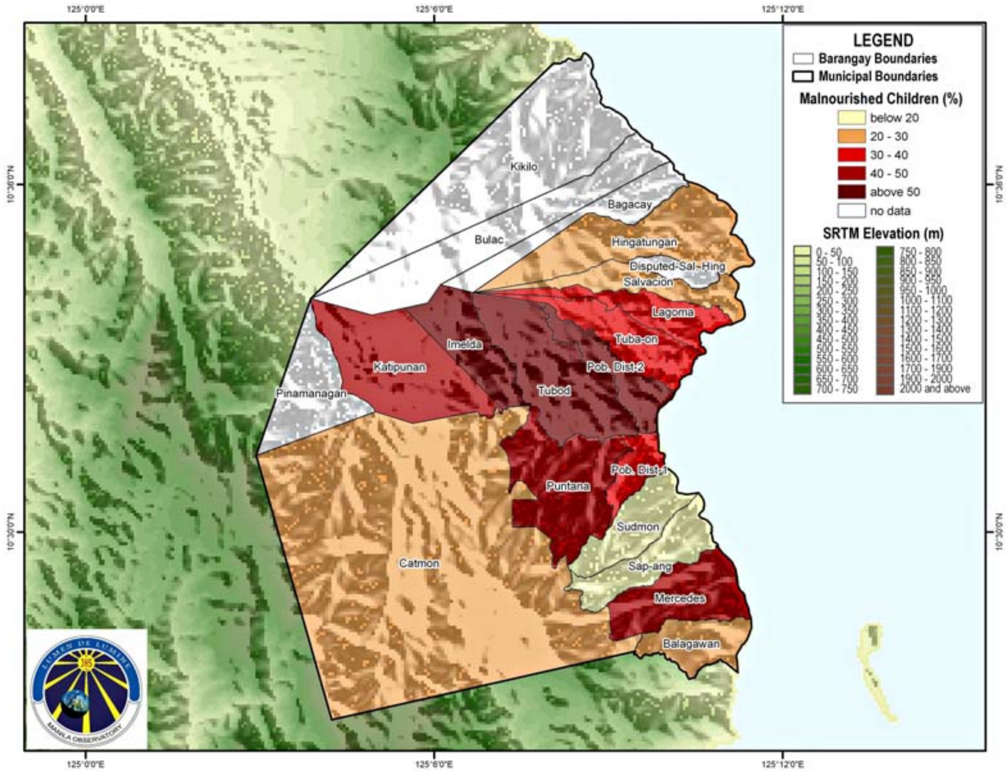

Figure IX.4. *Malnourished children in Silago in 1999 per barangay expressed as a percentage of the population 14 years old and below. (Data taken from Silago CLUP (MPDO, 2010). Source of data cited in the CLUP is from RHU Silago). . (Map Data Source: Shuttle Radar Topographic Mission version 4 (Feb. 2000)).*

While there are pre-existing vulnerabilities in Silago, it is important to note as well existing measures or programs that may be indicators of resilience and better capacity to adapt to the negative impacts of future climate change. In the forestry sector, for example, there were forestry programs in barangays Catmon, Katipunan, Imelda, and Puntana. Note that Catmon and Katipunan are projected to have higher increase in temperatures compared with the other barangays in Silago (Figure IX.5). For the agricultural sector, the Municipal Ecological Profile also enumerates agricultural support facilities that are being implemented per barangay. Production support facilities include Farm to Market roads, solar driers, rice, corn, vegetable seeds and fruit trees seedlings, fertilizers and fertilizer loans among others (MPDO, 2009). There are also irrigation systems in place in Silago. There are communal irrigation systems in Hingatungan, Salvacion, and Laguma and a communical irrigation project in Pob Dist II that may help alleviate the adverse impacts of rainfall decrease in these barangays. The strategic agriculture and fisheries development zones (SAFDZ) in Silago are shown in Figure IX.6. Barangay Catmon, which will have greater temperature impacts is essentially a primary forestry/watershed zone. Major portions of Katipunan, however, which will have the same temperature impacts as Catmon, are agro-industrial zones and more than a fourth of the barangay are forestry/watershed zone. Many food crop zones are located along the coastal region, for example Hingatunan and Salvacion where decrease in rainfall are relatively stronger. With these development zones, the projected climate impacts in this study maybe used to enhance and/or support the effectivity of defining the specific zones in Silago.

