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Evaluation of Negative Impacts of Metolong Dam, South of Phuthiatsana River in Lesotho

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ABSTRACT

The purpose of this article is to assess how the adverse effects of the Metolong Dam project have influenced the daily lives of the local community. Data was gathered using purposive sampling. A purposive-heterogeneous sampling approach was utilized because the study required participants from diverse backgrounds who could provide insights based on their awareness and personal experiences with efforts to restore their livelihoods. The primary methods for gathering data were interviews and observations. These approaches were chosen as they are suitable for handling complicated and sensitive issues. The article's findings revealed that the construction of the Metolong dam and reservoir had detrimental impacts on nearby communities. While the dam was planned to bring numerous socio-economic benefits to these areas, the outcomes showed that the project had limited positive effects, such as national advantages like infrastructure development and water security. This research reveals a significant gap between the intended benefits of the development initiative and the actual experiences of the people impacted. More research is necessary to fully understand the negative effects and to find ways to lessen them, addressing the unfulfilled needs and helping communities regain their means of survival. Because the project's positive effects on the local area were limited, more inclusive and community-focused strategies are needed for large developments. Future studies should focus on identifying effective ways to ensure these projects truly benefit local people and don't unfairly burden them with negative outcomes.

Keywords: Displacement; Resettlement; Environmental Degradation; Biodiversity Loss; Social Disruption; Cultural Heritage Loss; Conflict Over Resources; Debt Burden

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1. Introduction

1.1. Background of the Area and Project

The Metolong Dam project is situated in Lesotho, a member of the Southern African Development Community (SADC) consisting of 15 countries. The country's mountainous landscape and plentiful rainfall provided a unique chance for Lesotho to harness its hydroelectric power capacity and supply water resources to neighboring South Africa. The Lesotho Highlands Water Project (LHWP), comprising a network of dams and tunnels, was launched to tackle South Africa's water shortages and to support Lesotho's economic growth [1]. This project was executed in stages, involving the construction of dams that not only redirected water to South Africa but also produced hydroelectric energy for use within Lesotho and for export [2]. Matli noted that this mutually advantageous arrangement, originally motivated by South Africa's demands for water, granted Lesotho a vital source of income and energy self-sufficiency, significantly transforming its economic framework [2]. The initiation of the LHWP marked an important shift in Lesotho's development path, moving from a predominantly agricultural economy to one increasingly dependent on the sale of water and electricity generation [3].

1.2. LHWP and Its Impacts

LHWP began in 1986 and is regulated by a treaty between the governments of South Africa and Lesotho. This initiative is one of the largest water transfer projects globally. According to Devitt and Hitchcock (2010) [4], the LHWP is the second-largest water transfer and hydroelectric project in Africa, with the largest being the Meroe Dam, built by the Chinese on the fourth cataract of the Nile River in Sudan. Furthermore, the Katse Dam is the second tallest dam, following the Akosombo Dam at Lake Volta in Ghana, see **Table 1**.

Table 1. Six tallest dams in Africa [5].

Name	Country	Dam wall height
Katse dam	Lesotho	185 m
Cahora Bassa dam	Mozambique	171 m
Hassan 1	Morocco	145 m
Akosombo dam	Ghana	134 m
Bine El Ouidane	Morocco	133 m
Kariba dam	Zambia/Zimbabwe	128 m

The LHWP entailed building four major dams within the Senqu River watershed. This initiative is being executed in four stages (Stage IA and IB, Stage II, III, and IV) as detailed by **Table 2**.

Table 2. Stages of LHWP [6].

Stage(s)	Activity
Stage IA Building of Katse Dam on the Malibamatso River	- Wall construction reaching 185m in height - 45 km Transfer Tunnel to Muela - 15 km Southern Delivery Tunnel - 22 km Northern Delivery Tunnel - Catchment region of 1860 km^2
Stage IB Building of Mohale Dam on the Senqunyane River	- 145 m high wall of concrete face rock-fill embankment - 180 m long Matsoku Weir and 5.6 m long diversion tunnel - Mohale Access Roads
Construction of Mashai Dam on the Orange/Senqu River	- Mashai Dam - Pumping Station - Transfer Tunnel - Delivery Tunnel - Hydroelectric Plant - Catchment region of 7977 km^2

Table 2. *Cont.*

Stage(s)	Activity
Stage II Building of Polihali Dam	- Polihali Dam, a 163.5 m high rockfill dam with a 49.5 m saddle dam - Kobong Pump Storage 101 m high
Stage III Building of Tsoelike Dam on the Orange/Senqu River	- Tsoelike Dam - Pumping Station - Catchment region of 10,375 km^2
Stage IV Building of Ntoahae	- Ntoahae Reservoir

The research[7] observed that people residing in the Lesotho highlands prided themselves on their distinct identity compared to their compatriots in the lowlands. Their unique culture resulted from the challenging environmental conditions presented by the highlands for establishing a livelihood. According to Hunting Consult 4 Joint Venture (2001)[8], these individuals were independent, inventive, and capable of surviving in a harsh physical environment. The LHWP led to the relocation of approximately 27,000 individuals, which accounted for about 1.5% of Lesotho's population at that time.

Phase IA displaced and resettled approximately 20,000 people. About 2,300 individuals, distributed among 372 households, were directly affected by the Katse dam. Some were impacted by the reservoir's filling, while others experienced disruptions due to the construction of access roads and power lines. According to Hoover (2001)[9], Phase IB displaced and relocated around 7,000 individuals by December 2003. The number was reduced compared to Phase IA due to lessons learned from the Katse dam, leading to a more comprehensive and effective environmental management strategy[10].

All residents whose homes were located in the trajectory of the power lines were appropriately relocated and resettled in different areas. When phase IA began, the research[10] noted that no Environmental Impact Assessment had been conducted, leading to various environmental and socio-economic problems arising during implementation. These problems included diminished livelihood security, an increase in sexually transmitted infections, erosion of belief systems, and stressed family relationships[9]. Therefore, this study aimed to address that gap by assessing the negative effects on a local community directly affected by the construction of the Metolong Dam in Lesotho in a more conventional manner, using common synonyms.

2. Literature Review

To lay the groundwork for the article, the Sustainable Livelihoods Approach (SLA) is employed, serving as a framework to assist in developing sustainable livelihoods for disadvantaged groups[11]. This method is intended to enhance our understanding of the various types of livelihoods among those considered impoverished. The elements of SLA are crucial for enhancing the conditions of individuals living in rural poverty[12]. Hence, SLA can act as a tool for planning new development initiatives and as an evaluative mechanism to measure the success of current activities in sustaining livelihoods[13]. The research[14] notes that the concept originated as a development idea from the Brundtland Commission on Environment and Development and was further advanced at the 1992 United Nations Conference on Environment and Development. Subsequently, various scholars, including Chambers and Gordon (1992)[15] and Kinconco *et al.* (2022)[16] refined the theory.

