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Mainstreaming Sustainable Land Management in Land Use Planning for Upland Areas: Case of La Libertad, Negros Oriental

Djolly Ma. P. Dinamling
Bureau of Soils and Water Management, Quezon City, Philippines
djollyma.dinamling@bswm.da.gov.ph

Jose M. Regunay, PhD
School of Urban and Regional Planning, Quezon City, Philippines
jmregunay@up.edu.ph

Abstract

Land degradation in upland areas poses significant environmental and socioeconomic challenges. This study applied the Driver–Pressure–State–Impact–Response (DPSIR) framework to analyze the causal relationships and system dynamics of land degradation in La Libertad, Negros Oriental, with the aim of supporting the integration of Sustainable Land Management (SLM) into local land use planning. The key drivers identified were population growth, steep slope farming, household income levels, and land tenure insecurity—factors that collectively contributed to land cover change. Land cover analysis revealed a major conversion of grasslands to croplands between 2003 and 2015. The state and trends of degradation were assessed using indicators such as land cover transitions, land productivity dynamics, and soil organic carbon levels. Results showed that the most prominent trend was the shift from shrubland and grassland to cropland, leading to increased soil erosion and reduced soil fertility. In response, SLM technologies were implemented, resulting in environmental improvements, including enhanced soil fertility, better land cover, and reduced erosion. Economic benefits included increased agricultural production, higher farm incomes, and improved market access. Socio-cultural impacts involved strengthened decision-making, greater awareness of conservation practices, and improved living conditions. The findings underscore the value of the DPSIR framework as a practical tool for diagnosing land degradation and guiding the mainstreaming of SLM in local land use planning processes.

Keywords: land degradation, sustainable land management, upland areas

1. Introduction

Agricultural expansion in upland areas presents a significant challenge to sustainable land use, particularly where farming practices remain exploitative in nature. In many cases, sloping agricultural lands in the uplands are cultivated without soil and water conservation measures. The erosion of nutrient-rich topsoil renders the land increasingly unproductive, compelling farmers to convert nearby forestlands into agricultural areas. This cycle of resource depletion contributes to land degradation and reinforces poverty and underdevelopment in rural communities (Briones, 2010).

According to the Land Degradation Assessment in the Philippines (LADA, 2013), approximately 11.45 million hectares, or 38% of the country's total land area, are vulnerable to land degradation. These vulnerable zones are largely characterized by sloping terrain, intensive cultivation, and limited adoption of conservation practices. In the upland barangays of La Libertad, Negros Oriental, land degradation has been linked to the open burning of crop residues, corn monocropping, and continued deforestation due to forest conversion for agricultural purposes. These barangays lie within the Pacuan Watershed, an area experiencing unregulated encroachment into forestland for cultivation.

Understanding land degradation in such contexts requires a systems-based approach. The Driver–Pressure–State–Impact–Response (DPSIR) framework provides a useful structure for analyzing the interconnected causes and effects of degradation. In this framework, driving forces such as poverty, insecure land tenure, and unsustainable agriculture exert pressures on land systems, resulting in changes to soil quality and land cover (state), which ultimately affect productivity and ecosystem services (impact). Responses, in turn, can include policy reforms, conservation technologies, and participatory planning tools.

However, applying the DPSIR framework in upland, agriculture-dependent areas remains a challenge. Farmers often rely on traditional knowledge and short-term coping strategies, while local government units (LGUs) may lack the technical capacity or analytical tools to assess land degradation or develop appropriate interventions. Bridging the gap between grassroots practices and available technologies requires building institutional awareness, integrating local knowledge with scientific assessments, and mainstreaming sustainable land management (SLM) into local planning processes.

This study aimed to address land degradation in the upland areas of La Libertad, Negros Oriental, through the application of SLM strategies. Specifically, it seeks to:

1. Examine the underlying drivers and direct causes of land degradation in the upland areas of La Libertad, Negros Oriental
2. Assess the environmental, spatial, economic, and socio-cultural on-site impacts of land degradation in the study area
3. Evaluate the outcomes of existing sustainable land management practices in terms of their environmental, spatial, economic, and socio-cultural effectiveness
4. Formulate spatially informed and sector-specific policy and planning recommendations to mitigate land degradation in upland ecosystems.

This study highlights the potential of institutionalizing the DPSIR framework as a strategic tool for land use and agricultural development planning, particularly among LGUs with extensive upland agricultural areas. Integrating the DPSIR framework into the Comprehensive Land Use Plans (CLUPs) of municipalities can enable a more systematic situational analysis of land degradation. It can also provide a robust evidence base to guide land managers and policymakers in mainstreaming Sustainable Land Management (SLM) into local development plans (Porta and Poch, 2011).

For LGUs in agriculture-dependent municipalities, recognizing land degradation as a critical issue—particularly through scientific assessments that reflect the experiences of upland farmers—is imperative. Through the Municipal Agriculture Offices (MAOs) and Municipal Environment and Natural Resources Offices (MENROs), LGUs must build institutional capacity to diagnose the drivers, processes, and impacts of land degradation using empirical methods. Such diagnostic capabilities are essential for designing targeted, locally relevant SLM strategies.

If left unaddressed, the current trajectory of land degradation threatens the long-term viability of upland ecosystems and the welfare of future generations. As land degradation is closely linked to land use decisions and socioeconomic practices, addressing its root causes not only contributes to improved land productivity but also supports climate change mitigation, biodiversity conservation, food security, and sustainable livelihoods.

2. Research Design

2.1 Conceptual Framework

The DPSIR framework is a widely adopted approach for assessing and managing environmental issues. As illustrated in Figure 1, the DPSIR framework was applied in this study to examine the issue of land degradation in upland communities in the Philippines. The analysis focused on identifying the key drivers, pressures, current environmental state, associated impacts, and potential responses to land degradation.

A review of relevant literature identified the primary drivers as steep slopes, population growth, small farm sizes, insecure land tenure, and limited household income. These drivers exert pressure on the landscape through land cover change, which in turn alters the environmental state. The resulting trends include declining soil fertility and increased soil erosion.

The conceptual framework also emphasizes the potential for strategic responses to both drivers and pressures. In this context, SLM practices are proposed as appropriate interventions to mitigate the adverse impacts of land degradation. The anticipated benefits of SLM include improved soil fertility, reduced erosion, enhanced land cover, increased household income, and positive socio-cultural outcomes for farming communities.

