DISASTER RISK MANAGEMENT FOR RESILIENT PUBLIC SCHOOL BUILDING IN SAMAR

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DOCTOR OF PHILOSOPHY

Technology Management

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APPROVAL SHEET

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The Researcher

DEDICATION

To those whose lives have been devoted to public service, this study is especially for you...

Rene B. Novilla

ABSTRACT

This study assessed the disaster risk management of public school buildings in the Province of Samar, with the end-view of proposing resilient public school buildings for the province. This study was descriptive type of research which the vulnerability of public school buildings in the Province of Samar. Schools along the coast are exposed to storm surges during typhoons with strong winds. A NOAH simulation will submerge low lying towns of Downtown Catbalogan which will submerge most schools with at least up to 1.5m height. Only schools in found upland are safe from storm surge. These are Calapi National High School, Lawaan National High School, Bonga National High School, Casandig National High School, Bagacay National High School, Tenani National High School, Calbiga National High School, Hinabangan National High School, Parasanon National High School, Valeriano C. Yancha Memorial Agricultural School, and Old San Agustin National High School. Office at DepEd in-charge to physical plant and facilities lacks manpower to monitor construction activities and assessment of building conditions for appropriate action. Those school campuses re-built after typhoon Yolanda has the most number of school compliant to DepEd building standards. There is a disaster risk management plan, implementation of such is wanting. It is highly recommended to conduct site specific geohazard risk to be performed by a competent authority such as the Mines and Geosciences Bureau of the Department of Environment and Natural Resources of academic institutions like SSU who can conduct risk assessment.

TABLE OF CONTENTS

Chapter 1

THE PROBLEM AND ITS SETTING

Introduction

Living with disaster is a new norm and almost everyone is exposed to iton daily basis. The Philippines is considered the third most disaster prone country in the world (Bündnis Entwicklung Hilft, 2017). Hence, the government is rightly to enact a law aimed at making the country prepared to potential disasters through RA 101211 or the Philippine Disaster Risk Reduction and Management Act (Congress of the Philippines, 2010). The effects of disaster affect everyone, basically disrupting all processes, and immediate response is usually evacuation to safe grounds and shelter with food and medication. Facilities providing such help must be the last to stand. This means the country should be resilient to any kind of disaster.

School buildings are most likely candidate for mass evacuation, and therefore must be resilient. Most school buildings are not constructed to serve as an evacuation facility, and suffer a lot in the process (SEAMEO-INNOTECH, 2014). During the 2013 typhoon Haiyan, more than 16 million people were affected, 792,018 persons or 161,973 families were pre-emptively evacuated (NDRRMC, 2013) many of which were in public school classrooms. Some classrooms were damaged, several were used as evacuation centers, a death trap for some (ECHO, 2013; GIZ, 2014; Esteban et.al., 2015).

Disasters in the Philippines abound, most are natural hazards like typhoons, earthquakes and the after effect of such catastrophic events. During the years 1993 to 2012, the Philippines experienced 311 extreme weather events, the highest in the world (Hashim and Hashim, 2016). Most recently, the Philippines was bound to have the highest expected annual mortality, affected population, and loss in gross domestic product (GDP) globally in relation to climatic hazards (Shi, et.al., 2016).

Locally, Western Samar is included in the list of top 20 provinces in the Philippines most at risk to projected rainfall changes. In addition, it is highly at risk to the occurrence of tropical depressions, tropical storms, typhoons and super typhoons. Lastly, it is also most at risk to a combined climate and weather-related risks (Center for Environmental Geomatics, Manila Observatory, 2005). The municipalities in Samar heavily hit by Typhoon Haiyan are Marabut, Sta. Rita and Basey (NDDRMC, 2014a). On December 06, 2014, the Municipality of Daram was greatly affected by Typhoon Ruby (Hagupit). According to the report of the Disaster Risk Reduction and Management Office of Daram, Samar, there were 1,664 totally damaged houses, 5,773 partially damaged, worth Php 34 million pesos damage in infrastructure and Php 62.5 million pesos damage in agriculture and fisheries. Typhoon Ruby packed maximum sustained winds of 175 km/h near the center, and gusts of up to 210 km/h. It generated storm surges of up to 4.5 meters as it made landfall. The same year, many towns were also submerged in water due to Typhoon Seniang (Jangmi) bringing with her extremely high precipitation; a landslide occurred in Brgy. Mercedes, Catbalogan City, where 22 lives and properties were lost (NDRRMC, 2014b).

Aside from serving as evacuation facilities, schools need to be protected; school buildings must be strong enough to protect its users. To be truly safe and sustainable, school buildings in areas at high risk from natural hazards and the effects of climate change must be built for long-term durability and resilience (DepEd, 2010). Apart from the inherent vulnerability of some critical areas to disasters, understanding what factors are driving unsafe construction practices will enable decision-makers to make targeted adjustments to planned investments to ensure the quality of new construction and avoid the creation of new risks (World Bank, 2015).

It is also noted that many LGUs in Samar have no updated disaster-responsive Comprehensive Land Use Plans (CLUP) to guide everyone where to safely construct structures such as school buildings. Salasar-Quitalig and Orale (2016) found out that of the 27 Local Government Units (LGUs) in the Province of Samar, 17 have CLUPs where 16 have expired validity. The old CLUPs have not extensively considered disaster risk reduction and management and climate change adaptation (DRRM-CCA). Some don't even have CLUPs. Are the public schools in the Second District of Samar exposed to these risks? What are they doing to address the risks? Are the buildings prepared for such risks? What should be done to minimize or avoid the risks from becoming a disaster?

Statement of the Problem

This study assessed the disaster risk management of public school buildings in the Province of Samar, with the end-view of proposing resilient public school buildings for the province.

More specifically, the study sought to answer the following objectives:

1. What are the critical areas for disaster in the Province of Samar in terms of the following:

    1.1 geophysical risks;

    1.2 climate and weather related risks; and

    1.3 other risks.

2. What are the disaster risk exposure of public school buildings in the province of Samar to the following risks:

    2.1 earthquakes

    2.2 tsunami

    2.3 landslides

    2.4 flooding

    2.5 storm surge

    2.6 fire

3. What is the profile of the public school buildings in terms of the following:

    3.1 technical aspects

        3.1.1 building design and purpose;

3.1.2 construction materials used; and

3.1.3 methods of construction and maintenance;

3.2 non-technical aspects

3.2.1 aesthetics;

3.2.2 disaster/risk reduction measures; and

3.2.3 location of the building.

4. What is the structural integrity of the public school buildings in Samar along the following aspects:

4.1 foundation

4.2 basement/crawl space water

4.3 framing

4.4 roof

4.5 interior/exterior and

4.6 general building structural integrity

5. What disaster risk reduction and management plan for public school buildings in the Province of Samar may be proposed from the findings.

Theoretical Framework

This study was anchored on the Theory of Structures, the Expand Contract Theory on Disaster Management and the General Contingency Theory of Management.

The Theory of Structures is concerned with establishing an understanding of the behaviour of structures such as beams, columns, frames, plates and shells, when subjected to applied loads or other actions which have the effect of changing the state of stress and deformation of the structure. In relation thereto, the process of structural analysis applies the principles established by the Theory of Structures, to analyse a given structure under specified loading and possibly other disturbances such as temperature variation or movement of supports. For instance, the drawing of a bending moment diagram for a beam is an act of structural analysis which requires knowledge of structural theory in order to relate the applied loads, reactive forces and dimensions to actual values of bending moment in the beam (Jenkins, 1982; Marti, 2013).

In this study, Theory of Structures was used as a basis of evaluating whether the building structures are strong enough to receive the expected loads. There were no mathematical calculation whether a member of a building or strong enough. The structural carrying capacity of the buildings were based on the prevailing standards set by the authorities in building construction such as but not limited to the National Building Code of the Philippines (DPWH, 2005), the National Structural Code of the Philippines (2016), and others that are used by the government as reference in designing buildings.

Buildings collapse because of poor design and wrong construction methodologies (Ellirtwood, 1987). Poor design of buildings may include the improper materials specification, when not all probable loads and material capacities (including foundation) were included in the design (Calvert, 2002). On the other hand, even if the design was correct if the construction is defective (eg. specified materials were not used, curing of concrete or care of materials during construction were not observed, or building procedure were not followed, and others) the likelihood of building failure is increased (Parfitt, 2012).

Disasters, either natural or man-made, can cause changes to the state of structures; most structures in the Philippines were designed without considering much the current state of risks. More particularly, natural disasters will inevitably continue to occur, and thus, having an understanding of resilience and the factors that lead to it, vulnerabilities of structures could be minimized and resilience could be increased (Kapucu et al., 2013). In the disaster context, resilience is explained as the ability of people to recover within the shortest possible time with minimal or no assistance. Therefore, it is necessary to strengthen existing structures and institutions to resist disasters and thus resilience can be viewed as a "bounce forward" strategy following a disaster (Manyena, 2006). It can further be viewed as "the intrinsic capacity of a system, community or society predisposed to a shock or stress to 'bounce forward' and adapt in order to survive by changing its non-essential attributes and rebuilding itself" (Manyena et al., 2011). In summary, resilience can be defined as the "ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner including the preservation and restoration of its essential basic structures and functions" (UNISDR, 2007).

As such it is important to design, develop, operate and maintain the built assets in a community in such a way that it can withstand disaster and be able to protect the functioning of the community, its people and other associated physical and social systems. Inadequate structural capacity of the built environment has been identified as one of the major reasons of extensive damage from natural disasters (Mannakkara & Wilkninson, 2013). Adding to that, insufficient consideration of coastal risks, non-disaster resistant building designs and constructions in disaster prone areas, inaccurate assessment of hazards, lack of consideration of climate change effects, incompatibilities between structural designs and hazard levels, lack of consideration of risks in town planning, neglected building codes and regulations, illegal occupancy in high risk lands have been identified as factors which increase the risk of disasters (Mannakkara & Wilkninson, 2013). As such it is important to reduce the risk by use of hazard resilient designs, specifications, construction methods, materials and technologies; and construction of protective infrastructure and also protecting critical infrastructure available (Haigh & Amaratunga, 2011).

A second theory on which this study is anchored is the Expand Contract Theory on Disaster Management which proposes that there is a series of activities that run parallel to each other rather than as a sequence, as seen in Figure 1.