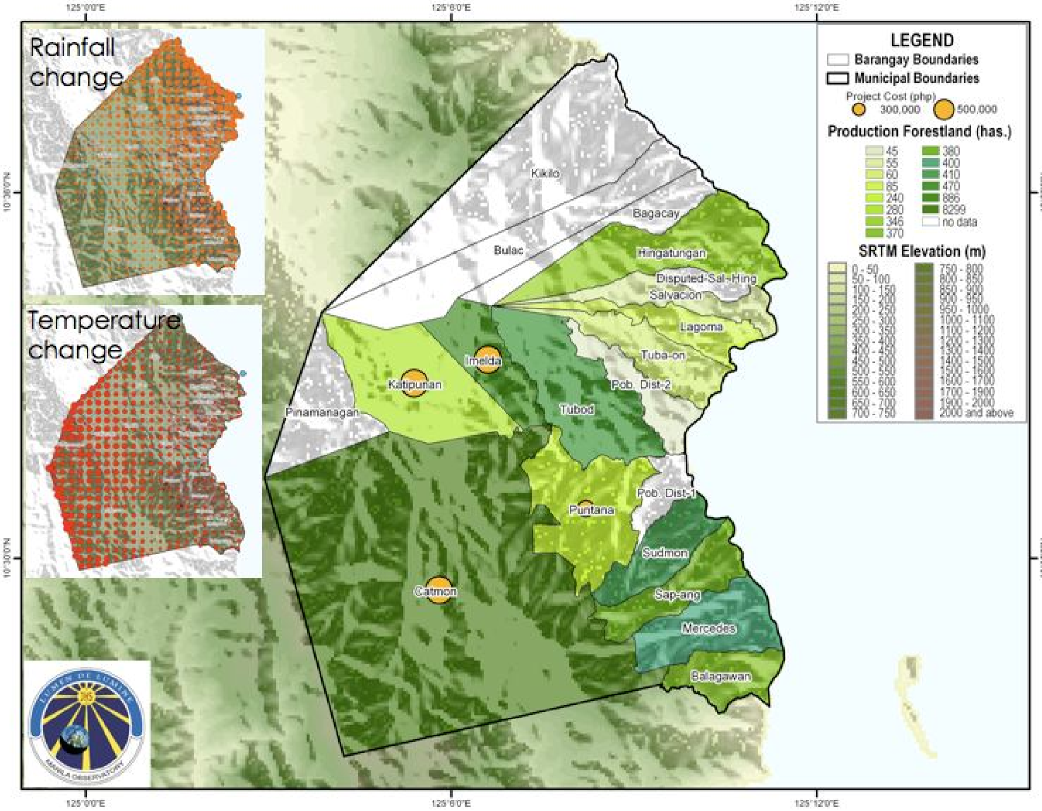

Figure IX.5. *Forestry programs and projects in Silago. . (Map Data Sources: Shuttle Radar Topographic Mission version 4 (Feb. 2000), Temperature and Rainfall Anomalies RCS-MO)*

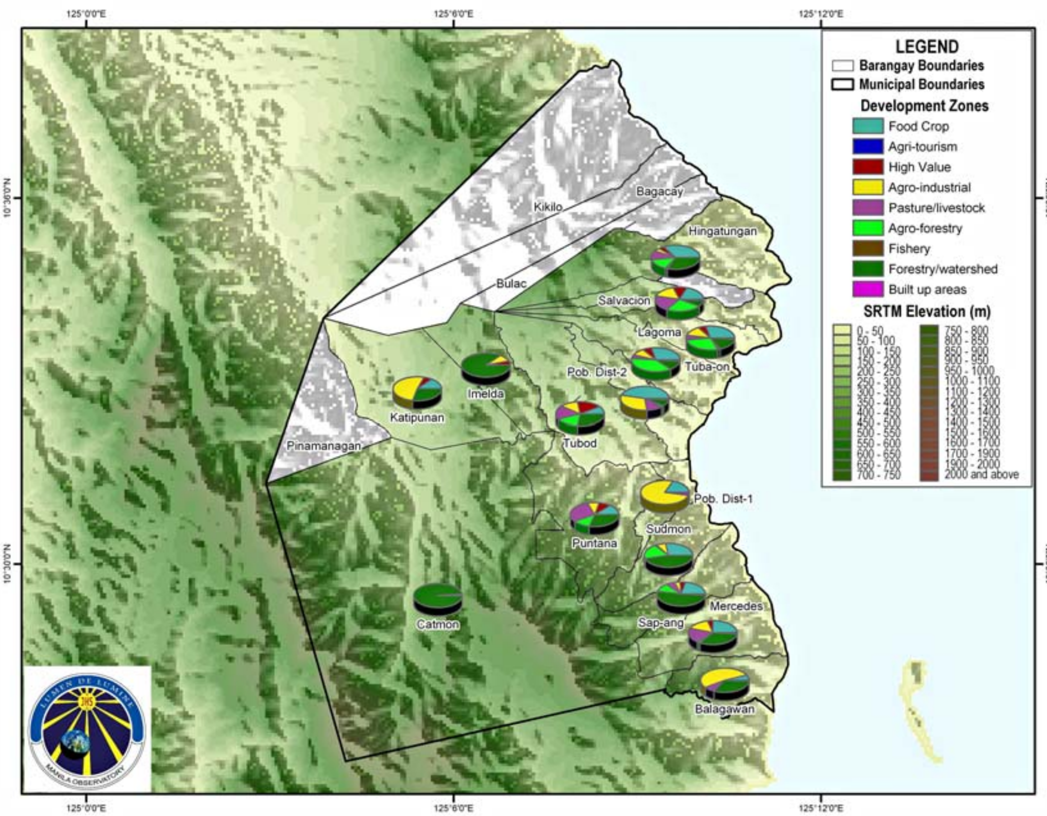

Figure IX.6. *Strategic agriculture and fisheries development zones in Silago. (Data taken from the Silago CLUP (MPDO, 2010)). . (Map Data Source: Shuttle Radar Topographic Mission version 4 (Feb. 2000)).*

