

Boon or Bane: The Pebble Picking in Luna, La Union

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ABSTRACT

The municipality of Luna, La Union, is distinguished by its unique coastline rich in naturally occurring pebbles, which support a vital source of livelihood for many residents. However, the unregulated extraction of these coastal resources has led to alarming environmental consequences, including accelerated erosion, flooding, and ecological imbalance, placing both the community and its future at risk. This study critically examines the intersection of local economic activity and environmental degradation through the lens of sustainable development. Using a mixed-method research design, the study employed interviews, documentary analysis, and survey questionnaires to investigate the environmental impacts of pebble picking, the regulatory response of the Provincial Mining Regulatory Board (PMRB), and the compliance behavior of local extractors. Findings revealed that while awareness of environmental policies is relatively high, enforcement gaps, boundary encroachment, and inconsistent policy implementation continue to exacerbate coastal vulnerabilities. The PMRB's moratorium on pebble extraction, though well-intentioned, has created tensions between economic survival and environmental protection. This research underscores the pressing need to reframe local natural resource governance within the framework of the Sustainable Development Goals (SDGs), particularly those relating to responsible consumption and production (SDG 12) and life below water (SDG 14). The study proposes a context-sensitive, LGU-led coastal resource management strategy that integrates ecological sustainability with livelihood resilience demonstrating the critical role of local governance in achieving long-term environmental justice and sustainable coastal development.

Keywords: Sustainable Development, Coastal Resource Management, Local Governance, Environmental Degradation, Luna La Union

INTRODUCTION

Coastal sediment resources play a critical role in maintaining shoreline stability, supporting biodiversity, and sustaining local livelihoods. Among these resources are pebble beach deposits. Pebble Beach deposit is a non-metallic and naturally occurring resource that is conveyed and produced through several geological processes. These deposits hold significant roles both in ecological and economic aspects. Currently, their utilization across various sectors includes landscaping, accent features, and decorative mosaics. Apart from its economic value, pebbles can be a natural barrier against geohazards. As evidenced by the research of Ivan (2018), pebble deposit is effective in mitigating geological hazards by serving as a natural coastal barrier by dissipating wave energy thereby reducing shoreline erosion and maintaining stability.

One of the most well-known occurrences of pebble beach deposits is found in the Municipality of Luna, Province of La Union. According to Corono, Faminialagao, Valdez, and Morante (2021), the coastal barangays of Luna have been well known for their abundant pebbles of various colors and shapes along their shores. The Geological Assessment Report of Araojo, Corono, and Valdez (2020) identifies that the Luna Pebble beach deposit is underlain by Quaternary Alluvium composed mainly of unconsolidated aggregates consisting of various rock types that are probably transported and/or derived from the Amburayan River.

Economically, the pebble beach deposits contribute to Luna's local revenue and tourism industry. Pebbles are being extracted in the coastal areas of Luna, providing a livelihood for the coastal communities. A Special Pebble Picking Permit is issued to a cooperative for the manual gathering or removal of pebbles along the shoreline. The Provincial Government of La Union issues the permit by virtue of the Provincial Ordinance No. 274-2021,

in which the materials extracted are commercially disposed to accredited traders at a fair market value of Php 380.00 per cubic meter.

In 2020, records of the Mines and Geosciences Bureau Regional Office 1 (MGBRO1) indicated that six (6) active cooperatives collectively produced a total volume of 14,983 cubic meters, generating an estimated value of Php 5,693,540.00. Additionally, an “extraction fee” is imposed for the pebble-picking activities, as provided in the ordinance. The fee is equivalent to ten percent (10%) of the Fair Market Value of the commodity. Taxes collected are shared by the province, the municipality, and the barangay where the extraction is located, with the corresponding percentage: 40% for the barangay, 30% for the province, and 30% for the municipality.

Despite its economic benefits, various concerns over environmental sustainability emerged. The MGBRO1 conducted Geological assessments to verify the sustainability of pebble-picking activity in Luna. Based on the beach profiling and field observation on the report of Corono & Faminialagao (2021), the assessment revealed that there is thinning (depletion), a decrease in slope, and changes in the morphology of pebble deposits in barangays Barrientos, Magallanes, Victoria, Sto. Domingo Sur, and Sto. Domingo Norte. Accordingly, the volume of pebbles observed in these barangays during the February 2021 assessment was exiguous compared to the deposits observed during the July 2020 field assessment.

Excessive and often illegal extraction, an increase in the population of pebble pickers, and drastic changes in the physical conditions of the beach through time pose serious threats to the coastal communities. These include increased vulnerability to geologic hazards such as coastal erosion, storm surge, and flood events along the coast. Moreover, the threat of a decrease in the replenishment rate and depletion of pebble deposits is conceivable, considering that this material is seasonal and dependent on geological processes such as changes in weather conditions, enough sources of sediments, and exposure to agents of weathering processes such as water and wind.

Philippine environmental legislation reflects growing concern over resource exploitation. Various laws and bills in the country characterize the imbalances of some extraction activities concerning environmental sustainability. Each law insinuates the prohibition of extracting materials along coastal shorelines to prevent environmental degradation and the occurrence of geological hazards.

Batas Pambasa Bilang 265, also known as an “Act Prohibiting the Extraction of Gravel and Sand from Beaches and Providing Penalties,” categorically prohibits the extraction of gravel and sand and such other activities along beaches as it would erode or diminish the natural beauty of beaches. Similarly, *Department of the Interior and Local Government Memorandum Circular No. 44, Series of 2014*, which directs all local chief executives to be strictly guided by the legal restrictions on black sand and beach mining, quoted that illegal black sand mining causes among others, coastal and soil erosion and the intrusion of salt water into agricultural areas, and adversely affects both local tourism and the fisher folk in the host communities.

Further reinforcing these restrictions, former Senator Leila M. De Lima introduced *Senate Bill No. 1075*, which aims to prohibit black sand mining in the Philippines to prevent resource depletion, land erosion, and flooding. Collectively, these legal frameworks concluded with a prohibition and restriction of extraction along the shoreline to diminish the circumstances of geological hazards and adverse effects on the community. Consequently, the moratorium on pebble-picking activities of the cooperatives issued with special pebble-picking permits in Luna, La Union, by the Provincial Mining Regulatory Board (PMRB) – La Union is aligned with the national directives. The moratorium aims to conserve and protect the environment and lessen the effects of natural events that can cause damage to lives and property.

The Sustainable Development Goals (SDG) by the United Nations Development Program (2022), recognize that action in one area will affect outcomes in others, and that development must balance social, economic, and environmental sustainability. Goal No. 12 of the SDGs, “Ensure sustainable consumption and production patterns,” is identified as crucial for sustainable development alongside poverty eradication and natural resource management. The United Nations emphasizes that sustainable production and consumption are essential for sustainable global development.

Equally relevant is Goal No. 14, “*Conserve and sustainably use the oceans, seas, and marine resources for*

sustainable development". This goal by the United Nations presents the urgent need to protect marine ecosystems against anthropogenic pressures. The Luna pebbles form part of the intertidal coastal system, contributing to shoreline stability, biodiversity protection, and sediment cycling. The over extraction of these materials disrupts the geomorphology of the coastline, increasing the vulnerability to storm surges, wave scouring, and sediment loss.

As SDG 14.2 urges the sustainable management and protection of marine and coastal ecosystems by 2020 and beyond, the continuous extraction of pebbles in Luna, serving as a natural barrier to coastal geohazards, contradicts international sustainability benchmarks. Furthermore, 14.5, which promotes the conservation of coastal areas, demands locally-appropriate governance models that go beyond extraction moratoria toward community-led ecosystem stewardship.

This study is anchored on Political Ecology Theory. According to Benjaminsen & Svastard (2019), this theory focuses on power relations and the coproduction of nature and society. Hence, this explains how environmental problems arise from the interaction between ecological processes, governance institutions, and socioeconomic inequalities. Political ecology contends that environmental issues should not be tackled solely but must also consider other factors such as power relations, institutional responses, resource governance, and social challenges. Hence, the theory provides a framework for the study, as the sustainability issues surrounding the pebble-picking activity cannot be explained solely by geomorphological processes but require consideration of the interactions among environmental degradation, livelihood dependence, and institutional regulation. Pebble picking in Luna, La Union, is an intersection of environmental conservation and community survival, in which policies designed to protect the ecosystem directly affect the well-being of coastal communities.

Despite the growing literature on coastal resource management and sustainable development, most literature has focused either on the environmental impacts of shoreline extraction or on the socioeconomic dependence of coastal communities on livelihoods such as pebble picking. There has been limited attention to integrating geological evidence, regulatory compliance, and local governance within a single analytical framework that informs policy development. Studies on pebble picking/extraction are still limited in the Philippines. Technical geological assessment has been the focus of most studies rather than exploring how resource depletion, community livelihood, and local governance also influence coastal management. Consequently, there remains a need for an evidence-based framework that aligns environmental conservation with livelihood security in coastal communities dependent on pebble extraction.

As such, this study contributes to the literature on sustainable coastal resource governance through the integration of geological assessment, regulatory compliance, stakeholder perceptions, and policy analysis within a single interdisciplinary framework. This study illustrates how local governance institutions can balance livelihood protection with ecosystem conservation through a livelihood diversification strategy.