Dipholo and Molosi-France (2017)[17] SLA employs a framework to comprehend how individuals maintain and enhance their livelihoods, focusing on five primary types of capital assets: human capital, social capital, natural capital, financial capital, and physical capital. Each of these assets plays a vital role in determining a person's capacity to manage crises, seize opportunities, and achieve sustainable livelihoods. The same authors point out that Human Capital includes the knowledge, skills, and abilities embodied in individuals, enhancing their productivity and earning potential. Social Capital pertains to the networks of relationships among individuals and groups, facilitating cooperation and the exchange of information. Natural Capital consists of the world's stock of natural resources, including minerals, forests, and water, which provide essential ecosystem services. Financial Capital refers to the financial resources, including money, investments, and credit, used to fund eco-

nomic activities. Physical Capital comprises tangible assets like machinery, equipment, and infrastructure used in production processes[17].

The research[18] assert that the SLA enhances the understanding of local livelihoods. This approach highlights the key factors affecting the livelihoods of the poor while demonstrating the distinct characteristics and interconnections among these factors. Consequently, SLA can offer a framework for creating new development proposals and serve as a tool for evaluating the impact of ongoing efforts in sustaining livelihoods[19]. Therefore, it is crucial for the SLA framework to be integrated into rural development policies without replacing other existing strategies such as participatory development, sector-wide approaches, or integrated rural development.

The research[19] suggests that SLA can be employed primarily as a systematic and instrumental framework for designing programs or evaluating their implementation. This can be based on the poor's income sources. As such, SLA is similar to other approaches, like the Integrated Rural Development approach, which has been used in various studies in Africa, Kotelo-Molaoa (2007)[20] and outside Africa by Vanclay (2017)[21] Amankuich *et al.* (2021)[22], among others, when examining the livelihoods of individuals impacted by large-scale projects.

The adoption of SLA in this article is significant because it offers a framework for understanding and addressing the complex interplay between dam projects and the well-being of impacted communities. The research[23] mention that SLA emphasizes the interconnectedness of various factors influencing people's livelihoods, including economic, social, environmental, and political aspects. By employing this approach, an article can go beyond merely listing the negative impacts (e.g., displacement, loss of resources, environmental degradation) to explore how these impacts affect different groups within the community, their coping mechanisms, and their ability to adapt to change. This nuanced perspective allows for a more comprehensive and impactful analysis, underscoring the need for equitable and sustainable solutions that move beyond just compensation and instead focus on empowering communities to rebuild and prosper[24]. Furthermore, SLA aids in identifying potential pathways for mitigation and adaptation, promoting a more just and resilient outcome for those affected by large dam projects. Overall, SLA provides a holistic and human-centered perspective that is essential for a thorough and meaningful examination of the negative consequences of large dams.

2.1. Negative Impacts of Large Dams

The research[25] have suggested that the creation of major water projects can have both advantageous and detrimental effects on indigenous communities, either directly or indirectly. These impacts can manifest at different phases of the project, such as planning, construction, or operation, and can affect areas both upstream and downstream. While large dams offer benefits like hydroelectric power and water storage, they have notable adverse global effects. Scudder (2005)[26] argues that the advantages of these projects have been overstated, whereas the negative outcomes have been understated. Both positive and negative impacts are complex and influence various ecological, social, and economic dimensions of the regions where they are built.

Ecologically, large dams offer significant advantages in terms of water storage, hydroelectric power generation, and flood control[27]. However, they disrupt river ecosystems. The natural river flow is altered, resulting in habitat loss and fragmentation for aquatic species[28]. Sedimentation patterns are altered, affecting downstream ecosystems and reducing the fertility of farmland. Zwick (1992)[28] noted that changes in water temperature and oxygen levels further stress aquatic life, leading to a loss of biodiversity. Additionally, dam construction can cause the displacement and loss of riparian vegetation, affecting terrestrial ecosystems as well[29]. The formation of reservoirs can also increase greenhouse gas emissions due to the decomposition of organic material submerged during flooding.

Socially, building large dams can provide local communities with employment, ensure reliable irrigation water sources, and boost agricultural productivity and food security for surrounding populations. Holden (2007)[30] notes that job opportunities arise during various project phases. Supporting this view, Grassi *et al.* (2015)[31] mention that employment opportunities begin during feasibility studies, continue before construction, and persist throughout the construction phase.[32] confirmed that the construction of significant dam projects like the Kariba and Grand Coulee dams resulted in the employment of 10,000 and 15,000 workers, respectively.

However, large dams often lead to the displacement of communities. Heming *et al.* (2001)[32] highlight that people living in areas flooded by the reservoir are compelled to relocate, frequently with insufficient compensation or resettlement options. This displacement can disrupt social structures, livelihoods, and cultural heritage. Scudder (2012)[33] indicate that access to traditional resources, such as fishing grounds or farmland, may be lost, causing economic hardship and social unrest. The construction process itself can also lead to social conflicts due to land acquisition and resource allocation issues[34].

Economically, while dams can generate hydroelectric power, the long-term economic benefits are often contested. The initial construction costs can be substantial, and the ongoing maintenance and operation expenses can also be significant[32]. The economic advantages may not be evenly distributed, with some communities benefiting while others face economic losses. Furthermore, Kombe (2010)[35] state that the environmental damage caused by dams can have considerable economic repercussions, such as reduced agricultural productivity and the collapse of fisheries.

2.2. Case studies on Negative Impacts of Large Dams

Large dams, while frequently praised for their role in generating energy, supporting irrigation, and managing floods, have clearly adverse effects worldwide[36]. These repercussions span environmental, social, and economic domains, influencing both local populations and broader ecosystems. The case studies in **Table 3** from various global locations consistently show patterns of displacement, loss of biodiversity, changes in hydrological patterns, and heightened vulnerability to natural disasters. Recognizing these detrimental outcomes is essential for making informed decisions about the construction of future dams and the management of current infrastructure[37].

Table 3. Negative impacts of large dams globally[5].