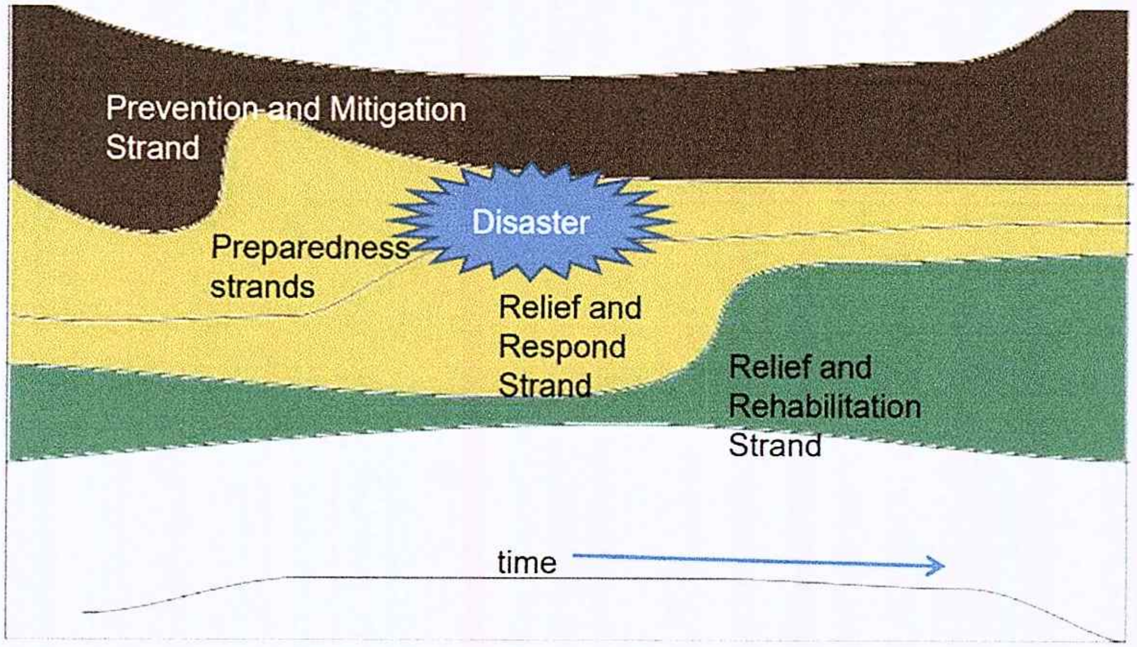


Figure 1. Expand contract theory on disaster management.

Disaster is mathematically expressed as (hazard + risk) x vulnerability. Hazard is defined as the potentiality of a physical event, phenomenon or human activity that may cause loss of life or property characterized by its location, intensity, frequency and probability; could be natural or man-made; and could be single, sequential or combined in origin and effect. Risk, on the other hand, is the probability of harmful consequences or expected losses such as death, injury, property, livelihood, economic activity disrupted or environment damage. Lastly, vulnerability is the extent to which a community can be affected by the impact of a hazard such as poverty, lack of information, poor living conditions, overloaded or poorly-maintained equipment, and inadequate safety precautions which usually precede disasters and contribute to their severity and impede disaster response. The onset of disasters is inevitable and the impact on communities may not be uniform. Yet, effective disaster management approaches may reduce the impact of disasters to the community.

This study focuses on what can be done to minimize the impact of hazards to school buildings and the people using it. It starts in understanding the risks, evaluating the resiliency of the campuses and proposing intervention to counteract the possible occurrence of hazardous events. The risks for hazards are determined using various resources available. It utilizes secondary data produced by authorities in the Philippines such as the Mines and Geosciences Bureau and the Department of Science and Technology – Philippine Volcanology and Seismology. It also considered local risks and disaster reports and researches. This information was also used in the computer-aided analysis.

A third theory on which this study was based is the General Contingency Theory of Management suggesting that management principles and practices are dependent on situational appropriateness (Luthans & Stewart, 1977). The ever changing risks characteristics require new approaches to manage it. These new strategies must be based on the latest scientific knowledge and consideration of its probability of occurrence and impact (CACA, 2010). The needed breakthrough for management theory and practice can be found in a contingency approach. It means that different situations are unique and require a managerial response that is based on specific considerations and variables. For management and emergency management alike, the successful application of any theory or concept is greatly influenced by the application of any theory or concept and is greatly influenced by the situation.

Managers tasked to look into emergency situation are expected to establish an organizational structure and develop a culture of innovation to address specific problems (hazard) for each disaster is unique. The organizational structure shall be established based on the hazard including who are to be involved and what actions are needed (Kreps 1991).

Essentially, the occurrence of natural disasters can highlight the efficiency of the governmental system because the authority in charge, are facing the short time and the limited sources while they are being forced to continue to help the victims. Natural disasters reveal not only the structural strengths and limitations of the physical environment of a community but also how local, state and national response organizations function effectively and ineffectively. Therefore, the countries which have not structured comprehensive and strategic plan would be confronting more problems than other countries. So in spite of natural disaster's unpredictability, governments can be prepared beforehand in order to cope with disasters.

In disaster management the weakest point should be recognized, the problem can be pinpointed by situational analysis in strategic planning and deal with it. Therefore, strategic planning provides the appropriate infrastructure for integrated, coordinated decision making following natural disasters such as earthquakes. Hence, applying strategic planning to disaster management can reduce the impact of earthquake on the community which results in reducing the number of casualties and disabilities.

The results of this research would give the Department of Education in the Province of Samar valuable inputs regarding the critical areas for disasters in the province and the profile of the public school buildings. These inputs would eventually serve as bases for the building of disaster-resilient public school in the province.

The aforementioned theories were used in formulating ways how to address the current weaknesses in facing hazardous events such as geohazards and the likes.

Conceptual Framework

The study aims to determine risks from natural (geohazards) and man-induced hazards to public school buildings in the second district of Samar taking into consideration the building's structural integrity/capacity and the existing management activities towards ensuring safety of the property and users of the buildings. These are conducted with an end purpose of developing intervention such as proposing some mitigating strategies to prevent untoward disasters. Shown on Figure 2 is a resilient school building that is designed and constructed properly and maintained by competent professionals who have access to information and technology to effect immediate appropriate solutions to an identified potential geohazard risk.

Risk exposure of buildings are based on the available information collected from various sources most specifically from authorities such as but not limited to Department of Science and Technology (DOST) specifically from the Philippine Institute of Volcanology (PHIVOCS and Philippine Astronomic, Geophysical and Astronomical Services (PAGASA) as well as from the Department of Environment and Natural Resources (DENR) specifically from the Mines and Geosciences Bureau (MGB). Location of school buildings were identified using handheld global positioning systems (GPS).

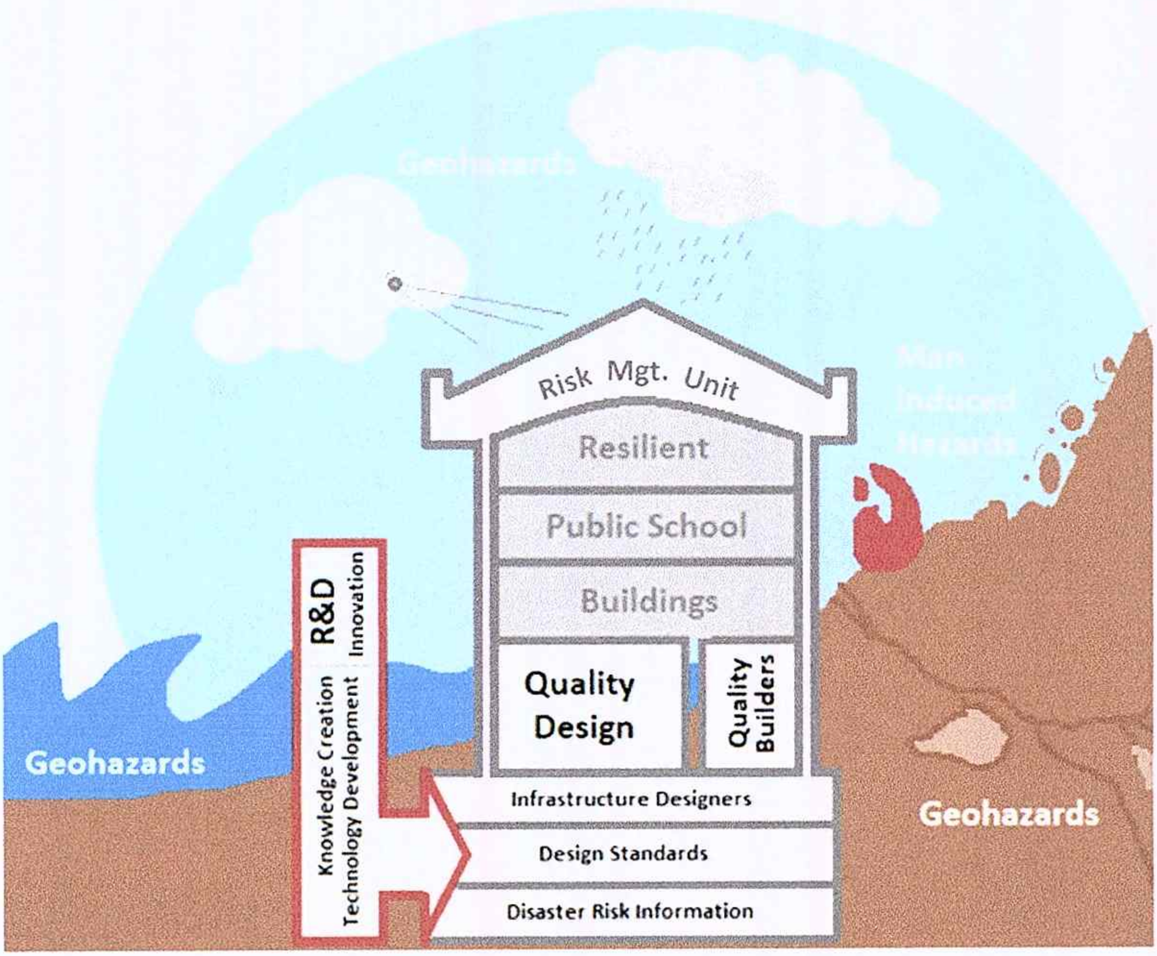


Figure 2. The Conceptual framework of a resilient public school building from hazards.

The structural integrity of the buildings was determined based on the existing design standards and whether these were followed in the construction of the building. If the buildings were designed and constructed properly, indicators such as structural member sizes, material used and the quality of materials must pass the design standards that have incorporated natural and manmade induced risks into it.

Aside from the technical aspects of the building, non-technical aspects such as aesthetics, disaster risk reduction measures and location of the school were also examined. There were newly added design concepts such as canopy wall, basement/crawl space water, and special window designs to mitigate natural and man-made risks.

A resilient public school building is one that is designed based on disaster risk information, compliant to minimum design standards. These should result into a quality design for buildings that have incorporated the potential effects of the hazards to the building where mitigation strategies and technologies have been included. On the other hand, quality designs are useless when it is not properly implemented, thus trusted builders is key to a disaster resilient infrastructure. Risks are unique from place to place and therefore specific studies are necessary before buildings are designed. Research, development and innovation are crucial in ensuring all possible risks and potential solutions have been integrated in the designs.

To ensure a resilient building, there must be a well-equipped team who are tasked to oversee the design, implementation and management of physical plant of public schools in Samar. This can be managed best by a group of competent professionals who have enough background about natural and man-made risks and supported by a staff to regularly monitor the status of the campus and the identified risks.

Significance of the Study

Inasmuch as the study is aimed at assessing the disaster risk management of public school buildings in the Province of Samar with the end-view of proposing resilient public school buildings for the province, this would serve as model or framework for safe school buildings against disasters and risks. Most importantly, this would be beneficial to the local development planners, to the local executives, to the education stakeholders, to the students, to the engineers and designers, and to the researchers.