Accordingly, this study was guided by the following research question

1. What is the current environmental, institutional, and socioeconomic status of pebble picking in Luna, La Union?
2. To what extent do pebble pickers comply with and understand existing policies and regulations governing pebble picking?
3. What environmental, institutional, and socioeconomic challenges affect the sustainability of pebble picking in Luna, La Union?
4. What policy framework can effectively balance livelihood security, environmental sustainability, and local governance in Luna, La Union?

Ultimately, the study is expected to contribute to evidence-based policymaking on coastal resource governance while providing strategic policy directions rooted in the experiences of the LGU and pebble pickers. This policy direction strives to balance social inclusion, economic development, and environmental sustainability, thereby contributing to informed decision-making that promotes the development and conservation of Luna's natural coastal resources. Subsequently, the proposed Pebble Picking Diversification Scheme provides a practical governance model that may be adapted by other coastal local government units facing similar resource management challenges.

METHODOLOGY

Research Design

The study employed a mixed-method research design, integrating both qualitative and quantitative approaches to examine the sustainability of pebble-picking activity in Luna, La Union. Quantitative data were collected through a survey administered to pebble pickers to assess their levels of compliance and awareness of existing policies and regulations. Qualitative data were gathered through documentary analysis, interviews with stakeholders, and focus group discussion involving representatives from the Local Government Unit (Municipality and Province), the Mines and Geosciences Bureau Regional Office No. 1, and members of the pebble-picking cooperatives. The integration of these data sources allowed the triangulation of findings, thereby improving the credibility and trustworthiness of the study. Triangulation was achieved through comparison of information obtained from documentary analysis, survey responses, interviews, and focus group discussion to identify convergent findings.

Subjects of the Study

Primary data sources included the Provincial Government of La Union, Municipal Local Government of Luna, the MGBRO1, and the pebble pickers. The study population consisted of 407 pebble pickers belonging to six (6) cooperatives operating in the Municipality of Luna, La Union. To determine an appropriate sample size, the study employed Cochran's sample size formula for estimating a population proportion, using a 90% confidence level, an assumed population proportion ($p=0.50$), and a 10% margin of error. After applying the finite population correction for the known population of 407, the minimum required sample size was 58 respondents. During the actual field data collection, however, additional eligible pebble pickers were present and voluntarily agreed to participate. To maximize representation and improve the precision of the estimates, all qualified respondents were included, resulting in a final sample of 68 respondents. A stratified random sampling technique was employed to ensure adequate representation of each registered cooperative. Each cooperative constituted one sampling stratum, after which respondents were randomly selected proportionate to the cooperative's total members. This sampling procedure minimized selection bias and ensured that the characteristics of the different cooperatives were adequately represented in the study.

Data Gathering Procedure and Analysis

Survey questionnaires were administered to operationalize the regulatory provisions contained in Resolution No. 3, Series of 2006, which governs pebble-picking activities in the Province of La Union, into measurable indicators of compliance and awareness. The questionnaire was researcher-developed and operationalized directly from the regulatory provisions prescribed in the Resolution. The statistical tool, through a Likert scale, was employed to determine the numerical parts of the study through weighted mean and composite mean, with respondents responding to a five-point scale ranging from "fully compliant" to "not fully compliant" for compliance, and "very highly aware" to "not aware" for awareness. A documentary analysis was undertaken to examine geological assessment reports, local ordinances, production records, and regulatory issuances related to pebble-picking activities. Subsequently, interviews and focus group discussion were conducted to obtain in-depth explanations regarding implementation issues, livelihood dependence, enforcement challenges, and perceived environmental impacts.

The quantitative data were analyzed using descriptive statistics. Weighted and composite means were computed to determine respondents' levels of compliance and awareness regarding existing pebble-picking regulations. The weighted mean values were interpreted using a predetermined interval ranges corresponding to the five-point Likert scale. On the other hand, qualitative data were analyzed using thematic content analysis. Responses were systematically coded, categorized into recurring themes, and interpreted in accordance with the study's objectives.

Ethical Considerations

Prior to data collection, permission to conduct the study was obtained through formal letters to the concerned government agencies, local government units, and cooperative presidents. Participation of respondents was

entirely voluntary and written informed consent was obtained. All respondents were informed of the study's objectives before their participation. Stakeholders were assured that their responses would be treated confidentially and would be reported in aggregate form. The study adhered to the principles of voluntary participation, anonymity, confidentiality, and respect for all participants throughout the research process.

RESULTS AND DISCUSSION

Status of Pebble Picking in Luna, La Union

Beach Profile. Between 2020 and 2022, the MGB RO1 conducted a series of geological assessments in Luna, La Union. The primary objective was to evaluate the feasibility of extracting aggregate deposits along the coastal barangays of Nalvo Norte, Barrientos, Magallanes, Victoria, Sto. Domingo Sur, and Sto. Domingo Norte. These assessments involved beach profiling to study changes in slope, morphology, and pebble distribution, alongside shoreline tracking to analyze shoreline movement, coastal erosion, sediment deposition, and tidal behavior. Baseline and follow up measurements were taken in June 2020 and February 2021, respectively, with one section measured per barangay.

