as a historically cultural place full of little-intervened environments [45]. This determination is corroborated by the finding that only 35% of respondents were aware of the objectives and goals of the project when the government began to intervene in the area to develop the hydroelectric plant (Question 6).

Discussing the results, the answers show that 79% of responders were negative (Question 10). Comparing these results with other countries, Laos surveyed to analyze the environment of hydropower construction (Nam Ngum project) between meetings in two villages and one-on-one interviews with 50 households per village. This case study was determined because data from the plant displaced about 23 villages and 570 households, revealing that the hydropower projects are essential energy support for the country and were accompanied by the development of medical support facilities. However, the natural environment of rivers and forests was vulnerable, similar to the communities' considerations close to the Coca Codo Sinclair hydropower [46].

In India, a survey of 140 participants was conducted on the impacts of hydropower projects in the Bhagirathi River in the northwest. Among the adverse effects are a decrease in flora, fauna, and agriculture, and increased water pollution due to the extraction of sand and stone in the riverbeds. By contrast, the perceived benefits are better road connectivity, transport, and tourism. The main impression is that hydropower projects are undesirable in the study area due to the modifications [47]. Similar conclusions can be made from the responses of the 183 respondents in the Coca Codo Sinclair surrounding areas.

As the target groups to collect information (Question 1 and 2) contrast, in Kenya, a reservoir study on the Tana River was conducted. Information was collected from 181 respondents interviewed by farmers, herders, hunters, gatherers, and fishermen, represented by 124 men and 57 women. The target population was intentionally selected in the upper

and lower sections of the river that directly observe the impacts and benefits. The results showed that there needs to be more consideration of the long-term impacts on the means of subsistence downstream [48]. In addition, there is currently a reduction in agriculture near the dam and growing conflicts in the communities [49].

Brazil, a neighboring country to Ecuador with similar cultural, climatic, and social characteristics, provides a valuable point of comparison. In Brazil, a survey was conducted among a resettled population during the construction of the Belo Monte dam in the Brazilian Amazon, surveying 269 households. The findings indicate that a slight majority believe the hydropower plant is worth the cost; however, this support diminishes as perceived negative impacts increase [50,51]. Similarly, in Ecuador, the survey reveals that perceptions of adverse effects vary among respondents when considering ecological systems both collectively and individually. Notably, 52% of communities in the Napo and Sucumbíos provinces surrounding the Coca Codo Sinclair reported a lack of support from the project operator company regarding environmental and social care (Question 8).

Beyond the cases of India and Brazil, international evidence further highlights similarities and differences in community perceptions of large-scale hydropower. For instance, studies in Laos and Kenya reported concerns about displacement, loss of agricultural lands, and conflicts over water use, which mirror the negative perceptions expressed by communities near the Coca Codo Sinclair project [52,53]. Likewise, research on the Bui Dam in Ghana revealed tensions between promised development benefits and environmental degradation, reinforcing patterns of distributive and procedural injustice also observed in Ecuador. These comparative insights indicate that while local contexts differ, the trade-offs between energy development and community well-being are a recurring challenge across the Global South [54].

This study captures perceptions at a single moment, yet community views on large-scale hydropower are not static. Experiences during construction, subsequent ecological changes, and the way authorities manage ongoing challenges all shape attitudes over time. Recognizing these dynamics highlights the need for future longitudinal studies to understand how acceptance or resistance evolves as projects mature [55].

While this study emphasizes the perceptions of communities, these views align with ecological and hydrological research that has documented measurable impacts of the Coca Codo Sinclair. Recent analyses (2024–2025) confirm that regressive erosion in the Coca River has intensified since the plant's construction, accelerating sediment transport and contributing directly to the disappearance of the San Rafael waterfall, one of Ecuador's emblematic natural landmarks [56]. Other studies highlight risks of land subsidence and potential sinkhole formation near the catchment area, raising concerns over long-term geomorphic stability. Likewise, ecological monitoring indicates significant reductions in aquatic biodiversity and altered riparian vegetation, which reinforce community observations regarding diminished fishing resources and changes in river navigation [57].