Name of Dam(s)	Location	Impacts
Three Gorges Dam	China	**Positive:** Generates substantial hydroelectric power, improves navigation on the Yangtze River, facilitates trade and transport, reducing shipping costs, provides flood control, and boosts economic growth by creating jobs and enhancing infrastructure. **Negative:** Has caused significant community displacement and environmental harm.
Narmada Dam	India	**Positive:** Enhances agricultural productivity in irrigated areas, produces hydroelectric power, supplies drinking water to several previously water-stressed regions, improving public health and sanitation. **Negative:** Displaced hundreds of thousands from their homes and ancestral lands, inundated extensive fertile areas resulting in agricultural losses and decreased biodiversity, altered the natural flow of the Narmada River.
Aswan High Dam	Egypt	**Positive:** Its construction increased agricultural productivity by expanding irrigated land and establishing a steady water supply, lessening drought and flood impacts, boosting food production and economic growth in agriculture, generating hydroelectric power, and Lake Nasser created opportunities for fishing and tourism. **Negative:** While providing irrigation, has disrupted the Nile's ecosystem and reduced sediment flow, affecting agricultural output.
Xin'anjiang Dam	In China	**Positive:** Provides flood control, hydroelectric power, and the reservoir supports irrigation, improving agricultural output. **Negative:** Displaced large populations from homes and ancestral lands, causing social upheaval and economic strain for the relocated. The dam's reservoir submerged fertile land, reducing agricultural production and affecting local livelihoods, and altered local climate with potential effects on biodiversity.
Kariba Dam	Located on the Zambezi River between Zambia and Zimbabwe	**Positive:** Generates hydroelectric power, Lake Kariba is a significant tourist attraction generating revenue through fishing, boating, and wildlife viewing, and irrigation projects heightened agricultural productivity. **Negative:** The dam's construction led to substantial displacement of local populations and biodiversity loss in submerged areas.
The Belo Monte Dam	Brazil	**Positive:** Makes a significant contribution to Brazil's energy supply, created numerous jobs during construction, and improved infrastructure such as roads and electricity grids. **Negative:** Caused considerable deforestation and displacement of indigenous communities, disrupting their traditional lifestyle and affecting biodiversity in the Amazon rainforest.

Table 3. *Cont.*

Name of Dam(s)	Location	Impacts
The Ilisu Dam	Turkey	**Positive:** Generates hydropower, and improved irrigation infrastructure from the dam's reservoir led to heightened agricultural productivity; the reservoir created a new body of water offering recreational opportunities such as fishing and tourism. **Negative:** While providing hydroelectric power, it submerged historical sites and archaeological treasures, leading to irreversible cultural loss.
The Sardar Sarovar Dam	India	**Positive:** Offers irrigation for a large agricultural area, boosting crop yields and farmer incomes, the reservoir helps mitigate droughts and provides a stable water source for drinking and industrial use, generates hydroelectric power, and improved infrastructure like roads and canals, enhancing connectivity and access to services in previously underserved areas. **Negative:** Similar to Narmada Dam, has faced criticism for displacing populations and affecting downstream water availability and ecosystems.
The Itaipu Dam	Between Brazil & Paraguay	**Positive:** Produces hydroelectric power, and the reservoir created a large lake that impacts the local ecosystem and opens opportunities for tourism and recreation, fostering technological progress and international cooperation between Brazil and Paraguay. **Negative:** While being a significant energy source, has disrupted river flows, affecting aquatic life and downstream ecosystems.
The Mekong Dam	Southeast Asia	**Positive:** Generates hydroelectric power, the reservoir provides opportunities for irrigation, boosting agricultural productivity and food security, supports fisheries and aquaculture offering more income and food security, and facilitates trade and transport along the Mekong River. **Negative:** Raised concerns about impacts on the Mekong River's biodiversity, fisheries, and the livelihood of millions depending on the river.
Yangtze River Basin	Eastern Asia	**Positive:** Generates hydroelectric power, supports irrigation and agriculture, transportation and trade, fisheries and aquaculture; the Yangtze is a biodiversity hotspot home to numerous plant and animal species, and its scenic beauty attracts global tourists. **Negative:** Despite focusing on economic development, the dam has resulted in several adverse effects on environment and society, including significant biodiversity loss, water pollution, alteration of river flow patterns, community displacement, and increased soil erosion.

The above examples underscore the intricate relationship between ecological, social, and economic factors linked to large projects, highlighting the importance of thorough planning, environmental impact assessment, and community involvement to reduce adverse effects. Case studies reveal extensive ecological harm, such as habitat destruction, loss of biodiversity, and disruption of river ecosystems. Silicialno *et al.* (2018)[38] mention that these disturbances often lead to a decline in fish populations and deteriorate water quality downstream. Additionally, dam construction commonly results in the displacement of communities, leading to social and economic upheaval, loss of livelihoods, and cultural heritage[39]. The long-term sustainability of many large dam projects is debatable, with concerns about sediment accumulation, reservoir sedimentation, and the risk of catastrophic dam failures[40]. Although the advantages of hydroelectric power are undeniable, a thorough cost-benefit analysis considering the complete range of environmental and social impacts is essential before initiating such large-scale projects. Kondolf and Jaeeng (2022)[41] assert that evidence from numerous case studies strongly suggests that a more nuanced approach, favoring smaller-scale, environmentally friendly alternatives, is necessary to mitigate the negative outcomes of large dam construction.

3. Research Methods

3.1. Project Area

The construction area for the Metolong Dam was established on the South Phuthiatsana River in the western lowlands of Lesotho, about 35 km from Maseru, as shown in **Figure 1**.

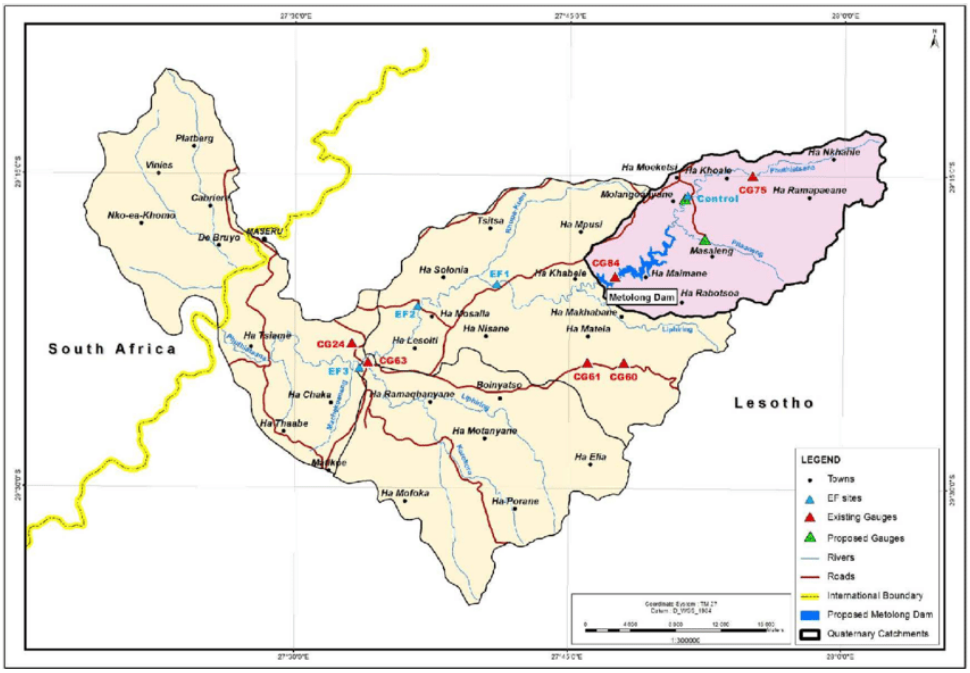

Figure 1. The study area[42].