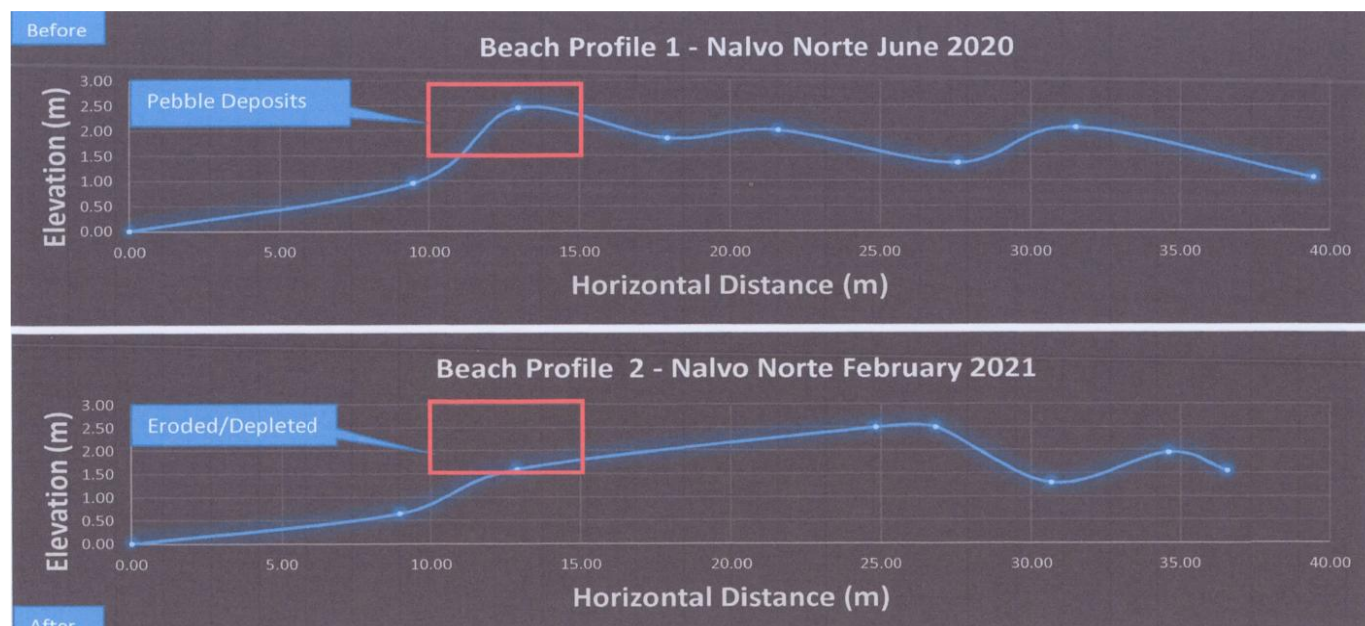


Figure 1 Beach Profile of Barangay Nalvo Norte

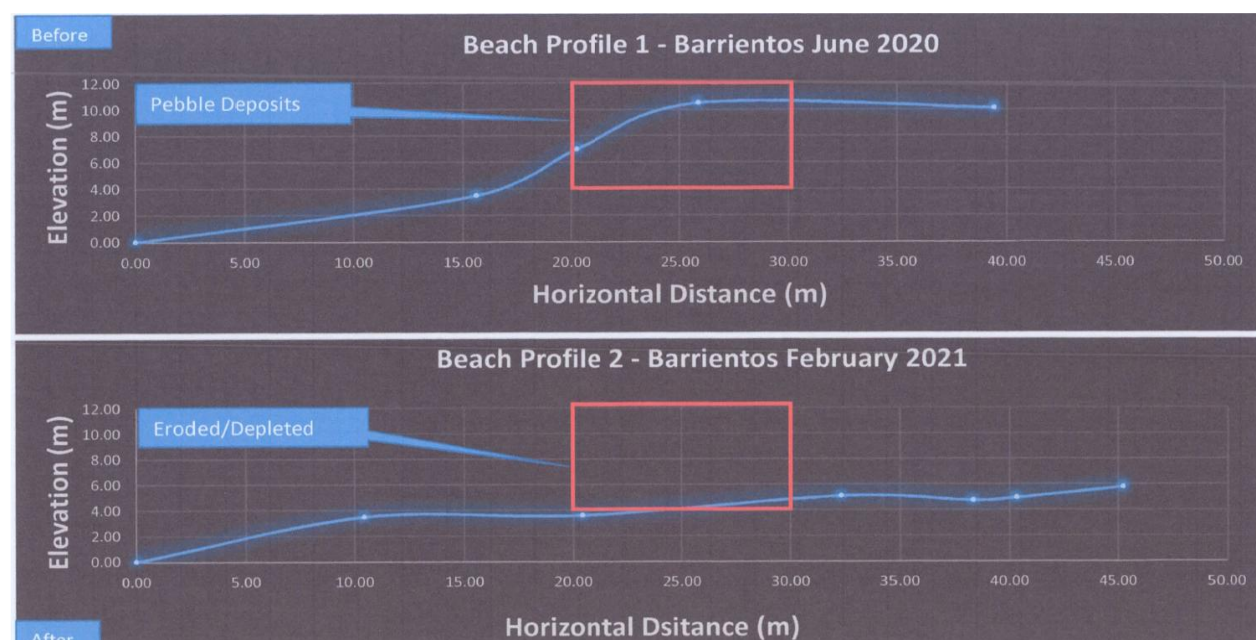


Figure 2 Beach Profile of Barrientos

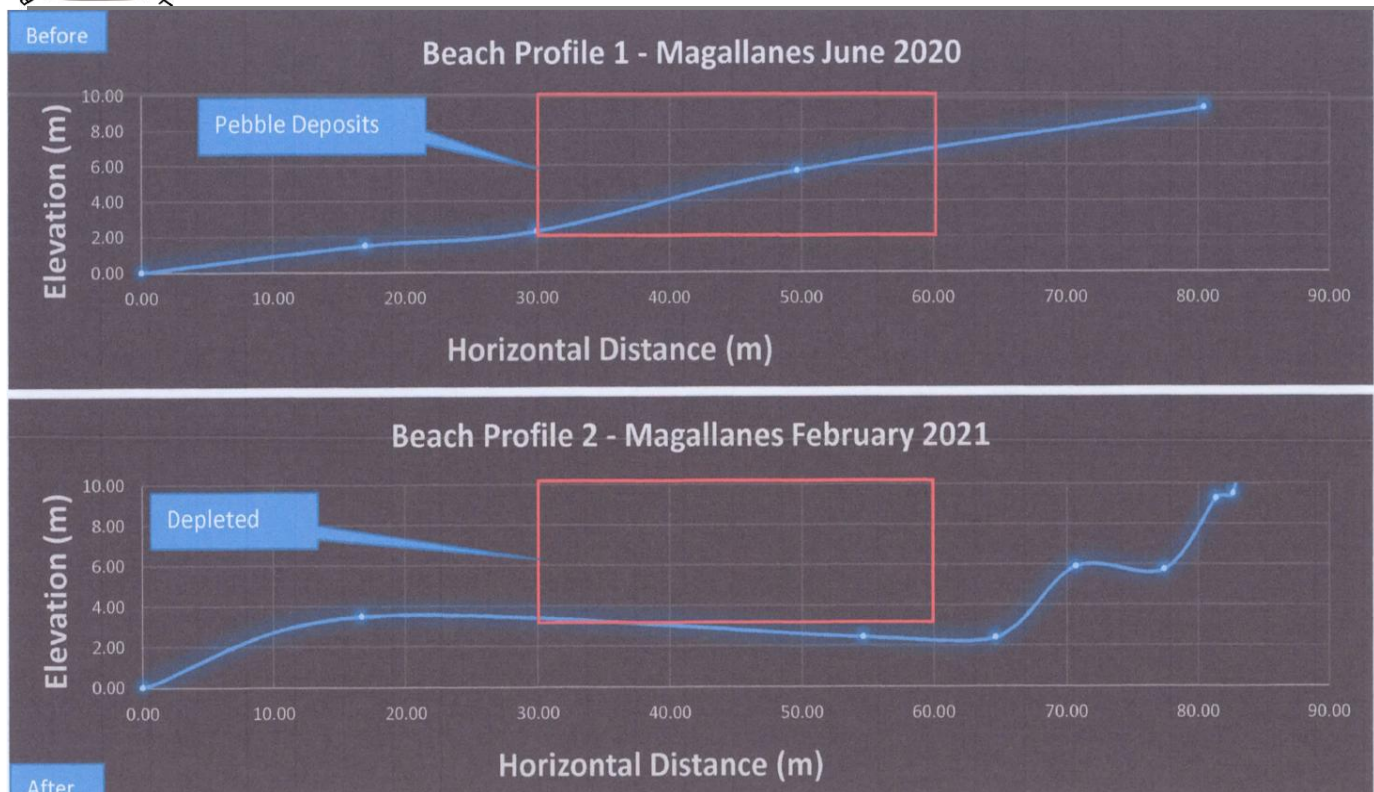


Figure 3 Beach Profile of Barangay Magallanes

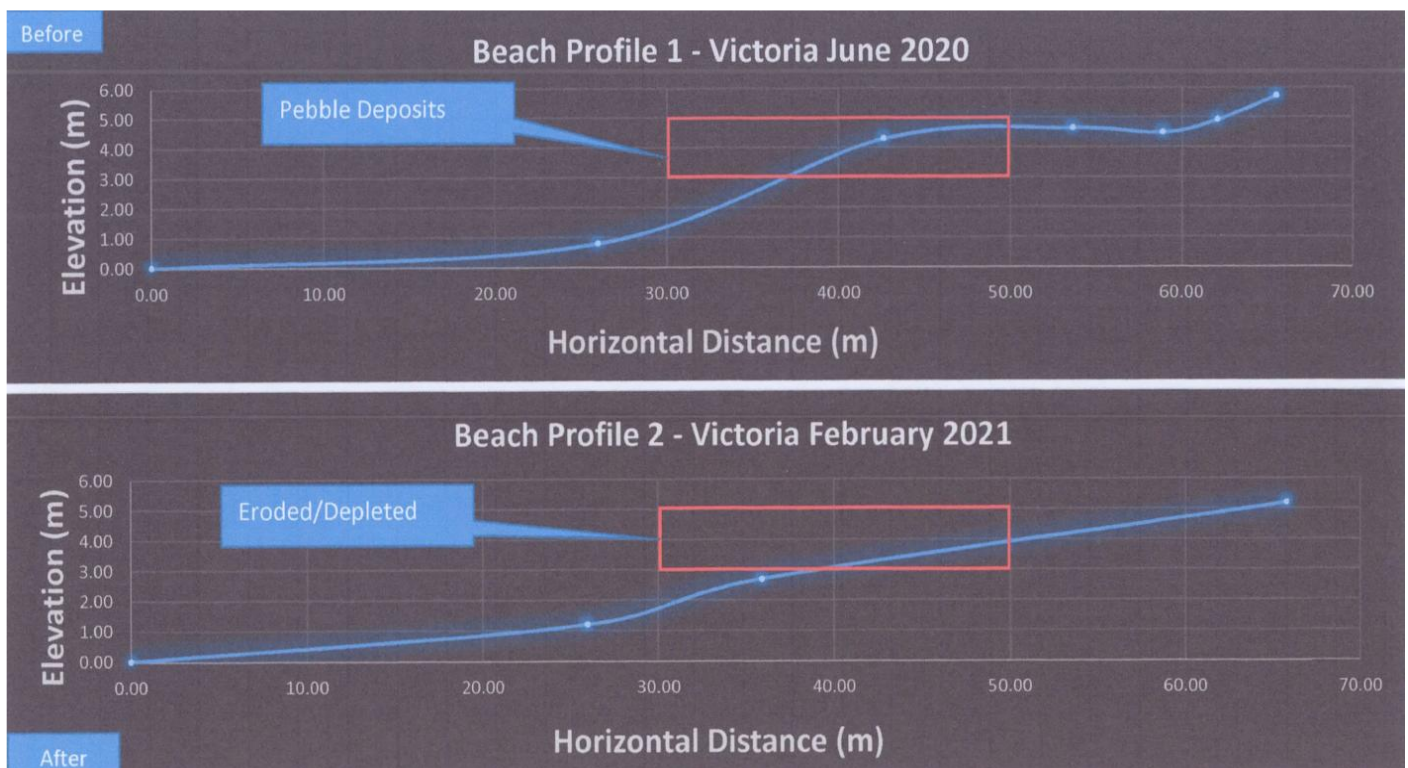


Figure 4 Beach profile of Barangay Victoria

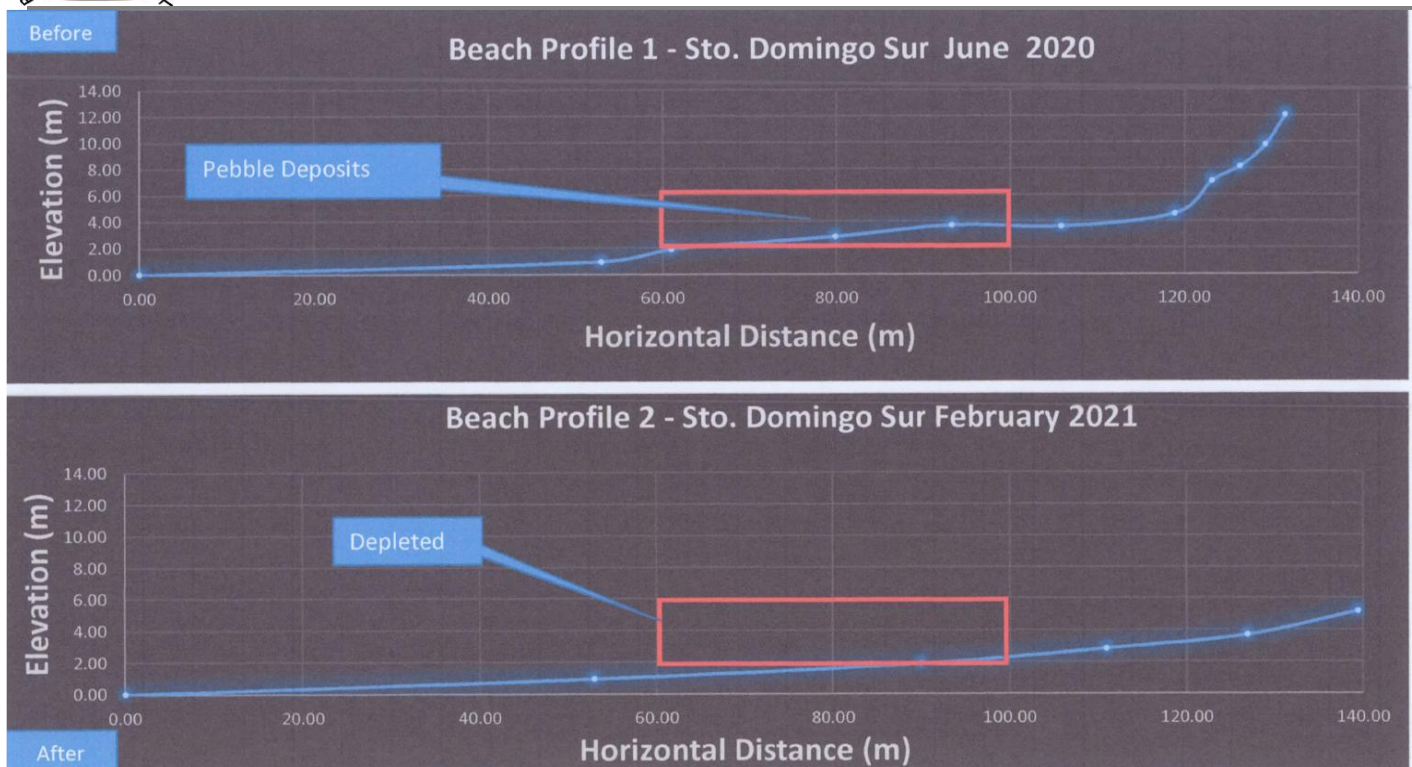


Figure 5 Beach profile of Sto. Domingo Sur

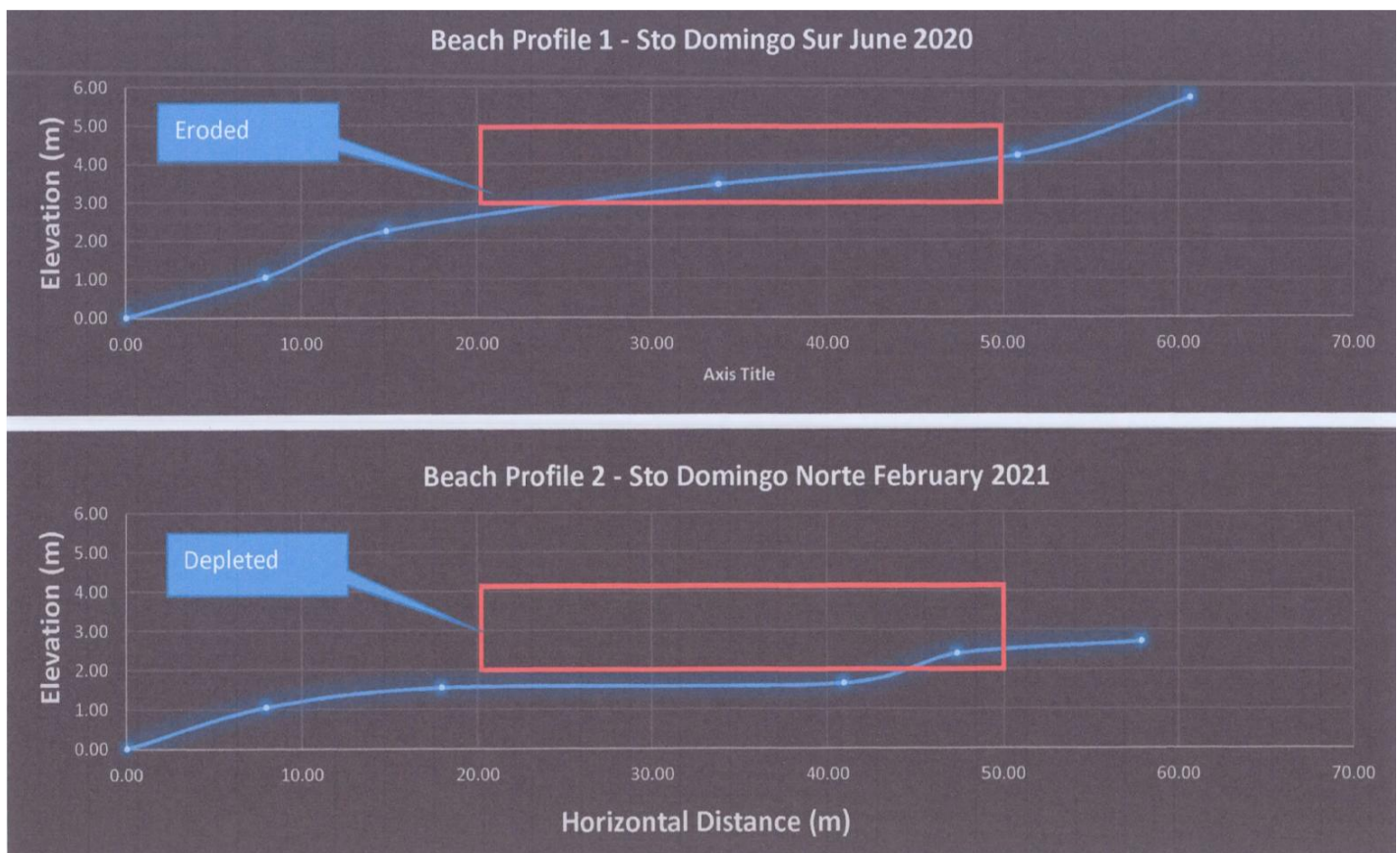


Figure 6 Beach profile of Sto. Domingo Norte

The comparative beach profile analyses consistently present notable geomorphological changes across the six monitored barangays. Although the degree of change varies, the overall trend indicates thinning of pebble deposits, a decrease in beach slope, and some localized flattening of the coastal profile. The physical change shows that natural sediment replenishment has not kept pace with extraction, thereby reducing the beach's capacity to maintain its natural equilibrium.

Among the monitored sites, Barangays Nalvo Norte (Figure 2) and Victoria (Figure 5) exhibited evidence of slope failure and notable erosion. Likewise, Barangay Magallanes, Sto. Domingo Sur and Sto. Domingo Norte (Figures 4, 6, and 7) showed progressive flattening of the beach profile, with angles of repose approaching zero degrees in some sections. Such geomorphological changes are significant because pebble beach function as natural barriers. The depletion of these deposits weakens the natural capacity to resist coastal geohazards.

These findings are consistent with previous geological investigations conducted by MGB RO1, which likewise documented declining pebble thickness and uneven material replenishment along the coastline. The observed variability among barangays further indicates that the replenishment is governed by natural sediment transport processes rather than by uniform annual deposition. Consequently, areas subjected to continuous extraction may experience prolonged recovery periods, thus increasing the susceptibility of coastal barangays to degradation.