To the Local Development Planners. The results of this study would provide evidence-based and objective assessment of the structural integrity of the public school buildings. This will enable the local development planners to focus more on the mitigation of the potential impact of disasters on public school buildings instead of on the relief operations after the aftermath of disasters. Most importantly, this study would provide local development planners with inputs in the development of policy guidelines for the strict implementation of the disaster risk reduction and management plan for public school buildings.

To the Local Executives. The results of the study would help local executives to formulate policies for the adoption of the disaster risk reduction and management plan for public school buildings. This would likewise enjoin local executives to strictly impose building laws in the construction of public school buildings as well as to update the Zonal Code of the Province to identify the areas which are vulnerable to disasters.

To the Education Stakeholders. As the primary actors in the education sector, the education stakeholders, which include the teachers, school administrators, and key officials of DepEd, would possess knowledge regarding the strengths or weaknesses of the public school buildings to disasters that are geologic, hydrologic and meteorological in nature, and to fire as well. They would be able to formulate and implement a system-wide, either district, division, region, or national level, plan of action to mitigate the impact of disasters given the structural integrity of public school buildings. Ultimately, they would be able to provide a safer environment to students.

To the Engineers and Designers. The results of this study would help the engineers and designers construct public school buildings which are disaster-resilient. The disaster risk reduction and management plan for public school buildings which would be developed from the findings of this study would serve as model/framework for the engineers and designers to improve on their designs based on the specifications of DepEd and DPWH.

To the Researchers. The inputs from this study would enable future researchers to conduct similar researches exploring other localities and involving other aspects of structural analysis.

To the Students. The students are oftentimes forced to adjust to reduced number of school days due to the occurrence of disasters which damage school buildings and/or transform them into evacuation centers. Also, they may be victims of unsafe school environment in times of disasters such as fire. When school buildings are structurally strong to withstand the impact of natural disasters, they are thus the direct beneficiaries of safe school environment. Hence, the results of this study would enable students to devise their own response and adaptive mechanism in times of disasters such as familiarization with the lay-out of the building, its entrances and exits, and escape routes, as well as in knowing how strong the buildings are.

Scope and Delimitation

The paper focuses only on infrastructure of secondary schools and integrated schools in the second district of Samar. The evaluation of school buildings was performed during the first quarter of 2018.

In the determination of geohazard exposure, secondary data were used. These information was sourced from various offices such as but not limited to

DENR-MGB, DOST-PAGASA, DOST-PHIVOCS, National Disaster Risk Reduction Management Council (DRRMC) and other published researches about geohazards in Samar. The location of schools was based on a handheld GPS with error of position between plus or minus 10 meters.

The structural integrity of the buildings was based only on the available plans and what can be measured physically. Footing design of buildings without available plans existing were estimated based on the knowledge of school administrators or the people from the locality who may have witnessed the construction. Reinforcing bars used and how they were placed were based only on existing plans available. Similar buildings from other campuses with plans were used as basis of estimation as to what type of reinforcing bars and design. Strength of concrete was based on the use of rebound hammer.

Construction standards, construction materials used, construction methods, as well as maintenance program of buildings were all based on interview. Participants to the interview are building officials of the Department of Education and the Officer-in-charge of the campuses like the Principals or Head Teacher of the schools visited.

Disaster risk exposure specifically for earthquake and rain induced landslides, tsunami and earthquake itself was determined using DOST's Rapid Earthquake Damage Assessment System (REDAS) software. Landslide and flood risks are based on the Mines and Geosciences Bureau Maps.

The following are the schools considered in this study.

Table 1. Schools involved in the study.

LGU	NAME OF SCHOOL	LATITUDE	LONGITUDE
Basey, Samar	Basey National High School	N 11^{0} 17.024'	E 125^{0} 04.085'
	Valeriano C. Yancha Memorial Agricultural School	N 11^{0} 20.070'	E 125^{0} 02.201'
	San Fernando National High School	N 11^{0} 16.833'	E 125^{0} 08.872'
	Old San Agustin National High School	N 11^{0} 19.509'	E 125^{0} 06.646'
	Simeon Ocdol National High School	N 11^{0} 16.602'	E 125^{0} 00.407'
	Mabini National High School	-	-
	Burgos Integrated School	-	-
Calbiga, Samar	Calbiga National High School	N 11^{0} 37.231'	E 125^{0} 01.032'
Daram, Samar	Daram National High School	N 11^{0} 38.109'	E 124^{0} 47.670'
	Bagacay National High School		
	Birawan National High School	N 11^{0} 38.928'	E 125^{0} 44.962'
	Parasan National High School	N 11^{0} 42.332'	E 124^{0} 45.254'
	Bakhaw National High School	N 11^{0} 35.524'	E 124^{0} 45.947'
	Baclayan National High School	N 11^{0} 35.846'	E 124^{0} 50.626'
	Cabiton-an Integrated School	N 11^{0} 43.500'	E 124^{0} 43.511'
	Sua National High School	N 11^{0} 34.055'	E 124^{0} 48.109'
Hinabangan, Samar	Hinabangan National High School	N 11^{0} 42.006'	E 125^{0} 03.850'
	Bagacay National High School	N 11^{0} 49.126'	E 125^{0} 14.012'
Jiabong, Samar	Jiabong National High School	N 11^{0} 45.856'	E 124^{0} 57.153'
	Malino National High School	-	-
	Casapa National High School	-	-
Marabut, Samar	Marabut National High School	N 11^{0} 06.505'	E 125^{0} 12.771'
	Osmeña National High School	N 11^{0} 11.876'	E 125^{0} 11.266'
Motiong, Samar	Motiong National High School	N 11^{0} 46.717'	E 124^{0} 59.935'
	Calapi National High School	N 11^{0} 56.751'	E 125^{0} 01.219'
	Bonga National High School	N 11^{0} 50.687'	E 125^{0} 01.512'
Paranas, Samar	Wright National High School	N 11^{0} 46.121'	E 125^{0} 01.275'
	Casandig National High School	N 11^{0} 49.892'	E 125^{0} 05.862'
	Tenani Integrated School	N 11^{0} 48.347'	E 125^{0} 07.760'
	Lawaan National High School	N 11^{0} 51.953'	E 125^{0} 04.884'
Pinabacdao, Samar	Pinabacdao National High School	N 11^{0} 36.645'	E 125^{0} 59.020'

Continuation of Table 1

LGU	NAME OF SCHOOL	LATITUDE	LONGITUDE
Pinabacdao, Samar	Parasanon National High School	N 11^0 30.689'	E 125^0 01.646'
	Quintin Quijano Sr. Agricultural School	N 11^0 35.108'	E 124^0 59.409'
San Jose de Buan, Samar	San Jose de Buan National High School	-	-
San Sebastian, Samar	San Sebastian National High School	N 11^0 42.625'	E 125^0 01.062'
Sta Rita, Samar	Sta Rita National High School	N 11^0 27.729'	E 124^0 56.221'
	Tominamos Integrated School	N 11^0 27.170'	E 125^0 01.238'
	Dampigan National High School	N 11^0 19.551'	E 124^0 59.740'
	Hinangutdan National High School	N 11^0 28.126'	E 124^0 54.851'
	Anibongon Integrated School	N 11^0 28.128'	E 124^0 59.778'
Talalora, Samar	Independencia National High School	N 11^0 31.637'	E 124^0 50.207'
Villareal, Samar	Villareal National High School	N 11^0 33.858'	E 124^0 55.677'
	Guintarcan National High School	N 11^0 36.294'	E 124^0 53.210'
	San Andres National High School	-	-
	Igot National High School	N 11^0 34.065'	E 124^0 57.530'
	Plaridel National High School	-	-
	Primitivo Torrechiva National High School	-	-
	Lamingao National High School	-	-
Zumarraga, Samar	Zumarraga National High School	N 11^0 38.271'	E 124^0 50.607'
	Mualbual National High School	N 11^0 38.874'	E 124^0 52.253'
	Bioso Integrated School	N 11^0 41.148'	E 124^0 51.168'
	San Isidro National High School	N 11^0 44.310'	E 124^0 47.479'
Catbalogan City	Samar National School	N 11^0 46.404'	E 124^0 52.999'
	Eastern Visayas Regional Science High School	N 11^0 46.395'	E 124^0 53.083'

Continuation of Table 1

LGU	NAME OF SCHOOL	LATITUDE	LONGITUDE
Catbalogan City	Guinsorongan Integrated School	N 11⁰ 45.586'	E 124⁰ 53.216'
	Pangdan National High School	-	-
	Antonio G. Tuazon National High School	-	-
	Catbalogan National Comprehensive High School	N 11⁰ 47.053'	E 124⁰ 52.182'
	Silanga National High School	N 11⁰ 49.058'	E 124⁰ 50.468'
	Catbalogan 1 District	N 11⁰ 46.480'	E 124⁰ 53.053'
	Catablogan 2 District	N 11⁰ 46.305'	E 124⁰ 53.049'
	Catbalogan 3 District	N 11⁰ 46.786'	E 124⁰ 53.086'
	Catbalogan 4 District	N 11⁰ 47.647'	E 124⁰ 51.986'
	Catbalogan 5 District	N 11⁰ 47.006'	E 124⁰ 52.619'

Definition of Terms

The following terms are defined for better understanding of the study:

Basement/crawl space. It is a shallow unfinished space beneath the first floor or under the roof of a building especially for access to plumbing or wiring (Merriam Webster). In this study this refers to the space between the first floor and the natural grade line where water may flow or maybe accommodated during flooding.

Climate Change. It is a change in the usual weather found in a place. This could be a change in how much rain a place usually gets in a year. Or it could be a change in a place's usual temperature for a month or season (NASA, nd).

Climate Change Adaptation. It is an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (BBB Manual, 2015). In this study, adaptation only focused on the government interventions made (or to be made) to make school structures resilient to the hazards attributed to changes in the climate condition such as extreme precipitation and strength of typhoons.

Disaster. It is defined as a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses that exceed the ability of the affected community or society to cope using its own resources (UN-ISDR, 2004). In this study, the term referred to geologic disasters (i.e. earthquakes, landslides); hydrologic disasters (i.e. floods, tsunamis); meteorological disasters (i.e. typhoons/thunderstorms); and fire.

Disaster Risk. Disaster risk is expressed as the likelihood of loss of life, injury or destruction and damage from a disaster in a given period of time. It is calculated by multiplying hazard level, extent of exposure to the hazard and the vulnerability level. (PreventionWeb, 2015). In this paper, disaster risk was reported through secondary data from authorities in the Philippines and abroad. Some of the risks were based on computer simulation, physical assessment and based on historical or experiential information from key informants.

Disaster Risk Reduction. It is the concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness of adverse events (BBB Manual, 2015).

Earthquake. It is the sudden slip on a fault and the resulting ground shaking and radiating seismic energy caused by the slip, or by volcanic or magmatic activity, or other sudden stress changes in the earth (USGS, nd).

Epicentre. It is the point on the earth's surface located directly above the focus of an earthquake (USGS, 2017).

