

Synthesis of Impacts on the Affected Communities due to the Myitsone Hydropower Project and its Resettlement in Myanmar



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Abstract

The Myitsone hydropower project (MHPP), possessing a capacity of 6000MW, stands as one of the foreign joint venture investment projects. If commissioned in 2019, it would have become Myanmar's largest hydropower initiative and rank as the 15th largest globally. Due to the extensive flooding area, the ramifications of MHPP's impact on 2556 households across 63 Villages, with a population of 11807 people, have been verified. The initial phase of the project was launched in December 2009, followed by the relocation and resettlement of five Villages (410 households with 2146 people) situated close to the construction sites and confluence river during May and June 2010. MHPP was anticipated to yield multiple advantages including flood control, irrigation, addressing the country's electricity needs, constructing fundamental infrastructures, boosting local economic growth, and generating revenue. However, the concerns on MHPP development and its resettlement which didn't sufficiently bolster up MHPP's sustainability, outweighed those benefits. These concerns encompassed the loss of land identity, detrimental effects of mental stress on both the affected and local populations, uncertainties surrounding the long-term livelihoods of the displaced people, negative consequences on long-term food security, loss of historical and cultural heritage sites, impacts on community-driven social movement, considerations of political security, negative influence on upstream and downstream environments and ecosystems, as well as the vulnerability of dam infrastructure to earthquake hazards. Furthermore, the study posited that the then prevailing policies and legislation governing environmentally and socially responsible hydropower development and resettlement processes were deficient. This paper amalgamates diverse credible sources to assess the scope of public concerns related to the development of MHPP and its impact on the resettlement of affected communities.

Keywords: Myitsone; Hydropower; Resettlement; Livelihoods; Sustainability; Public concerns

Introduction

Myanmar has been facing an urgent need to enhance its electricity generation capacity in order to fulfill its ambitious economic growth objectives and accommodate the escalating power requirements spurred by both foreign and local investment endeavors. The country boasts numerous rivers that offer suitable conditions for the establishment of hydropower dams, which can play a pivotal role in constituting the base load for the country's energy provision. Simultaneously, Myanmar is in the midst of a significant surge in dam development, capitalizing on its abundant hydrological energy potential. Since 2006, the country has been strategizing the construction of up to 51 dams,

excluding Upper Paunglaung hydropower project which was commenced in 2004 (Figure 1) [1,2], which would possess the highest count of planned dam projects within the southeast Asian region [3], adopting three distinct business models: (1) State-owned investment, (2) partnerships through Memorandum of Understanding (MOU) and Build-operate-transfer (BOT) mode with Local companies and (3) collaborations via Joint Venture Agreement (JVAs) and Build-operate-transfer (BOT) mode with foreign firms or joint efforts involving domestic and foreign enterprises, as to augment the energy supply for the country's economic progress and enabling the trading of power with

neighboring countries, particularly China and Thailand. Among these projects, Chinese investment is predominant, accounting for the majority of funding for dam construction initiatives. A total of 31 projects, whether proposed, underway, or planned, are supported by Chinese funding. This trend underscores the drive to engage the private sector more extensively in power generation, facilitating mutually advantageous economic development rooted in natural resources and electrification. Among the 51 planned dam projects, three have already been constructed and are operational: the 3.2 MW Upper Nam Htum (State-owned), the 99 MW Chipwi Nge (JVA) and the 66 MW Mongwa (Locally-driven BOT). Subsequently, the focus has primarily shifted towards the construction of six medium and large-scale hydropower projects (under construction stage). Meanwhile, progress on eleven other hydropower initiatives has been halted, and one project has been officially terminated as per an NGO of Myanmar [4], resulting from prompting by significant public demonstrations. Notably, there was plan of a sequence of seven cascade dams charted for the upper reaches of Ayeyarwady (Irrawaddy) river in Myanmar. Upon the MHPP's intended completion in 2019, it was claimed that the MHPP would have been the 15th largest hydropower facility globally. The proposed reservoir area for the MHPP, spanning 766 square kilometers, would exceed the landmass of Singapore and closely match the size of New York City [5-8]. The project's primary objectives encompass electricity generation, flood control, and irrigation. A noteworthy fraction, 10 percent of the power generated by the MHPP was earmarked for domestic consumption in Myanmar [9], where a dearth of electricity supply posed a significant challenge. Consequently, this venture might have stood to bring about favorable outcomes for the country's economy and foster advancements at local, regional and national scales. The introduction of greater electricity was anticipated by the project developers to stimulate industrialization, generate new employment opportunities, and contribute to the alleviation of illiteracy and poverty in the region. Additionally, the MHPP would have offered distinct advantages such as cost-effective operations, despite higher initial investment, and a prolonged operational lifespan by capitalizing proven technology, except for accounting for concerns like upstream sedimentation, reservoir evaporation and downstream sediment load changes. Beyond its direct electricity sales, Myanmar would have harnessed revenue from export earnings by trading cash crops or processed products stemming from electricity-intensive industries. In this context, the envisaged Myitkyina-Myitsone Economic Corridor would have served as a pivotal link connecting China, India, and Myanmar, driving regional development, fostering job creation, and nurturing an industry base with export capabilities.

In contrast, the developers of the MHPP and the policymakers were surprised at the vehement public criticism against the gaga-scale construction of the MHPP although the venture of energy production was anticipated by the project developers for both environmentally friendly and renewable, promising a host of

favorable impacts on the local, regional and national economy. The swell of public critique intensified steadily from February 2004, culminating in its suspension in 2011. The construction of MHPP had been steeped in controversy for multiple reasons. The expansive flooding area it entails, disputed over distribution of economic benefits, environmental repercussions, the well-being of local communities, the deep-seated historical and cultural significance to the Kachin community, and security consideration are among the main concerns [10]. The region submerged by the Myitsone reservoir, followed by Laza project, within the context of seven cascade projects, encompasses a significant number of residents, agricultural lands, orchards brimming with economically valuable trees, and sacred sites such as pagodas, churches, monasteries. Additionally, the array of worries further extended to seismic vulnerabilities of dam infrastructure, irregular flood hazards, and ecological imbalances downstream. The first phase of Myitsone Dam's construction was initiated in December 2009 [9,11], a mere three months before the finalization of the Environmental Impact Assessment (EIA) report (2010), a process funded and overseen by the Changjiang Institute of Survey, Planning, Design and Research (CISPDR). This timing underscored the project developer's decision to commence construction without waiting for the EIA's completion [12]. Notably, the environmental impact assessment (EIA) (2009) produced by Biodiversity and Nature Conservation Association (BANCA) became the focal point of public concern regarding the project. This report raised alarms about the potential harm to invaluable ecosystems and livelihoods, underscoring the complexity of the situation. Rather than embarking on the construction of the expansive Myitsone dam at the confluence, an alternative proposal emerged advocating for the establishment of two distinct dams: one along the Mali River and another within the N'Mai River. This alternative approach aimed to generate a comparable amount of electricity as the Myitsone Dam, by prioritizing environmental considerations and fostering the country's sustainable development [13]. In contrast, the compiled report of Environmental Impact Assessment, funded and initiated by CISPDR, reached its finalization and online publication in March 2010 and September 2011, respectively. Regrettably, this report encountered substantial criticism due to a multitude of shortcomings that deviated from best practices. It notably lacked an exhaustive analysis of alternatives, failed to adequately assess downstream effects, overlooked the cumulative impact of all seven dams, presented a superficial evaluation of the dams' repercussions on freshwater biodiversity, and inadequately accounted for the temporal and spatial scale of the social and environmental consequences of these dams. Furthermore, the report's social impact assessment lacked adequate engagement with diverse stakeholders, did not encompass authentic public consultation with all affected local communities, and omitted assessments of the social impact of other cascade dams, particularly Laza. It predominantly emphasized the adverse effects of damming river

on the ecosystem, flora, fauna, biodiversity, natural habitats, and environment [14,15]. While the report acknowledged significant downstream negative impacts on the Ayeyarwaddy River, these

effects were seemingly disregarded by both the hydropower project developers and the researchers behind the Environmental Impact Report for the MHPP development.



Figure 1: The fifty-one existing planned and future hydropower projects including three resettlement project works across the trans-boundary river systems in Myanmar.