Viewed through the lens of Political Ecology Theory, this suggest that coastal degradation cannot be attributed solely to natural geomorphological processes but is the result of an interaction between ecological limits and human dependence on natural resources. The continued extraction of pebbles, driven by livelihood needs, affects replenishment, which in turn constrains the geological process. This interaction illustrates the challenge policymakers face in balancing environmental conservation with the socioeconomic dependence of coastal communities on pebble picking.

In order to assess the volume of the materials, MGB RO1 conducted a Geological Resource Estimate in Luna's coastal barangays. The total pebble picking permit area was divided into two: Area 1 (encompassing Barangays Nalvo Norte, Barrientos, and Magallanes, totaling 35,398 square meters) and Area 2 (covering Barangays Victoria, Sto. Domingo Sur, and Sto. Domingo Norte, totaling 71,195 square meters). The estimation methodology involved multiplying each permit area's total land area by the pebble resource's approximate thickness. Area 1 was multiplied by 0.2 meters, resulting in a volume of 3,539.8 cubic meters, while Area 2 was multiplied by 0.1 meters, equating to 7,119 cubic meters. Collectively, the Total Estimated Geological Resource amounted to 10,659.3 cubic meters. This figure is notably lower than the recorded annual extracted volume of 11,154 cubic meters, as indicated in the Monthly Production and Extraction Reports for CY 2022. This discrepancy suggest that the extraction has exceeded the estimated available resource within the monitored areas, raising concerns regarding the long-term sustainability of current extraction practices.

In the findings of Corono (2022), the estimated replenishment rate of pebbles was calculated by dividing the total estimated geological resource by the number of months during which active extraction took place in 2020. The result was an approximate replenishment rate of 1,498.39 metric tons per month (MT/month).