Fire. It is a state, process, or instance of combustion in which fuel or other material is ignited and combined with oxygen, giving off light, heat, and flame (www.dictionary.com). In this study, fire refers to the risk of a building catching fire due to the material used and the surrounding conditions such as faulty/poor electrical wiring, adjacent to a residential community or facilities like gasoline stations, restaurants and the likes that are considered high fire risk.

Flood. It is any relatively high stream flow that overtops the natural or artificial banks of a river (USGS, 2018). In this paper, it refers to any excessive amount/height of water that is accumulated on a land (specifically of the school premises and the surrounding environment) that ordinarily is dry. It may be due to poor drainage, excessive runoff during heavy precipitation.

Foundation. The bottom most part of the substructure which transmit load of the structure along with its own weight into the soil underneath or surroundings without carrying shear failure or bearing capacity failure and excessive settlement (www.civilengineeringterm.com, nd).

Framing. It is the fitting together of pieces to give a structure support and shape (Oxford Dictionary, 2009). In this study it refers primarily to the roof framing. It may also refer to the building frame of a wooden or part-wood school building.

Structural integrity. Structural integrity is the ability of a structure to function as specified under service loading while keeping its strength (i.e. no structural failure) and shape (i.e. no excessive deformation). Hence the structural integrity is a measure for the quality of the structure (Fatec-Engineering, 2018). In this study, it refers to the general building structural integrity which is widely based on the researcher's observation on the physical condition of the building as compared to what are the prevailing building design standards.

Geohazard. These are events caused by geological features and processes that have potentials to create threats to human, property and the natural and built environment. It may include earthquakes, floods, landslides, volcanoes, avalanches and tsunamis (ICIMOD, 2016). In this study, it refers to floods, landslides, earthquakes, and the effects of it like tsunami and landslides. Other geohazards were not considered in the study.

Geologic disaster. It occurs when natural geological processes impact on people activities, either through loss of life, injury, or through economic loss (www.heritage.nf.ca, nd.). In this study, it refers to disasters caused by land/earth-based geohazards such as earthquakes and landslides.

Hydrologic disaster. The term refers to the violent, sudden and destructive change either in the quality of the earth's water or in the distribution or movement of water on land below the surface or in the atmosphere; includes floods and tsunamis (en.wikipedia.org). The term was used in the study as one of the types of natural disasters which were evaluated as regards their impact on the structural integrity of the public school buildings in the Province of Samar.

Interior/Exterior. It refers to the interior and exterior of building such as siding and window (Criterium Engineers, 1994). In this study, this referred to the analysis of evidence of walling and ceiling distress, deterioration and weather tightness that might indicate conditions affecting the overall structural integrity of the interior and exterior of public school buildings in the Province of Samar.

Landslides. It refers to the movement of a mass of rock, debris, or earth down a slope primarily due to the pull of gravity. Landslide encompasses five modes of slope movement: falls, topples, slides, spreads, and flows. These are further subdivided by the type of geologic material (bedrock, debris, or earth). Debris flows (commonly referred to as mudflows or mudslides) and rock falls are examples of common landslide types (USGS, nd). In this study, landslides may be triggered by earthquake (manmade or natural) and are categorized as an earthquake-induced landslide. On the other hand, a type of landslide that is caused primarily by too much moisture from rain is termed as rain-induced landslide.

Meteorological disaster. The term refers to the types of natural disasters which are meteorologically caused such as typhoons and thunderstorms (en.wikipedia.org). The term was used in the study as one of the types of natural disasters which was evaluated as regards its impact on the structural integrity of the public school buildings in the Province of Samar.

Public School Building. In this study, a public school building is that building inside a government school. This is a structure inside a government school funded by the government. Those infrastructure projects funded by private sector and were donated to the government were also considered public school buildings.

Resilience. It is the ability of a system to absorb changes and disturbances in the environment and to maintain functionality of the system (Furuta, 2014).

Risk. It is the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard. It may also apply to situations with property or equipment loss, or harmful effects to the environment (CCOHS, nd). In this study, it only refers to risks that the buildings will be exposed to hazards.

Roof. It refers to the covering of the top of a building, serving to protct against rain, snow, sunlight, wind, and extremes of temperature (Britannica, nd). In this study, this referred to the analysis of conditions requiring attention such as condition, type, current performance and evidence of leakage of public school buildings in the Province of Samar.

Resilience. It is the ability of a system, community or society exposed to hazards to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions. (Congress of the Philippines,).

Structural integrity. It is the ability of a structure to retain its strength, function and shape within acceptable limits, without failure when subjected to the loads imposed throughout the facility/structure/building service life (MAA, nd). In this study it will refer to the ability of the public school buildings in the Province of Samar to support its designed load specifically in the face of disasters attributed to hazards such as geologic, hydrologic and meteorological in nature, as well as fire.

School Building Standard. This refers to the standards of buildings stipulated in the National Building Code of the Philippines. In this study it will specifically refer to the modified standard for DPWH-DepEd School Buildings (DPWH, 2017) and the Build Back Better Manual (DILG & Australian Volunteers, 2015).

Sub-standard. It is a deviation from or falling short of a standard or quality specified by law or of an accepted or established standard (Merriam Webster, nd). In this study, it refers to infrastructure facilities that do not conform to the specified standards such as the modified standard for DPWH-DepEd School buildings and the Build Back Better Manual (DILG & Australian Volunteers, 2015).

Chapter 2

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter discusses relevant literature on disaster-resilient school communities and buildings in the Philippines and other parts of the world.

Related Literature

This part of the chapter presents the over-all literature to shed light on some of the concepts on disaster management specifically of school buildings in the Philippines.

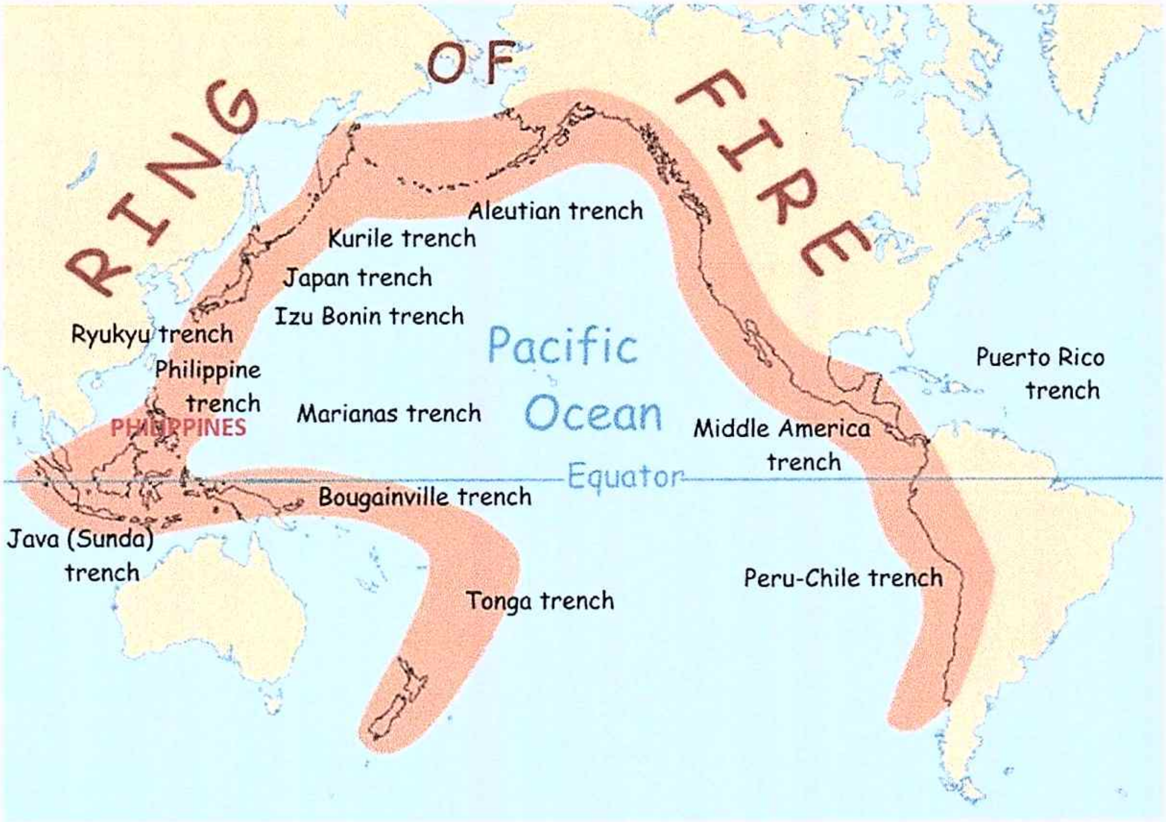


Figure 3. The Philippines is found along the Pacific Ring of Fire (source: National Georgaphic)

There is a continued increased of disasters ranging from earthquakes, floods, storms, epidemics, fires, landslides, hurricanes, tsunamis and social conflicts, experienced by everyone throughout the world, all threatening loss of life and property (Rambau, et al., 2012). The Philippines is considered one of the most disaster-prone countries of the world. The country is located in the western part along the circum-pacific seismic belt or the Pacific Ring of Fire (as shown on figure x) making it vulnerable to different natural disasters. Around 60 percent of the Philippines is exposed to multiple hydro-meteorological and geo-physical hazards such as storms, typhoons, floods, and droughts. It is further aggravated by the effects of climate change, as well as earthquakes and volcanic eruptions (Swiss NGO DRR Platform, 2014).

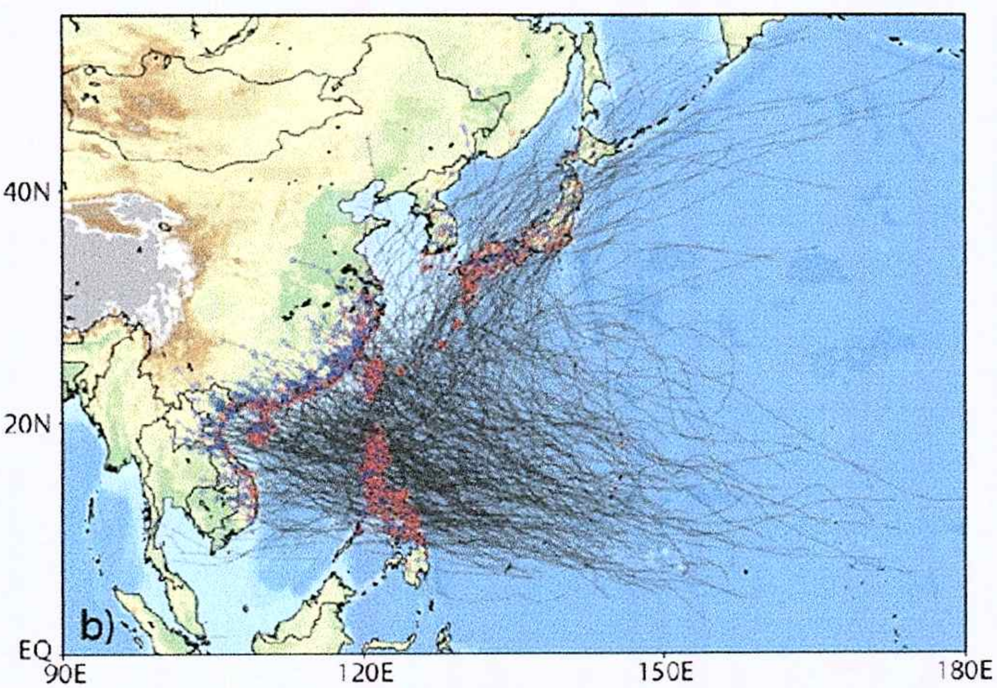


Figure 4. Typhoon paths in the Philippines since 1902 (source: www.homesecurity.pres)

According to the UNICEF (2017), the geographical characteristics of the Philippines compounded by the uncontrolled settlement in hazard-prone areas, high poverty rate, failure to implement building codes and construction standards, and degradation of forests and coastal resources, among others, make the Philippines among the high-risk countries worldwide against geohazard risks. It is estimated that around 27.6 million Filipinos who are among the poorest and marginalized felt the brunt of the hazards. People in the country are often trapped in a seemingly never-ending cycle of disaster, displacement and rebuilding.