On the other hand, according to Sovacool's framework on energy justice, energy projects must ensure fairness in distribution, recognition of local voices, and inclusive participation; however, the Coca Codo Sinclair case highlights deficiencies in community engagement and compensation, underscoring issues of distributive and procedural injustice [58]. Agyeman's concept of environmental justice emphasizes the equitable treatment of marginalized populations and their meaningful involvement in environmental decision-making, a principle challenged here as affected rural communities face displacement, loss of livelihoods, and ecological degradation with limited redress or dialogue [59].

Our findings align with the growing body of literature that positions hydropower as a critical arena for examining energy injustices, particularly from a distributional and procedural perspective. Beyond the social dimensions, recent methodological advances highlight

how justice metrics can quantitatively integrate equity principles into renewable energy evaluations, offering a structured pathway to embed fairness within sustainability assessments [60]. Incorporating these justice-oriented indicators into Ecuador's hydropower governance could help ensure that local well-being, recognition, and participation are considered alongside technical efficiency and broader development goals, ultimately fostering more socially balanced energy transitions [61].

Hydropower currently serves as a major energy source in some countries and continues to hold significant potential for short-term growth [62]. Although various approaches to power supply support the expansion of hydropower, this study and its comparative analysis reveal a complex tension between environmental concerns and sociocultural factors associated with its development [63]. Public opinion plays a crucial role in the deployment of energy systems, as the perspectives of communities living near hydropower projects can significantly influence decisions about plant locations [64]. In this context, the data from Ecuador provides a valuable case study illustrating the social impacts arising from the development of a large-scale hydroelectric facility. Overall, the findings broaden the discourse on hydropower development, highlighting that while it offers substantial benefits, it also entails unavoidable adverse effects on the ecosystems [65].

Based on the collected viewpoints of the communities near the Coca Codo Sinclair project, this research is a basis for hydropower project development, and the principle is that providing livelihood improvement programs should be mandatory for energy and policy entities to help affected communities rebuild or enhance their livelihoods [66]. Policymakers can refer to the concerns of changing natural ecosystems due to the construction of hydropower plants. The novelty of this manuscript lies in examining community perspectives, highlighting social gaps that could inform improvements in future projects, because current studies focus on simulations and predictions of upcoming energy production, but not on the needs and impressions that communities have.

The shortcomings of this study are that the analysis focused on aggregated perceptions across the four surveyed communities, rather than disaggregating the data at the community level. While this approach ensured statistical robustness and allowed for clear interpretation of overall trends, it does not capture possible variations among the communities themselves. Other research with larger samples should examine whether differences in geographical location (upstream versus downstream) or community size may influence perceptions and acceptance of large-scale hydropower projects.

5. Conclusions

The Coca Codo Sinclair hydropower project illustrates not only the promise of large-scale renewable energy in Ecuador but also the profound socio-environmental trade-offs it entails. The 183 surveys collected from four neighboring communities reveal that nearly four out of five households hold negative perceptions, emphasizing concerns about ecosystem disruption, displacement, and insufficient compensation. This evidence underscores that hydropower expansion in Ecuador cannot be assessed solely through technical or economic metrics; social legitimacy, fairness in benefit-sharing, and participatory decision-making must become central criteria for future projects.

The survey was taken in the communities, two upstream (El Chaco and San Carlos) and two downstream (San Luis and Lumbaqui) nearest the CCSHP, and it indicates that 79% of the respondents showed negative perspectives. Of the respondents, 15% have positive discernment and believe that the project benefits by opening temporary jobs for personnel and providing various supporting facilities for the communities (Question 10). However, 52% of the surveyed believe that the hydropower company should have to provide environmental or social care resources to the communities (Question 8).