Table IX.1 provides a qualitative assessment and summary of the projected impacts and exposure/vulnerability indicators for the different barangays in Silago. There are three qualitative categories of impacts and vulnerability: very high, high, and mid. Very high means that the barangay experiences the greatest climate change impact (categories colored in blue) or the greatest sectoral impact due to climate change (categories colored in orange) or the highest vulnerability/exposure indicator (categories in green). The barangays highlighted in red are the top six barangays that are more at risk to the projected impacts of climate change based on the data collected and the results and analysis of this study. The barangays are Hingatungan, Salvacion, Lagoma, Poblacion District 2, Poblacion District1, and Katipunan. Based on the table, Hingatungan, which is a coastal barangay, is particularly at risk because of very high and high climate change impacts on rainfall decrease and sea level rise, respectively, very high climate impacts on rice production, and high population density. The inland barangay of katipunan on the other hand is more at risk due to very high increase in temperature, very high impacts on rice (given the proportion of non-irrigated rice and the combined impacts of warming and decrease in rainfall), high temperature impacts on forest, and high percentage of malnourished children. The relatively high risk to climate change in Poblacion District 2 is mainly due to exposure/vulnerability indicators. Poblacion District 2 has a very high population density and very high cases of malnourished children and these combined with high rainfall impacts on rice, and high climate hazards in terms of sea level rise and rainfall decrease puts the barangay at a relatively greater risk compared with the other barangays. It is important to note though that these assessments are qualitative and are very much reliant on 1) the projected climate changes using a particular regional climate model and scenario and 2) on the available data obtained for this study.

Table IX.1. *Qualitative assessment of climate impacts and exposure,vulnerability indicators per barangay in Silago.*

Barangay	Tmp Inc	Rain Dec	Sea level rise	Tmp Impact Rice	Rain impact Rice	Tmp Impact Forest	Population Density	Malnourished Children	Irrig	Forestry Programs
Kikilo	-	High	-	-	-	-	-	-	-	-
Bulac	High	High	-	-	-	-	-	-	-	-
Bagacay	-	High	-	-	-	-	-	-	-	-
Hingatungan	-	**Very high**	**High**	**Very high**	**Very high**	Mid	**High**	-	CIS	-
Salvacion	-	**Very high**	**High**	**Very high**	**Very high**	-	Mid	Mid	CIS	-
Lagoma	-	**Very high**	**High**	**High**	**High**	-	Mid	**High**	CIS	-
Tuba-on	-	High	-	-	-	-	-	High	-	-
Pob Dist 2	-	**High**	**High**	**High**	**High**	-	**Very high**	**Very high**	CIP	-
Tubod	Mid	Mid	Mid	-	High	Mid	-	Very high	-	-
Pob Dist 1	-	Mid	**Very high**	**High**	**High**	-	**Very high**	**High**	-	-
Puntana	-	-	-	-	-	-	-	High	-	Yes
Sudmon	-	Mid	High	Very High	High	-	-	-	CIS	-
Sap-ang	-	Mid	High	-	Mid	-	-	-	CIP	-
Mercedes	Mid	Mid	High	-	Mid	-	Very high	High	-	-
Balagawan	Mid	Mid	High	-	Mid	-	High	Mid	-	-
Catmon	Very high	-	-	-	-	High	-	Mid	-	Yes
Katipunan	**Very high**	-	-	**Very high**	-	**High**	-	**High**	-	**Yes**
Pinamanagan	Very high	-	-	-	-	Very high	-	-	-	-
Imelda	High	Mid	-	-	-	Mid		Very high	-	Yes

E. Integration in Climate Change: Cross-Sector Relationships

Impacts, Vulnerability and Risks

The term 'integration' in climate change Vulnerability and Adaptation (V & A) assessments refers to a coordinated and holistic approach to the development and the implementation of adaptation options or strategies. When considering integration in the context of V & A, the interaction of various climate change impacts across sectors or within a particular area needs to be considered. Integration can also be useful for examining total vulnerabilities to climate change[7]. Cross sector integration links two or more related sectors, models relationships and promotes thinking about the cross-cutting implications of climate change. Figure IX.7 below gives us a schematic overview of this relationship among sectors under assessment.

Figure IX.7. *Simple Schematic Diagram of Qualitative Cross-Sector Relationships. (Adapted from "UNFCCC: Handbook on vulnerability and adaptation assessment").*

Integration is important because impacts do not happen in isolation; they can adversely or positively affect one sector or another. Some sectors maybe affected directly, indirectly or can offset the effect of climate change in another sector. Quantitative integration is necessary for ranking vulnerabilities and adaptations for prioritization.

For Silago, integration was done thematically by sectors for all barangays; using the results presented in the influence diagrams and qualitative vulnerabilities presented in Table IX.I. With reference to Figure IX.7, the integrated vulnerability of Silago is presented in Figure IX.8.

[7] UNFCCC,2008 Resource Guide: Module 2: Vulnerability and Adaptation to Climate Change