This river is a tributary of the Caledon River and originates from the highlands of Lesotho. Referred to as the Metolong Dam and Water Supply Program, this project encompasses a dam (83 m high and 278 m wide as depicted in the **Figure 2**), a raw water pumping station (with a capacity of 1.2 cubic meters per second), associated water treatment facilities (a conventional treatment plant capable of producing an average of 75 million liters per day of drinking water, with a maximum of 93 million liters per day), and distribution networks (comprising 125 km of pipelines with diameters ranging from 200 mm to 1168 mm; two booster pumping stations; eight reservoirs; and five chlorination stations) to support water supply for both residential and industrial purposes.

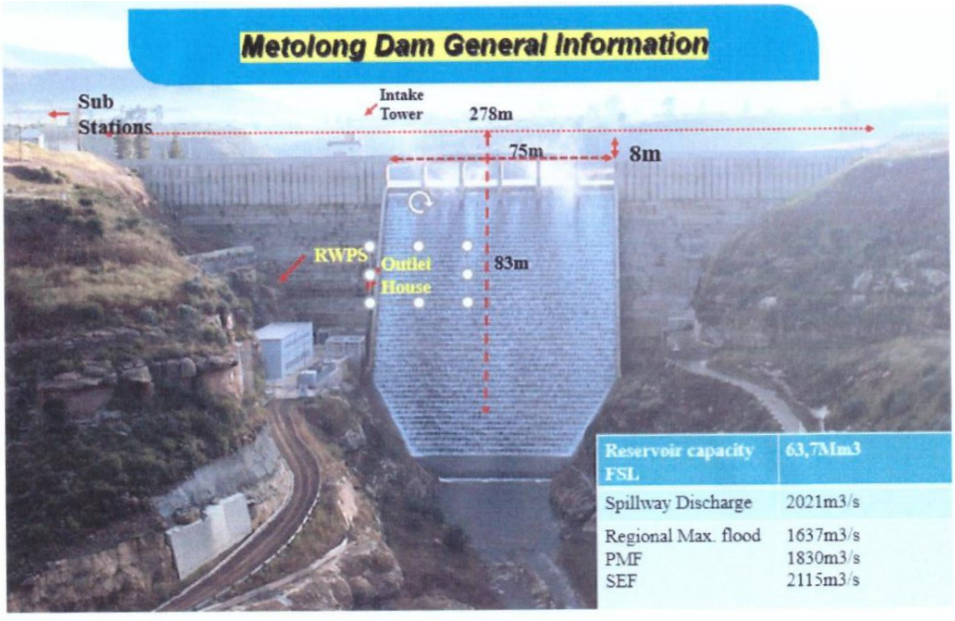

Figure 2. Metolong dam wall[43].

The area covered by the reservoir includes the districts of Maseru and Berea, see **Figure 3**. The scope influenced by the Project is significantly larger, as it will supply water to the capital city, Maseru, as well as the towns of Teyateyaneng and Roma. Furthermore, the indirect effects of drawing water from the South Phuthiatsana River might influence those utilizing water further downstream at the Mohokare (Caledon) River.

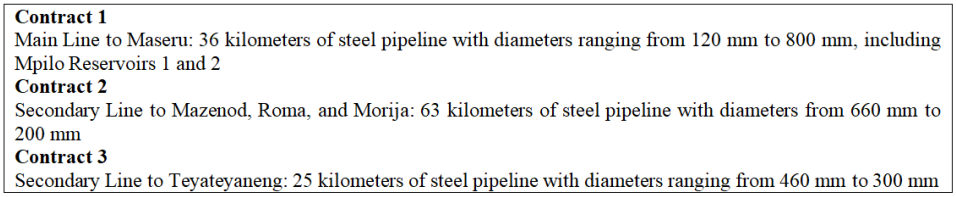

Figure 3. Metolong span areas[44].

3.2. Collection of Data

3.2.1. Research Approach

This study took a qualitative research route because it was the best way to explore the issue at hand.[45] qualitative research gives us a really thorough and detailed understanding of the complicated social, environmental, and financial effects involved-more than just numbers ever could. As some researchers have noted, this approach lets us uncover the subtle opinions of all sorts of people involved, from the communities affected to the government and the project's builders. Ahmad and Islam (2024)[46] this helps everyone make better decisions and lessen any potential downsides. Others have pointed out that using this kind of research helps us spot and understand possible disagreements and dangers connected to building dams. Basically, qualitative research adds a critical human element to big dam projects, making sure we don't ignore the social, environmental, and financial aspects while chasing engineering and financial goals. It encourages development that's fairer and more sustainable by putting people's participation and well-informed choices first[47].

3.2.2. Sampling Method

The selected method for choosing samples is purposive sampling, with interviews and observation being the main data collection techniques. According to Grbich (2013)[48], purposive sampling entails deliberately selecting a sample while considering the study's objective or focus. This approach is favored due to the diverse characteristics of the population and the study's objectives. Lim (2025)[49] states that there are seven types of purposive sampling: heterogeneous, homogeneous, typical case, deviant case, critical case, total population, and expert sampling. For this research, the emphasis was primarily on heterogeneous sampling. The researcher specifically opted for purposive-heterogeneous sampling because the study required participants from varied backgrounds to provide their insights based on their knowledge and personal experiences with livelihood restoration programs.

3.2.3. Study Population

The study included 35 individuals from the area surrounding the Reservoir. The researcher aimed for a sample size that wasn't too large or too small. Campbell *et al.* (2019)[50] they avoided very large samples to make sure the results accurately reflected the broader population, reducing the influence of unusual cases and chance fluctuations. This is particularly important when examining the complicated environmental, social, and economic effects of building large dams, since these effects can differ substantially depending on the specific situation. At the same time, the researcher also wanted to avoid very small samples because they increase the chance of errors and skewed results, making it difficult to draw trustworthy conclusions. Sardare and Admane (2013)[51] a small sample size would limit the study's statistical strength and make it difficult to apply the findings to other similar dam projects. Participants in this study were aged 19 and older, as those below 18 were not included due to their young age and participation would require parental or guardian consent. Of the participants, 19 (54%) were male and 16 (46%) were female.

3.2.4. Data Collection Methods

The main techniques used for collecting data in this research project consisted of detailed interviews. Furthermore,

the researcher utilized observation to collect information about the project's vicinity. The objective was to record the development in the affected communities and the living conditions of the impacted individuals.

3.2.5. Data Analysis

The data examination was organized around themes that were directly derived from the data. The research employed thematic analysis as the approach for investigating the collected data. A significant portion of the information used was sourced from policy documents and academic articles that had previously detailed the implementation of the SLA, effects of large dams, etc. Thematic analysis was selected due to its appropriateness for qualitative research, which mainly aims to establish frameworks for classifying data and then identifying relationships [52].