However, field observation by Corono revealed that this rate of replenishment along the coasts of Luna is not equally distributed. This finding is supplemented by the initial assessment report of Arajo, Corono, & Valdez (2020), which observed that Barangay Nalvo Norte has the thickest deposit, while areas from Barangay Magallanes northwards to Sto. Domingo Norte showed visible sand exposures and reduced pebble coverage. Additionally, aggregate sizes in the northern barangay were relatively smaller than those of the southern barangays. Accordingly, the thickness, volume, and distribution of pebbles in the area vary from time to time due to changes in sea level and continuous extraction along the shoreline. While annual replenishment continues through natural sediment transport, the imbalance indicates that replenishment alone may be insufficient to offset continuous extraction.

LGU Issuances/ Local Ordinances. Local ordinances and other regulatory interventions are crucial in resource extraction activities, such as pebble extraction. This is also an essential governance mechanism in balancing environmental conservation with the socioeconomic dependence of coastal communities in resource extraction. As emphasized by Ralph & Steven (2016), it can impact various aspects, including business constraints and local content policies.

In response to the findings of the geological assessments, the MGB RO1 recommended a five-year moratorium on any pebble-picking activity in Luna, La Union. The purpose of the recommendation is to allow sufficient time for natural replenishment and to ensure a substantial volume of pebble deposits is available for extraction.

Acting on this recommendation, the PMRB adopted and issued *Resolution No. LU-2021-02 Series of 2021*, on December 27, 2021, formally imposing a five-year moratorium on the operation of special permits for pebble picking. The moratorium was grounded on the Geological Report of the MGB RO1, which provided findings that excessive use of implements during the extraction of pebbles had significantly reduced the rate of replenishment of pebble deposits. Left unchecked, this pattern of over extraction could result in drastic depletion of pebbles, making pebble picking an unsustainable livelihood.

This was not the first regulatory measure introduced to mitigate unsustainable extraction. Earlier on August 7, 2006, former La Union Governor Victor Francisco C. Ortega approved *Resolution No. 3, Series of 2006*, which specifically prohibited pebble picking in Barangays Rimos 4 and 5. The moratorium enforcement stemmed from a letter by MGB RO1 to the former Governor dated July 25, 2006, warning of unsustainable extraction rate and evident depletion of deposits along Luna, La Union's coast, particularly in Barangays Victoria and Rimos 5. Since its adoption, the resolution has remained in effect, ensuring that these areas remain closed to pebble picking activities. The continued implementation of Resolution No. 3, Series of 2006 further demonstrates the adaptive nature of environmental governance. The resolution introduced targeted management by permanently prohibiting extraction in areas where geological assessments indicated accelerated depletion.

The issuance of the five-year moratorium illustrates the application of the precautionary principle in environmental governance. The Provincial Mining Regulatory Board adopted a preventive approach by temporarily suspending extraction activities before irreversible environmental degradation could occur. With scientific evidence indicating the decline of pebble deposit and increase in geomorphological instability, the moratorium sought to preserve the remaining coastal resources while allowing sufficient time for natural replenishment. From the perspective of Political Ecology Theory, the moratorium presents the tension between ecological sustainability and livelihood dependence. The PMRB and MGBRO1 prioritized long-term ecosystem protection as per scientific assessment. However, local communities perceived the suspension of the activity through its immediate socioeconomic consequences by disrupting the primary livelihood. This illustrates how environmental policies may redistribute economic burdens toward resource-dependent communities unless accompanied by a livelihood transition mechanism.

Collectively, these regulatory measures demonstrate that local government responses to pebble-picking activities have evolved from simple permitting mechanism into adaptive environmental governance informed by scientific assessment.

Pebble Pickers. The socioeconomic conditions of pebble pickers show the extent to which coastal communities have become economically dependent on pebble picking as their primary livelihood. In many rural municipalities, limited employment opportunities compelled residents to rely on resource-based activities. According to a study conducted by the Philippine National Rural Development Programs and the ordinary Filipino's Life Satisfaction (2023), lack of job opportunities and high unemployment rates remain significant challenges in rural areas of the Philippines. As defined by Briones (2013), the labor market in rural areas is characterized by informal, temporary, and low-paid jobs with limited access to regular and productive employment opportunities.

Consistent with the characteristics of rural labor markets identified, the interviews revealed that most pebble pickers in Luna, La Union, have no permanent jobs and depend primarily on the pebble-picking activity as their main source of income. Unfortunately, the residents in the coastal barangays of Luna were compelled to cease pebble-picking activity due to the issuance of a resolution for the five-year moratorium of the operation of the special permit for pebble picking. In response, displaced pebble pickers would explore other employment alternatives, such as offering laundry services, subsistence farming, and construction, to make ends meet. These options, proved to be sporadic and unstable, creating financial uncertainty for many families. This economic strain has had wider social repercussion. Due to financial constraints and inability to provide for their basic needs, some of the children of the pebble pickers were forced to temporarily discontinue their children's education. These suggest that environmental policies have also indirect social costs.

Interview responses likewise highlighted that pebble picking, prior to the moratorium, also offered a level of flexibility that made it particularly attractive to local workers. Its informal structure allowed individuals to adjust their working hours based on daily financial demands and personal responsibilities. This adaptability made pebble picking not just a source of income, but a livelihood mechanism that accommodated the socioeconomic realities of Luna's coastal communities.

Level of Compliance and Awareness with the Laws and Regulations of Pebble Picking as provided under Resolution No. 3, Series of 2006

As indicated in Table 1, the respondents demonstrated a notably high level of compliance with the Guidelines established to regulate pebble-picking activities in Luna, La Union. These guidelines, outlined in Resolution No. 3, Series of 2006, which modifies and expands upon specific provisions of DENR Administrative Order No. 28, Series of 1992, received an overall mean rating of 4.90.

This level of compliance reflects that the community effectively adopted, implemented, and enforced the guidelines. The respondents' adherence to these regulations indicates a strong commitment to responsible and sustainable pebble picking practices, aligning with the objectives of the regulatory framework.

Among all indicators, the guideline concerning the acceptable size range of picked pebbles garnered the highest weighted mean at 4.97. This indicates the picker's attentiveness to ensuring that collected materials fall strictly within the permitted diameter range of not less than 10 mm and not greater than 100 mm.

Items	Weighted Mean	Interpretation
1. The pebble size (diameter) for the pebbles I picked is not less than 10 mm and not greater than 100 mm	4.97	Compliant
2. I gather pebbles through hand sorting or manual gathering only. I do not use scoops, shovels or similar implements, including salandra or screens.	4.85	Compliant
3. I only hand carry the picked pebbles. I do not use any animal-driven carts (karison) in transporting the materials.	4.90	Compliant
4. All picked pebbles are surrendered to the concerned cooperatives prior commercial disposition to any registered traders and dealers. Hence, I do not sell my picked pebbles to any traders and dealers.	4.85	Compliant
5. I only pick pebbles where normal wave actions (at high tide) could only reach or areas bounded by the low and high tide mark.	4.96	Compliant
I picked pebbles outside the 500-meters radius of the Victoria Brick Tower (Baluarte).	4.94	Compliant
No picking activities are conducted in Barangays that are closed to pebble picking (Rimos 5 and 4)	4.84	Compliant
Overall Mean	4.90	Compliant

Table 1 Level of compliance with the laws and regulations on pebble picking by the LGU implementers and pebble pickers in Luna La Union

While still indicative of a high level of compliance, this slightly lower score in certain indicators suggest that some pebble picking activities may inadvertently encroach upon restricted areas. This observation underscores the need to strengthen both awareness campaigns and enforcement mechanisms, particularly in barangays where pebble picking is explicitly prohibited. Doing so is essential to achieving full regulatory compliance and mitigating potential environmental degradation caused by unauthorized extraction.

Complementing these findings, Table 2 reveals that the respondents exhibit a similarly high level of awareness, with an overall mean of 4.93. This suggest that the majority of community members are well-informed about the regulatory framework outlined in Resolution No. 3, Series of 2006, which modifies certain provisions of DENR Administrative Order No. 28, Series of 1992, governing the issuance of Special Permits for pebble picking along beaches.

Items	Weighted Mean	Interpretation
1. The pebble size (diameter) for the pebbles I picked is not less than 10 mm and not greater than 100 mm	4.96	Highly Aware
2. I gather pebbles through hand sorting or manual gathering only. I do not use scoops, shovels or similar implements, including salandra or screens.	4.88	Highly Aware
3. I only hand carry the picked pebbles. I do not use any animal-driven carts (karison) in transporting the materials.	4.93	Highly Aware
4. All picked pebbles are surrendered to the concerned cooperatives prior commercial disposition to any registered traders and dealers. Hence, I do not sell my picked pebbles to any traders and dealers.	4.97	Highly Aware
5. I only pick pebbles where normal wave actions (at high tide) could only reach or areas bounded by the low and high tide mark.	4.94	Highly Aware
I picked pebbles outside the 500-meters radius of the Victoria Brick Tower (Baluarte).	4.88	Highly Aware
No picking activities are conducted in Barangays that are closed to pebble picking (Rimos 5 and 4)	4.94	Highly Aware
Overall Mean	4.93	Highly Aware

Table 2 Level of Awareness of the LGU implementers and pebble pickers on the issuances of permits and applicable laws on pebble picking in Luna La Union

The analysis further indicates that respondents are most aware of the guideline stipulating that traders and dealers should only procure pebble requirements from cooperatives with valid and existing permits, with a weighted mean of 4.97. Conversely, the guidelines indicating that pebble picking activities are limited to hand-sorting or manual gathering only, and that no picking activities are allowed in Barangays Rimos 4 and 5, both received the lowest weighted mean of 4.88, respectively. While still indicative of a high level of awareness, these slight discrepancies suggest a need for targeted information dissemination and localized education campaigns to ensure that all regulatory nuances are clearly understood, especially those related to method restrictions and spatial boundaries. Improving awareness in these areas is critical to prevent unintentional violations and promoting comprehensive compliance with environmental protection measures.