The MHPP region has been widely acknowledged for its ecological significance and holds a position among the world's eight "hottest hotspots of biodiversity". The river also holds a vital role as a significant commercial waterway within the country, sustaining the livelihoods of farmers and fishermen residing along its banks. The implementation of the MHPP would carry profound consequences. It would hinder the seasonal migration of fish and disrupt the natural hydrological and sedimentary cycles of the river system, thereby greatly impacting downstream livelihoods that rely on the river [16]. Furthermore, it is steeped in historical significance, being recognized as the birthplace of Myanmar's civilization [17]. This project would entail the displacement of thousands of people from communities upstream, influencing those downstream as well and fundamentally altering the country's river system dynamics with regulation of dam gates. The viability of rice-growing downstream areas would also be adversely affected. Initial estimates from 2007 indicated that around 47 villages, encompassing approximately 10,000 residents, would face inundation due to the project [5,16], while the 2009 BANCA's GIS map survey indicated that 31 villages would be flooded, and 5000 houses with a population of 8,000 would be sunk referencing local information [13]. These communities rely on farming, fishing, and the collection of non-timber forest products for their livelihoods. Subsequent assessments by the CISPDR in their Environmental Impact Assessment (EIA) report of 2010 suggested that the MHPP development would impact a total of 2556 households comprising 11807 people across 63 villages. As a result, communities residing in proximity to the dam's construction sites expressed significant concerns. These included apprehensions about relocation and resettlement, the loss of their properties and livelihoods, and the uncertainty surrounding their future living conditions. Despite the apprehensions voiced by the communities directly impacted, the authorities asked them to involuntarily relocate at the outset of the Environmental Impact Assessment (EIA) process, with the Social Impact Assessment (SIA) being conspicuously omitted from the state of resettlement [9]. Under the premise of compensation, residents of five original villages from the area that would soon be inundated by the dam's reservoir, were relocated and ushered into "two model resettlement villages" constructed by the developer. Regrettably, this initial resettlement phase was marked by a forceful displacement of roughly two thousand people. The process involved the bulldozing of village homes, schools, and orange orchards, leading to the fragmentation of communities. The relocation came at a significant cost to the residents, with many being severed from their primary agricultural livelihoods due to the transfer onto land with poor fertility [18]. Amid this process of involuntary relocation, there was a notable absence of a concrete long-term plan for the living arrangements of the local population, even though the project developer had provided compensation to the villagers [9]. No indications were discovered that the compensation system for the relocated people had been enhanced prior to the suspension of the MHPP. Observations suggested

that the disbursement of compensation was inconsistent [4]. As a result of these involuntarily relocations and resettlements, the affected Villagers encountered considerable difficulties in securing appropriate agricultural land. Moreover, instances of theft involving the compensation money provided by the developer were reported [18]. Then, their access to vital resources, including land, agriculture, fisheries, artisanal and small-scale gold mining, tourism, and freshwater quality and distribution, was severely disrupted. This situation contributed to a host of social, economic, and cultural predicaments in the resettlement model Villages. The rapid influx of large groups of displaced people from various original Villages created a destabilizing boomtown effect. Additionally, the escalation of illicit mineral and timber extraction activities by certain companies heightened tensions between these entities and the local communities [19].

Conversely, the MHPP location had the potential to rekindle latent conflicts due to the prevailing internal political and ethnic disputes in Myanmar. Almost all designated dam sites are situated within regions predominantly inhabited by ethnic minorities, where armed groups are engaged in struggles for varying levels of self-governance [20]. In the context of the MHPP project, Myanmar government forces entered the region to safeguard their undertaking, escalating and rekindling hostilities between the Kachin and government troops after a 17-year ceasefire [10]. From another angle, it's worth noting that the Myanmar government lacked legitimate authority and failed to offer clear directives on environmental and social safeguards. It could be seen that specific requirements for conducting the Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) in Myanmar were only established in January 2016 [21]. Therefore, overlooking the actual environmental and social consequences of the dam, persons who emotionally attached to the Ayeyarwady river, played a more pivotal role in driving opposition. Consequently, the MHPP issue became a matter of national importance, transcending mere empathy for the Kachin population [17]. This was due to the fact that the broader society would have suffered from the loss of access to natural resources and cultural heritage submerged by reservoir created by the dam. Concerns about the MHPP were widely voiced in the media, highlighting the need to address the project's challenges [16]. Eventually, on 30 September 2011, the President of Myanmar announced the suspension of the project, citing the imperative to heed public sentiment, local opposition, and environmental worries [7,10,22]. Since then, the MHPP has remained a subject of intense controversy on multiple dimensions [4], critiqued for issues like inequitable profit distribution, lack of transparency, inadequate risk assessment, insufficient consideration of downstream impacts, and neglect of social impact assessment and the cumulative impact of the seven cascade dams. Additionally, the project faced internal political and ethnic conflicts [9,23]. Taking a synthesis approach by combining insights from various reputable journals and reliable sources, this study delves into diverse viewpoints, including socio-economic

transformations, concerns regarding the inundation of historical and cultural sites, environmental and ecological repercussions, political considerations, and the inadequacy of compensation to support the long-term livelihoods of the displaced. Given the

MHPP's nationwide resonance, it goes beyond merely addressing the displacement and resettlement of affected people in Kachin State.

The Myitsone Hydropower Project (MHPP)

Table 1: The comprehensive details of the MHPP [13,17,25,26,27,29].

| Project Description | |
|--|---|
| Dam site Location | Roughly 5.4km (measured along the waterway) or 7km (measured along the road) downstream the confluence of N' Mai and Mali rivers and situated approximately 40km away from Myitkyina City |
| Catchment Area | 47300km ² |
| Average Discharge | 4540m ³ /s |
| Average Annual Inflow | 158,500MCM |
| Average annual rainfall | 91 inches |
| Normal Water level | 245m |
| Dam type | Concrete face Rock-filled dam |
| System Design | Reservoir type |
| Max. Dam height | 139.5m |
| Length of Dam axis | 1310m |
| Storage Capacity | 12382MCM |
| Design head | 155.3m |
| Installed capacity | 6000MW |
| Average Annual generation | 30864GWh |
| Start of Construction | December 2009 |
| Estimated construction period | 8 years |
| Estimated total Investment cost | USD 3.6 billion |
| Invested cost as of 2012 | USD 1.2 Billion |
| Equity Financing (raising capital) | 80% CPI, 15% Myanmar, 5% AWC |
| Partnership Structure | Joint-Venture Agreement/ Build-Operate-Transfer |
| Benefits sharing from electricity generation | 90% (export to China) & 10% (Myanmar's own consumption). Division of annual profit from electricity exports; 20% (MOEP) and 70% (CPI) and 10% (Brokerage fees) |
| Estimated Affected Villages, households and population | 2556 households with 11807 people from 63 Villages |
| Project current condition | Suspended since 30 September 2011. Consequently, it also led to the cessation of other six cascade projects. |

The Ayeyarwady (Irrawaddy) River, which holds the distinction of being Myanmar's longest river with the highest runoff, covers an area of approximately 396,000km² [24]. Its origins at the merging point of the N' Mai and Mali rivers (also known as N' Mai Hka and Mali Hka) in Kachin State of the northernmost of Myanmar. The N' Mai river originates from the southwest base of the Boshula Mountains in southeastern Tibet, entering Myanmar's Kachin State. Its eastern branch, at Myitsone(confluence), joins with the Mali river which originates from northern mountain region of Myanmar and meets the western source of Myitsone after traversing through the Putao Basin. As a result, the confluence of these two rivers, situated about 45km upstream from Myitkyina

in Kachin, forms the foundational origin of the Ayeyarwady River basin [25,26]. This river then courses through Myanmar from north to south, spanning a total main channel length of 2714km [25]. It collects contributions from tributaries including Taping (Daying), Shweli, Myintnge, Mu, Chindwin and Yaw rivers. Along its journey, it passes through the southern part of Kachin State, Sagaing, Mandalay, Magway, Bago and Ayeyarwady Divisions [13], branching into several streams before reaching the Andaman Sea of the Indian Ocean. The estuary witnesses an average annual flow of around 13000m³/s [25]. The dam site of the MHPP is positioned approximately 7 km downstream from the confluence (Myitsone) of the N'Mai and Mali Rivers, and about 40 km upstream from