Respondents generally perceive that the Coca Codo Sinclair project causes social and environmental problems such as altering the natural river course, causing a change in the population's life, undermining ecosystem resilience, unfairness in worker recruitment, and lack of care provided by the hydropower operator company; however, it also represents a variety of opportunities for the government of Ecuador to implement projects in these areas far from large cities.

These findings can serve as a practical input for public administrators and decision-makers. By presenting the data in an accessible way through community reports and policy briefs, the results may guide the design of social and environmental programs that address community concerns. Such actions could include strengthening dialogue mechanisms, implement livelihood improvement projects, and develop compensation or restoration plans. In this sense, the evidence provided here not only characterizes current perceptions but also offers pathways for policies and interventions that may help to improve the relationship between local communities and the hydropower project.

It is recommended that policymakers prioritize infrastructure enhancement, educational support, and entrepreneurship programs, with particular emphasis on agricultural training, given its prominence among respondents. Future research can analyze the current complications of CCSHP operation in order to address the aggressive interventions associated with Ecuador's most significant project.

Author Contributions: S.N.-S. conceptualized the study, assembled the data, conducted the analysis, and prepared the initial draft of the manuscript. D.J.P.-G. and E.A.J.-D. critically evaluated the work, contributed to subsequent revisions, refined the content, and provided final approval of the manuscript. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: This study did not require ethical approval from any academic, private, or public institution, as it was conducted by an independent group of researchers focused on energy projection. Moreover, ethical approval was not applicable since the study did not involve human participants or animals.

Informed Consent Statement: Informed consent was obtained from all participants prior to the survey, providing them with information that the process entails that their responses would be anonymous and that the data collected would be used exclusively for an academic study aimed at assessing the current situation and identifying possible improvements through public policy.

Data Availability Statement: The data supporting the findings of this study consist of survey responses and observational notes collected from rural communities. Due to ethical considerations and the need to protect the anonymity and privacy of participants, these data cannot be made publicly available. However, anonymized datasets (info tabulated) will be made available in this manuscript, in line with MDPI Research Data Policies. In addition, the case of Coca Codo Sinclair relied solely on voluntary surveys and non-intrusive observations of adult participants, without experiments or biological data collection. According to Ecuadorian regulations, anonymous surveys that involve no physical, psychological, or social risk are exempt from mandatory ethics review; nevertheless, the research strictly followed the Declaration of Helsinki (1975, revised 2013), ensuring informed consent, voluntary participation, anonymity, and confidentiality.

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Appendix A

Table A1. Questions of the survey administered in El Chaco, San Carlos, San Luis, and Lumbaqui.

No.	Question	Theme
1	Mention your gender and age?	Personal data
2	What is your occupation?	
3	How long have you lived in El Chaco, San Carlos, San Luis, or Lumbaqui?	
4	Is your work or any direct relative's work related to the Coca Codo Sinclair project?	Job perception and training for the communities
5	Are there capacity-building programs for the inhabitants of Chaco, San Carlos, San Luis, or Lumbaqui based on the needs identified by the Coca Codo Sinclair operator company?	
6	Did the company that built the Coca Codo Sinclair hydropower share the objectives and goals of the project via talks, meetings, approaches, etc.?	Objectives and goals communicated to the communities
7	Is there encouragement and participation from the Coca Codo Sinclair hydropower operator company to gather ideas from people to improve the community's care?	
8	Does the hydropower operating company strive and provide environmental or social care resources in El Chaco, San Carlos, San Luis, or Lumbaqui?	Support from the operator company to the communities
9	Does the company arrange financial aid to the communities' inhabitants from the Government, Foundations, or Non-Governmental Organisations (NGOs) to address problems or undertakings?	
10	Please detail any other data, topic, or observation you want to mention or that the hydropower project operator company should consider. (This is extracted from the narration provided by the respondents.)	Additional observations

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