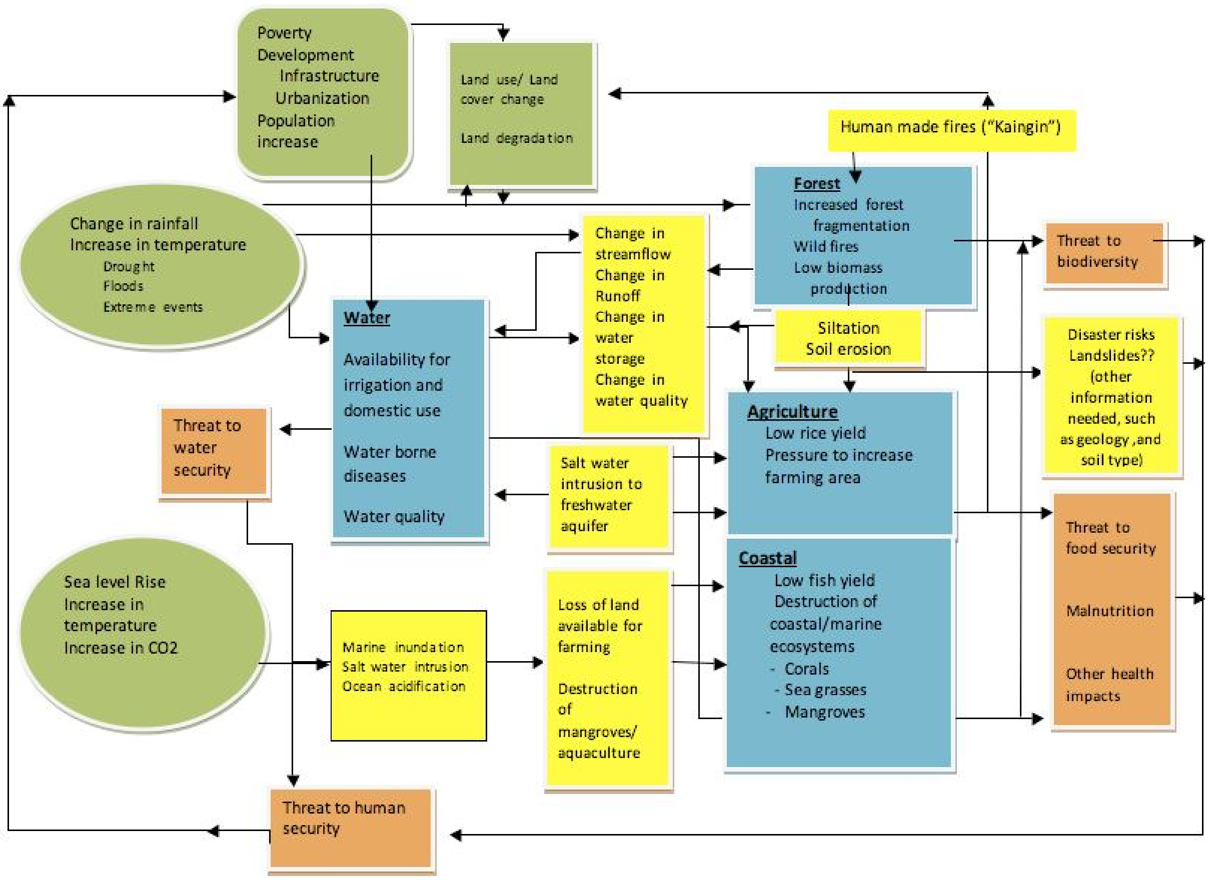

Figure IX.8. *Integrated risks and vulnerability assessment of Silago.*

The green objects are primary physical and socio-economic (oval and rounded square) and secondary (box) drivers of vulnerability. The physical drivers consist of changes in the climate parameters such as rainfall and temperature. Other factors are sea level rise and increase in carbon dioxide emissions. The socio-economic drivers such as poverty (26% of total number of households are below the poverty threshold), development and population increase are only indicative. Other factors may exist in reality but were not available to the study team at the time. The green box contains the secondary drivers as a result of the biophysical and socio-economic baseline. Because of economic reasons, there is a need to till the land for agriculture, use forestry resources for livelihood, particularly the less fortunate ones, hence land cover change occurs. Because of conversion, probably due to infrastructure development (such as road construction) and urbanization, there is land use change. All of these drivers directly affect the sectors under the study: forestry, water, agriculture and coastal (in blue boxes). In the analyses, it appears that water is the most limiting sector and can be directly linked to hydro-meteorological and environmental changes. The yellow boxes are biophysical impacts while the orange boxes represent the general risks or threats.

While water availability is still not yet a challenging issue in Silago at the moment, human activities such as land conversion, increase in temperature, and changes in rainfall patterns can affect the regeneration rate of water aquifers in the future. Different water users such as in the domestic and in the agriculture may compete for fresh water. Agriculture, the largest water user will be greatly affected. Pressure to convert more upland areas into farm land could happen because lower rice yields and loss of coastal agricultural lands due to marine flooding when sea level rises. Further land use conversion will continue to pose threat to the forest sector. Forest will respond naturally by shrinking and further fragmentation would occur. Long period of droughts followed by very wet rainy season could lead to soil erosion and siltation of waterways. Water pollution and waterborne pathogens will affect the available safe water for consumption, thereby posing a threat to water security and health. As Silago is within the vicinity of areas where landslides have previously occurred, it would be good to seek more information on the matter. Certainly, the silts and debris will be carried downstream to the coastal areas, where these can affect the coastal ecosystems particularly sea grasses. Turbidity and sea level rise may cause mangroves and corals to "drown"[8]. Municipal and subsistence fishers will be most affected as they will have low fish catch if there is at all. Clearly, unless acted upon, this is a large threat to food security together with decrease agricultural productivity, can cause malnutrition and compound other health impacts. Loss of upland forests due to various reasons, including climate change and loss of coastal ecosystems due to sea level rise and ocean acidification, are threats to biodiversity. All these risks, if not attended to are threat to human security over all, and may perpetuate poverty and misalign development efforts.