Myitkyina city [27]. On 28 December 2006, the memorandum of understanding (MOU) was signed between the Ministry of Electric Power (1) and China Power Investment Corporation (CPI) to initiate the development of seven hydropower projects in a cascade formation, which included the Myitsone dam (6000 MW), positioned at the confluence of the Ayeyarwady River. This cascade also encompassed Chipwi (2800MW), Wutsok (1800MW), Hpizaw(Pisa)(2000MW), Kaunglanhpu (2700MW), Renam (1200MW) along the N' Mai river, as well as Laza (1900MW) along the Mali river. The total projected capacity of these projects amounted to 18,400 MW, excluding the additional 99MW Chipwi Nge HPP, a construction power project on the Chipwi river [25]. To mark the beginning of the construction phase for the Myitsone and Chipwi dams, a groundbreaking ceremony was conducted on 6 May 2007. This milestone was reached an agreement between the Myanmar government and CPI to collaboratively construct the seven dams [5,26]. Subsequently, on 16 June 2009, a Memorandum of Agreement (MOA) was established between the Myanmar government and CPI, outlining the terms for the operation of hydropower development, and transfer of the seven interconnected cascade projects [26,28]. Further progress was made as on December 2009, CPI Yunnan, Department of Hydropower Planning (DHPP), and Asia World Company Ltd (AWC) entered into a Joint Venture Agreement (JVA) pertaining to the development of the Myitsone HPP, intended to be situated at the confluence of the N' Mai and Mali rivers. This culminated in the commencement of the initial stage of the MHPP's construction on 21 December 2009 [28]. The comprehensive details of the Myitsone project are presented in Table 1.

When the MHPP had been suspended in 2011, it was claimed by the project developers that the original five villages, from close proximity to the dam construction sites, had been relocated downstream to two resettlement Villages, and other essential groundworks such as land leveling for site formation, internal road construction, water supply infra- structure, power supply establishment, telecommunications setup, and oil storage depots had been accomplished, while the construction of a river crossing bridge downstream of the dam was in progress, and initial efforts were underway for the spillways and water diversion system [28]. As the Myitsone project came to a halt, it was understood that the advancement of the remaining six cascade projects was also put on hold. The suspension of the Myitsone dam construction initially occurred during the period of 2011 to 2015, aligning with the tenure of the President U Thein Sein's government, which preceded the National League for Democracy (NLD) government that assumed office in March 2016. However, during the NLD government's tenure from 2016 to 2020, the suspension continued, primarily due to inconsistencies with their governmental policies [30]. This decision was influenced by the publication of the Environmental Impact Assessment (EIA) Law and associated procedures between 2012 and 2015.

Research Scope and Methods

Regarding the impacts of the MHPP, there was significant objections to its construction and the associated resettlement efforts expressed by the residents of Tanghpri Village starting from January 2004. The Kachin Development Networking Group (KDNG) conducted a comprehensive survey of both environment and the affected population in the region. They meticulously analyzed the adverse consequences linked to the construction of dams and issued a report titled "Damming the Irrawaddy" in 2007 [5]. This report, which was one of the earliest online publications, provided intricate insights into potential displacement, estimated numbers of submerged villages, households, and affected population. Additionally, it identified key stakeholders, evaluated risks related to river health, livelihoods, dam safety, earthquake risk, and the preservation of Kachin heritage sites [31]. Subsequently, in October 2009, they released a follow-up report titled "Resisting the Flood: Communities taking a stand against the imminent construction of Irrawaddy dams." This report aimed to illustrate the mounting resistance among the public against the construction of the Myitsone and Chipwi dams. The report highlighted concerns regarding involuntary relocations, the compensation process devoid of public consultation, and reinforced the overall objection to the dam development [32]. Both these reports, available in both English and Burmese versions, were widely disseminated internationally and garnered substantial citation [18]. Before the suspension of the MHPP, there were limited research papers addressing Chinese overseas investments across diverse sectors in Myanmar; including the MHPP and the six cascade hydropower projects. Among these, McDonal (2009) notably underscored the need for Chinese dam constructors to adhere to internationally recognized social and environmental standards for their large hydropower projects abroad, which encompassed the Myitsone cascade hydropower projects [33]. The declaration of the MHPP's suspension prompted scholars to intensify their focus on Myanmar due to the failure of one of Chinese-funded overseas major projects.

These scholars delved into various aspects of the Myitsone Dam's suspension, resulting in diverse findings. They highlighted numerous facets concerning the influence on Myanmar's foreign policy, the strategies adopted by Chinese investors, such as business activities shaping Sino-Myanmar bilateral relations [9,34], China's policy approach and Myanmar's political reform [35,36], the evolving post-Myitsone relationship, and endeavors to raise public awareness through project benefit-sharing within local communities [10], systematic investigations of China's Investments in Myanmar and its corporate social responsibility(CSR) practices [9], the complex interplay between Myanmar activists and dam developers [4], China's development approach avoiding ethnic-political entanglements and the dynamics of Kachin and Burmese nationalist politics[18], Myanmar's domestic political transition and how it impacted

Chinese investments [4,9,17,35], the stagnation of China's investments in Myanmar's electric power sector after the MHPP's suspension [37] and the MHPP's role in legitimizing energy policy decisions [29]. Other notable focal points encompassed apprehensions regarding national security due to internal political and ethnic conflicts [7], adherence to social safeguard standards [39], the emergence of anti-dam resistance and social movements culminating in the suspension of the project [17,23,29,31,40,41] and insights from local populations and the concerns of project-affected people [5,31,32,40]. There were also explorations about the linkages between Kachin and Burma Nationalisms and their collaborative efforts in interethnic political endeavors aimed at opposing China's Myitsone dam project [31], the limitations within Chinese institutions responsible for overseeing the Myitsone dam project [9] and ecological challenges and the importance of avoiding the reinforcement of xenophobic narratives about China's investments [42].

Differing from previous researchers, our focus is on the impacts that people have perceived, and the range of socio-economic, political, and environmental concerns surrounding the MHPP that need to be comprehensively addressed. Our analysis aims to synthesize various sources, utilizing multiple forms of evidence, including previously published data and studies [4,5,9,17,18,31,40]. There are still gaps remained in updating research on the project's environmental, social, economic, and political dimensions, as well as its resettlement process and ensuing impacts. We primarily draw on data from peer-reviewed publications, published survey reports, and news media reports, arranging them in descending order of relevance for our analysis. Our research methodology takes a synthesized approach to critically evaluate dominant narratives concerning the MHPP's overall impacts, however not aiming to capture on-the-ground practices and perceptions. In pursuit of our research objectives, we extensively reviewed scholarly articles and reputable online sources regarding the MHPP's impacts, resettlement, and the underlying reasons for its suspension. This paper presents an examination of social, economic, and environmental influences on the MHPP by analyzing previous scholarly findings. Our synthesized framework encompasses a spectrum of socio-economic factors including land acquisition, resettlement, compensation, livelihoods, social economy, historical identity, cultural traditions, and political considerations. Moreover, it delves into environmental aspects such as ecosystem impact, environmental factors, and the seismic risk posed by the dam.