Exposure to hazards such as cyclones, floods, earthquakes and many others is considered normal in many parts of the Philippines. The Internal Displacement Monitoring Center (2013) reported that the country is prone to multiple recurring hazards such as cyclones, floods, earthquakes and landsides. The World Risk Report for 2017 which considered the 2012-2016 data has ranked the Philippines third out of 171 countries in terms of disaster risk (Kirch et al., 2017). In the last 20 years, about 90% of disasters were attributed to floods, storms, heat waves and other water-related events which is about 6,457 occurrences as recorded by EM-DAT claiming a total of about 606,000 lives or 30,000 per year (UNISDR, 2016). From 1995 to 2015, the Philippines encountered around 274 disasters while the United States has 472, China 441, and India has 288. (DOE, 2015).

Figure 5. Number of weather-related disasters reported per country from 1995-2015 (Source: UNISDR, 2016)

The Philippines has devoted significant efforts and resources in trying to build a disaster capacity and minimize exposure and vulnerability of its people to disasters (Alcayna et al., 2016). The Philippines have adopted several approaches in managing the ill-effects of disasters from disaster preparedness and response in the 1970s. It evolved to disaster management during the 1980s. In 1990, it was named disaster risk management and eventually it became disaster risk reduction sometime in 2005 to date. The National Disaster Risk Reduction and Management Council (NDRRMC) was created to perform policy-making, coordination, integration and supervisory functions, as well as monitoring the preparation, implementation and evaluation of the National DRRM Plan (NDRRMP). This is to ensure the protection and welfare of the people in times of disaster (COA, nd).

The efforts of the government in preventing huge losses from disasters through its programs were tested in 2013. The weaknesses and significant gaps in the country's disaster response and management system were exposed during the 2013 Super Typhoon Haiyan (Yolanda). Even with a functioning disaster risk reduction and management (DRRM) structure with local, regional and national level councils, it failed miserably. The local councils are often understaffed with NDRRMC unable to supervise all the local councils (Harkey, 2014). The government's response in the aftermath of TS Yolanda was more of a reactive and not proactive; insufficient, inefficient and for the most part, was very slow (Displacement Monitoring Center, 2013).

A proactive risk management approach is imperative for a country like the Philippines. More than 40 percent of Filipinos or approximately 37 million are under 18 and children are the most affected in any disaster (UNICEF, 2017). It is therefore very crucial that they participation in DRR (UNICEF, 2017).

The Philippine Disaster Risk Reduction and Management Act of 2010 or Republic Act No. 101211 (RA 101211) has already been in place since 2010. This has made it the policy of the State to develop, promote and implement a comprehensive National Disaster Risk Reduction and Management Plan (NDRRMP) that aims to strengthen the capacity of the national government and the local government units (LGUs) to build the disaster resilience of communities and to institutionalize arrangements and measures for reducing disaster risks (Congress of the Philippines, 2010). The aforementioned Act provides for the development of policies and plans and the implementation of actions and measures pertaining to all aspects of disaster risk reduction and management, including good governance, risk assessment and early warning, knowledge building and awareness raising, reducing underlying risk factors, and preparedness for effective response and early recovery (ibid).

The National Disaster Risk Reduction and Management Plan (NDRRMP) fulfills the requirement of RA 10121, which provides the legal basis for policies, plans and programs to deal with disasters. The NDRRMP covers four thematic areas, namely, a) Disaster Prevention and Mitigation; b) Disaster Preparedness; c) Disaster Response; and d) Disaster Rehabilitation and Recovery, which correspond to the structure of the National Disaster Risk Reduction and Management Council (NDRRMC). By law, the Office of Civil Defense formulates and implements the NDRRMP and ensures that the physical framework, social, economic and environmental plans of communities, cities, municipalities and provinces are consistent with such plan (NDRRMC, 2010).

The NDRRMP is consistent with the National Disaster Risk Reduction and Management Framework (NDRRMF), which serves as the principal guide to disaster risk reduction and management (DRRM) efforts to the country. The Framework envisions a country of safer, adaptive and disaster resilient Filipino communities toward sustainable development. It conveys a paradigm shift from reactive to proactive DRRM wherein men and women have increased their awareness and understanding of DRRM, with the end in view of increasing people's resilience and decreasing their vulnerabilities (NDRRMC, 2010).

There have been efforts in identifying areas high in risks which are carried out by the government agencies such as the Department of Science and Technology as well as some organizations like the Manila Observatory (Alcayna, et. al., 2016). These areas are identified through maps and are available on-line. There is a level of uncertainty how well disaster risk is communicated to the public and how many projects focus on improving community knowledge on hazards and disaster risk. To date, there is lacking investigations to study the combined socio-ecological resilience of the Philippines to help more effectively the decision-makers in locating areas considered highly vulnerable (ibid).

The National Economic and Development Authority (NEDA) of Region 8 cited a report of the Office of Civil Defence Region 8's Disaster-Prone Areas in Region VIII as of 2009. It identified earthquake, landslide, tsunami, volcanic eruption and liquefaction as the hazards. It identified the entire region as prone to hazards, most belongs to earthquake. These areas are found close to the Parallel NW Faults of the Philippine Fault Zone (PFZ), the 25 km danger zone along the Philippine Fault Zone and the NNE Splay Fault from PFZ. Tsunami, liquefaction and some type of landslide is secondary to earthquakes. The report however did not include climate related hazards like those attributed to typhoons and too much precipitation which may results into massive flooding.

Table 2. Disaster-prone areas in Region VIII as of 2009 (OCD Region 8 as cited by NEDA 2010)

Hazard	Areas to be Affected
Earthquake	Leyte: Tacloban City, Babatngon, San Miguel, Sta. Fe, Palo, Tanuan and Tolosa Samar: San Sebastian, Calbayog and Catbalogan Eastern Samar: Can-avid and Giporlos Leyte: Leyte, Carigara, Kananga, Capoocan, Jaro, Tunga, Ormoc City, Albuera, Burauen, Baybay, Abuyog and Mahaplag Southern Leyte: Silago, Sogod, Bontoc, Tomas Oppus, Malitbog, Padre Burgos, Hinunangan, Limasawa, St. Bernard, San Juan, Hinundayan, Anahawan, Liloan, San Franicsco, Pintuyan and San Ricardo Maasin City,
Landslide	Leyte: Coastal Section of Abuyog. Upland and mountainous portion of Ormoc City and Isabel, Leyte Southern Leyte: Hilly areas of Maasin City, Mountainous portion of Sogod, Southern Leyte Samar: Rock formation of Catbalogan, Samar
Tsunami	Samar: Calbayog City, Catbalogan, San Sebastian Northern Samar: Catarman and low-lying municipalities Eastern Samar: The whole of Eastern Samar since it is fronting the Philippine Trench Southern Leyte: The coastal villages of Panaon Island
Volcanic Eruption	Biliran: Maripipi and Kawayan Southern Leyte: San Juan
Liquefaction	Leyte: Alang-alang, Pastrana, Dagami, Sta. Fe, Tabontabon, Dulag, Tolosa, Tanauan, San Miguel, Tacloban City

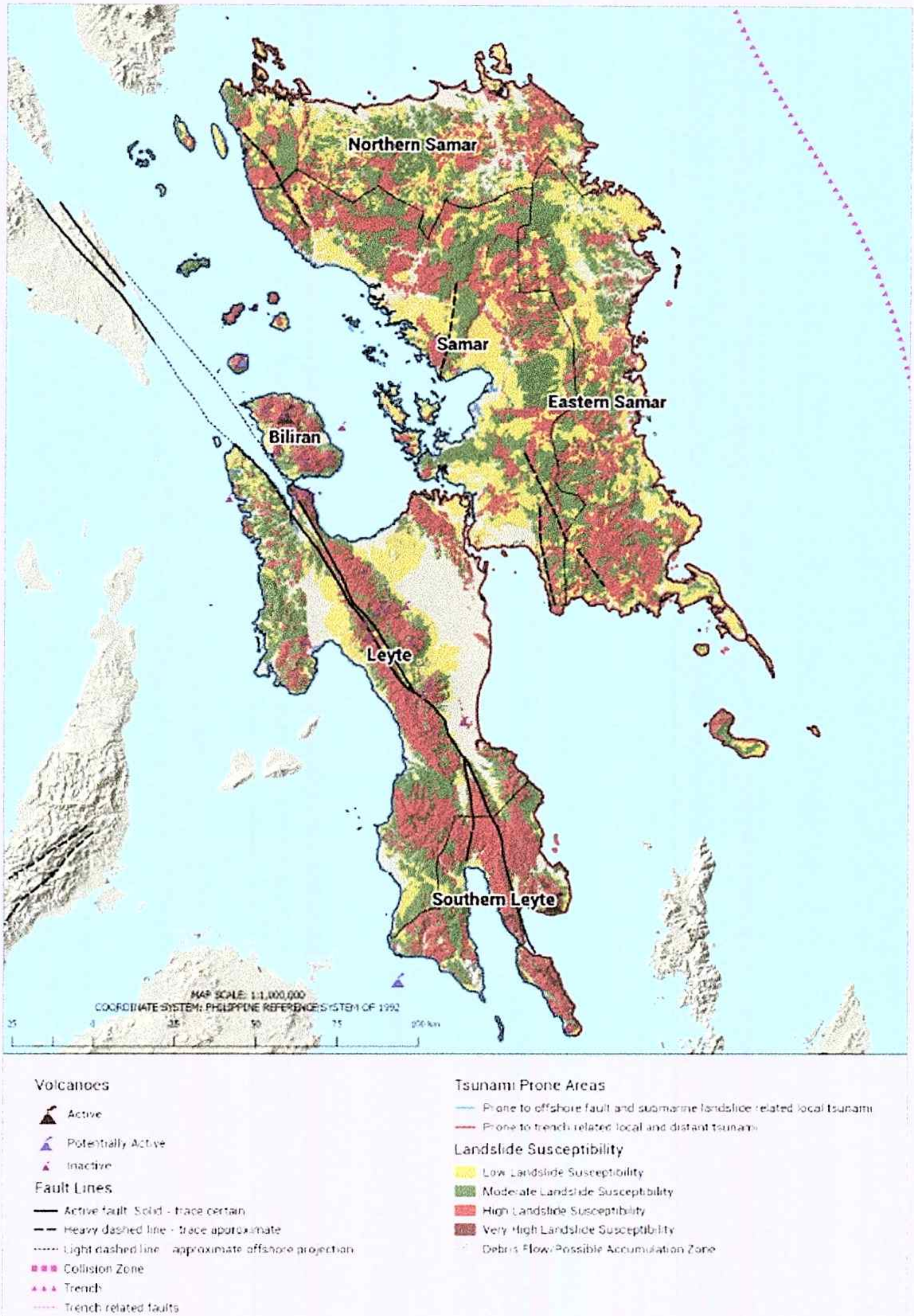


Figure 6. Geologic Hazard Map of Eastern Visayas (Source: PHIVOCS as cited by NEDA 2017)