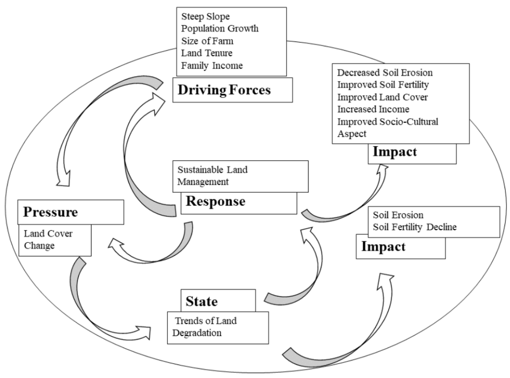


Figure 1. Conceptual Framework of the Study

2.2 Data Gathering Methods

A combination of qualitative and quantitative methods was employed to gather primary data from both farmers and key local stakeholders. Fieldwork was conducted in four Conservation Farming Village (CFV) barangays in La Libertad, Negros Oriental: Aya, Elecia, Nasunggan, and Pitogo.

2.2.1. Primary Data were collected through farmer interviews, key informant interviews (KIIs), focus group discussions (FGDs), and field observations. Forty purposively selected farmers (10 per CFV barangay) participated in structured interviews using a five-point Likert scale to assess their perceptions of land degradation, land use change, agricultural intensification, and SLM adoption.

Table 1 shows the variables for each of the parameters using the DPSIR framework.

Table 1. Parameters and the Variables used in the Study

Parameters	Variables
Drivers of land degradation	1. Population growth (no. of population) 2. Slope ranges (area per slope range) 3. Family income (monthly household income) 4. Land tenure (tenant, owner) 5. Size of farm lots (Area in ha)
Pressures of land degradation	1. Land Cover Change (% change in land cover over two periods) 2. Land Use Change 3.Cultivation/ Farming Practices (change in types of farming practices) 4. Agricultural Land Use Intensification (agricultural land use change, increased inputs, crop change)
State of land degradation	1. Type of land degradation 2. Trends of Land Degradation
Impact of land degradation	1. Soil Erosion in tons/ha/year 2. Soil Fertility Decline (levels of N, P, K) 3. Organic Matter (OM) and pH)
Response (SLM)	1. Number of SLM Technologies 2. Location of Farms practicing SLM technologies
Impacts of SLM: Environmental	1. Soil Fertility (Level of N, P, K, and % OM) 2. Soil Erosion (Soil loss in tons/ha) 3. Water Availability 4. Improved Land Cover (Areas improved, stable, and degraded) 5. Farm income
Economic	1. Agricultural production 2. Change in market access
Socio Cultural	1. Leadership ability and decision making 2. Farmers' attitude towards 3. Conservation (attitude about continuing the SLM technologies) 4. Improvement in the level of living

Socio-demographic data were also gathered. KIIs with officials from the MAO, MPDO, and MENRO provided institutional insights on program implementation and land degradation. FGDs in each barangay supported the validation of individual responses and explored community-level perspectives. Transect walks and field observations complemented survey data by capturing physical indicators of land degradation on-site.

2.2.3 Secondary Data supported spatial and historical analysis of land degradation trends. Land cover maps from NAMRIA (2003, 2010, 2015) were processed in QGIS with the Trends.Earth plugin to assess land cover transitions. Soil data, including fertility and erosion parameters, were sourced from reports (2008–2015), while digital elevation models (DEMs) provided topographic information. Additional socioeconomic and demographic data were drawn from national statistics, CFV reports, and local development plans. The integration of primary and secondary data enabled a comprehensive assessment of land degradation and SLM interventions in the La Libertad study area.

2.3 Data Analysis

A combination of ecological profiling, GIS-based land cover change analysis, and spatial statistics was employed to characterize land degradation in La Libertad. Ecological profiling was used to assess geo-physical conditions (e.g., slope, water sources), natural resources (e.g., land cover), and socioeconomic attributes of farming households to identify key drivers of land degradation. Land cover changes between 2010 and 2015 were analyzed using the Trends.Earth plugin in QGIS, classifying transitions as degradation, stability, or improvement (Fig. 2). Spatial overlay was conducted to evaluate the influence of slope and elevation on observed degradation patterns. Additionally, hotspot analysis in GIS was performed to detect statistically significant spatial clusters of degradation, highlighting priority areas for intervention.

		Land Cover in Target Year						
		Tree-covered	Grassland	Cropland	Wetland	Artificial	Bare land	Water Body
Land Cover in Base Year	Tree-covered	0	-	-	-	-	-	0
	Grassland	+	0	-	-	-	-	0
	Cropland	+	-	0	-	-	-	0
	Wetland	-	-	-	0	-	-	0
	Artificial	+	+	+	+	0	+	0
	Bare land	+	+	+	+	-	0	0
	Water Body	0	0	0	0	0	0	0

Degradation	Stable	Improvement
(red)	(cream)	(green)

Source: Modified from Trends.Earth

Figure 2. Definition used for the effect of land cover change

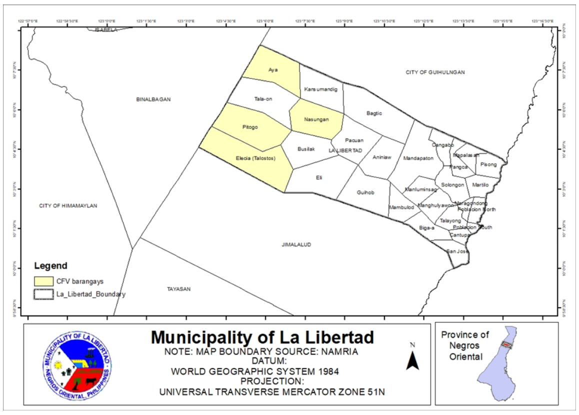
To evaluate the effectiveness of SLM practices, a "before and after" analysis was conducted using empirical data from farmer surveys and secondary sources. This approach assessed environmental (e.g., soil fertility and erosion), economic (e.g., farm income and market access), and socio-cultural (e.g., leadership and conservation attitudes) conditions prior to and following SLM implementation. Descriptive statistics were applied throughout the analysis to examine drivers (e.g., population, income, and land tenure), pressures (e.g., land use change and intensification), and the resulting impacts and benefits of SLM. These methods provided a comprehensive understanding of land degradation dynamics and management outcomes in the study area.