The compliance and awareness results indicate that pebble pickers generally understand and follow the regulatory provisions. Nevertheless, the geological assessments demonstrate that environmental degradation continued despite these favorable survey results. This apparent inconsistency presents that sustainable coastal resource management cannot be achieved solely on individual compliance but must also consider human behavior, ecological carrying capacity, law enforcement, and natural replenishment processes.

Challenges in Pebble Picking in Luna La Union

Geohazard. Coastal communities are susceptible to a range of geohazards, including offshore earthquakes, tsunamis, coastal floods, cyclones, hurricanes, and high tides, as highlighted by De Risi et al. (2022) and Capozzo (2019). These hazards pose significant risks to both life and property, often resulting in substantial economic losses and loss of human lives, as emphasized by Hao et al. (2020). Geohazards represent one of the most

significant issues affecting the municipality. Geological assessment indicate that continued extraction not only reduces available pebble deposit but also weakens the natural protective function of the coastline which increases its susceptibility to erosion, storm surges, and coastal flooding.

According to the Detailed Landslide and Flood Hazard Map of Luna, La Union by MGB RO1 (Figure 7), the coastal barangays are generally categorized under Low Flood Susceptibility. This classification implies that flooding in these areas is typically rain-induced, with expected flood heights of 0.5 meters or less and flood duration of less than one (1) day. Such areas are usually characterized by low hills, gentle slopes, and sparse to moderate drainage density.

Supporting this, Araojo, Corono, and Valdez (2020), reported anecdotal evidence of coastal flooding during periods of inclement weather, including instances of elevated tides. Their initial field assessment on February 7, 2020, observed significant sand patches along the coast of Barangay Magallanes extending towards the end of the northernmost barangay (Sto. Domingo Norte). Accordingly, this is due to the scouring and erosion of the beach due to wave action.

A more comprehensive historical perspective is provided by Polidario and Marrero (2018), who documented a series of catastrophic weather events that had a lasting geomorphological impact on Luna's coastal zones, such as storm surges, shoreline erosion, and accretion. The intensity of these hazards varies across barangays, influenced by the geology of area and the presence of coastal protection or barriers, which can be natural or manmade.

Numerical modeling studies of Terry, Lau, and Etienne (2013) demonstrated that gravel barriers, including pebbles, can effectively protect shorelines from storm wave conditions and over wash. Similarly, Pollard et al. (2021) affirmed that pebble formation is effective as coastal defense during extreme hydrodynamic conditions.

In fact, the coastal geohazard mapping and assessment of Polidario and Marrero revealed that ten (10) coastal barangays, including all six (6) with pebble picking permits, were affected by the coastal erosion. Among them, Barangays Nalvo Norte and Victoria were particularly affected by both erosion and coastal flooding.

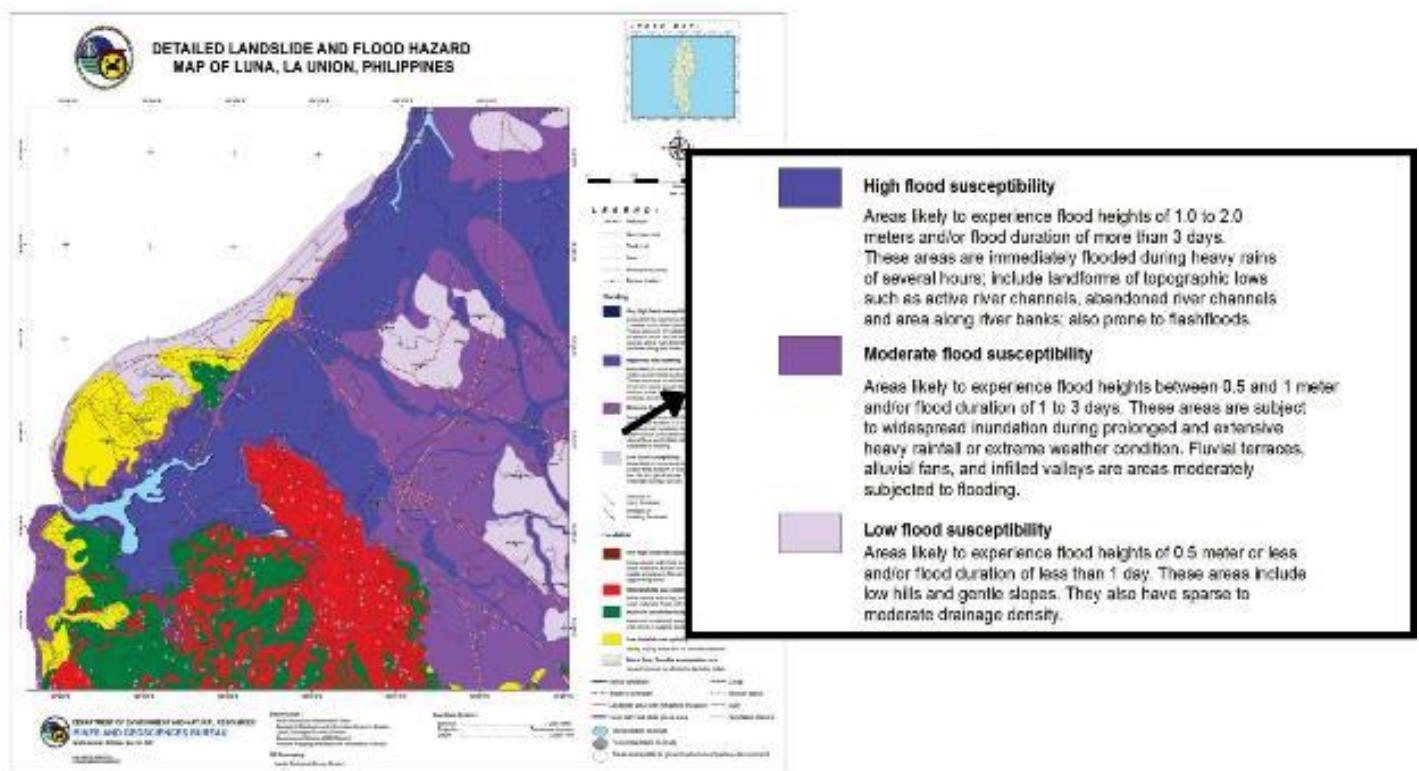


Figure 7 Detailed Landslide and Flood Hazard Map of Luna, La Union from the Mines and Geosciences Bureau- Regional Office No. 1

Historical accounts from local residents indicate that typhoons such as *Gorio*, *Mario*, *Lando*, *Feria*, and *Peping* have significantly contributed to flooding in Luna, La Union, with floodwaters reportedly reaching heights of up to four meters. Corroborating these accounts, the Shoreline Shift Map produced by Polidario and Marrero (2018), as seen in Figure 8 classifies the coastal barangays of Luna under Moderate Severity in terms of erosion rate.