Table 3. Status of provinces, cities and municipalities with and without approved CLUPs, December 2015 (Source: HLURB as cited by Salazar-Quitalig and Orale, 2016)

Province/City/Municipality	Date Approved	Resolution No	Municipalities without CLUPs
1. Calbayog City	1-Dec-2005	SP 11-190-05	1. Almagro
2. Marabut	20-Aug-2003	SP 116-03	2. Matuguinao
3. Motiong	17-Mar-2005	SP 1133	3. Pagsanghan
4. PPFP* of W. Samar	17-Apr-2002	R 720**	4. Pinabacdao
5. Basey	1-Jun-2000	SP 108	5. San Jose de Buan
6. Hinabangan	21-Oct-1991	R494, S91	6. San Sebastian
7. Gandara	21-Apr-1987	R380, S87	7. Sto. Nino
8. Sta. Margarita	4-Apr-1986	R297, S86	8. Tagapul-an
9. Villareal	22-Nov-1985	R271, S85	9. Talalora
10. Daram	11-Jul-1985	R249, S85	10. Zummarraga
11. Jiabong	13-Dec-1884	R219, S84	
12. San Jorge	6-Sep-1984	R202, S84	
13. Paranas (Wright)	5-Jul-1984	R199, S84	Of the 17 with CLUP, only 1 is active.
14. Calbiga	4-Jan-84	R172, S84	
15. Tarangnan	1-Sep-1982	R85, S82	
16. Sta. Rita	2-Dec-1981	R36, S81	
17. Catbalogan	24-Sep-80	NCC PLAN	

Note: R –Resolution SP- Sangguniang Panlalawigan
** Provincial Physical Framework Plan (PPFP)*
*** Approved By National Land Use Commission*
NCC- National Coordinating Council for Town Planning

In 2017, Leyte Island was hit with a 6.5 magnitude of earthquake damaging various infrastructures in Leyte Province as well as nearby provinces. It again revealed the weakness of the overall disaster risk management initiatives of the government. It appeared that many local government units do not have properly prepared comprehensive land use plans (CLUPs) or worse, they don't have duly approved CLUPs. In Samar Philippines for example (see Table 2), out of 27 LGUs, only one has an active CLUP, 16 outdated and 10 municipalities has no CLUP

(Salazar-Quitalig and Orale, 2016). Since all CLUP were prepared before DRRM was required to be mainstreamed, most if not all of these CLUPs have not given DRRM the much needed attention. Concerns like communities or buildings constructed in hazardous (i.e. buildings along fault line) areas exist. Furthermore, compliance to the zoning ordinance is still a challenge to many LGUs.

According to NDRRMC SitRep No. 23, the earthquake affected 4,130 families or 16,052 persons in 27 baranggays of Leyte alone. It totally damaged around 1,484 houses, and partially damaged around 2,155 houses costing a little more than PhP 220 million (NDRRMC, 2017). In this earthquake, about 113 school buildings, 10 health facilities, 35 government buildings/facilities, 16 tourist establishments and 7 commercial buildings were either totally damaged or partially damaged (ibid). Some of these buildings and their campuses are found on top of a fault line.

Figure 7. School campus/buildings in Leyte built on top of fault line (Source: PhilVOCS, 2017)

Schools are constantly at risk to many hazards, both man-made and natural. In a report with data coming from DepEd BEIS in 2013, 22,828 elementary schools and 4,338 high schools have experienced typhoons (David and Paguirigan Jr., 2016). The same report enumerated that in 2013, about 48% of 9,784 Mindanao elementary schools, 61% of 15,937 Luzon elementary schools and 81% of 7,987 Visayas elementary schools are experiencing natural disasters (ibid). In short, about 20,887 of 33,708 or about 61.96% of all elementary schools are at risk to natural disasters (ibid). The Department of Education of Central Luzon listed 257 public schools in the region that are at high risk to floods (PDI, 2013). In Metro Manila, over 800 large schools are found along flood-prone roads which affects commuters to and from the schools; 242 of which are in flood prone areas (GMA, 2013). In Zamboanga City, DepEd identified 32 schools that are found in hazardous zones specifically to floods (13), landslides (13) and four are built along congested roads (Lacastesantos, 2018). Typhoon Yolanda in 2013 has partially damaged 6,018 and totally damaged 1,567 schools in the divisions of Leyte, Ormoc City, Eastern Samar, Samar, and Tacloban City (SEAMEO INNOTECH, 2014).

Over the past decades schools have served as temporary shelters of internally displaced people specifically during disasters of Pacific countries (APCSS, 2017). The use of schools as evacuation centers poses several risks as well. Most buildings were not constructed for that purpose and that buildings may be exposed to other forms of hazards. During the aftermath of Typhoon Haiyan in 2013, many school buildings that were used as evacuation centers were severely damaged (PDRF, 2016); some died from drowning due to storm surge (House of Representatives, 2016). The use of school facilities has affected many students and teachers alike. Evacuees caused damages to educational facilities and equipment, sometimes endangering children to abuse, neglect and exploitation (APCSS, 2017). In many areas of the country, only the school buildings are built strong enough to resist inclement weather such as typhoons (ibid).

Ideally, there should be a different structure to serve as evacuation centers during disasters and not schools which lacks facilities such as water, kitchen, comfort rooms and sleeping areas (House of Representatives, 2016). This is the reason why the House of Representatives during the seventeenth congress has filed House Bill No. 1763, a legislation to mandate to build Permanent Evacuation Center (PEC) that is big enough to accommodate the target population, strong enough to withstand natural calamities and situated away from waters and landslide prone areas.

Schools serve as a central point of learning, cultural gathering and social bonding in most communities. The school system has the capacity for knowledge innovation particularly in building a culture of safety, prevention and resilience. It can be transformed into a community of learning and practice that significantly influences disaster mitigation, response and recovery. Making schools the focal point in DRR education for the entire community is a proven effective approach. However, even the schools can be potentially affected by disasters. It is for this reason that assessments must be made regarding the structural integrity of the building structures.

Figure 8. Classroom used as evacuation center after Mount Mayon eruption (Source: Manila Bulletin)

Most schools are built before the emphasis on multi-hazards was incorporated in the fundamental designs. The German Technical Cooperation (2008) prepared a handbook on Good Building Design and Construction in the Philippines. The handbook was based on its rich experience in previous disasters. It addresses some common mistakes in building construction in the countryside especially when local engineering offices are not serious in imposing building codes/standards.

Figure 9. Some common building design issues in the Philippines (Top-Left: poor foundation/swampy; Top-Right: bad location; Bottom-Left: rigid structure in liquefaction zone; Bottom-Right: poor structural condition)
Source: GTZ, 2008

During the 1st National Conference of DepEd engineers and architects at the Development Academy of the Philippines (DAP) made several design considerations to wit: a) functions and needs of users; b) economy in construction, utilization and maintenance; c) human dimensions; d) applicable building codes; e) effect of climate change; f) calamity-resilient school buildings; g) designed to withstand 250kph wind velocity; h) designed to withstand major earthquake; and

i) complies with the 2010 edition of the National Structural Code of the Philippines or the NSCP (Llego, 2016).

As regard the architectural features of the school buildings, the upgrade include: a) doors and windows, with security grills at front, casement window at rear side, concrete jamb; b) stair width from 4.5 meters to 5.0 meters; c) fire exit stair width from 0.90 meter to 1.20 meters (clear width); c) provision of wet standpipe system for four-storey school building; d) provision of dry standpipe system for two-storey and three-storey school building; and e) color scheme (Llego, 2016). The following structural components are likewise upgraded: a) roof framing; b) columns; c) beams; d) tie beams; and e) foundation (Llego, 2016).

For the roofing, the upgrade includes the use of 0.4mm thick base metal (0.43m with metal coating), pre-painted long span corrugated GI sheet. As for the structural design of the windows, the upgrade includes 14 glass jalousie blades on a shutter type window holder with fixed clear glass transoms on 50 x 150mm concrete jambs. The upgrade for the structural design for the doors of disaster-resilient school buildings include: 1) 2-panel type door, swing out, with level type lockset; and b) fixed glass transom on 50 x 150mm concrete jambs/frames.

As for the ceiling, 4.5mm thick fiber cement board on metal furring at 400mm OC with aluminium for insulation will be implemented. For the lightings and fixtures, the following shall be observed: a) six units of 2-36 watts (T5) box type fluorescent lamps equally spaced inside the classroom; and b) two units of grounding type convenience outlet (CO) on the windowless side of the classroom.

Moreover, even the installation of the classroom's chalkboard has several structural requirements. The chalkboard must be built-in measuring 4.88 meter length by 1.22 meter width, framed with thickness of 13 cm at center and 42 cm at the ends. The elevation height is 750mm for secondary and 650mm for elementary.

The DepEd Educational Facilities Manual (DepEd, 2010) identified site selection as key to making schools are safe. The National Building Code of the Philippines (2005) requires that the land or site where the structure is to be built including ancillary or auxiliary facility shall be sanitary, hygienic or safe. It must be free from streams or bodies of water and/or sources of air considered to be polluted; far from volcanoes or volcanic sites or any other structures that has a potential to experience fire or explosion. The identification of sites that is not exposed to man-made or natural hazards, and other perils maybe conducted through hazards assessments.

School mapping is a dynamic process of planning the distribution, size and spacing of schools and physical facilities requirements for optimum utilization and benefit. It is a process of identifying current inadequacies in distribution and of providing appropriate types and patterns of school plant. It is a continuous process involving the uninterrupted recording of basic information required for analysis of the school map at any given point in time. The initial step in school mapping is to make a survey of the existing situation in order to obtain all information about the network of schools and their physical resources and means considering the environmental/geographic factors which include both natural (rivers, mountains, etc.) and man-made (source of electricity, roads, railways, communication network, etc.) features; demographic factors such as size, growth, density, social structure, migratory trends, school drop-outs and retention rates, etc.; economic factors such as per capita income, commercial establishments, mass media, size of schools/classes; and educational factors such as the number of study hours per week and their distribution by subjects, the number of pupils/students per class, normal length of time for which premises shall be used and the possibility of introducing double shift, teachers' working hours, etc (DepEd, 2010).