3. Study Area

La Libertad, Negros Oriental, one of the designated CFVs in the Philippines, serves as the study area. The CFV program adopts a participatory, community-based approach to SLM, integrating local planning, monitoring, and evaluation to enhance farming system viability and stakeholder engagement (Cruz, 2016).

The CFV initiative aims to: (1) promote SLM awareness through model farms in sloping areas; (2) strengthen stakeholder capacity for upland resource management; (3) conduct sustainability assessments to inform local planning; and (4) establish institutional linkages for research, extension, and support services. The criteria for site selection include upland location, presence of soil erosion, watershed relevance, agricultural activity, accessibility, university partnership, and LGU support.

La Libertad is a third-class municipality in northern Negros Oriental, covering approximately 17,480 hectares across 29 barangays (Fig. 3). It is bounded by Guihulngan City (north), Tañon Strait (east), Jimalalud (south), and Binalbagan in Negros Occidental (west).



Source: Clipped from the Philippines Administrative Map of NAMRIA

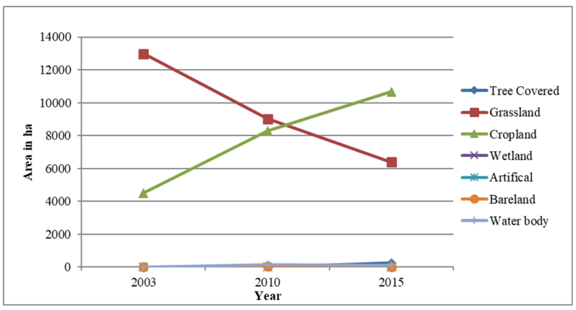
Figure 3. Map of the Municipality of La Libertad, Negros Oriental

4. Results and Findings

4.1 Driving forces and pressure of land degradation

Population growth emerged as the primary driving force contributing to land degradation in the upland areas of La Libertad. The increasing population intensified demand for land, particularly for agriculture and settlements, which in turn triggered changes in land cover. The land cover maps for 2003, 2010, and 2015 (Fig. 4) reflect this trend, showing a marked decline in grassland areas and a corresponding expansion of cropland over the 12-year period. These changes were particularly notable in barangays where upland agriculture dominates.

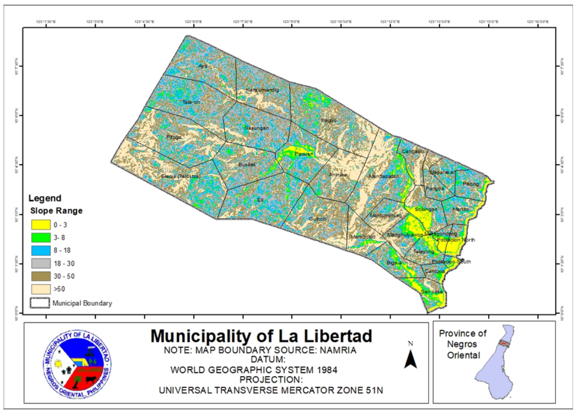
In 2003, grassland was the predominant land cover type; however, by 2010, a significant portion had been converted to cropland. According to farmer interviews, this shift was driven by the low economic returns from grassland used for livestock grazing. Despite this transition, economic outcomes remained limited—79% of farmers cultivating cropland reported household incomes below the 2018 poverty threshold (PHP 7,000/month).



Source: Land Cover Maps, NAMRIA

Figure 4. Land Cover Change from 2003-2015 in hectares of the municipality

Topographic analysis using a Digital Elevation Model (Fig. 5) revealed that a significant portion of the municipality lies within slope classes exceeding 18%, particularly in the range of 30–50%, which accounts for 26.9% of the land area. CFV barangays are predominantly located in terrain categorized as rolling to very steep (>18%), making them highly susceptible to soil erosion.

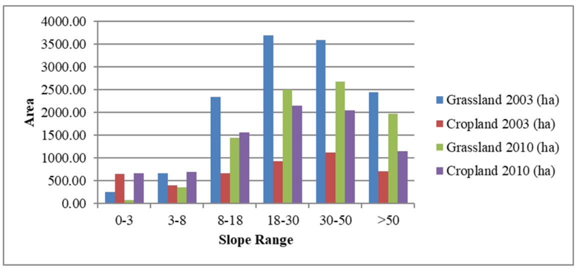


Source: NAMRIA

Figure 5. Slope Map of La Libertad

An overlay of slope and land cover data from 2003 and 2010 showed that approximately 75% of the grasslands were situated in areas with slopes above 18%. During this period, grassland cover declined by nearly 4,000 hectares, 65% of which occurred on moderately steep to very steep slopes. Simultaneously, cropland expanded by more than 3,500 hectares, with over 60% occurring on slopes above 18%. These findings indicate that the majority of land cover change occurred in areas with high erosion risk due to slope.

Ideally, croplands should be established on gently sloping terrain (3–8%), which is more suitable for cultivation and less prone to erosion. However, due to the limited availability of lower-slope areas in La Libertad, agricultural expansion has encroached on steeper, more fragile upland zones. This has significant implications for land degradation and long-term productivity.



Source: Land Cover Map, NAMRIA

Figure 6. Areas per land cover per slope range for 2003 and 2010

Figure 6 presents the distribution of grassland and cropland by slope range in 2003 and 2010, highlighting the conversion trends. While cropland expansion supports food security goals, maintaining a portion of grassland is ecologically and economically important. Grasslands serve as grazing land, water catchment zones, biodiversity reserves, cultural spaces, and potential carbon sinks that help mitigate greenhouse gas emissions (Boval & Dixon, 2012).