3.2.6. Methodological Transparency

Ensuring methodological transparency is essential for confirming the trustworthiness and accuracy of research outcomes, especially in intricate fields such as assessing the impacts of large dams. According to Venette et al. (2002) [53], methodological transparency entails thoroughly and explicitly documenting every facet of the research process, enabling others to comprehend the study's execution and evaluate the results' legitimacy. This includes a comprehensive account of the research design, data collection approaches, and data analysis methods [54]. Openly sharing the research methodology invites examination and replication, enhancing the conclusions' credibility. Ahmed (2024) [55] assert that transparency should cover the entire research process, from the initial literature review to the final analysis. This article achieved a transparent literature review strategy by clearly outlining the keywords used, databases consulted (such as Web of Science, Scopus, etc.), and the criteria for inclusion and exclusion. This approach helps readers understand the extent of the search and determine if any relevant studies may have been unintentionally excluded. Additionally, detailing the coding process in this work, including the coding framework used and any checks for inter-rater reliability, ensures objectivity and uniformity in data analysis. Albu and Flyverbon (2019) [56] emphasizes that acknowledging limitations in the search strategy and coding process is equally important, as it demonstrates intellectual honesty and enables readers to critically assess potential biases or constraints in the findings. By adopting methodological transparency, a researcher bolsters the robustness and replicability of their work. This not only fortifies the findings' validity and reliability but also builds trust and assurance among readers and stakeholders [57]. Openly discussing the research process allows for critical assessment and potential enhancements in future studies, ultimately contributing to a deeper and more thorough understanding of the effects of large dam projects. Such transparency is particularly vital given the significant social, environmental, and economic implications associated with large dam projects [58]. Furthermore, a sound research design explicitly detailed the sampling method, including the sample size and reasoning for its selection. The sample size in this article was ample enough to yield statistically significant findings and accurately represent the population studied. Kingdom (2022) [59] suggest this might involve stratified random sampling to include diverse stakeholders, such as affected communities, government entities, and environmental organizations. In this article, the population of interest was clearly defined, specifying the geographical region, for example. A failure to properly define the population can introduce sampling bias, leading to incorrect conclusions [60].

4. Results and Discussion

The Metolong Dam Project utilized a comprehensive strategy for involving the community, and the success of the community engagement mechanisms was a complex matter, influenced by the established formal structures and the broader socio-political environment of the area. The project encompassed various levels of interaction, from official consultations and committees to informal dialogues and feedback systems. Formal structures included community liaison officers who served as links between project developers and local communities. These officers facilitated meetings, spread information, and gathered feedback. Community-based organizations (CBOs) and local leaders were key in mobilizing participation and representing community interests. According to Kang et al. (2017) [61] CBOs often acted as channels for information and facilitated discussions on project impacts and mitigation strategies. Braun (2011) [62] note that the effectiveness of these mechanisms varied based on factors such as the level of community organization, literacy rates, and the capacity of project staff to engage ef-

fectively with diverse stakeholders. The Three Gorges Dam in China included community-based resettlement projects as a formal structure. Informal participation also took place through channels such as community meetings, public forums, and individual interactions. These informal channels lacked the formal structure and accountability of the more official mechanisms. The Sardar Sarovar Dam in India is an example of a major dam project that included community-based projects, although often informally and with varying degrees of success concerning genuine community participation and benefit-sharing. While the official project structure was hierarchical and top-down, numerous smaller-scale initiatives related to resettlement, livelihood support, and environmental mitigation were undertaken by local groups and NGOs with limited formal integration into the overall dam project.

Furthermore, the Metolong Dam Project serves as an intricate case study in cost-benefit analysis, accounting for both social costs and national advantages. Although the project was intended to enhance water security for Lesotho and South Africa, its execution involved notable social and environmental compromises. Concerning social costs, the project led to the displacement of numerous communities, requiring efforts in relocation and resettlement. This resulted in the disruption of livelihoods, social connections, and access to critical services. The environmental impact of the dam included alterations to the downstream ecosystem and water quality, affecting local populations reliant on these resources.[32] suggests that compensation and mitigation strategies are typically employed in large dam projects, yet their effectiveness in completely addressing social costs continues to be debated. The Three Gorges Dam is frequently mentioned due to its complicated and sometimes contentious cost-benefit profile owing to its unique scale and impact, but the Itaipu Dam on the Paraná River shared by Brazil and Paraguay provides a relevant comparative study. Despite the social costs, Metolong offered considerable national advantages for both Lesotho and South Africa. According to Gondaliya et al. (2017)[63], improved water security leads to increased agricultural productivity, enhancements in industrial capacity, and better access to potable water for a larger population. Additionally, Metolong contributed to economic development by creating jobs during both construction and operation phases, as well as generating increased revenue from water sales. These economic advantages have the potential to drive national growth and reduce poverty[35].

A significant portion of experienced labor employed at Metolong came from outside the region, and this practice affects local social inequality. The arrival of skilled workers often stimulates economic activity in the project area. However, this advantage is not always evenly distributed. Local unskilled workers find themselves competing for limited resources and opportunities, which potentially widen the gap between the skilled and unskilled workforce. This results in heightened income disparity, unequal access to resources, and social stratification[64]. The temporary nature of many dam projects means that the economic benefits are frequently short-lived. Once the project is finished, the skilled workers leave, potentially leaving behind a destabilized local economy and increased social tensions. This may provoke resentment and social unrest among the local population, who may feel exploited or left behind. The long-term effects on the local community may not outweigh the short-term economic benefits.

Although large dam projects offer economic opportunities, the practice of hiring skilled labor from outside the local area significantly influences social inequality. Large dam projects frequently do not sufficiently take into account factors such as local skill deficiencies and ineffective policies, which can result in adverse outcomes. A lack of skills can impede the efficient building and functioning of the dam, whereas poor policies can generate economic, social, and environmental issues. These neglects can lead to budget overruns, delays in the project timeline, and detrimental effects on local populations and the ecosystem. It is vital to address these aspects through thorough planning and stakeholder involvement to ensure the successful execution of dam projects[65].

The project also caused notable tensions between workers and nearby communities. This was due to the arrival of workers, which increased competition for limited resources such as housing, food, and land, driving up prices and creating resentment among local residents who felt marginalized and economically disadvantaged by the project's presence. Consequently, local communities felt excluded from the economic benefits of the project, leading to feelings of injustice and dissatisfaction. Furthermore, tensions arose from disputes related to land acquisition and compensation. There

were disagreements over fair compensation and resettlement packages that fueled conflicts between the project developers and displaced communities. Additionally, cultural differences and varying expectations regarding behavior and social norms contributed to friction. According to Islam and Kähkönen (1999)[60] note that the influx of workers from diverse backgrounds often led to misunderstandings and conflicts. The Three Gorges Dam serves as an example of a large dam project that effectively utilized formal protocols to manage conflicts between workers and the surrounding community. The Chinese government implemented formal grievance mechanisms and resettlement programs. These protocols were designed to provide channels for addressing community concerns and worker disputes formally. Effective conflict resolution requires formal protocols that prioritize communication, transparency, and equitable solutions.