In constructing school maps, geological and hydro-meteorological hazard maps generated by mandated national government agencies are available and should be referred to by each school and used in site location, planning, and implementation. The hazard maps will help identify areas or zones prone to specific hazards such as those related to earthquakes (ground rupture, ground shaking, liquifaction, earthquake-induced landslides and tsunami), volcanic eruptions (pyroclastic flows, lava flows and ash fall) as well as hydro-meteorological hazards brought about by tropical cyclones and heavy monsoon rains such as rain-induced landslides, floods and flash floods, and storm surges (DepEd, 2010). Geological and hazard maps shall be provided to each school. This will identify areas prone to hazards like landslides, soil erosion, floods and earthquakes.

Meanwhile, the established philosophy behind the design of any structural component is to ensure that the strength of the material, of which the component is made of, is higher than the maximum applied stress in service. If the former appears to be greater than the latter, then the component is considered to be fit for service, otherwise, modification in design or the use of another material with a higher strength is required. In the conventional design approach, shown in Figure 14, maximum applied stress should not exceed a certain fraction of the yield strength (i.e. elastic limit) of the material used. The ratio of the yield strength to the applied stress is often called *safety factor*, typically in order of 1.5 to 3. This approach is based on the assumptions that a) the component is free from any flaws and defects, and b) the safety factor would compensate for any unexpected overloading or deterioration of the component during its service life.

In 2015, the Department of Interior and Local Government (DILG) together with the Australian Volunteers for International Development (AVID) have formulated a Build Back Better Manual (BBB Manual) to assist Local Government Units in rebuilding efforts after the devastating impact of Typhoon Yolanda in 2013. The BBB Manual provided guidelines to make structures more resilient. It emphasizes five principles of achieving resilient infrastructures. These includes (1) risk and site assessments, (2) scoping and planning of projects, (3) site analysis, (4) architectural, engineering and urban design and documentation, and (5) materials and construction quality.

The recommended designs by DepEd and DPWH versus DILG and AVID shows some dissimilarity such as the roof design. The DepEd/DPWH proposed roof designs are high pitched and DILG/AVID is curved or parapet covered roofs. The later emphasizes that steep slopes or even low pitch roof are less resistant to wind forcers and should be avoided. It argued that suction over a roof is significantly influenced by the roof configuration.

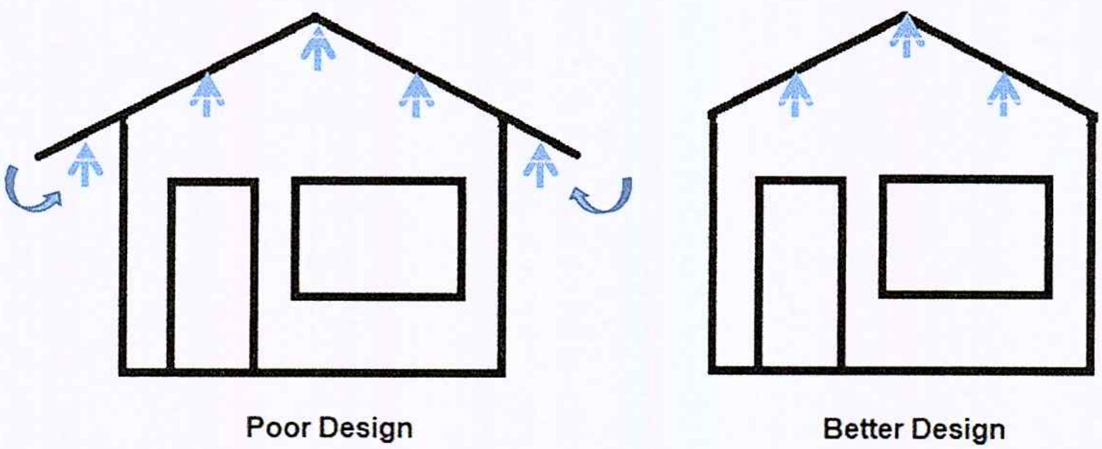


Figure 10. Roof design and its impact to wind forces.

A 30 to 45 degree gable (two sided) and hip (four sided) roofs performed better with the hip roofs recording significantly less suction than their gabled counterparts based on a wind tunnel testing of low rise building models (Prasad et al, 2009; New Jersey Institute of Technology, 2007). The presence or absence of eaves (left illustration of Figure 10) or overhangs expose the roof to increased wind load to blow off the roof (New Jersey Institute of Technology, 2007). Parapets can be used to further protect the connection of the roof to the wall and prevent uplift (DILG & AVID, 2015). The steeper is the roof slope, the less its chances to be blown away, however, a steeper slope means greater total wind force acting on the wall. This suggests that the design of roofs must consider all factors to make it more resilient.

Sizes of building openings (ie. doors and windows) must also be controlled as well as the use of glazing materials such as glasses. Glazing if not insulated, laminated or double-glazed, allows more heat to enter making it less efficient in terms of cooling. The size of opening and use of glazing materials must be balanced; wider doors and windows exposes the building to more harmful elements during disasters such as strong winds versus its gains (ventilation and light). The need for larger openings and glazing may be protected through shutters which can be installed or rolled down before an expected typhoon (DILG & AVID, 2015).

All roofs are subject to wind uplift depending on the shape, size, and location; some locations are prone to strong wind specifically during typhoons. The strong and fast wind towards the roof results into lower air pressure above the roof (see figure 11). The wind entering and stopped inside the room increases room air pressure. When the weight of the roof and the air pressure above the roof is lower compared to the air pressure inside the room, the roof is likely to be blown away (Dixon & Prevatt, 2010).

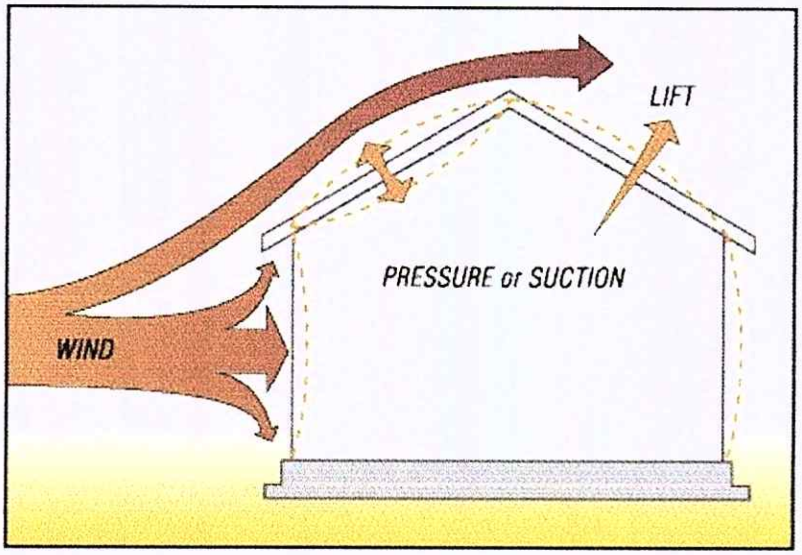


Figure 11: Wind flow over building (Source: Simpson-StrongTie Co., Inc.)

Until early 19th century, design engineers relied on using large safety factors in order to overcome the uncertainty associated with the actual strength of various components and their joints due to inevitable and undetectable internal defects. However, the catastrophic failure of some naval ships and tankers in cold seawater during World War II led to a broad research program in order to find out the cause of such failures. However, such yield-point-based designs, which incorporate high safety factors, are not an optimum approach for all engineering structures. Optimum selection and use of structural materials in order to reduce the weight, manufacturing and running costs of almost all engineering structures, requires profound understanding of failure mechanisms.

In fracture mechanics-based approach, unlike yield point-based design approaches, a material should withstand the maximum applied load when a crack-like flaw exists. In this approach, material resistance is expressed in terms of tensile properties (yield and tensile strengths) and fracture toughness (resistance of a material against any crack growth). However, applied load/stress is expressed in terms of crack-tip loading parameters, such as $K_{applied}$, or $J_{applied}$. For linear elastic materials *K*, and for non-linear elastic and elastic-plastic materials or *J* are applicable.

In fracture mechanics-based integrity assessments require the following competences: a) someone who can address materials issues; b) an engineer to estimate applied and residual stresses experimentally or by modelling; c) a non-destructive testing expert to detect the size and location of any flaws in the structure; and c) a structural integrity expert to assess the fitness of the structure for service (Motarjemi & Shirzadi, 2012).

Therefore, capacity building of DepEd engineers in terms of constructing disaster-resilient infrastructure must be given focus by the government. Local engineers who are involved in building resilient structures specifically classrooms must be qualified. The capacity building should include ability to identify risks and be able to provide specific measures to address the risk. Risk management must be based on actual conditions of the site. It must not be based on a cure-all, generic approaches.

Related Studies

The researcher reviewed significant findings of previous researches to shed light to the topic under investigation.

Disaster management is handled by competent professionals, those who are aware of the issues that affect resiliency of communities against hazards, both man-made and natural. It starts with good grasp of available information and putting this good information in planning. Structures needed to be built in sound location ideally free from hazards. In the study of Salazar-Quitalig & Orale (2016), only 17 have formulated Comprehensive Land Use Plan (CLUP) but almost all have expired (one is technically active but is obsolete) and all have not yet incorporated disaster risk reduction and management. It was also found out that people lack the needed competencies and support in producing the most responsive CLUPs.

Most of those who are assigned in making communities resilient are civil engineers. They are the usual people trained to build structurally sound buildings and safe environment. Most of those who are working as civil engineers were old graduates. A study of civil engineering students about civil engineering practices in Samar which was followed-up by Orale and Gomba (2016) showed that civil engineers feel they are satisfactorily performing their management functions in the several areas of civil engineering but validation of their responses revealed that they are very dependent on manuals with limited understanding of its contents.

This is very evident on the projects implemented which are low in quality in many aspects.

The study of Salazar-Quitalig and Orale (2016) and the study of Orale and Gomba (2016) are related to this study in the area of planning and management. Making a resilient campus require competent (appropriately trained) personnel and enough support. Failure to plan is planning to fail; a good and responsive plan is expected to minimize the risks, be it natural or manmade. This suggests that people who will be assigned in an office that is tasked to ensure safety of structures and its users' needs be capacitated regularly.

The study of Banks (2014) investigated the impact of Yolanda on those living there, framing the investigation through the idea of resilience. Among the key findings of this study were: a) resilience for those affected by Yolanda is not something that can easily be measured qualitatively; it is not just based around physical assets but also feeling safe and secure, having independence and being included in the rehabilitation process; b) a house that is perceived as strong and expensive in relative terms (concrete, large in size, etc) is central to the affected population's definition of what feeling secure (resilient) is; c) access to work (livelihoods) is both a key aspect of allowing people to meet basic needs and a central component of making those affected by Yolanda feel less vulnerable to future shocks; d) cash transfers (especially when unconditional) can be very effective in allowing those affected to start to rebuild their assets as well as to meet basic needs in the immediate post-disaster phase; e) the huge scale of Yolanda's impact meant that community-level support networks that might in other situations have enabled people to build back more quickly were not in place during the emergency phase, meaning most of those building back did so individually (at a family or household level); f) a perceived lack of communication from government, and in some cases NGOs, left those affected by Yolanda feeling unsupported and vulnerable; g) using development terms such as resilience and livelihoods is not always the best way to frame recovery programs, especially when trying to engage with the affected population; they can leave the target beneficiaries feeling isolated and confused about the programmes aims and goals; and h) resilience for those affected by Yolanda is not just about long-term planning and development; it is also about feeling safer and more secure when the next typhoon hits or the rainy season starts again.