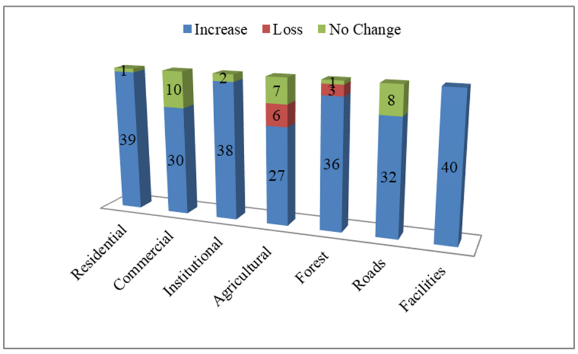
Within the DPSIR framework, land cover change—particularly the conversion of grassland to cropland and built-up areas—is recognized as the primary pressure influencing the state of the environment in La Libertad. This transformation was driven not only by agricultural demand but also by infrastructure development, such as road construction, to improve accessibility in upland barangays.

Land cover classification between 2003 and 2015 included six major categories: tree-covered, grassland, cropland, wetland, artificial surfaces, bare land, and water bodies. During this period, cropland and artificial areas (settlements and urban zones) expanded, while grasslands declined significantly.

Farmer interviews corroborated these findings. Between 2015 and 2019, all respondents observed changes in land use within their barangays (Fig. 7). These included expansions in residential, commercial, institutional, agricultural, and forest areas, along with infrastructure development. All farmers reported increases in housing and facilities, underscoring the socioeconomic pressures contributing to land degradation.

4.2 State of Land Degradation

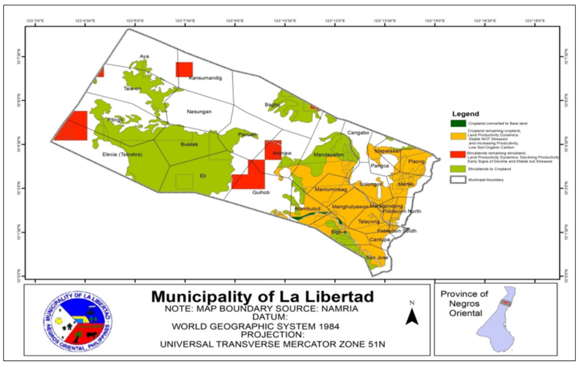
The current state of land degradation in La Libertad was assessed using three key indicators: (1) Land Cover Change (LCC), (2) Land Productivity Dynamics (LPD), and (3) Soil Organic Carbon (SOC) (Figure 8). These indicators reflect biophysical changes in land condition over time and form the basis of global frameworks such as the UNCCD's Land Degradation Neutrality (LDN) approach.



Source: Farmer Survey

Figure 7. Number of farmers who observed land use changes

Land cover change serves as a proxy for shifts in land use and vegetation cover, signaling potential degradation when beneficial ecosystem functions are lost. LPD provides insight into the long-term performance of land productivity and ecosystem functionality. Soil Organic Carbon, measured in topsoil layers per land cover class, is a critical determinant of soil fertility and the capacity to sustain biomass production. Figure 8 shows the land degradation of 2003-2010 in the municipality.



Source: Bureau of Soils and Water Management (BSWM)

Figure 8. Land Degradation Assessment 2003-2010

From 2003 to 2010, approximately 9,215.67 hectares of the municipality showed trends consistent with land degradation (Fig. 9). While some croplands remained stable and continued to be productive, other intensively cultivated areas exhibited low SOC levels, likely due to nutrient depletion associated with imbalanced fertilization. Prolonged use of chemical inputs in multi-cropping systems targeting market-oriented production has contributed to declines in soil quality, potentially leading to induced deficiencies in nitrogen, phosphorus, and zinc.

Negative trends were particularly prominent in upland barangays, where shrubland was converted into cropland, often on steep slopes. Cultivation of sloping terrain, including the planting of herbicide-tolerant corn varieties, has increased soil exposure and susceptibility to erosion.

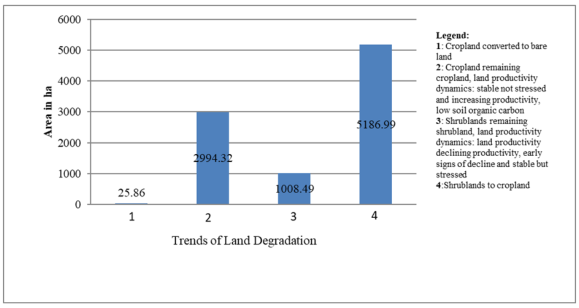


Figure 9. Areas in hectares with trends of land degradation

Findings from farmer interviews confirmed the presence of visible erosion features even before the implementation of SLM interventions. Common forms of erosion reported included rills, sheetwash, sedimentation, root exposure, and gully formation, with rill erosion being the most prevalent. Approximately 83% of respondents observed rill erosion on their farms.

To spatially analyze the distribution of land degradation, a hot spot analysis was conducted using survey and geospatial data (Fig. 10). This analysis revealed statistically significant clusters of farms experiencing land degradation (hotspots, in red) and areas exhibiting stable conditions (coldspots, in blue). These spatial patterns reinforce the concentration of degradation in specific upland areas and highlight priority zones for targeted SLM interventions.

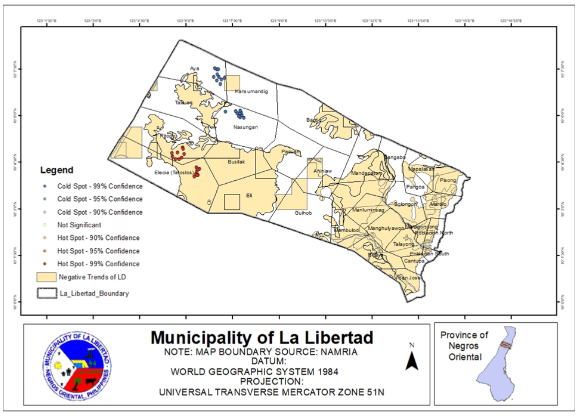


Figure 10. Land Degradation Hot Spot Analysis

4.3 Impacts of Land Degradation

The impacts of land degradation in the four upland barangays included in the study are primarily reflected in declining soil fertility and increased erosion. Soil analysis conducted in the area revealed low levels of nitrogen (N) and phosphorus (P), strongly acidic soil pH, and medium levels of potassium (K) and soil organic matter (OM) (Elauria, 2017). These fertility constraints were attributed to practices such as open burning of crop residues, continuous corn monocropping, and the conversion of forested areas to agricultural use—activities that compromise the regenerative capacity of upland soils.