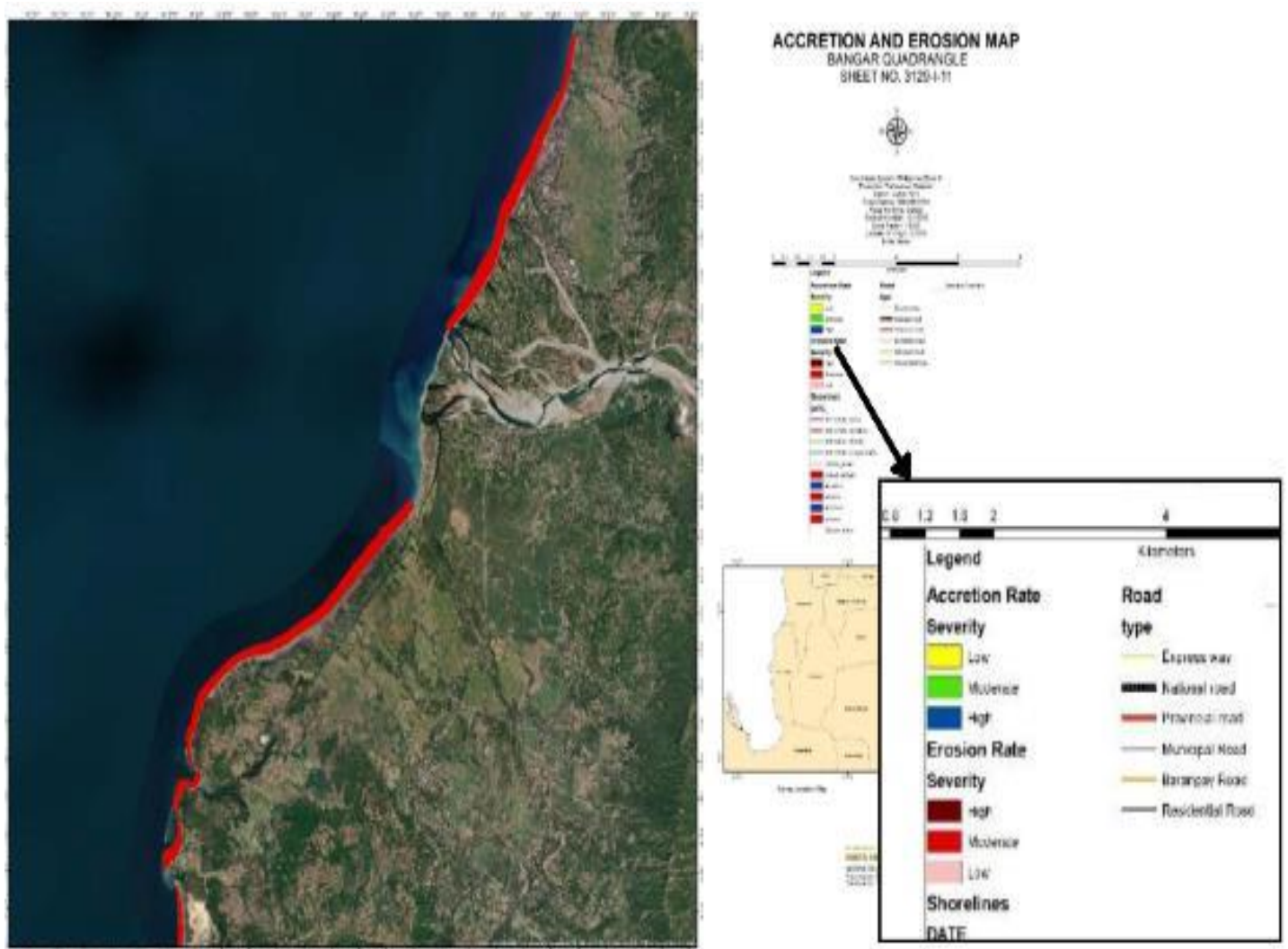


Figure 8 Shoreline Shift Map of Bangar Quadrangle from the Mines and Geosciences Bureau Cordillera Administrative Region.

Issuance of Ordinances. Under Provincial Ordinance No. 274-2021, specific fines and penalties have been established for violations related to the extraction, disposition, and utilization of quarry and other mineral resources. During interviews, most pebble pickers expressed general acceptance of the ordinance and its intent to regulate activities and protect the environment. However, concerns were raised regarding the inconsistent implementation and monitoring of the law, particularly in areas where illegal pebble-picking activities continue to occur with limited enforcement.

This observation is noted by Vito, Ivana, and Tatjana (2022), whose research found that higher penalties and fines may not always effectively deter illegal activities. While increasing penalties may seem like a viable option, it may not necessarily lead to a significant increase in compliant behavior. This suggests that alternative approaches beyond punitive measures may be necessary to address illegal pebble-picking activities effectively.

In response to regulatory challenges, a Multipartite Monitoring Team (MMT), which is the monitoring arm of the Mine Rehabilitation Fund Committee (MRFC) – La Union, chaired by Provincial Governor has been established. The MMT is tasked with quarterly compliance checks of permit holders and reporting findings for

policy deliberation. Additionally, barangay officials are actively involved in on-site monitoring and enforcement of the ordinance at the community level.

However, despite these mechanisms, it was acknowledged during focus group discussion that monitoring efforts remain insufficient, particularly due to the limited on-ground presence of the Provincial Environment and Natural Resources Office (PGENRO). The Environment and Natural Resources Officer of the Province of La Union also emphasized the need for reinforcement from other agencies, such as the Local Government Unit and La Union Police Provincial Office (LUPPO), to strengthen the implementation of regulations throughout the day.

Illegal Pebble Picking Activities. Illegal pebble-picking activities emerged as one of the most critical governance challenges identified in the study. Despite existing regulations and the implementation of a moratorium, illegal pebble extraction, transport, and trade remain persistent challenges in Luna, La Union. Findings from focus group discussion and interviews with community members revealed that unauthorized activities continue to operate covertly, often taking place during early morning hours to avoid detection.

One common practice involves illegal traders recruiting local residents to collect pebbles outside of cooperative oversight. In exchange for immediate cash payments, these pickers bypass the formal cooperative system, leading to the transport of pebbles without the necessary delivery receipts or legal documentation. In some cases, illegal traders also employ their own pickers to conduct extraction in prohibited areas, including within the 500-meter buffer zone surrounding the Victoria Brick Watchtower (Baluarte), as observed during site monitoring by Corono (2022).

The Provincial Government of La Union (PGLU) and the Philippine National Police have confirmed the ongoing nature of these illegal activities. In April 2023, the Luna Municipal Police Station intercepted a tricycle loaded with twenty (20) sacks of pebbles, all of which were in violation of size and documentation requirements, according to a report by Dacanay (2023). Similarly, in May 2023, the Provincial Government of La Union (PGLU) responded to a tip regarding 120 sacks of pebbles stored in Barangay Carlatan, San Fernando City. Upon investigation, the delivery lacked any supporting documentation or receipts, prompting the confiscation and storage of the materials, as detailed by Galvez, Cardenas, and Hidalgo (2023).

Political Ecology Theory provides a useful explanation for this phenomenon. Communities facing limited economic opportunities may continue extracting pebbles despite regulatory restrictions because immediate livelihood needs outweigh long-term environmental considerations. Consequently, the illegal extraction is a manifestation of a broader socioeconomic vulnerability.

Cooperatives. Cooperatives occupy a central position in the governance of pebble extraction in Luna, La Union. Beyond facilitating regulatory compliance, cooperatives function as intermediary institutions that coordinate extraction activities, disseminate information, and represent the interests of their members before government agencies. Compliant entities can be adversely affected by illegal operations in various ways. Firstly, they may inadvertently support illicit trade by purchasing goods that originate from illegal sources or by providing financial or logistical support to illicit traders, as mentioned by Lapprand, (2021). For instance, in the investigation report by Galvez, Cardenas, and Hidalgo (2023), the enterprise unknowingly purchased pebbles that were illegally extracted, resulting in the confiscation of the materials.

Secondly, Haugh, (2016) mentioned that compliant entities may encounter unfair competition from illegal trade, as counterfeit, tax-evading, or non-compliant products challenge regular sales. This can undermine the competitiveness and profitability of legitimate businesses, creating an uneven playing field in the market.

Based on interviews, it was observed that most cooperatives adhere strictly to existing ordinances, particularly those governing the extraction, handling, and commercial disposition of pebbles. Cooperative leaders expressed a commitment to ensuring that all members comply with the terms of their permits, recognizing that a single violation could jeopardize the credibility and legality of the entire organization. However, external pressures from illegal operations continue to disrupt their efforts. Resultantly, the cooperatives are affected mainly by the

issuance of the moratorium, citing the unsustainability of the activity and higher exposure to geological hazards due to the over-extraction of pebbles.

The presence of illegal activities signifies the importance of enhanced enforcement of existing regulations and the development of stricter measures to deter illicit practices. This only shows that there is a pressing need to strengthen monitoring systems, reinforce supply chain transparency, and implement alternative livelihood programs that reduce the community's dependence on environmentally sensitive resources.

Policy Direction on Pebble Picking Activity

The findings of this study indicate that sustainable management of pebble-picking activities requires an integrated governance approach that simultaneously addresses environmental conservation and livelihood security. Geological assessments confirmed the progressive depletion of pebble deposits, while interviews and survey results demonstrated that coastal communities remain economically dependent on pebble picking despite high levels of regulatory compliance. These findings suggest that restrictive regulatory measures alone are insufficient to achieve long-term sustainability. Instead, conservation efforts must be complemented by structured livelihood transition programs that reduce dependence on environmentally sensitive resources while strengthening community resilience.

Rationale. The coastal areas of Luna, La Union are apportioned with pebble deposits which have long supported the local economy. Beyond their commercial value, these pebbles also act as a natural barrier against coastal geohazards. Empirical studies affirm the role of gravel and pebble formations in enhancing shoreline resilience, particularly during extreme weather events.

However, pebbles are considered non-renewable resources that can be depleted over time. The continuous exploitation of these materials, especially under unregulated and illegal practices, escalates threats to both environmental sustainability and community safety. With climate change accelerating sea-level rise and storm intensity, the vulnerability of Luna's coastal areas is likely to increase in the absence of conservation measures.

Drawing parallels from the Kerala sand mining crisis in India, where unsustainable extraction led to irreversible ecological damage and community displacement (Padmalal & Maya, 2014), the Luna experience signifies the urgency for proactive, locally driven interventions. In response, this study proposes a Pebble Picking Diversification Scheme, a phased, community-centered strategy aimed at mitigating economic displacement while ensuring environmental protection.

Objective. The Pebble Picking Diversification Scheme seeks to facilitate a just transition from extractive livelihoods toward sustainable, resilient income sources. It aims to mitigate the socio-economic impacts of the moratorium, protect coastal ecosystems, and reduce long-term dependency on finite natural resources. The policy emphasizes collaborative governance between the Local Government Unit (LGU), national agencies, cooperatives, and community stakeholders to align local practice with global sustainability targets—specifically SDG 12 (Responsible Consumption and Production) and SDG 14 (Life Below Water).