Responding to present and futures threats

Identification of adaptation options is a logical step after an integrated analysis of vulnerability, impacts and risks. The study team provide general measures for the sectors that are found in adaptation literatures. Aside from those, some recommendations were also given for the specific sectors. Table IX.2 provide additional analyses[9] as to the potential of these strategies to enhance the social or community cohesion /cooperation, potential for disaster risk reduction, particularly flooding and landslides, sand nutrition. Technological viability and costs are also used where applicable.

While the water and agriculture sectors noted that irrigation infrastructure should be put in place to address the water needs of the Municipality, this should be taken in the context of integrated approach. Building large irrigation infrastructure may help in storing water for future needs and can serve as flood control structures as well. Cost wise, it is very expensive to build. It may also prevent or cut off nutrients downstream, which is detrimental for the health of coastal ecosystems. As such, these irrigation facilities should continue the nature

[8] Marine scientists say that sediment loading and heavy rainfall events can literally drown and kill mangroves. Source: (http://www.epa.qld.gov.au/wetlandinfo/site/factsfigeures/FloraAndFauna/Flora/mangroves/mangrove dieback.html). For corals, there is a critical depth or rate of sea level rise that usually lead to coral drowning. See, for example: Grigg, R. W. and D. Epp, 1989: Critical Depth for the Survival of Coral Islands: Effects on the Hawaiian Archipelago, Science 3 February 1989: Vol. 243 no. 4891 pp. 638-6412004: DOI: 10.1126/science.243.4891.638

[9] Methodology was used in the Vulnerability and Adaptation Assessment Component, Second National Communication, 2010.

of current structures: small and communal but should be distributed strategically in order to service more users.

With or without climate change, social and health services must be continued by the LGU to uplift the living conditions of the residents, create more sources of livelihood to broaden economic opportunities and lessen dependency on single agricultural crop alone (e.g., rice). This is a way to increase adaptive capacity of the people, along with health, education and general well being.

Generally, most of the recommended adaptation strategies in Table IX.2 are geared towards the improvement or enhancement of the adaptive capacity of the people. Adaptation activities currently being undertaken are listed in Table IX.3, which also includes suggestions for actions. For if ever the leaders in Silago expect transformative results, new information, including appropriate climate change and socio-economic scenarios, is essential.

Table IX.2. *Assessing Adaptation Potential*[a]

Proposed Adaptation Strategies	Potential for					Technological viability	Estimated Cost
	Enhancing social cohesion	Increasing disaster risks reduction	Improving adaptive capacity	Generating livelihoods	Improving health and nutrition		
Forest sector							
Erosion control measures		X	X		X	X	Medium
Agroforestry	X		X	X			Medium
Community-based forest management REDD	X		X	X		X	High
Water Sector							
Irrigation infrastructure		X	X			X	Medium to high
Rainwater harvesting			X		X	X	Low to high
Agriculture							
Planting appropriate rice varieties			X	X	X	X	Low to Medium
Improved farm production	X		X	X	X	X	Low to high
Switch to cash crops[b]	X		X	X	X		
Post harvest/Storage [b]facilties		X	X	X	X	X	Medium to high
Financial management systems	X	X	X			X	Low to medium
Irrigation systems		X				X	
Coastal Sector[b]							
Integrated coastal management	X	X	X	X			Low to medium
Marine protected areas	X	X		X		X	Medium
Mangrove reforestation		X			X	X	Medium

[a] Methodology adapted from Perez and Taylor, 2010: Integrated V and A for the Second National Communication (Unpublished)

Table IX.3. *Existing adaptation initiatives.*

Adaptation Measures	Current Practices / Recommended Additional activities	Remarks:
Erosion Control	Use of coconut husks and coconut-derived geotextiles across slope contours to control soil erosion	Need to evaluate the effectiveness of such method, and the areal coverage – is it enough? Additional technical information needed
Agroforestry	To go into rubber tree plantation.	Rubber trees are water guzzlers. Need to study the impacts on water availability in relation to water supply and demand.
Community based forest management	To go into REDD	REDD is a political issue and expensive too. It can be done but needs a lot of safety nets. A simple CBFM would be good, the challenge is who will finance when REDD has theinternational financial support.
Flood Risks	Regional DPWH Flood response	Better to go into preparedness, include into the infrastructure design the return periods of most probable extreme rain in the future.
Food security	Rice sufficiency is monitored through a production - consumption analysis	Given the potential negative impacts on rice yield dueto projected changes in climate and climate variability, it will be important for Silago to incorporate climate scenarios when analysing the future relationships between production and consumption

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ANNEXES

A. PROJECT DETAILS OF THE JUNCTION PPH HIMAYANGAN-SILAGO-ABUYOG JUNCTION PPH ROAD PROJECT

The implementation of the project was divided into two contract packages. Contract Package I covered all construction activities between the Junction PPH Himayangan and Silago. Meanwhile, Contract Package II addressed all construction activities between Junction PPH Abuyog and Silago (Table 1).