The breakdown of employment data by gender in the construction of large dams is essential for recognizing and addressing potential gender biases in job distribution. This process involves gathering and examining employment statistics separately for men and women, uncovering differences in hiring, promotion, and pay across various roles. At Metolong, women were predominantly found in lower-paying positions such as cleaning and catering, whereas men dominated higher-skill and better-compensated positions like engineering, construction, and machinery operations. This imbalance mirrors broader societal gender roles and prejudices within the construction sector. Schapper and Urban (2021)[64] emphasize that analyzing these figures allows project managers to identify areas where bias may exist and take specific actions to address them. Similarly,[66] argue that examining gender-segregated data provides a more detailed understanding of workforce composition, moving beyond simple aggregate numbers to show the particular roles that women and men hold. According to[67], effective measures to combat gender bias include employing blind recruitment methods, establishing clear and transparent promotion criteria, and offering targeted training and development opportunities for women.

The project's creation of job opportunities was intended to either exacerbate or alleviate poverty for displaced individuals and those who lost their sources of income. However, governmental policies and actions are directly influencing the living conditions of those affected by the project because the government might fail to provide adequate resettlement plans or compensation, potentially leading to increased poverty and social unrest. For instance, the environmental impact of The Three Gorges Dam in China changed water flows and disturbed the ecosystem, adversely affecting local economies dependent on fishing, agriculture, or tourism. On a more positive note, the Chinese government, during the construction of The Three Gorges Dam, significantly contributed to poverty reduction by carefully planning and executing dam projects. This involved offering fair compensation and resettlement for displaced communities, investing in infrastructure and development in nearby areas, and addressing the negative environmental effects of the dam[68].

Despite its implementation, the Metolong project did not succeed in creating a sustainable income stream for nearby communities after its completion. Opportunities for seasonal employment, such as fishing or reservoir tourism, could provide a feasible solution and enhance income sources. According to Hickey and Tompkins (1998)[69], recreational fishing activities can generate employment in fishing, processing, and distribution, offering a steady, though seasonal, income source. The Three Gorges Dam in China serves as an example where seasonal jobs, such as fishing and reservoir tourism, were used effectively to create sustainable development and enhance income sources. In developing reservoir tourism, activities like boating, swimming, water sports, and camping draw visitors and generate revenue. Ashley et al. 2007[70] note that this leads to the creation of employment opportunities in hospitality, transportation, and recreational services, thereby further diversifying the local economy. The Hoover Dam is a notable example of how job growth in hospitality, transportation, and recreation was stimulated, diversifying the local economy.

Moreover, the enhanced water supply has driven agricultural advancement and related industries, generating new income opportunities for local populations. Unlike other initiatives mentioned in Section 2, the Metolong project primarily focuses on hydroelectric power production, supplying clean and more affordable fossil fuels, and encouraging economic growth by lowering energy costs for industries and consumers. According to Cherp et al (2012)[71] , decreased dependence on imported energy also strengthens national energy security and minimizes exposure to global price variations. Additionally, dams form reservoirs that enable irri-

gation, enhancing agricultural productivity and improving food security. This boost in agricultural output results in increased earnings for farmers and contributes to the national GDP[72]. Reservoirs also support fishery industries, offering jobs and a protein source for local populations. Besides direct economic advantages, dams often improve navigation, allowing previously inaccessible areas to engage in trade and commerce[73]. The construction phase itself creates significant employment opportunities, stimulating local economies by raising the demand for labor and materials. Reservoirs can also serve as leisure destinations, attracting tourism and providing income for local enterprises[74].

Metolong encountered difficulties related to the gap between expectations and actual outcomes concerning social and environmental impacts. In practice, the accountability mechanisms intended to ensure responsible development and mitigate adverse effects often fell short. Promises of economic growth and improved living standards for local communities were not fully achieved due to issues like displacement, loss of traditional ways of living, and unequal benefit distribution. Environmental impacts such as habitat destruction and loss of biodiversity were underestimated or overlooked during the planning stages. Maropo (2018)[75] highlights that accountability mechanisms, including public consultation, can be flawed due to insufficient participation, lack of transparency, and weak enforcement. The power dynamics among developers, governments, and affected communities often impede effective accountability[76]. The Three Gorges Dam in China serves as a similar example to Metolong, where expectations regarding its construction and operation were not met, and accountability measures failed. Konisky (2016)[77] notes that the failure to meet promises and the lack of accountability lead to negative consequences for the environment and affected communities.

The research[78] highlights that agriculture is the primary economic activity in the Metolong community. However, the reduction of arable land has had a significant negative effect on local livelihoods and food security. Until recently, alternative farming techniques like hydroponics were unfamiliar in Metolong, despite their potential to offset these land losses and broaden opportunities for diversification. Hydroponics, as described by Sardane and Adname (2023)[79], is a technique of cultivating plants without soil by using a nutrient-rich water solution. This approach makes efficient use of water and space, offering a viable option in areas with limited land or depleted soils due to dam construction. By providing a controlled growing environment, hydroponic systems enable year-round crop production, enhancing yields and offering farmers a more reliable income[79]. According to Maurya et al (2023)[80], hydroponics can be tailored to fit various scales, from small household setups to large-scale commercial farms, meeting the diverse needs of farming communities impacted by dam projects. This flexibility allows hydroponics to integrate with existing farming practices, encouraging diversification and reducing dependence on traditional methods that might suffer due to land loss. However, as noted by Velazquez-Gonzalez et al. (2022)[81], the upfront costs of setting up hydroponic systems can be prohibitive for some farmers. Therefore, there is a pressing need for government support through subsidies, training programs, and credit access. Successfully integrating hydroponics should also involve comprehensive strategies that address broader needs for livelihood diversification, such as improving market access, offering business management training, and promoting the value-added processing of hydroponically grown produce.

Assessing compensation for land taken for large dam projects is a complex issue that demands a comprehensive strategy to ensure fairness and clarity. Comparing market values with actual payments requires a thorough methodology that accounts for various elements affecting land value and the project's impact on the affected landowners. At Metolong, market values versus actual payments for seized lands were not considered, leading participants to feel insufficiently compensated to meet their needs. Wagner et al (2020)[82] mentions that the market comparison method is commonly used, involving the analysis of recent sales of similar properties near the dam project. The Three Gorges Dam is an example of this. This technique relies on the principle of substitution, assuming a willing purchaser would pay a price akin to that of similar properties[83]. Another strategy is the income approach, which assesses land value based on its potential to produce revenue. This is especially pertinent if the land is utilized for farming, where income can be projected based on crop yields and market prices. The Three Gorges Dam serves as an example since its construction necessitated extensive land acquisition. However, Hoffman and Splitze (1999)[84] state this approach requires precise estimations of

future income streams, which can be uncertain, particularly in the context of a large-scale development project that might alter the agricultural landscape.