Land Acquisition, Resettlement and Compensation

Land acquisition emerges as a pivotal aspect within the context of the planning and implementation of the Myitsone dam. The MHPP necessitates the displacement of a significant number of residents, leading to the submergence of 63 villages and impacting 11,807 people across 2,556 households. This

displacement encompasses their housing areas spanning 50.73 acres, along with 7,958.7 acres of farmlands, 6,579.8 acres of orchards including 2,835.7 acres of cultivated economic trees, and 14 acres of 211 religious and community infrastructures encompassing mausoleums, temples, churches, schools and hospitals. In total, 14,603.23 acres of displaced people's land area will be affected solely by the MHPP project. As a whole, 100,035.23 acres of overall cumulative coverage areas encompass 1,284.36 acres of arable land, 84,006.28 acres of forested area encompassing woodlands, other forested land, and non-forested regions, 1,631.81 acres of building lands such as rural settlements and other built-up areas covering, 9,433.5 acres of waters bodies such as rivers and 3,679.28 acres of Marshlands [25]. It's noteworthy that the land acquisition of built-up areas for the MHPP vastly exceeds that of the Laza HPP, rendering it the second-largest resettlement endeavor following the MHPP. Furthermore, a section of road spanning 48 km from Tang Pe to Tiangzup on the Myitkyina – Putao route, as well as a 64-kilometer road section on the Myitkyina-Chipwi route will be inundated. Notably, the 59th mile bridge (Sha Ngaw Bride) on the Myitkyina- Chipwi road, Inzup Bridge, Tianzup Bridge and several small bridges along the Myitkyina -Putao road will also be submerged [13]. Between 31 July and 19 August 2009, a collaborative team consisting of five parties conducted an on-site survey to assess the implications of land acquisition at the confluence of rivers designated for the MHPP. This survey involved an examination of each household's situation, encompassing all related facilities. The gathered survey data was then consolidated and validated through the signature of the respective household head or responsible representative to confirm its accuracy. Subsequently, the team engaged with the local inhabitants who would be affected by the project, conveying the news of their impending relocation and outlining the compensation arrangements [26]. This initiated the process of swiftly formulating strategies for the resettlement plan in coordination with the project developers and government authorities. However, the residents who were to be resettled expressed substantial apprehension about various aspects, notably the submersion of the Myitsone area – a site of interest for tourists, the specifics of their resettlement destination, the adequacy of compensation for their property losses, the condition of infrastructure at the new sites, and the dynamics of rapid development (boomtown conditions) in these resettlement zones [25]. Two distinct resettlement sites were identified for the five affected villages, each chosen based on factors such as livelihood opportunities and the preference of the residents, considering their proximity to or presence within the dam construction site [28]. In September 2009, government officials, accompanied by Village leaders, visited the homes of those affected to receive their sign as an agreement mandating their departure from their residences [26]. Subsequently, on 9 October 2009, these officials presented models of new housing for the forthcoming villages to the inhabitants of Tanghpri. Despite the concerns voiced by

the Villagers regarding the construction of the dam, the formal process of relocation commenced on 28 May 2010[26]. While Myitsone Village, also known as Mazup in Kachin, was started to resettle in Aung Min Thar Resettlement Village, the situation differed for Tanghpri Village. Some residents from Tanghpri were permitted to work on their land to sustain their livelihoods until the inundation of their original village occurred. This selective allowance was due to their resistance against leaving their ancestral land and established livelihoods in their village [40]. The relocation of other three villages took place in June of 2010 [26], a period marked by rainy season. It should be noted that some new residences were not habitable, creating a challenging situation for the relocated people. The process of relocation and resettlement had a notable impact on women [40]. This phenomenon resonates with the aftermath of similar resettlement projects, like Upper Paunglaung and Tha Htay, which predominantly affected women’s livelihoods [43-46].

The involuntary displacement resulted in significant adverse social consequences. This involuntary relocation process affected a total of 410 households, encompassing 2146 people from five villages situated near the future flooded area of the dam reservoir. These affected communities were relocated into two designated model resettlement Villages: Aung Min Thar and Maliyang Villages [28,40]. These two sites shown in Figure 2, are positioned on opposing sides of the Ayeyarwady River, roughly 26km upstream from Myitkyina City, and about 19km from the confluence of the rivers. To break down the details, Myitsone (Mazup), Tanghpri (with some villagers resisting and remaining in the village), and Lahpye (Padang) Villages from the Myitkyina City were relocated to Aung Min Thar resettlement village. Similarly, Dawng Pang and

Awng Ja Yang from Waimaw township were resettled in Maliyang resettlement Village. It was worth noting that Aung (2014) had actually included six relocated villages, which accounted for part of Maliyan (Dingga Zup) Village in the relocation to the new Maliyang resettlement Village [40]. Regarding her case study research up to 2013, she found that the two resettlement Villages involved 437 households relocated: 317 households in Aung Min Thar resettlement village and 120 households in Maliyang resettlement village [40]. However, this paper focuses on the relocation of five villages as per local administration statistics [18,28]. The initial phase of resettlement witnessed a forceful and violent displacement of more than two thousand residents. This involved the destruction of original village houses, schools, and orange orchards, leading to the disruption of local communities. This displacement had severe economic implications as well. The affected people lost access to their traditional sources of livelihood, including agricultural activities, fishing, livestock grazing, fuelwood collection, gathering of forest products (including traditional medicinal plants), non-forest products, and local gold mining. Numerous resettled villagers experienced a disconnection from their agricultural livelihoods due to being relocated onto land with poor fertility [18]. The initial reports highlighted the challenges faced by resettled villagers, including inadequate healthcare services, limited opportunities for livelihoods, contamination of water sources, and a prevalence of mosquitoes [26]. Consequently, the implementation and construction of the resettlement plan were concluded by October 2010 whereas the overall process of relocating and resettling households within the dam-affected area was finalized by 29 June 2011[47].



Figure 2: The location map of Myitsone area, proposed Myitsone dam and two resettlement Villages.

From relocated five villages, 268.23 acres of housing areas, 268 acres of farmland, 104 acres of garden land, 393.5 acres of Taungya (upland), and 3585.62 acres of perennial crops land, totaling 4619.35 acres were occupied by the project developers. All households that were relocated due to the MHPP received timely cash compensation, which served as the primary method for delivering resettlement benefits, although it often fell short of fully replacing their lost livelihoods. Additionally, compensation in the form of assets was given for the loss of land, housing and other possessions. To support the living conditions of those affected by the project, alternative two-story timber houses were constructed. Each household was allocated an independent courtyard, significantly enhancing housing conditions. Efforts were made to enhance religious and cultural activities, resulting in the construction of 2 Baptist Churches, 2 Roman Catholic Churches, 2 monasteries, 1 folk museum and 1 ancestral workshop hall in the resettlement Villages. Educational facilities included primary schools, middle school and high school within the resettlement villages. Moreover, a 16-bed hospital and a clinic were established in the Aung Min Thar and Maliyang resettlement villages respectively. Various other essential amenities were introduced, such as a newly built 19.68 km concrete road, 1 post office, 2 police stations, 2 administrative buildings, 2 fire stations, 2 libraries, 1 guesthouse and market place. These additions greatly improved the daily lives of the resettled villagers. During the transitional phase of relocation and resettlement, a living subsidy of 100,000 MMK (approximately S\$ 140), a 21-inch color TV and other essential items were provided to each resettled household. To aid those affected by the project in resuming their livelihoods, 440 acres of farmland were reclaimed to compensate for their land loss, based on their specific needs. Additionally, they were supplied with one year's worth of rice for consumption, along with 30 kg of rice seeds and 50 kg of fertilizers to support agricultural production [10,27]. However, the quality of the allotted agricultural land was subpar, even though essential amenities like electricity, healthcare services, and educational facilities were made available. The provision of electricity was complimentary. Compensation for the loss of various plants including perennial crops and horticultural plants such as pyingado, teak, rubber, oranges, mangoes, jackfruit, jengkol and lemons was provided in cash. The amount varied depending on the type of plant, ranging from 50 to 400 Kyat (MMK) (interview: man, Myitkyina). Starting from 2010, the developer took the initiative to offer free water and power supply to the resettlement villages, ensuring uninterrupted access to both 24 hours a day. This involved the construction of a water storage tank for each household within the village, followed by the installation of pipelines to distribute water to the water storage tanks, thus ensuring an adequate daily water supply. Consequently, the overall living conditions in the resettlement village have significantly improved compared to the first few years after resettlement [27].