Erosion resulting from vegetation loss is a critical manifestation of land degradation. In upland agricultural areas, the interplay of high-intensity rainfall, steep slopes, erodible soils, and insufficient vegetative cover accelerates soil loss. Repeated tillage and exposure of bare soil surfaces further exacerbate the problem by removing fertile topsoil essential for crop productivity (Elauria, 2017). The estimated soil erosion in the study area during the 2008–2009 period was 72.0 and 63.2 tons per hectare per year, respectively (Table 2).

Table 2. Soil loss for 2008-2009

Year	Soil erosion (tons/ha/yr)
2008	72
2009	63.2

Source: Elauria, 2017

These values significantly exceed the generally accepted tolerable erosion threshold of 10 tons/ha/year (PCAARRD, 2001) and are categorized as "very high" based on standard classification ranges (Tab. 3).

Table 3. Soil loss for erosion classes

Soil erosion class	Soil loss (tons/ha/yr)
Very Low	0-7
Moderate	13-35
High	26-37
Very High	>37

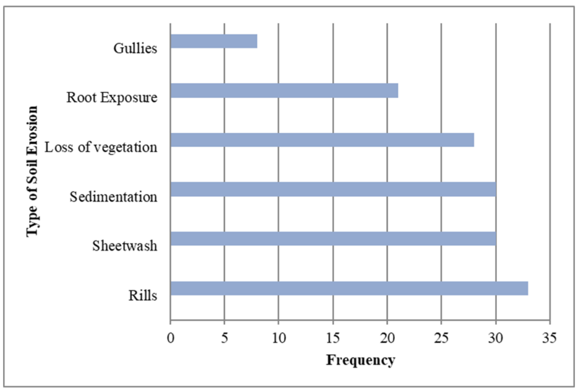
Source: BSWM, 2019

These biophysical findings are supported by qualitative data from farmer interviews. Respondents consistently reported visible signs of soil degradation prior to the implementation of SLM practices. Commonly observed erosion features included rills, sheetwash, sedimentation, root exposure, and gully formation (Fig. 11), with rill erosion identified as the most widespread. Approximately 83% of respondents noted the presence of rill erosion on their farms, indicating a widespread and long-standing issue of topsoil depletion in the study area.

4.4 Response to Land Degradation in Upland Areas

The impacts of land degradation in La Libertad, particularly the decline in soil fertility and increased soil erosion, have led to reduced crop productivity and farm income. In response to these challenges, SLM technologies were introduced in the upland barangays through technical assistance from the Department of Agriculture.

The primary aim of implementing SLM practices was to enable farmers to maintain agricultural productivity while restoring and conserving soil health. According to the Bureau of Soils and Water Management (2019), SLM interventions are categorized into: (1) agronomic measures (e.g., conservation agriculture, composting, mixed cropping, mulching); (2) vegetative measures (e.g., grass strips, agroforestry, hedge barriers); (3) structural measures (e.g., terraces, bunds, palisades, and other erosion control structures); (4) management measures (e.g., land use change, rotational grazing); and (5) combinations of the above, where synergistic effects are expected.



Source: Farmer Survey

Figure 11. Soil Erosion Observed

Farmers were encouraged to adopt context-appropriate technologies based on the biophysical characteristics of their farms and their socioeconomic conditions. Recommended practices included contour hedgerows, sloping agricultural land technologies (SALT) with integrated livestock components, natural vegetative strips (NVS), composting, and other agroforestry and water conservation measures (Elauria et al., 2017).

Analysis of adoption patterns showed that land tenure significantly influenced SLM uptake. A majority of SLM adopters were owner-cultivators, suggesting that tenure security plays a critical role in encouraging long-term investments in soil conservation. This observation aligns with prior findings that secure land tenure is positively associated with conservation adoption (Briones, 2004; Rola et al., 2004; Lapar & Pandey, 1999). Survey results indicate that nearly 70% of farmers who implemented SLM interventions in the barangays of Aya, Elecia, Nasunggan, and Pitogo were landowners.

The municipality of La Libertad, recognizing the severity of land degradation, supported the promotion and diffusion of SLM technologies. This initiative contributed to increased farmer motivation and improved knowledge and capacity for SLM implementation (Tab. 4).

Table 4. Motivations of the Farmers in the Implementation of SLM Technologies

Motivations of farmers in the adoption of SLM technologies	Number of farmers	% Total of farmer respondents
Increased production	35	88%
Prevention of land degradation	29	73%
Enhanced SLM knowledge and skills	22	55%
Increased profitability	19	48%
Environmental consciousness	16	40%
Rehabilitation of denuded land	15	38%
Payment/Subsidies	6	15%
Affiliation to movement/project/group	1	3%

Source: Farmer Survey

Findings from interviews with 40 farmers showed full adoption of contour hedgerows, with 72.5% also implementing contour rock walls. Other frequently used practices included natural vegetative strips, contour fencing, mulching, multistorey cropping, and vermicomposting. These practices collectively contributed to reducing erosion, improving soil fertility, and enhancing farm sustainability.

4.5 Impacts of SLM

4.5.1 Environmental Impact

The environmental impacts of SLM interventions in the CFVs of La Libertad, Negros Oriental, were evaluated using biophysical indicators such as soil fertility, soil erosion rates, and land cover change. According to Elauria et al. (2017), there was a measurable improvement in soil potassium levels during the 2008–2015 period. However, no significant changes were observed in nitrogen, phosphorus, soil organic matter (SOM), or pH levels. This stagnation was attributed to the limited adoption of organic farming practices and the low application of soil amendments, which constrained soil nutrient replenishment. Additionally, while soil erosion rates declined overall, erosion remained present in some model farms.

Prior to the implementation of SLM technologies, soil losses were recorded between 41.1 and 67.6 tons/ha/year—exceeding the Philippine standard for tolerable erosion, which is set at less than 10 tons/ha/year (PCAARRD, 2001). Following the implementation of SLM, soil erosion was significantly reduced, with rates ranging from 8.5 to 11.9 tons/ha/year. Barangay Aya, in particular, demonstrated erosion levels below the tolerable threshold, indicating the effectiveness of SLM practices in reducing degradation.