Table 1. *Construction/rehabilitation activities associated with ARLDP Phase IV – Junction PPH Himangayan-Silago-Abuyog Junction PPH Road.*

Activity	Length	Width
Contract Package I		
Construction of Pavement (Junction PPH Himayangan-Silago)	44.703 km	6.10 m
Improvement/upgrade of drainage and shoulders		
Replacement of 17 bridges	566.806 m (total length)	
Rehabilitation of 3 existing bridges	187.62 m (total length)	
Drainage, slope protection and miscellaneous structures		
Contract Package II		
Construction of Pavement (Junction PPH Abuyog-Silago)	44.005 km	6.10 m
Improvement/upgrade of drainage and shoulders		
Replacement of 13 bridges	424.988 m (total length)	
Rehabilitation of 2 existing bridges	184.4 m (total length)	
Drainage, slope protection and miscellaneous structures		

SOURCE: MARIS J, 2006

B. EVOLUTION OF IMPACT CHAINS

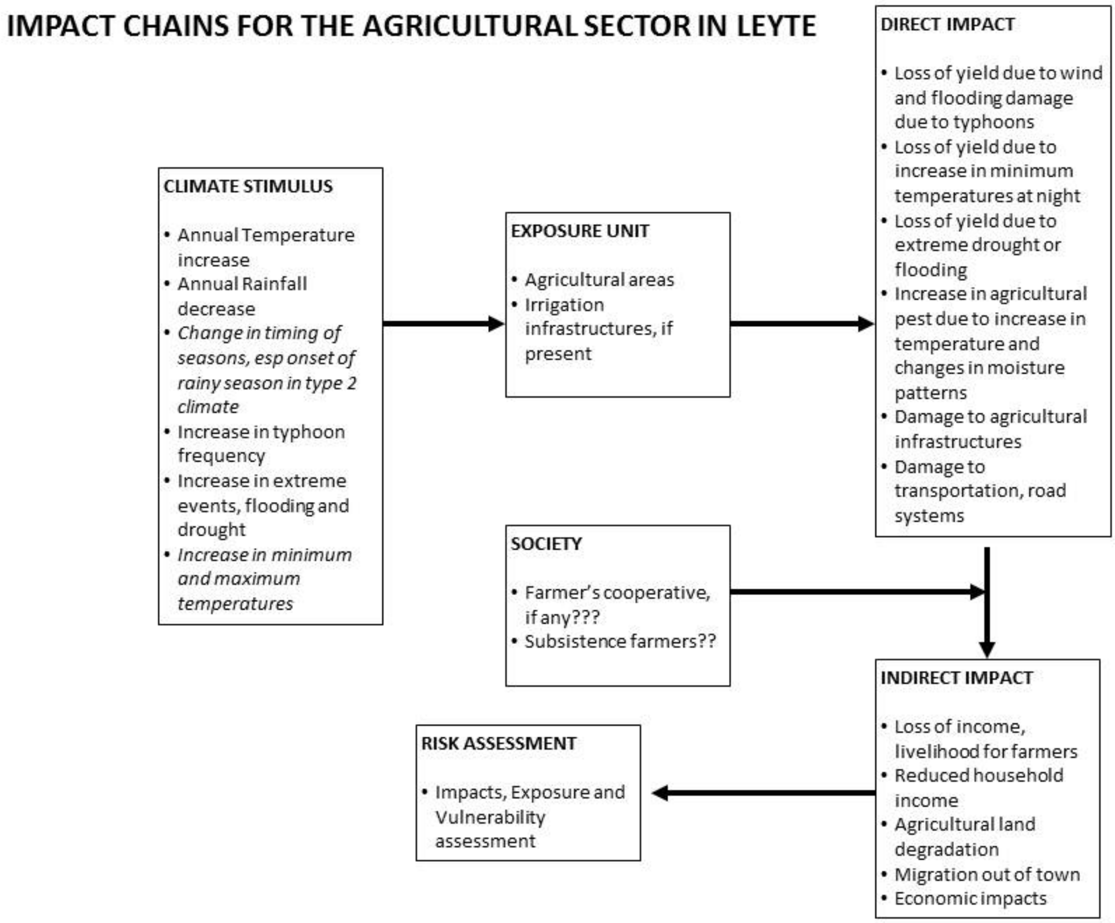

Figure 1. *Original Impact Chain for the Agriculture Sector.*

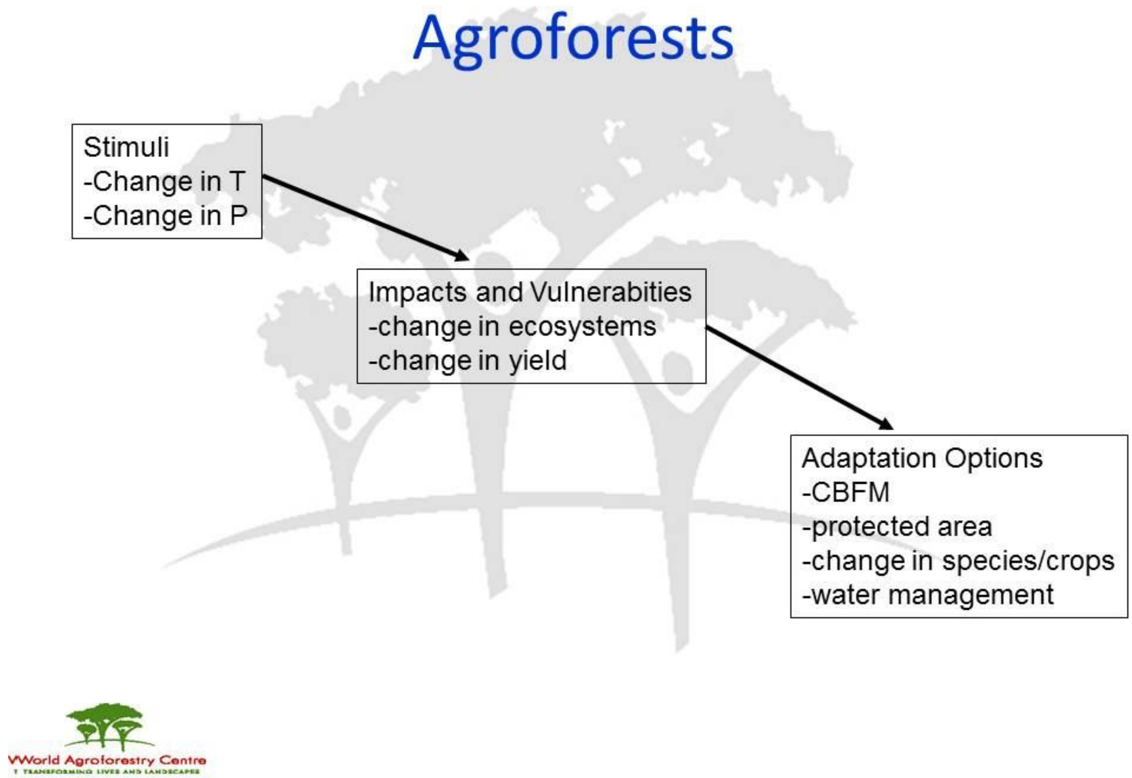

Figure 2. *Original Impact Chain for the Agroforestry Sector.*

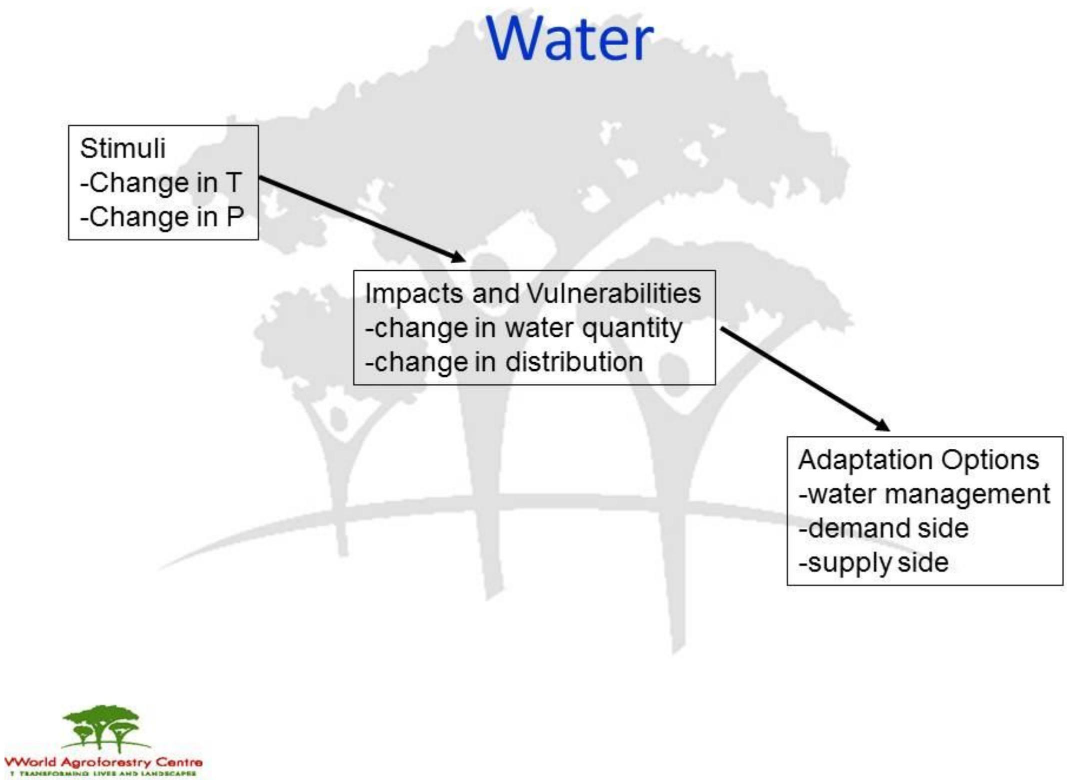

Figure 3. *Original Impact Chain for the Water Sector.*

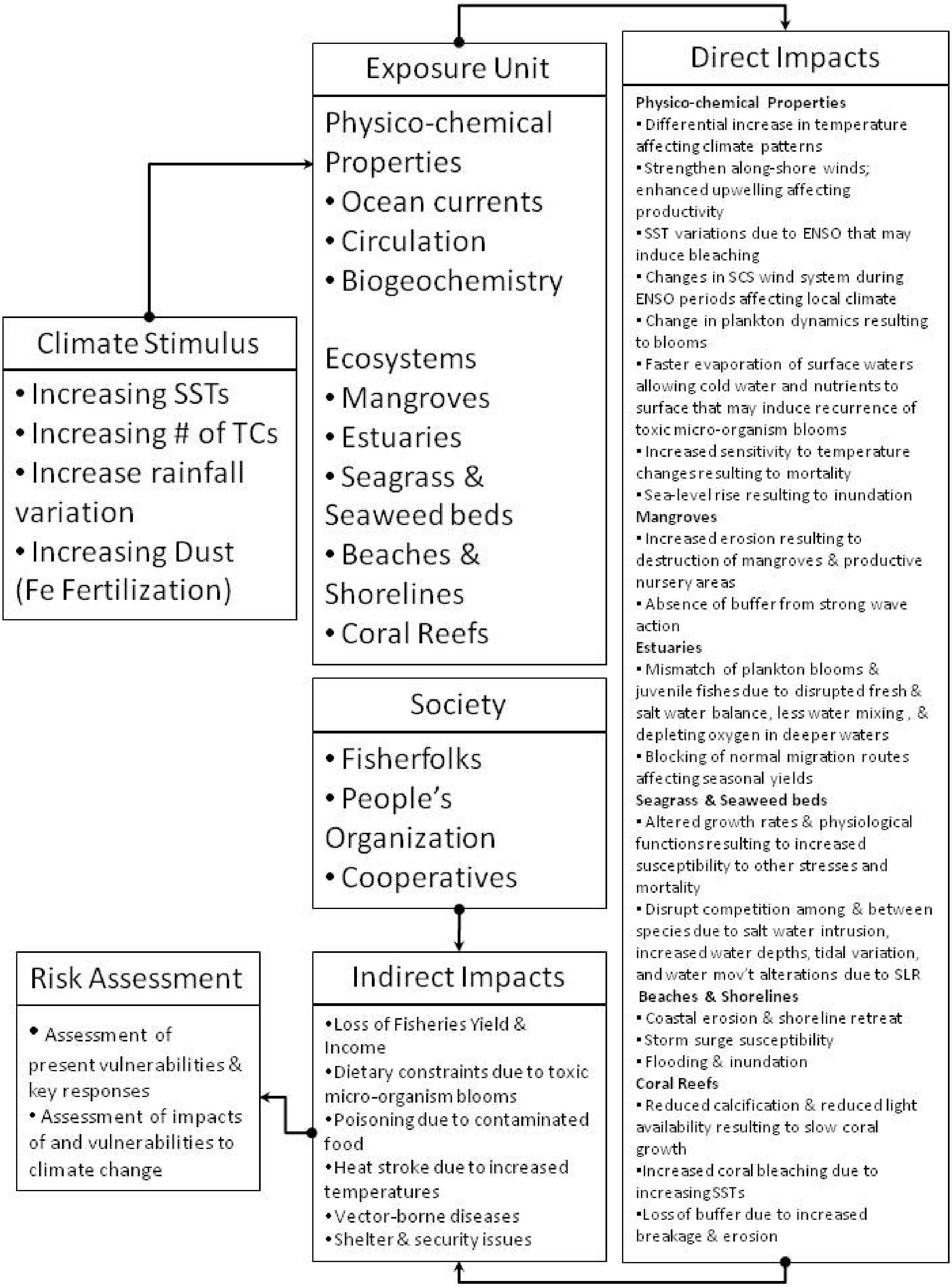

Figure 4. *Original Impact Chain for the Coastal Sector.*