Livelihoods and Social Economy

The potential benefits of hydropower development, such as boosting regional economies, creating jobs, and enhancing local living standards, were anticipated by project developers. Nevertheless, the implementation of the MHPP raising new attractions and bolstering local tourism development would have remained uncertain due to the rarity of such occurrences in Myanmar, even if the project continued. Traditionally, the people of Kachin have relied on the N'Mai Hka and Mali Hka rivers, particularly at their confluence, for their livelihood activities like agriculture, gardening, fishing, mining, and forest-based resource collection. Thus, the relocation of local people resulted in shifts in their production methods and lifestyles, which consequently affected their health as well as that of the local residents in the inundation zones. The land acquisition of forests and farmlands also had an impact on local agricultural practices. The inundation of the reservoir would bring about changes in river dynamics, access to resources, and livelihoods, thereby influencing the displaced, host communities, and those living along the river [25]. They experienced the loss of traditional income sources like arable land, communal resources such as agriculture, vegetation, forests, pastures, fishing grounds, and confluence area used for tourism and small-scale gold mining [40]. Moreover, changes in resource access and productivity were observed. Most people used to cultivate rice during the rainy season and vegetables during the dry season. Riverbanks and small islands in the rivers had supported their gardening activities [5]. After resettlement, some residents from Aung Min Thar Resettlement Village had to travel daily to their previous hillside fields, incurring transportation costs as staying overnight was not permitted even after the project's suspension. The compensated land provided for farming in some cases was not suitable due to its rocky or hard nature. The loss of bamboo plantations affected some villagers' income as they used to sell bamboo as a seasonal crop. Similarly, in Maliyang resettlement village, restrictions on using pastures in their original villages led to villagers selling their cattle. This had long-term consequences, as they lost the ability to farm and utilize animals for cultural practices such as weddings. The limited space in the new resettlement villages prevented the creation of kitchen gardens for family consumption of seasonal vegetables [40]. Regarding fishing, the villagers were prohibited from returning to their original fishing spots within the project sites. Additionally, fishing near their new villages was challenging as those areas were under private ownership. In terms of tourism, they used to drive income from local tourism, ferrying individuals to more remote upstream regions via boats [40]. Tourism at the confluence significantly contributed to the income of the residents there. However, after resettlement, the local tourism industry dwindled in the Myitsone area. Visiting the confluence area required permission from the companies involved, and boat transportation for visitors was restricted. Nonetheless, a few villagers managed to

operate restaurants near the confluence area with the company's consent, resulting in reduced income from local tourism. In contrast, there has been local boat transportation near Aung Min Thar resettlement Village for crossing the Ayeyarwady River, along with food restaurants. Concerning forest products, the resettled people lost their livelihoods rooted in forest access. This particularly affected women who had relied on the forest for their whole life. They had to purchase all their kitchen necessities with money. Traditional medicine, derived from locally-collected herbs, was a heritage passed down through generations. However, due to restrictions and the destruction of the forest for construction and gold mining, those dependent on these herbs were unable to access them [40]. Widows and elderly individuals faced difficulties due to the loss of access to forests for resources or cultivation lands [5]. Regarding small-scale gold mining, some resettled villagers were forbidden from conducting mining in both their former and new village lands. This led some to migrate to other parts of Kachin State for gold mining as they lacked income opportunities. Some became casual workers for rubber and timber plantations of the private companies adjacent to their villagers. A small number of families ran small grocery stores for their livelihood, while women between 20 and 40 sought work in other areas of Kachin State and even in China. Older people experienced depression due to their inability to contribute to their families [40]. In terms of social services access, improvements have been made in the new villages compared to the old ones. The road infrastructure has been upgraded, and the two model resettlement villages have been constructed with modern amenities. Schools, hospitals and offices have been developed. Both new resettlement villages have better access to electricity than the old ones. Regarding healthcare, the public hospital in Aung Min Thar Village initially lacked skilled medical staff. Similarly, the Maliyang village clinic lacked full-time medical personnel and adequate medicine. High clinic fees caused financial strain for some. Education was available up to high school in Aung Min Thar Village, and attendance rates in the high school had improved. However, school dropout rates increased in the resettled villages due to parents' inability to afford school fees_ it did not achieve the previous parental expectations of their children's education development [40].

Historic identity, Cultural sites and Traditional Customs

The consequences linked to historical identity, cultural heritage, and traditional practices are classified as communal repercussions resulting from the construction of the MHPP. The confluence region holds immense importance within Kachin history and heritage, representing both a cherished site for future generations and an integral facet of Kachin identity. All original sites of historical and cultural significance, including religious structures such as Churches, Buddhist monasteries, and pagodas, situated at the confluence region as well as along two rivers, will be submerged. This consequence due to the reservoir will impact the religious practices of the local populace, causing

the disappearance of sites bearing historical, cultural, spiritual, or religious significance for Kachin people, even though new religious structures can be rebuilt. Indeed, the historical narrative of the Kachin people is closely intertwined with the N'Mai and Mali rivers and the confluence where they merge. This triangular region, referred to as Myitsone, is believed to be the heartland and birthplace of the Kachin people, and it is here that the Ayeyarwady River originates, providing sustenance for millions across the country [5,40]. This cultural and historical significance has led the local populace to be deeply attached to their heritage, and they are resolute in their desire to preserve their cultural sites, historic locations, and traditional practices [40]. Within Kachin culture, the N' Mai Hka is metaphorically characterized as "impatient"- flowing swiftly and restlessly from Mount Hkakaborazi, like a groom, while the Mali Hka is depicted as "very quiet", akin to a bride. The Kachin people often invoke the example of N'Mai and Mali rivers to illustrate the union of young couples resulting in a harmonious relationship_ they become the finest waterway when they meet together. Besides, the Myitsone area is interwoven into Kachin movie, music, ancient narratives, and legends [5,31].

Due to the natural splendor and cultural significance of Myitsone, the region draws a considerable number of visitors, making tourism a pivotal contributor to local economic activity. Local vendors offering traditional crafts and food, with a notable majority being women, heavily depend on the steady stream of tourists originating from both Myitkyina and other areas. This is largely due to the fact that a significant portion of tourists seek the experience of boat rides and sightseeing tours offered in the area [5]. On the other hand, the original inhabitants of the resettlement villages were proprietors of their gardens and farmland, diligently safeguarding their properties. They typically maintained a separation between activities of agricultural cultivation and gardening, and the rearing of animals, particularly cows. Pasturelands designated for the animals held particular importance for the Villagers. Raising cows held a distinct cultural significance tied to marriage customs, as cows were customarily given from the groom's family to the bride's family as part of the marriage traditions - before they got married. Thus, families with sons usually engage in cow rearing from the time their sons were born. Additionally, poetic verses often featuring the confluence of the two rivers were a customary component of wedding ceremonies and special occasions. Besides, a unique flower known as "Hka law pan", which exclusively flourished near the river, held special significance and was traditionally presented during weddings [40].

Community-Led Social Movement

The influence of community-led responses to the dam construction is notable. Starting from 2004, residents of the affected areas actively voiced their objections, advocating for the cessation of the MHPP. They initiated communication by sending letters to various entities such as the Kachin Consultative

Assembly and Kachin ceasefire groups like KIO, and Northern Regional Commander as early as January 2004, a substantial three years before the memorandum of understanding's signing. This proactive stance demonstrated their initial awareness of potential social and environmental issues linked to the MHPP [5,26]. Transnationally affiliated Kachin activists subsequently undertook covert research and organized protests. Thus, the affected communities and Kachin civil society groups gained early insights into the possible challenges posed by the MHPP. Their displeasure was expressed through diverse means, including petition letters to Myanmar government, clandestine leafleting, makeshift posters, and prayer gatherings [17]. A significant event occurred on 21 May 2007, when 12 Kachin leaders collectively appealed to Senior General Than Shwe to halt the dam's construction at Myitsone [26]. Subsequently, on 6 July 2007, KIO Special Region 2 submitted a letter to Senior General Than Shwe, urging the discontinuation of the dam project in the Myitsone area. Furthermore, on 11 July 2007, the same KIO Special Region 2 addressed Chinese authorities, petitioning the cessation of confluence dam project and proposing the development of other dam projects in different parts of Kachin State [26]. On 9 October 2009, government representatives, including the commander of the northern region, presented prototypes of housing for upcoming resettlement villages to the inhabitants of Tanghphe Village. During this interaction, an open letter was directly handed to the northern regional commander, expression opposition to the dam. Subsequently, during a meeting on 10 October 2009, the Tanghphe Village Women's group made an appeal to cease the dam project [26,48]. The KDNG played a pivotal role in the progress. They published reports titled "damming the Irrawaddy" and "Resisting the Flood" in October 2007 and 27 October 2009, respectively. Both reports, available in English and Burmese, underscored the adverse implications of the Myitsone dam cascade projects. The dissemination of these reports across broader Kachin society generated substantial attention and citation [18,26]. Numerous actors within the Kachin community raised alarm regarding the Myitsone dam. Initially, resistance emerged among local villagers, which then extended to encompass a broader segment of Kachin society. Activists, church leaders, and societal figures portrayed the MHPP construction as a pressing Kachin national crisis. This perspective was shared not only by those directly affected around the Myitsone area but also resonated among Kachin people from other regions, driven by a sense of collective identity [31]. By October 2009, opposition to the dam projects had escalated nationwide, with affected communities voicing concerns and appeals to Northern Regional authority, Myanmar's national authority and Chinese entities, all of which went largely unheeded. The project developer showed unwavering determination to advance with the dam plans, disregarding the need for comprehensive assessments. Remarkably, the bilateral agreement for the hydropower project had been established and the preliminary construction of the