Land cover change (LCC) analysis from 2010 to 2015 was conducted to assess improvements in vegetation and land use. The results revealed that the majority of the land area across the four barangays—Aya, Elecia, Nasunngan, and Pitogo—was either stable or improving, with 53.20% identified as stable and 28.54% as improved. In contrast, only 18.26% (729.80 ha) of the total land area remained classified as degraded (Figure 12).

A comparative analysis of the total area with land degradation trends showed a marked reduction from 9,215.67 ha in 2003–2010 to 5,150.75 ha in 2010–2015 (Fig. 13). This reduction may be attributed to the combined effects of the CFV interventions and national reforestation initiatives, such as the Department of Environment and Natural Resources' National Greening Program (NGP), which contributed to forest cover restoration. Figure 13 shows a comparison of trends in land degradation from 2003-2010 and 2010-2015.

Qualitative data further supported these findings. Farmers interviewed reported noticeable improvements in soil fertility, vegetative cover, and water availability (Figure 14).

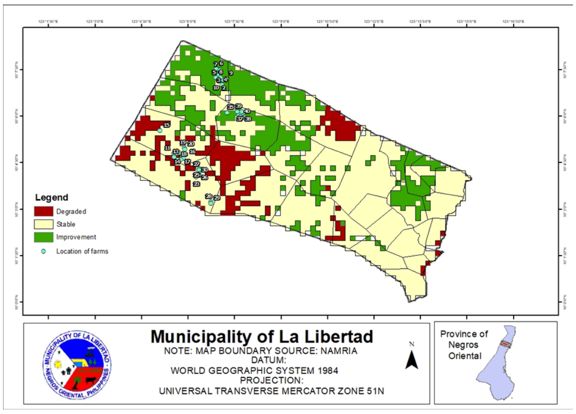
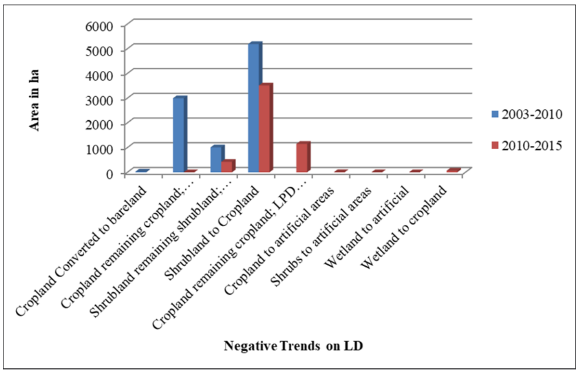


Figure 12. Land Cover Change Assessment 2010-2015 of La Libertad



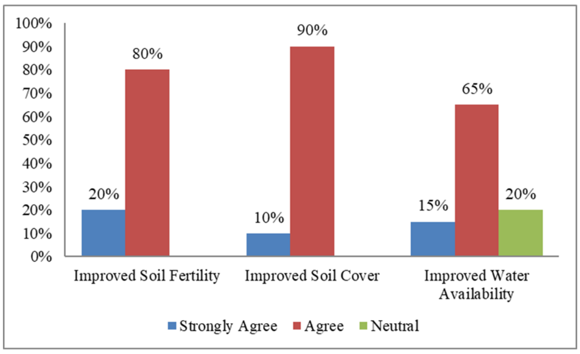
Source: BSWM, 2019

Figure 13. Comparison of Trends of Land Degradation for the periods 2003-2010 and 2010-2015

These perceptions align with the observed reductions in soil erosion and land degradation, suggesting that SLM interventions were successful in enhancing environmental conditions. Key informant interviews echoed these observations, citing improved ground cover and reduced soil loss as primary environmental benefits of SLM implementation.

4.5.2 Economic Impact

Table 5 records the number of farmers in the municipality from 2012 to 2015. The number of farmers in La Libertad is seen as slightly decreasing from 2012 to 2015. It is primarily due to the aging of existing farmers and the migration of the younger generation to other places to seek greener pastures. Most of the children of the farmers sought employment in Cebu because of the booming construction industry in Region VII.



Source: Farmer Survey

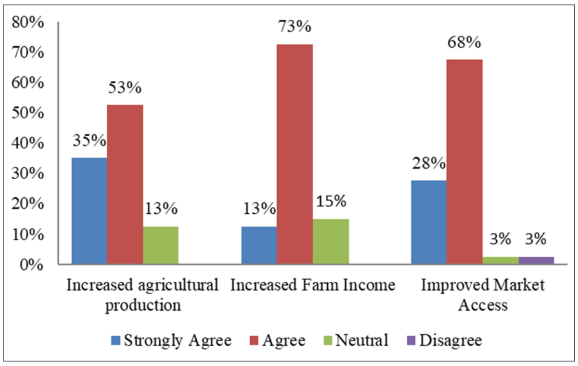
Figure 14. Farmers' perception of environmental impact of SLM

Table 5. Number of farmers in La Libertad from 2012 to 2015

2012	2013	2014	2015
4,500	5,000	5,500	6,500

Source: CLUP 2019-2028, La Libertad

The primary source of income for farmers in La Libertad is corn production, largely for subsistence. The implementation of CFV interventions, which promoted SLM practices, led to notable improvements in agricultural productivity and household income. Survey results revealed that 35% of farmers strongly agreed and 53% agreed that their agricultural production increased (Fig. 15). This rise in productivity was attributed to the expansion of cultivated areas and the adoption of diversified farming systems, including continuous cropping. Such diversification was perceived as essential for enhancing overall farm output.



Source: Farmer Survey

Figure 15. Farmers' perception of the economic impact of SLM

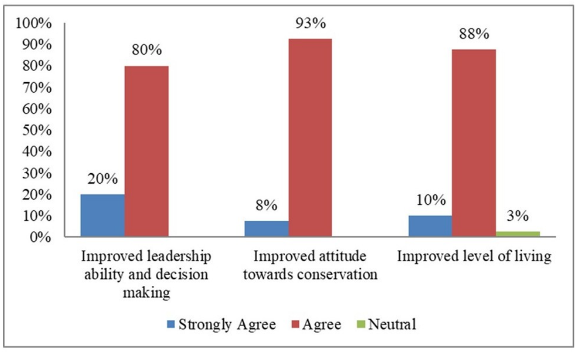
SLM practices directly contributed to increased farm income. According to local data, the average monthly income of farmers rose from Php 4,500 in 2012 to Php 6,500 in 2015 (CLUP 2019–2028, La Libertad). A study by Elauria (2017) further reported that net returns increased from Php 15,555.77 to Php 25,043.85 per hectare among ten CFV farmer volunteers. Farmers cultivating high-value vegetable crops within CFV areas experienced higher income gains compared to those in non-CFV sites. Overall, 13% of respondents strongly agreed and 73% agreed that their income improved due to CFV interventions. Profitability was also a motivating factor for the adoption and continued use of SLM technologies. Farmers using Flemingia hedgerows, for example, sold seeds to the LGU for added income, enhancing livelihood resilience. Increased incomes from SLM allowed farmers to support education and acquire household assets, improving their standard of living.