Figure 5. *Modified Impact Chain for the Agriculture Sector with inputs from the Stakeholders' Workshop and Identified Data Sources.*

Figure 6. *Modified Impact Chain for the Agriculture Sector with Identified Priority Data.*

Figure 7. *Modified Impact Chain for the Agriculture Sector with Identified Priority Data.*

Figure 8. *Modified Impact Chain for the Coastal Sector with inputs from the Stakeholders' Workshop and Identified Data Sources.*

Figure 9. *Modified Impact Chain for the Coastal Sector with inputs from the Stakeholders' Workshop and Identified Data Sources.*

F
igure 10. *Modified Impact Chain for the Coastal Sector with Identified Priority Data.*

Figure 11. *Modified Impact Chain for the Coastal Sector with Identified Priority Data.*

Climate projections analyses and indicator data on exposure and vulnerability show that the municipality of Silago, Southern Leyte is at risk to the impacts of future climate changes. The coastal barangays, where most of agricultural land are located and which have high population density, are especially at risk due to the projected decrease in rainfall and the potential increase in sea levels. Inland barangays, on the other hand, are at risk because of relatively higher increases in temperature, which may also have adverse effects on the inland forests located in the area. These results are based on the projected climate changes for an A1B scenario using a regional climate model, RS-GIS analyses, and the available data obtained for the study.

CONTRIBUTORS

Manila Observatory (MO)

Gemma Teresa T. Narisma, PhD (Climate Scientist)
May Celine T. M. Vicente, PhD (Risk-Mapping Scientist)
Emmi B. Capili-Tarroja (Project Research Assistant)
Faye Abigail Cruz, PhD (Climate Scientist)
Rosa T. Perez, PhD (Integration, Vulnerability and Adaptation Options Specialist)
Raul S. Dayawon (RS-GIS Researcher)
Julie Mae Dado (Researcher, Climate)
Ma. Flordeliza P. del Castillo (RS-GIS Researcher)
Marcelino Q. Villafuerte II (Researcher, Climate)
Leonard Christian G. Loo (Project Research Assistant)
Deanna Marie P. Olaguer (Project Coordinator)
Ma. Antonia Y. Loyzaga (Executive Director, Manila Observatory)
Joel T. Maquiling (Editor)

World Agroforestry Centre (ICRAF)

Ma. Regina N. Banaticla-Altamirano (Research Scientist, Forest and Water Sectors)
Lawrence T. Ramos (Researcher)
Christine Marie D. Habito (Researcher)
Rodel D. Lasco, PhD (Country Programme Coordinator, ICRAF Philippines)

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