It was discovered at Metolong that compensation was provided, although it was insufficient and did not align with the original agreements, causing further economic difficulties for the local population. In relation to the inadequate compensation in the Metolong Dam Project, some alternative redress methods, such as pursuing legal action against the dam developers or government agencies, failed to offer genuinely effective solutions. These processes were obstructed by prolonged delays, high costs, and limited access to legal representation for the affected parties. The experience at Metolong was comparable to the Xiaolangdi Dam on the Yellow River in China, where similar legal challenges were pursued. Numerous lawsuits were filed addressing issues such as land displacement, environmental harm, and insufficient compensation for affected communities [85].

Monetary compensation was provided, though it was not part of a comprehensive social protection strategy. This cash transfer is intended to alleviate adverse social and economic impacts on the affected communities. However, the cash transfer initiatives were not tailored to the specific needs and vulnerabilities of the impacted populace, unlike the Sardar Sarovar Dam Project in India, which incorporated cash transfer schemes alongside efforts for resettlement and rehabilitation. Cash transfers serve as a vital safety net for many displaced families, allowing them to invest in new livelihoods and housing [86]. Holmes (2023) [87] indicate that failures often arise from poorly designed programs lacking sufficient planning, monitoring, and evaluation. The Three Gorges Dam Project in China faced considerable criticism regarding its resettlement program, which included cash transfers. This led to many of the relocated individuals experiencing significant economic hardships and social disruptions.

The criteria for choosing recipients for cash transfers in the Metolong Dam Project involved a comprehensive strategy, taking into account aspects such as vulnerability, poverty levels, and potential effects on livelihoods. Nevertheless, the success of these programs has been questioned by participants who feel there needs to be more of a balance between large-scale development projects and social equity and environmental sustainability. This mirrors the experiences of The Three Gorges Dam Project in China and the Sardar Sarovar Dam in India. Despite The Three Gorges Dam providing hydroelectric power, it faced criticism due to the displacement of millions of people and the repercussions on local economies. The Chinese government initiated various resettlement cash transfers to aid displaced individuals, aiming to help them re-establish their lives. However, the effectiveness of these initiatives has been debated.

The postponed and inadequate compensation forced the community to take on unforeseen debts, which neither the developers nor the community had anticipated. Effective debt management programs can significantly help alleviate the adverse effects on livelihoods and improve the welfare of affected communities. The Three Gorges Dam in China illustrates how the Chinese government implemented comprehensive relocation programs and debt management strategies to reduce the negative impacts on the affected population. These programs involved providing new housing, infrastructure, and job training for those who were relocated. Owusu-Addo et al (2018) [88] highlights that effective debt management programs should be adapted to the unique needs and vulnerabilities of each community, acknowledging that the effects of displacement and economic disruption can vary considerably. One significant approach is to establish microfinance initiatives specifically aimed at impacted communities. Cernia (2004) [89] suggest that these programs can offer access to small loans, allowing individuals to start or expand businesses, invest in new skills training, or purchase essential assets lost due to displacement. These loans should have flexible repayment schedules and low interest rates, considering the potential economic hardships faced by these populations [90]. The Nam Theun 2 Dam in Laos serves as an example of a large dam project that included microfinance initiatives intended to help affected communities.

Furthermore, according to Field et al (2012) [91], these programs should include financial literacy training to equip individuals with the necessary skills to manage their finances effectively and avoid further indebtedness. Another strategy, as per [92], involves debt relief programs targeted at households experiencing financial strain due to dam construction. This involves partial or complete forgiveness of existing debts, particularly those arising directly from displacement or income loss. Such programs need to ensure transparency and accountability, preventing misuse of resources and guar-

anteeing that relief reaches those in the greatest need[93]. Additionally, the creation of community-based investment funds can offer a sustainable solution to debt management and economic empowerment.[94] suggest that these funds should be supported by contributions from dam project developers or government bodies and provide grants or low-interest loans for community development projects. According to da Costa Freitas and da Costa (2022)[95], this approach encourages local ownership and control over resources, ensuring that investments align with community priorities and contribute to sustainable economic growth. Meanwhile, Rigal (2023)[96]emphasizes that the management of these funds should be transparent and participatory, with community representatives involved in decision-making processes.

Metolong project had major health impacts on both construction workers and nearby communities. For workers, the dangers were mainly work-related risks. According to Sousa et al (2023)[97], exposure to harmful substances such as asbestos, silica dust, and heavy metals results in respiratory conditions like silicosis, lung cancer, and other chronic lung diseases. Hussen et al. (2020)[98] mention that manual laborers are vulnerable to musculoskeletal injuries and accidents on construction sites, which can lead to trauma and fatalities. At Metolong, communities were aware that some workers faced limited access to proper healthcare, which sometimes delayed or hindered timely treatment of injuries and illnesses. Similarly, the construction of the Three Gorges Dam in China had considerable health repercussions for construction workers and surrounding communities. Workers encountered risks from workplace hazards including landslides, explosions, and exposure to toxic materials. Communities downstream dealt with issues related to changes in water quality, a rise in waterborne diseases, and displacement, resulting in social and psychological stress.

The loss of land and unexpected debts also have considerable psychological effects. The emotional turmoil arises from the disturbance of one's way of life, cultural identity, and social support systems that are closely connected to land ownership and agricultural activities. This loss triggers emotions of anxiety, depression, and hopelessness, significantly affecting mental health. According to Siriwardhana (2013)[99], forced displacement and the disruption of pre-existing social arrangements and livelihoods result in various mental health issues. The loss of familiar environments, social connections, and cultural heritage leads to feelings of sorrow, anxiety, and depression. An example can be seen with the Itaipu Dam situated between Brazil and Paraguay, which demonstrates the complex nature of these impacts. The loss of land and subsequent relocation disturbed existing social structures and livelihoods, causing similar psychological distress among those affected.

In the surrounding communities of Ha Maimane, Masaleng, and Ha Robotsoa, construction and operations have resulted in displacement and disrupted livelihoods, causing stress and mental health concerns. Alterations in water flow and access have impacted sanitation and led to waterborne diseases such as cholera and typhoid. Additionally, stagnant water has increased mosquito breeding areas, potentially raising malaria cases. Similarly, the construction of the Aswan High Dam in Egypt significantly changed the natural flow of the Nile River. The creation of the dam has led to reduced flooding, which historically enriched the soil with fertile silt. This alteration, along with the dam's effects on water quality and availability, has contributed to heightened sanitation issues and outbreaks of waterborne diseases such as cholera and typhoid. The stagnant water behind the dam has created breeding grounds for vectors of disease.