Improved market access was a key economic benefit of the CFV program. About 96% of farmers agreed access had improved, facilitated by LGU initiatives such as the "Paunay sa Libertad" transport service and trading posts in barangays like Aya and Nasunngan. Partnerships with groups like the AFOS Foundation also supported the marketing of high-value, organic crops. As a result, 70% of farmer volunteers reported better market access after CFV implementation.

4.5.3 Socio-cultural Impact of SLM

The implementation of SLM technologies in the upland communities of La Libertad had notable socio-cultural impacts, particularly in terms of leadership development, conservation attitudes, and perceived improvements in household well-being.

All farmer respondents (100%) reported enhanced leadership capacity and improved decision-making skills (Fig. 16). This was demonstrated by their active involvement in farmer organizations, where many assumed leadership roles following SLM training and implementation. These organizational structures have fostered stronger social networks, allowing for mutual support and more efficient dissemination of agricultural knowledge and technologies. The formation of these networks represents a vital form of social capital, contributing to sustained engagement with soil conservation practices. Elauria (2017) similarly reported that 80% of respondents in a related study perceived improvements in their leadership abilities and decision-making processes as a result of SLM interventions.



Source: Farmer Survey

Figure 16. Farmers' perception of the socio-cultural impact of SLM

The entire sample of respondents also indicated a positive shift in their attitude toward conservation. They recognized the importance of soil and water conservation in preventing environmental degradation, particularly soil erosion. Many expressed a willingness to share the knowledge they acquired with other farmers in their communities who had not yet adopted SLM practices, reflecting a communal approach to environmental stewardship and peer-based knowledge diffusion.

A majority of respondents perceived improvements in their living standards following the adoption of SLM practices. They reported enhanced food security due to increased crop yields and improved farm productivity. The additional income generated was utilized to support educational needs, improve household infrastructure, and acquire essential farm tools and equipment. Key informant interviews reinforced these perceptions, highlighting the role of SLM in strengthening community institutions, enhancing the well-being of vulnerable groups, and increasing awareness of soil conservation strategies.

Figure 17 illustrates the socio-environmental dynamics influencing land degradation and the corresponding impacts of SLM interventions. During the baseline period, population growth and land cover change—particularly the conversion of grassland to cropland—exacerbated soil erosion and fertility decline. The introduction of SLM practices in 2010 contributed to reversing these negative trends by mitigating soil erosion and improving land productivity.

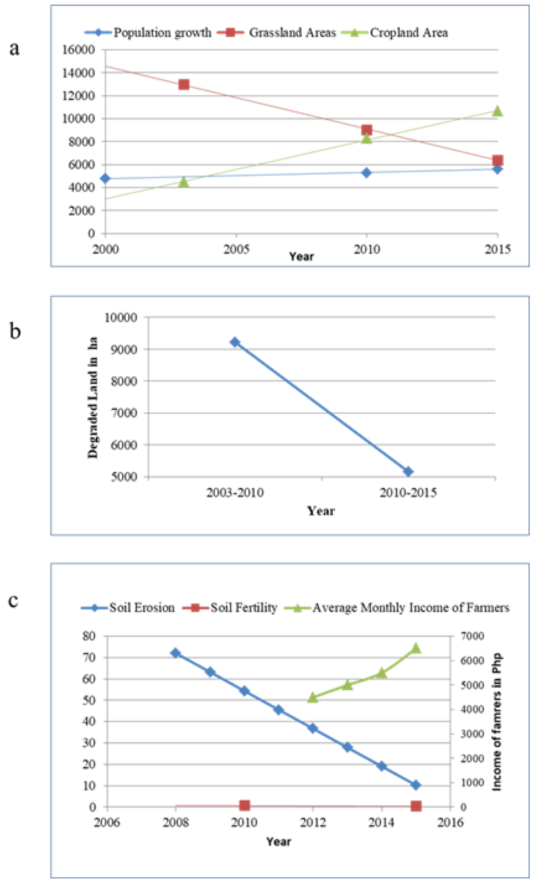


Figure 17. Summary of the various factors used for the DPSIR Framework: (a) Driver and Pressure; (b) State of Land Degradation; and (c) Impacts of Land Degradation and SLM

4.6 Mainstreaming of SLM in Land Use Planning

The Integrated Land Management and Framework Planning (ILMFP) process, as outlined in the national guidebook for mainstreaming SLM in the CLUP, provides a systematic approach to integrating land degradation concerns into local planning. The five primary steps include: (1) defining objectives and scope; (2) assessing land resource status; (3) identifying management issues; (4) preparing and implementing the management plan; and (5) establishing a monitoring and evaluation framework. This approach was applied in the municipality of La Libertad, Negros Oriental.

1. Setting the Objectives, Scope, and Limitations

The scope of the land management plan focused on upland barangays with a high dependency on agriculture. These areas were identified as vulnerable to land degradation due to their steep slopes and intensive farming practices.

2. Resource Assessment

a. Physical and Economic Profile. This included spatial and demographic information such as land cover classification, topographic slope data, population density, average household income, and

b. Farmers' Profile. Information collected through farmer surveys included farm size, land tenure arrangements, and sources of household income (on-farm, off-farm, and non-farm).
c. Land Degradation Types. Information collected through farmer surveys included farm size, land tenure arrangements, and sources of household income (on-farm, off-farm, and non-farm).
d. Financing SLM Allotment and Mobilization of funds. Local ordinances passed by the Sangguniang Bayan institutionalized CFV in the development and investment plans of the municipality. Funding was sourced from the Internal Revenue Allotment (IRA) and supplemented by a partnership with the AFOS Foundation of Germany under the OURFood project, which aimed to support food security and GAP compliance.
e. Monitoring and Evaluation of SLM Projects:

Monitoring and evaluation involved a comparative analysis of pre- and post-intervention conditions. Environmental indicators included soil fertility, erosion rates, and land cover stability. Economic outcomes were assessed based on changes in productivity, farm income, and market access. Socio-cultural effects focused on leadership development, decision-making, conservation attitudes, and overall improvements in quality of life. These were assessed using a combination of structured interviews, secondary LGU data, and spatial tools.