Myitsone Dam initiated in December 2009 [9,11,28], a mere three months prior to the completion of the EIA report and its submission to the MOEP-1 (Ministry of Electric Power-1). Consequently, immediate repercussions ensued, encompassing forced resettlement, livelihood loss, confiscation of property and land, and deforestation [40]. During the initial stages of protest, the key players like villagers from Tanghphe, the Rural Reconstruction Movement Organization, the KDNG and the Kachin Public Youth Organization played pivotal roles [4]. International and local NGOs, particularly International Rivers and Burma Rivers Network (BRN), seemed more visibly involved in the protests. On 10 June 2010, a letter was dispatched by Tanghphe Villagers to the Kachin Baptist Church in the United States, soliciting aid in addressing the challenges of forceful relocation and unjust compensation [26].

Kachin people endeavored to safeguard and maintain authority over their ethno-national heartland and villages encompassing the Myitsone area, whereas the Burmese population sought to preserve control over the significant Ayeyarwady River, as if it has been the foundation of lowland Burmese civilization for centuries. All Burmese and Kachin dissenters perceived the MHPP as an existential threat to their respective nation [23,31]. These concerns were extensively reported in the media, addressing the challenges of the project necessitated active engagement from developers in dialogue with affected and host communities, along with civil society organizations [16,19]. Various materials, such as the leaked report of BANACA's 2009 EIA (special investigation) [13] and reviews on it by Local NGO [49], the statement of the Irrawaddy Appeal [50], and the Briefing of Myitsone Dam on the Irrawaddy River [12], and discussions on the Interplay between Myitsone Dam's impact on national heritage and profits [51] were disseminated online. These materials contributed to heightening international awareness. Subsequently, a growing public concern emerged among the people of Myanmar. An alliance formed between environmentalists, civil society organizations, political opposition, academics, artists, musicians, celebrities, poets, historians, writers, journalists, photographers, documentary makers, political activists, like-minded advocates, ethnic activists, youth groups, renowned speakers, retired government officials and mainstream media to rally behind the "Save the Ayeyarwady" campaign movement across Myanmar. Their aim was to inform the public about the potential adverse consequences of the MHPP and advocate for the project's suspension. This widespread campaign exerted substantial pressure on the administration of the Myanmar Government [17]. Pro-democratic leader Daw Aung San Suu Kyi urged the government to reconsider the projects to avert adverse repercussions, by supporting the campaign of "Save the Ayeyarwady". She emphasized the importance of unity among the people concerning the Ayeyarwady river to achieve a positive outcome for the nation. This was due to the fact that the project sites, particularly the confluence, held immense significance to the identity of the Kachin people and marked

the source of the Ayeyarwady River [40]. Subsequently, during a workshop titled "Impact of Hydropower Projects in Ayeyarwady Basin on Ayeyarwady River and Natural Environment" held on 17 September 2011, in Naypyitaw, several ministers expressed their viewpoints that the long-term drawbacks of the dam would outweigh the economic benefits [52]. The project gained more attention as local civil society groups joined forces with the protests. Subsequently, the demonstrations grew in scale, encompassing photographic exhibitions and protests, even within downtown Yangon [4,18]. Prior to suspension of the MHPP, the opposition movement primarily spotlighted the inadequacy of the Environmental Impact Assessment accompanied by the lack of Social Impact Assessment. They also underscored the detrimental effects on the environment and the well-being of the people. The opposition to the Myitsone project from the public presented a significant challenge to the civilian government during the country's transition to democratization. The government endeavored to reform various aspects of the nation, including politics, economics, and democratic practices, in order to demonstrate that the country was genuinely undergoing a period of transition. Finally, Myanmar's President declared on 30 September 2011, that the construction of the Myitsone Dam on the Ayeyarwaddy River would be halted to respect the will of the people [22,52].

Political and Security Concerns

In this segment, public concern on political and security dimensions is regarded as a pivotal element of the community impacts resulting from dam construction. The Kachin ethnic minority groups inhabit in the Myitsone region which is under the partial control of the Kachin Independence Organization/Kachin Independence Army (KIO/KIA), an armed rebel faction advocating for self-determination. Despite not holding official recognition as the local governing authority in Kachin, any investment venture will face significant challenges if they decide to oppose it. The dam's location lies within a historically conflict-ridden territory, characterized by instability and escalating tensions between the KIO and the Myanmar Army. As far back as 2002, certain Kachin locals stumbled upon unannounced plans for the Myitsone dam's construction. They subsequently dispatched protest letters to Kachin authorities, however their concerns were met with silence and indifference [7]. It was claimed that economic benefits in the contract negotiation were not shared with Kachin community [18]. The situation further deteriorated in October 2008 when a large number of Chinese workers arrived at dam construction sites. This influx of laborers was followed by reports indicating possible unauthorized extraction of minerals and timber by Chinese enterprises, exacerbating emotional stress of the local communities [19]. Subsequently, at 4 am on 17 April 2010, a series of small bomb explosions rocked the vicinity of the Myitsone dam construction sites. Asia World Company's building at the dam

site suffered four blasts, while Tanghpree Village was hit by eight explosions, and Ching Hkrang Village by two. One Chinese worker sustained injuries, and several temporary structures and vehicles were destroyed. Subsequently, the Myanmar Military deployed soldiers around the construction sites for security reasons [26,29,53].

Initially, some leaders from the KIO held the perspective that politics and development were separate matters. However, due to the profound significance of the Myitsone region for the Kachin people, they gradually became involved in the Myitsone issue, recognizing its political implications [40]. Thus, the construction of the dam amplified ethnic tensions and internal conflicts within Myanmar. The Kachin community's interest in halting the dam stemmed not only from its environmental and social repercussions but also from the standpoint of territorial control against the Myanmar military [9]. Consequently, this dam project wasn't solely associated with its adverse effects; it also held a considerable political role within Kachin State [40]. Escalating militarization around the dam sites restricted local inhabitants' movement and livelihoods, exacerbating threats to human security. The deployment of higher Myanmar troop levels often resulted in heightened pressures on the local population [16]. The absence of benefits for local community and the disregard of their concerns fostered the feelings of resentment and fueled ethnic tensions [8]. Protests against the MHPP initially emerged from the region impacted by the project, with resettled villagers seeking assistance from the KIO and local church groups. They highlighted issues such as lack of enough compensation and involuntarily relocations, and instances of intimidation by the Myanmar Military. In March 2011, Kachin groups voiced concerns about the substantial presence of companies' gold miners encamped along the river. Through an open letter addressed to the Chinese Authority, the KIO indicated that the project might trigger a civil war scenario if Myanmar military forces were deployed to guard the construction, entering KIO territory. During the same period, the KIO also directed a letter to the Chairman (the Communist Party of China - CPC), urging China to reconsider its involvement in the MHPP [18,54]. The KIO's entreaties primarily included to build dams at different locations within Kachin State, excluding the Myitsone project. The disregard for their requests escalated tensions between the two groups, leading to outbreaks of violence in Kachin State, particularly in areas controlled by the KIO that are adjacent to the Chinese border [40]. In fact, government troops entered the territory to secure the Dapein-1 (Tapein-1 or Taping 1) dam construction project in the south-eastern part of Kachin State, intensifying tensions and reviving hostilities between the Kachin and government forces in June 2011 after a 17-year cessation of hostilities. It led to the understanding that the 1994 ceasefire had been effectively broken. This event was among the contributing factors leading to the breakdown of the ceasefire [10,26,29,53]. The ongoing armed conflicts in Kachin

State disrupted the transportation of construction materials from China to the project sites, effectively halting construction. On 28 October 2011, Chinese workers were observed departing the Myitsone dam site and returning toward the border, while the continued conflict and hostilities between the KIO and Myanmar Army forces in the dams' sites persisted [26]. Consequently, all personnel were also evacuated from the Chipwi dam construction site on 26 April 2012 due to armed clashes in Kachin State [28].