Scheme. The initial phase of the policy involves conducting thorough research and collaborating with national agencies like the Department of Trade and Industry (DTI) and the Department of Science and Technology (DOST) to find viable alternatives to pebble picking. A comprehensive dialogue with stakeholders, including national agencies and Local Government Units (LGU), will be conducted to analyze and understand potential livelihood opportunities for those currently in pebble picking. This phase aims to lay the groundwork for transitioning Luna, La Union's coastal residents, away from pebble picking towards a more sustainable livelihood option, referred to as "livelihood diversification."

In Year 2, the transition phase begins as the moratorium on pebble picking is lifted by the Provincial Mining Regulatory Board, albeit with stringent regulations. This regulatory framework, developed in collaboration with key stakeholders, including the Provincial Government of La Union, Municipality, and law enforcement agencies, allows for the gradual transition of pebble pickers towards livelihood diversification.

Additionally, Year 2 initiates a training program for livelihood diversification, ensuring a smooth transition process. While pebble picking continues under close supervision, pebble pickers undergo training to acquire the necessary skills and knowledge. This phase bridges the legacy of pebble picking and a sustainable future, emphasizing resilience and empowerment within coastal communities.

In Year 3, the transition to sustainable livelihoods and environmental conservation is completed. Pebble pickers shift seamlessly to livelihood diversification, fostering financial independence and community involvement. As the year progresses, pebble picking activities gradually cease, with the Local Government Unit implementing measures for conservation. A total ban on pebble-picking affirms the commitment to conserving these resources for future generations, emphasizing environmental stewardship.

During the ban, rigorous monitoring by National Agencies and the Local Government Unit prevents illegal pebble extraction, safeguarding the integrity of deposits and maintaining sustainable development principles. Year 3 marks the culmination of efforts towards sustainable livelihoods, environmental preservation, and community resilience.

Action Matrix:

Policy Area	Action Step	Lead Stakeholders	Timeline	Indicator
Livelihood Research	Conduct feasibility studies on “livelihood diversification”	LGU, DTI, and DOST	Year 1	Report on 3 viable options
Stakeholder Dialogues	Host barangay-level participatory forums	LGU, DENR, MGB, Cooperatives	Year 1	No. of dialogues conducted
Transition Regulation	Reissuance of pebble picking permits with stricter provisions such as allowable volume, area, and duration	PMRB, LGU, MGB	Year 2	Percentage of Compliance rate
Skills Training	Provision of skills and business trainings to pebble pickers	TESDA, DTI, and LGU	Year 2	No. of trained individuals
Full Ban and Monitoring	Ban pebble extraction and enforce strict monitoring	LGU, PNP, and MGB	Year 3	No. of violations reported/ month
Evaluation and Resilience Plan	Conduct pos-diversification evaluation and adjust policies	Academe, LGU, NGOs	Year 3 onwards	Sustainable income baseline

The financial requirements of the proposed activities may be sourced from existing national and local government programs, thereby minimizing the need for new funding appropriations. In addition, the implementation of the Diversification Scheme should be supported by periodic monitoring and evaluation to assess both environmental and socioeconomic outcomes.

Ultimately, the proposed Pebble Picking Diversification Scheme demonstrates that environmental conservation and livelihood protection need not be competing policy objectives. Rather, sustainable coastal resource governance can be achieved through evidence-based decision-making, adaptive environmental management, and inclusive socioeconomic development. By integrating geological assessment, institutional governance, and community livelihood transition within a single policy framework, the proposed scheme provides a practical model that may be adapted by other coastal local government units facing similar challenges in balancing natural resource conservation with community welfare.

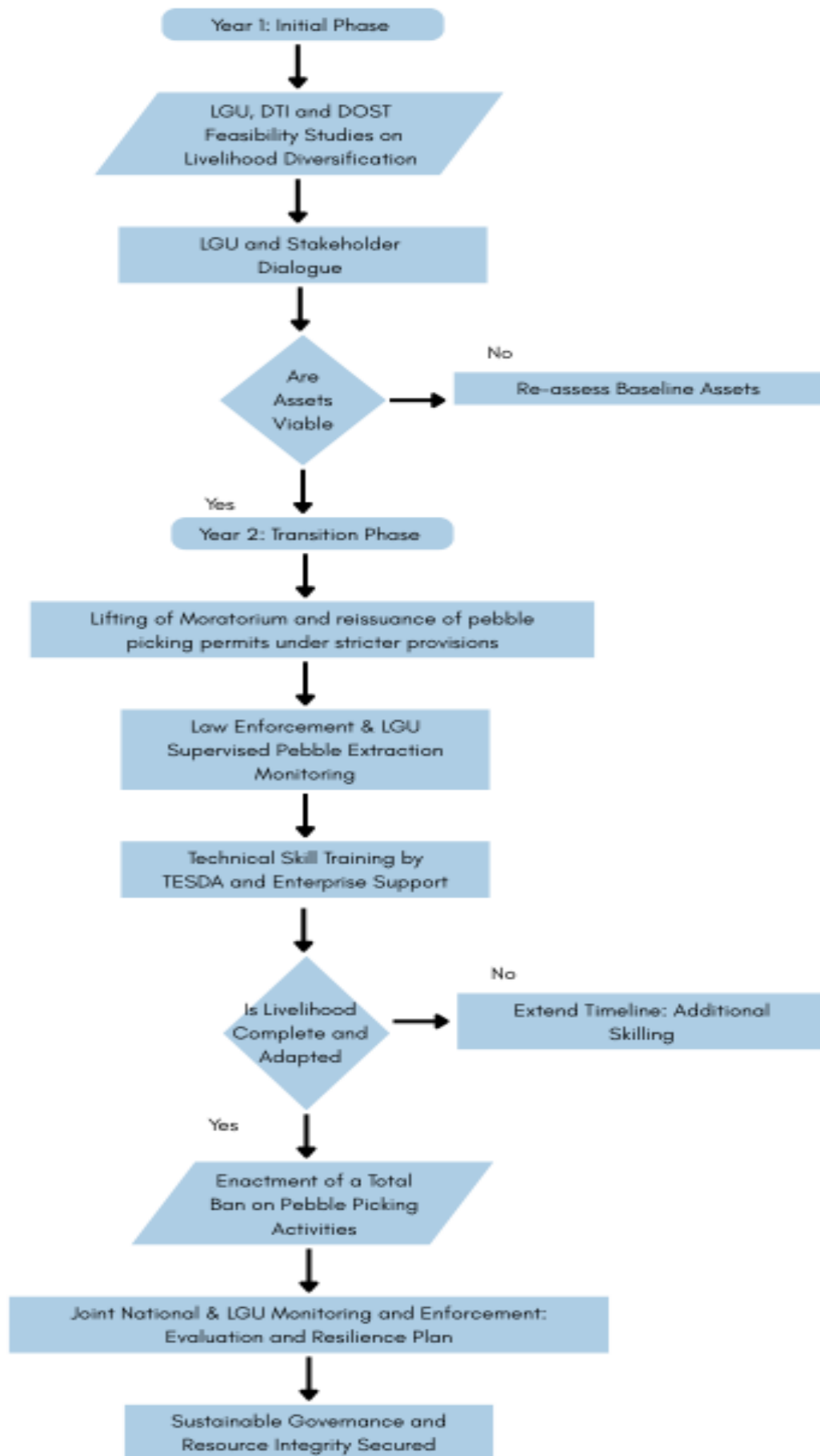


Figure 9 Pebble Picking Diversification Scheme Flowsheet

CONCLUSION

The findings of this study affirm that pebble picking in Luna, La Union, while offering crucial economic support for local communities, has led to environmental degradation, increased exposure to geohazards, and deepened socioeconomic vulnerabilities. Although current regulatory mechanisms have fostered high levels of awareness and compliance, enforcement remains inconsistent, and illegal activities persist. Moreover, the moratorium, though environmentally justified, has revealed critical gaps in livelihood resilience and the need for a transitional support framework. Thus, the study concludes that effective coastal resource management must go beyond prohibition. It requires a holistic strategy that balances ecological conservation with economic adaptation, integrating community participation, inter-agency coordination, and alternative livelihood development. By embedding these elements into local policy, Luna can serve as a model for localized SDG implementation, specifically addressing SDG 12 (Sustainable Consumption and Production), SDG 14 (Life Below Water), and SDG 13 (Climate Action).

RECOMMENDATION

It is recommended to implement regular monitoring and assessment by government agencies for coastal morphology and pebble resources to inform sustainable management practices and regulatory decisions in the long term; Implement enhanced enforcement mechanisms and boundary delineation strategies to ensure strict adherence to pebble picking regulations and promote sustainable resource management practice. Further, The Local Government Unit should focus on community interventions and Communication, Education, and Public Awareness (CEPA) campaigns to strengthen the awareness and compliance of pickers to the regulations. Implement a phased moratorium on pebble picking activities in Luna, La Union, allowing for two or more years of regulated pebble picking under strict supervision and monitoring. During this period, the local governments should actively introduce and promote alternative livelihood opportunities for pebble pickers. Simultaneously, conduct comprehensive awareness campaigns highlighting the environmental and social benefits of transitioning away from pebble picking and the importance of managing coastal ecosystems. This approach provides a structured timeframe for the community and adapt to alternative livelihood while gradually phasing out pebble picking activities to facilitate the recovery and conservation of the coastal environment. Lastly, implementation of the Pebble Picking Diversification Scheme, strengthened monitoring and enforcement, community engagement, capacity building, and long-term environmental planning are essential for promoting sustainable development and resilience in Luna, La Union.

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