A summary of these steps, including stakeholder roles, data sources, and decision-making processes, is illustrated in Figure 18.

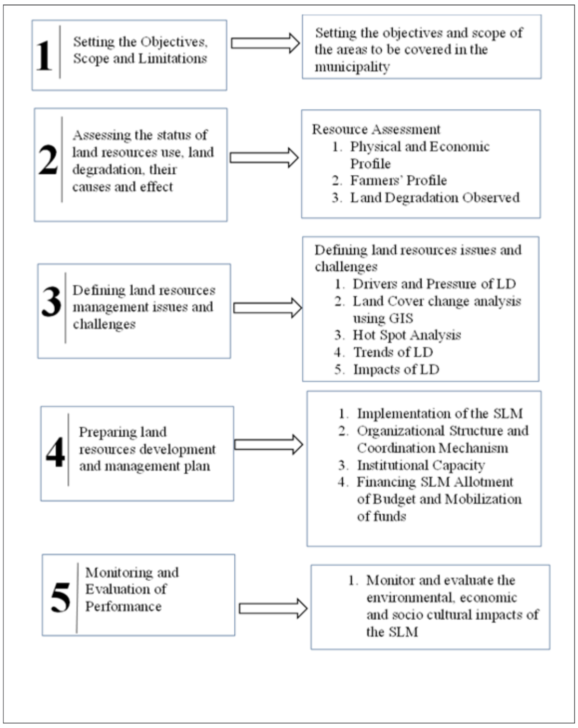


Figure 18. Summary of the steps in mainstreaming SLM in land use planning

4.7 Implications for Broader Application

The La Libertad case study provides valuable insights for upland land use planning and SLM implementation in similar agro-ecological contexts in the Philippines. It highlights the effectiveness of integrated, participatory, and site-specific approaches that combine scientific assessments with local knowledge. The CFV model demonstrates how community-led efforts, when supported by local government, can address land degradation while enhancing livelihoods. Key strategies such as using open-source geospatial tools and mainstreaming SLM into local planning instruments (e.g., CLUP and ILMF) offer a cost-effective and scalable pathway to sustainability. This localized, multi-stakeholder approach serves as a practical reference for policy and program design aiming to align environmental, social, and economic objectives.

4.8 Limitations

While the study presents a successful case of SLM application, its findings are context-specific and may not fully capture the diversity of upland conditions elsewhere. The assessment relied in part on farmers' perceptions, which, although valuable, may introduce subjectivity. Data limitations also restricted long-term biophysical monitoring of land degradation trends. Additionally, the sustainability of outcomes beyond the project period remains uncertain without continued institutional support and financing. These limitations suggest the need for further studies across varied settings and longer timeframes to validate and adapt the model for broader application.

5. Conclusion and Recommendations

This study examined the drivers, pressures, and impacts of land degradation in La Libertad, Negros Oriental, and evaluated the role of SLM interventions using the DPSIR framework. The results identified population growth, steep slopes, insecure land tenure, and low household income as the principal drivers of land degradation. These factors exerted pressure primarily through land cover changes, contributing to environmental degradation manifested in declining soil fertility and increased soil erosion.

In response, the local government implemented SLM practices in upland barangays through the CFV program. The findings indicate that SLM interventions led to measurable environmental improvements, including reduced erosion rates and improved land cover conditions, alongside positive socioeconomic and cultural outcomes such as enhanced leadership skills, stronger community networks, and perceived improvements in household well-being.

Furthermore, this study proposed and applied steps for mainstreaming SLM in local land use planning through the Integrated Land Management Framework, offering a model for future planning interventions in similar agro-ecological settings. To support the long-term effectiveness and sustainability of SLM efforts, the following recommendations are proposed:

1. Institutionalize Monitoring and Evaluation Systems. Regular monitoring of SLM outcomes is necessary, particularly with respect to soil fertility. Despite observed improvements in some parameters, levels of nitrogen, phosphorus, and organic matter remain suboptimal. Monitoring should integrate both field-based assessments and remote sensing tools to accurately capture temporal changes.
2. Establish Clear Guidelines for Grassland Conversion. Policy guidance is needed to regulate the conversion of grassland areas into croplands. While some idle grasslands offer agricultural potential, their overuse may lead to further degradation. A portion of these lands should be retained for their ecological functions, including livestock grazing, water regulation, biodiversity conservation, and carbon sequestration (Boval & Dixon, 2012).
3. Strengthen Land Use Planning through CLUP Integration. The Comprehensive Land Use Plan (CLUP) should delineate specific zones for protection, agricultural development, and community use within critical watersheds such as the Pacuan watershed. This will help prevent the unregulated expansion of agricultural activities into ecologically sensitive areas.
4. Utilize Degradation Trends as Baseline Data: The trends in land degradation identified for the periods 2003–2010 and 2010–2015 can serve as baseline indicators for future planning, prioritization of SLM interventions, and impact evaluation.
5. Validate National Land Cover Maps for Local Applications: National datasets, such as those from NAMRIA, require validation when applied at the municipal scale. Although accurate at the provincial level, further ground-truthing is essential to ensure reliability for localized land use planning and resource management.
6. Expand Research on Land Use–Degradation Linkages: Further studies are recommended to explore the specific interactions between land use patterns and the underlying drivers of land degradation. This includes assessing how socioeconomic and institutional factors influence land management decisions at the household and community levels.
7. Future research could explore how technological innovations—such as satellite-based monitoring, participatory GIS, and mobile data platforms—can support enforcement, monitoring, and adaptive management in rural areas. There is also a need to better understand the institutional and behavioral dimensions of sustained adoption, particularly the role of community norms, farmer networks, and tenure security in maintaining SLM gains over the long term.

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