Environment and Ecology Concern

It is important to note that this section does not cover all the detailed environmental impacts associated with the MHPP, but rather focuses on the national and local concerns regarding environmental effects. The Ayeyarwady (Irrawaddy) Basin, being one of the world's top thirty high-priority river basins, is recognized for its significant support of biodiversity and a high-priority water resource vulnerability index to future pressures. It also stands as one of the larger rivers across the world, at thirty-eight in the global ranking [24]. Consequently, the construction of the MHPP within this basin, raises concerns about the potential environmental impacts, focusing on the high biodiversity region. The proposed dams would inundate upstream forests within one of the most biodiverse areas on the world, which poses a threat to numerous plants and animal species. Lots of these species are endemic or endangered. The flooding of a specific forest area and changes in hydrology could affect the water environment, aquatic and terrestrial organisms as well as the livelihoods of affected individuals in the area [8,13,25]. Besides, there will inevitably be adverse effects on the regional ecological environment, including water pollution and deforestation within the catchment area, which can lead to waterlogging and an increase in sediment load. Increased sedimentation resulting from dam construction can have multiple effects on aquatic biodiversity. Deposition of sediments can significantly alter the physical environment for species that are adapted to specific conditions of water velocity, water depth and light penetration. On the other hand, deforestation and alterations to soil and land cover such as road construction and mining lead to the rate of changes in the particles' density carried within the drainage system. Mining operations in and around the rivers can introduce mercury into the ecosystem, which can transform into more toxic methyl-mercury before releasing it downstream through the dam. It has the potential to increase the prevalence of diseases and birth defects. Therefore, all flowing waters can carry the suspended materials, including material population, thermal pollution and the exploitation of native species. This makes dam construction a primary factor in the extinction of fauna and flora.

On the other hand, damming would hinder the seasonal migration of fish to their upstream spawning areas, resulting in broader consequences for the fish population's numbers and diversity. This would particularly affect those people who are reliant on the river's fisheries because fishing serves as a crucial

aspect of local livelihoods and diets within both upstream and downstream of the Myitsone dam. On the other point, the dam would obstruct the natural flow of sediment and disrupt the river's flooding cycle. This interference would disturb the usual process of replenishing water and nutrients downstream. A series of cascade dams would capture sediment from the river, which provides essential nutrients for aquatic plants and fish, preventing it from reaching downstream regions where it typically contributes to the productivity of floodplains and deltas. Changes in the river's flow and the disruption of sediment flows will have an impact on millions of farmers in Myanmar and affect rice production, as a significant portion of Myanmar's agriculture takes place downstream, along the banks of the Ayeyarwady River. The Ayeyarwady delta region is responsible for nearly 60% of rice production in Myanmar [5,8,16]. The dams will bring about irregular water fluctuations and shortages, which will have negative effects on both downstream transportation and fisheries. Additionally, during times when freshwater flow is restricted to accommodate electricity generation requirements or during the filling of the reservoir, reduced water levels will lead to saltwater intrusion into the farmlands of the Ayeyarwady delta region [8]. As a result, downstream cultivators will need to adapt their agricultural practices based on the nature of limited annual floods. In terms of downstream fishing, the breeding of fish species will be constrained because they would need to navigate through the upstream dam during their breeding season. This will result in a reduced capacity for fish breeding along the main course of the Ayeyarwady River, leading to a scarcity of fish breeding opportunities compared to previous conditions. It is a similar trend observed in Laos, where fish stocks dwindled due to unnatural water fluctuations and increased turbidity resulting from upstream cascade development along the main Mekong River in Yunnan Province, China [38] while downstream communities in Thailand also raised concerns about depleting fish populations and irregular water levels due to the dam operations [55]. Notably the delta ecosystem of Vietnam, have been negatively affected, endangering the country's food security, experiencing a combination of droughts and floods due to the activities of upstream dams [7]. Another approach is to release water from the dam's floodgates to enable natural river flows during crucial times of the year. However, large hydropower dam, by regulating water flow, bring about unnatural changes in the flow patterns that result in erosion of riverbanks. The KNDG also gave an example based on the other resource that Thailand's Mekong River region illustrated how dams constructed upstream in China have led to erosion, threatening the riverbank gardens of Thai Villagers [5]. These consequences raised from the controlled release or retention of water from the dams. Concerns from conservationists and environmentalists have arisen due to the potential downstream effects of the dam. Consequently, Zhang (2020) claimed that Myanmar authorities harbored comparable worries about foreign developer's potentially having control over

its crucial water resources, despite the understanding that the dam's ownership would be transferred to Myanmar after a span of 50 years [7].

Earthquake Risk on Dam

In this section, the focus is on the concerns regarding the impact of dam construction in relation to earthquake risks. Myanmar has witnessed around 20 significant earthquakes in the past century (1912-2012) [56,57]. Between 1029 and 1931, major earthquakes were notably concentrated along the Sagaing fault line. Its fault has played a crucial role in Myanmar's tectonics, with numerous earthquakes of magnitude greater than 7 occurring along the fault in the last century [57]. An example is the Kamaing earthquake on 28 January 1931, near Myitkyina, with a magnitude of 7.6 (Ms) [57,58]. This devastating earthquake caused substantial fissures, sand and water spouts, and extensive damage to the landscape. The epicenter was close to the Sagaing fault, triggering cracks on hill slopes and significant land slips [57]. Regarding statistical data of the Global Seismic Hazard Assessment Program (GSHAP), Myanmar falls within a high to very high seismic hazard region, particularly increasing towards the north, encompassing the Sagaing region and Kachin State [56]. The MHPP is situated less than 100 km (62.13 miles) from a major Sagaing fault line, making it vulnerable to earthquakes that could pose a threat to its dam infrastructure. Furthermore, a past incident adds to the apprehensions. On 31 May 2006, heavy rainfall caused the Ching Hkrang dam (HPP with installed capacity of 2.5MW), located close to the current resettlement Village of Aung Min Thar, to breach. This resulted in the destruction of Ching Hkrang Village and the loss of five lives [5,28]. This even heightened concerns about the safety of dam infrastructure, particularly among locals who had experienced the aftermath of dam collapses. Many people were worried about the security of the dam structures, citing both past earthquakes and a deadly dam failure in the vicinity. Kachin activists had explicitly warned that the construction site's proximity to a geological fault line could lead to an earthquake-induced break of the Myitsone dam. This could result in a catastrophic flood inundating Myitkyina city, which is merely 40 km downstream from the proposed dam site, potentially affecting its approximately 250,000 residents [5,18].

Discussion and Conclusion

Prior to the relocation and resettlement, the original villagers encountered challenges with the underdeveloped condition of the roads connecting them to other regions. These roads were often rugged and prone to becoming muddy during the rainy seasons. Despite this, the villagers were able to take buses that traveled to Myitkyina city on a nearly daily basis. Most of the villagers had limited opportunities for higher education, primarily at the university or college level. Their educational access was restricted to primary school levels. For middle school education,

parents sent their children to towns, which they managed without significant difficulty due to their livelihood activities such as gold mining, bamboo cultivation, selling forest resources including non-timber products like vegetables, fruits, and mushrooms, engaging in vegetable cultivation, farming, local fishing, and even participating in local tourism activities around the confluence. These tourism activities included selling local food and traditional crafts to both domestic and international tourists. In times of illness, villagers relied on natural herbs from the forest and traditional herbal remedies they crafted themselves, despite the fact that their original village had only a clinic [40].