The analysis revealed that the capacity development initiative was not successful. Capacity-building programs are vital for reducing negative impacts and ensuring the long-term success and sustainability of projects. According to Mwamlima (2017)[100], these initiatives aim to empower local communities and individuals through skills enhancement and job creation, ultimately seeking to boost employment rates following training. The Metolong project included capacity-building efforts to improve the skills and employment opportunities of the local populace. Adhered to Konduri et al (2017)[101] suggests that effective capacity-building programs should address several essential areas, such as identifying specific skills gaps within the local workforce and customizing training programs accordingly; designing training programs that consider factors like literacy levels, language barriers, and gender inequalities; and ensuring that training results in concrete employment opportunities. An example of a major dam project incorporating capacity-building initiatives is the Three Gorges Dam. It offered extensive training programs for local workers with the aim of enhancing their skills and increasing job opportunities related to the dam's

construction and operation.

5. Summary and Conclusions

The article examines the negative impacts of the Metolong Dam, located south of the Phuthiatsana River in Lesotho. Although economic advantages are claimed, the dam often exacerbates social inequities. The arrival of skilled workers primarily benefits outsiders, creating employment and income imbalances for the local populace. Government-led initiatives aimed at reducing poverty, which are often linked to such dam projects, frequently fall short of their goals, leaving communities vulnerable and discouraged. Cash transfer schemes meant to compensate for losses often undervalue land, leading to debt and financial instability for those affected. Furthermore, the psychological effects of displacement and loss are considerable, causing distress and disrupting traditional lifestyles. There is a significant gap between promised economic opportunities, such as reservoir tourism or new farming methods like hydroponics, and the reality, leaving communities with few tangible benefits. While the Metolong Dam may boost economic output, it often interrupts existing livelihoods, such as seasonal fishing, negatively affecting local economies. Efforts to build capacity often fail to tackle the complex challenges faced by displaced communities, particularly regarding inadequate mechanisms for resolving conflicts over land rights and compensation disputes. Additionally, cost-benefit analyses frequently overlook long-term social and environmental consequences, resulting in an incomplete evaluation of the project's overall impact. Genuine community involvement is often absent in the Metolong Project, despite being required, leaving local people without real influence in decision-making. Ultimately, the negative social effects of the Metolong Dam project outweigh its alleged benefits, particularly for vulnerable populations.

It can be inferred that the Metolong Dam Project, despite offering advantages like hydroelectric power and irrigation, often falls short in addressing the fundamental causes of poverty and the long-term impact of land loss on displaced communities. While cash transfer programs provide immediate financial relief, they are not sufficient as a standalone solution. A more holistic approach is necessary to address both immediate needs and structural issues. Ensuring that affected communities are actively involved in the project's planning and implementation stages is a crucial step. This participatory approach integrates local expertise and priorities, minimizing the potential for unintended negative impacts. Additionally, it encourages a sense of ownership and empowers communities to voice their needs. Beyond cash transfers, alternate livelihood programs are vital. These should emphasize skill development, job creation, and access to resources compensating for lost land and traditional livelihoods. This might include training in new farming techniques, support for small enterprises, or access to credit and microfinance efforts. Programs must be tailored to the needs and skills of the affected populations, considering aspects such as age, gender, and existing skills. Significant reforms are also needed in land rights and compensation mechanisms. Fair and transparent compensation for land loss should be provided, encompassing more than monetary value to recognize the intangible worth of ancestral lands and cultural importance. This might include offering alternative land suitable for farming or other livelihoods or investing in community infrastructure that compensates for reduced access to resources. Secure land tenure is vital for long-term economic stability and should be a key part of any compensation package. Finally, monitoring and evaluation are crucial to assess intervention effectiveness. Regular assessments should track impacts on poverty, income generation, and overall community well-being. This information should guide program adjustments to ensure they meet their objectives. Transparency and accountability are essential to ensure the benefits of dam projects are distributed fairly and the needs of displaced communities are addressed. A comprehensive approach that combines participatory planning, alternative livelihood programs, fair compensation, and rigorous monitoring is essential to mitigate the adverse effects of Metolong and similar large dam projects and promote sustainable development.

The ability to apply the results of the study on the Metolong Dam Project's impact on poverty and displacement to other situations is limited by several factors. This research is centered on a single dam project in a particular geographic area, making it challenging to generalize the findings to other dam projects in different settings. The unique socio-economic traits of the communities affected-such as their existing poverty levels, resource availability, and social

frameworks-might not reflect those of communities impacted by other dam projects worldwide. The success of suggested solutions, including planning, programs for alternative livelihoods, fair compensation, and oversight, can differ based on the social context in various regions. The study's reliance on a distinct set of interventions also restricts its applicability; what works in one scenario might not work in another. Additionally, the complex, long-term effects of displacement and land loss may not be fully understood within the study's timeframe, possibly leading to an incomplete grasp of the project's overall impacts. Although the findings provide valuable insights into the challenges and potential solutions related to large dam projects, caution is advised when applying them to other situations without accounting for specific circumstances and potential differences in outcomes.

6. Recommendation

Addressing the social and psychological impacts of displacement and inequality caused by large dam projects requires a comprehensive approach centered on mitigation, compensation, and long-term support for communities. Neglecting these critical aspects leads to social unrest, economic difficulties, and lasting trauma for affected populations. A holistic strategy is crucial to ensure the projects' success and the well-being of those affected. This includes, among other things:

6.1. Mitigation Strategies

Prioritizing the reduction of displacement is essential. This involves careful planning and consideration of alternative project designs that minimize the need for resettlement. When displacement is unavoidable, detailed resettlement plans should be formulated with the direct involvement of affected communities, guaranteeing their active participation in decision-making processes. This participatory approach fosters trust and ownership, leading to more effective and fair outcomes.

6.2. Fair Compensation and Support

Just and prompt compensation for lost land, livelihoods, and property is vital. This should go beyond financial compensation to include support for the creation of new livelihoods, access to education and healthcare, and assistance in rebuilding social networks. The compensation package must be tailored to the specific needs of each affected community, acknowledging the diversity of their economic activities and social structures. Transparency and accountability are crucial to build trust and prevent corruption.

6.3. Long-term Community Development

Sustainable development efforts are essential for the long-term well-being of displaced communities. These efforts should focus on creating resilient livelihoods, improving access to essential services, and strengthening community institutions. This requires ongoing engagement with affected communities, ensuring their participation in the planning and implementation of development projects. Regular monitoring and evaluation are necessary to assess progress and make necessary adjustments. Investing in community-based infrastructure and markets is essential for fostering social unity and economic growth.

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