Following the relocation, the villagers encountered significant challenges concerning their daily survival and income opportunities. They suffered from the loss of access to their land, forest resources, pastures for livestock, fishing spots, and gold mining areas. The new houses provided were insufficient to accommodate their kitchen gardens and livestock. Apart from livelihood losses, educational access for the villagers extended only up to high school levels. With the move, there was a decrease in children falling ill in new villages, but the children's attendance in schools was hampered due to family income constraints [40]. In fact, there had been substantial improvements in essential infrastructure such as residences, schools, hospital, clinic, post office, and various community facilities like religious structures, administration offices, libraries, fire stations, markets, cemeteries, and more. These improvements were aided by corporate social responsibility (CSR) initiatives and donations related to the project from 2010, extending up to three years after the suspension of the Myitsone project [9,27,28]. Infrastructure repair and development of road networks, bridges, and telecommunication stations had enhanced regional transportation and communication, fostering economic and social progress in resettled villages, like Aung Min Thar. While it was undeniable that the living standards of the resettled people had greatly improved compared to before, challenges remain. Cultivation of crops like rice and vegetables had become difficult due to infertile lands in the reclamation areas, leading to long-term livelihood issues. Additionally, the inability to access the previous cultivation areas had compounded these problems. Rearing livestock like pigs and cows within housing compounds has also been constrained compared to their previous conditions. Nonetheless, the development of the Myitsone project did offer job opportunities for local people during the pre-engineering phase, involving activities such as gravel and sand production, constructing structures, and building roads. During the dam construction phase, local service, transportation, and raw material processing industries were expected by project developers to flourish, providing substantial development chances and increasing local employment and to accelerate local economic growth [25]. However, after the construction phase, ensuring the resettled people have a livelihood comparable to or better than their pre-displacement state (rebuilt based on the "equal or superior to

former standard” principle) may be uncertain without a robust long-term livelihood plan. Consequently, there will be a potential for long-term livelihood challenges unless the government and developers allocate funds for sustainable livelihood improvement, ensuring that affected communities benefit from the generated revenue. This case pertained to just five out of sixty-three affected villages. The rest of the villages’ resettlement remains a pressing topic concerning the subsequent quality of life for the displaced people. The well-planned resettlement is still necessary for their livelihood sustainability because the adaptability of displaced people to the new environment is temporary. The circumstances of the other fifty-eight affected villages due to the MHPP’s development remain uncertain. There are concerns regarding flooded roads and bridges in the reservoir area as well.

It is acknowledged that constructing a dam on the Ayeyarwady river by human intervention will undoubtedly have environmental repercussions. Addressing these negative effects through human efforts to mitigate them is vital for the sustainability of hydropower development. The occurrence of a recent earthquake nearby and the failure of a small dam in this region have heightened concerns among people that the confluence area might not be suitable for the construction of a large dam. Moreover, apprehensions of the Myitsone dam have been raised due to the proximity of Myitkyina city and Waimaw township along the riverbank, just 40 km downstream of the proposed dam site despite the fact that the project developer has assured that the dam’s design will be earthquake-resistant, and flooded roads and bridges in the reservoir area will be reconstructed [27]. In fact, the Myanmar government’s lack of legitimacy in Kachin State and its failure to provide definitive guidelines on environmental and social safeguards during the project’s various stages had been noted. This stems from the fact that clear requirements for conducting an Environmental and Social Impact Assessment (ESIA) in Myanmar were only introduced in January 2016 [21]. However, foreign developer for the MHPP adhered to Myanmar’s insufficient domestic laws and regulations. The foreign developer claimed that the approval for the MHPP had been granted by the Myanmar government, and all requisite legal processes, including the submission and approval application, the establishment of a Joint Venture agreement, the issuance of a business license for the Joint Venture, the acquisition of an Investment permit, the grant of concession rights, and the endorsement of the Judge’s legal opinion, had been meticulously executed in full accordance with Myanmar’s procedural regulations [9,11] despite the fact that the government lacked comprehensive policies and legislation governing ecological environment and socially responsible resettlement until 2015 [59]. Additionally, the Myanmar government lacked the analytical capability to thoroughly assess the adverse effects of the Myitsone dam on the internally displaced population and environmental sustainability [60]. Consequently, environmental policies without

appropriate legislation and enforcement mechanisms have proven ineffective. Considering the considerable ecological and sociological concerns surrounding the MHPP, a comprehensive Environmental Impact Analysis was indispensable to evaluate potential impacts on the environmental and ecological systems. Although an Environmental Impact Assessment (EIA) report for the cascade hydropower projects was conducted by CISPDR in conjunction with BANCA in March 2010, it was criticized for its insufficient analysis of upstream and downstream effects [15] and found significantly poor in the area of project alternatives and unsatisfactory mitigation measures [61]. Furthermore, another significant concern revolved around the potential disappearance of rural riverine villages, religious sites such as churches and temples, historical landmarks and indigenous traditions that were deeply rooted in the confluence area. Moreover, reports from activists had circulated, highlighting that the seven dam sites were subject to logging and gold mining activities. In fact, Kirrk (2020) encountered individuals who expressed potential support for the project under the conditions that greater benefits would accrue to the Kachin people, if the largest dam was situated farther away from the cherished confluence. However, the concerns over environmental degradation persisted, as the cascade seven dam sites continued to be exploited through logging and gold extraction [31].

Despite the presence of social and environmental concerns surrounding the MHPP, a significant portion of activists sought to intertwine Myitsone’s issues with broader political matters. A multitude of challenges persisted within the context of Myanmar’s volatile political landscape, ongoing ethnic conflicts, and limited capacity to establish an equitable and transparent environment for foreign investors [9]. While the Kachin Independence Organization (KIO), alongside various Kachin activists and civilians, expressed no opposition against the other six hydropower projects from 2010 to 2015 [29], the construction of the Myitsone Dam was attributed to triggering the breakdown of the 17-year ceasefire with the Kachin Independence Army in June 2011. The escalation of hostilities between the Myanmar Military and the Kachin Independence Army, driven by apprehensions regarding the dam’s expansion, resulted in a rising loss of lives. Therefore, Kachin people’s resistance against the dam was rooted not only in its potential environmental and social repercussions but also in their desire to maintain territorial autonomy against the Myanmar Army [9]. The continuation of the MHPP would likely exacerbate armed conflicts with ethnic minority rebel groups in the Kachin region. Responding to this situation, the government’s decision to suspend the project was largely attributed to the widespread anti-dam protests and the will of the people [7]. Su Mon Tha Zin Aung’s analysis indicated that the KIA’s proximity-based attack to the project site raised core executive security concerns. However, such clashes were not unprecedented for the president. It appeared that the demand of KIO regarding the Myitsone project limited

political influence within the project's overall context. Thus, it was not perceived as a pivotal factor at that juncture, especially since several ministries expressed their positions against the project during press conference and government workshop held in Naypyitaw [52]. Since conflicts linked to dam development persist, Myanmar might soon face significant constraints on hydropower development options aimed at bolstering energy security [4].

There exists other factor that bears weight in the considerations of the Myanmar government. The construction of the Myitsone dam carries potential security implications of its own. Myanmar's government officials held apprehensions regarding the potential effects of releasing or withholding water from the cascade dams, which could significantly impact the utilization of the Ayeyarwady River for purposes such as navigation, irrigation, and fishing for downstream neighbors, even with the promise of full dam ownership transfer to Myanmar after five decades [7], thereby posing a threat to national security. Zhang (2020) claimed that it's important not to be excessively sensitive to national security concerns, as this factor could play a vital role towards the successful execution of the Myitsone project [7].

To facilitate the construction of large dams in Myanmar, there must be a collaborative effort involving dam developers, activists, political leaders and local communities, all working together to mitigate any adverse social impacts on the local population. This collaboration should adhere to international safeguard standards. All stakeholders within Myanmar should strive to identify responsible and mutually agreeable energy solutions that lead to sustainable dam development [4]. The process of developing large hydropower dams should had prioritized comprehensive scientific and environmental assessments, as well as engagement with communities and regions since the initial planning stages. Addressing the issues between the Myanmar government and ethnic groups should have been accomplished through constructive dialogue and negotiation, with the aim of achieving sustainable and mutually acceptable development because the exploration of Myanmar's hydropower potential could be seen as an opportunity to stimulate both national and regional economic growth.

Author Contribution

Conceptualization, A.T.L.; methodology, A.T.L.; writing-original draft preparation, A.T.L.; writing, review, and editing, A.T.L. and K.Y.; supervision, K.Y. All authors have read and agreed to the published version of the manuscript.

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