Although the study of Valo (2015) evaluated the success of post-disaster early recovery from a social perspective focusing on three sectors, namely, livelihoods and income restoration, adequate housing and disaster preparedness, and investigated the disaster resilience of the affected communities and individuals, it nevertheless provided important information regarding the indispensability of resiliency. The study findings show that a year after the disaster, people's major problems were drastically dropped income levels, inadequate housing and inability to restore livelihoods. Emergency phase had been successful however the critical shift from short-term aid to long-term development framework had not yet been purely successful. Nevertheless some important steps had been taken. Humanitarian assistance was not only distributing goods but included housing programs, emergency employment and livelihood support. Communities' own resilience systems in terms of social capital played an important role in disaster recovery.

Zalameda (2015) sought to explore the role of institutions and actors who are involved, to identify the challenges experienced in the adopting and implementing process, with the hope to illuminate from the data as to why these challenges exist. The results showed that institutions play important roles and hold responsibilities in communicating the main objective of adaptation strategies, but is lost among participating actors. In terms of knowledge and involvement with climate-related adaptation, it is an emerging aspect set within the larger disaster risk reduction context. Identified challenges in educating and communicating the strategies often emerge at the government and community-levels, potentially drawing from bureaucratic challenges funneling down to local government units, which are exacerbated by feelings of distrust and strained relations of communities toward the government. Finally, few themes were found from the data in connecting climate change adaptation strategies to a greater role in framing sustainable development in the Philippines. However, alleviation of impoverished conditions and education were two critical aspects for cultivating knowledge needed to promote long-term efforts toward resilience, and thus sustainability of the local people during disaster events.

Varona et al. (2017) assessed the knowledge, attitude and practices on disaster risk reduction and management of the barangay officials of the thirteen barangays of Baler, Aurora, Philippines considering that this province is prone to natural disasters because of its geographic location. Results showed that barangay officials were knowledgeable about disaster risk reduction and management, they have a positive attitude to this and almost all activities of this program have been practiced by the barangay officials.

Another study which was relevant to the present research was conducted by Borja (2009) which determined the different measures that the employees of Aquinas University of Legazpi utilize or make use of during disaster preparation. The study revealed that in the disaster preparation done on the preservation of life, 68 or 89.47 percent of the respondents answered that students are informed and warned about upcoming disasters by employees. In addition, in the common problems encountered during disaster preparation, 39 or 51.32 percent of the respondents answered that there is not enough space in lockers and file holders for keeping files and records; 46 or 60.53 percent answered not all employees partake in the disaster preparation; 31 or 40.79 percent answered there are not enough resources to use in covering and shielding appliances, amenities, fixtures and other paraphernalia; 25 or 32.89 percent answered there is not enough room or space in higher floors for transferring office appliances and paraphernalia; 19 or 25 percent answered there is insufficient supply of materials for repairing or reinforcing weak structures; 24 or 31.58 percent answered procedures are not done very orderly; 25 or 32.89 percent answered not all students and employees are informed; 39 or 57.32 percent answered not all employees are what? In the measures that may be proposed to enhance employees' knowledge and preparedness, 59 or 77.63 percent of the total frequency proposed ensuring sufficient supply of materials and resources useful in disaster preparation; 55 or 72.37 percent proposed development of programs for better or improved disaster preparation system; 58 or 76.32 percent answered create organizational disaster management systems in every department; 63 or 82.89 percent answered encourage involvement of students and staff employees in conducting disaster preparations and evacuation prompting; and 64 or 84.21 percent proposed setting up of programs and exercises that aim to improve or enhance disaster awareness and preparedness among employees and students.

The study found relevance with the research conducted by Villoria (2012) entitled "Barangay Government Disaster Preparedness: The Case of Typhoon Sendong Affected Iligan Communities." Said study revealed that most of the barangays are not prepared for the disaster due to lack of budget, which apparently resulted in negligence and over-confidence; only one barangay was able to implement its Barangay Disaster Risk Reduction and Management Plan (BDRRMP). The lack of proper information-based systems and the ignorance of the residents have contributed to their unpreparedness. Delayed response and relief are due to impassable roads, among other things. In the aftermath, barangay government officials have helped in the distribution of the relief goods and have coordinated with the city and national governments, the NGOs, and other private sector groups regarding their barangay long term rehabilitation.

This study of Villoria is worthy of note in the present research because of some aspects. First, they were both concerned about gaining insights regarding disasters and risks that are experienced by communities in the country. Second, both were researches concerned with the capabilities of the communities to be prepared in the midst of disasters. Despite the similarities, however, they differed because the study of Villoria focused on the barangay disaster preparedness compared to the present study which referred to the preparedness of the educational institutions in the face of disasters in terms of constructing disaster-resilient school buildings.

Another study conducted by Robas (2014) entitled "Flood Disaster Risk Reduction and Risk Management of Pasig City" is worthy of mention in this present research. The findings of the study found out that on the overall the respondents assessed the Flood Disaster Risk Management-Disaster Risk Reduction (DRM-DRR) programs of the Pasig City as effective. There is no significant relationship between the variables government affiliation, position, and length of service and the respondents on the overall assessment of the flood DRR-DRM. The respondents disagree that they encountered problems in lack of disaster management plan, lack of coordination between the LGU, NGO, NG and other agencies, and delayed implementation of project. However, the respondents moderately agree that they encountered problems in budget, Awareness thru education and information, community participation, political will (leadership of officials), community resistance, manpower, poor implementation of law, and insufficient assistance from National Government. In terms of program objectives, the respondents assessed the flood DRR- DRM program to be effective. The respondents assessed that the city has a sufficient funding in prevention and mitigation, emergency preparedness and risk reduction, emergency response, rehabilitation and recovery. In terms of program activities in emergency preparedness and risk reduction, the respondents assessed that the community level is responsive and aware of the disaster risk factors. First, the communities organize themselves to monitor potential disaster. Second, there are warning systems in place to the community level. Third, communities are ready and understand official warning and react. Fourth, community vulnerability has evacuation plans/maps. Fifth, there are trainings, simulation exercises, or local drills conducted at the community level. Sixth, the training conducted at the community level is relevant. Lastly, there is disaster awareness and public information projects or programmes being undertaken for the community.

The study of Robas was more specific to flood disaster risk reduction and risk management whereas the present research covered all types of natural as well as man-made disasters. Despite the difference in scope, however, Robas' study shed light on the importance of evaluating the disaster risk reduction and risk management efforts of local government units (LGUs) in much the same way that the present research assessed the structural integrity of public school buildings as part of the disaster risk reduction and management effort of the community.

Galindo (2014) revealed that the organizations are moderately prepared for natural disasters. However, findings from the individual category of infrastructure showed that facilities, utilities and transportation organizations are less prepared. Organizations responsible for electrical, fuel, gas, energy, waste and water utilities ranked number one with lowest preparedness level. The findings of this study may help identify vulnerabilities and strategies to improve the resiliency of these critical infrastructures and institutions and may provide the basis to improve local policies pertaining to disaster preparedness.

The similarity of the research of Galindo to the present research was on the focus – both were concerned about organizational preparedness for natural disasters. However, they differed in terms of other variates considered in the study as well as the procedures used.

Sobremisana (2014), in a research entitled "Disaster Risk Reduction Management in the City of Mandaluyong: Focus on Earthquake Impact Reduction," revealed that the City of Mandaluyong is prepared for a major earthquake. Six, out of the eight (8) items of preparedness, were perceived to be the strengths namely: legal framework, vulnerability assessment, DRRM plans, institutional and organizational structures, community awareness, and disaster response. Results likewise showed that preparedness of the City of Mandaluyong is weak in terms of private-public partnership, and recovery and rehabilitation.

Statistical analysis showed no significant difference in the groups' perception on legal framework, DRRM plans, and disaster response.

While the study of Sobremisana focused on earthquake impact reduction, the present research covered all types of natural as well as man-made disasters. However, the research of Sobremisana is cited here as it shed light to the significance of disaster risk reduction management of local government units in much the same way that the present research focused on an assessment of the structural integrity of public school buildings as part of the disaster risk reduction and management effort of the educational systems.

Finally, Pongan (2015) assessed the extent to which Albay's DRRM practices succeed in addressing the factors that make communities vulnerable to begin with, such as lack of economic opportunity or public health issues. Development and DRR are deeply intertwined, and development often becomes a conversation that excludes the very communities that it purports to serve. Participatory DRRM offers a means of returning some level of efficacy to victims of climate change, even in the face of disasters that are difficult to predict.

The study of Pongan was wider in scope as it dealt with the disaster risk reduction and management of Albay Province in contrast to the present research which was only concerned with the structural integrity of the public school buildings in the Province of Samar in the face of disasters. Yet, the study of Pongan provided significant insights regarding DRRM to the present research.

The use of computer simulation is also very effective in identifying potential impact of a particular disaster. The study of Ng et al. (2017) made use of Rapid Earthquake Damage Assessment System (REDAS) software in estimating damage to buildings in selected areas in Catbalogan. The software was able to find out that a magnitude of 6, 7, 8, and 9 will result into 24%, 41%, 65% and 98% damaged buildings. In studying flood risk, Hydraulic Engineering center - Hydrologic Modelling System (HEC-HMS) was also used in several researches of Orale & Novilla (2016) and Orale (2015), Fabillar and Gomba (2016). These studies were used to estimate swelling of rivers that may lead to flooding. The current study is quite similar to the studies herein identified for using simulation software to identify potential disasters such as earthquakes and floods. Also, the locale of these studies is in Samar like the studies primarily authored by Ng, Orale, and Fabillar.

All the studies are herein cited as they provided significant insights regarding the extent and scope of disaster risk reduction and management strategies of the different localities internationally as well as locally.

Chapter 3

METHODOLOGY

This chapter discusses the different procedures which were used in the conduct of the study. Included in this study are the research design, locale of the study, instrumentation, validation of instrument, sampling procedure, data gathering procedure, and statistical treatment of data.

Research Design

This study was a descriptive type of research which assessed the vulnerability of public school buildings in the Province of Samar, with the end-view of proposing resilient public school buildings for the province. The assessment of the school buildings focused on their structural integrity along foundation, basement/crawl space water, framing, roof, interior/exterior, and general building structural integrity. In addition, a thorough analysis of the public school building in terms of their technical aspects such as building design and purpose, construction materials used, construction cost, and methods of construction and maintenance; and non-technical aspects such as aesthetics, disaster/risk reduction measures, and location of the school was conducted.

The study likewise focused on an assessment of the vulnerability to disasters such as geologic disasters (i.e. earthquakes, landslides and tsunami); water related disasters (i.e. floods and typhoons,), and fire related disasters of the different municipalities in the Second Congressional District of the Province of Samar.

Locale of the Study

The study was conducted in the Second District of Samar with 52 schools found in 15 municipalities and 5 district elementary schools in the City of Catbalogan, as shown.

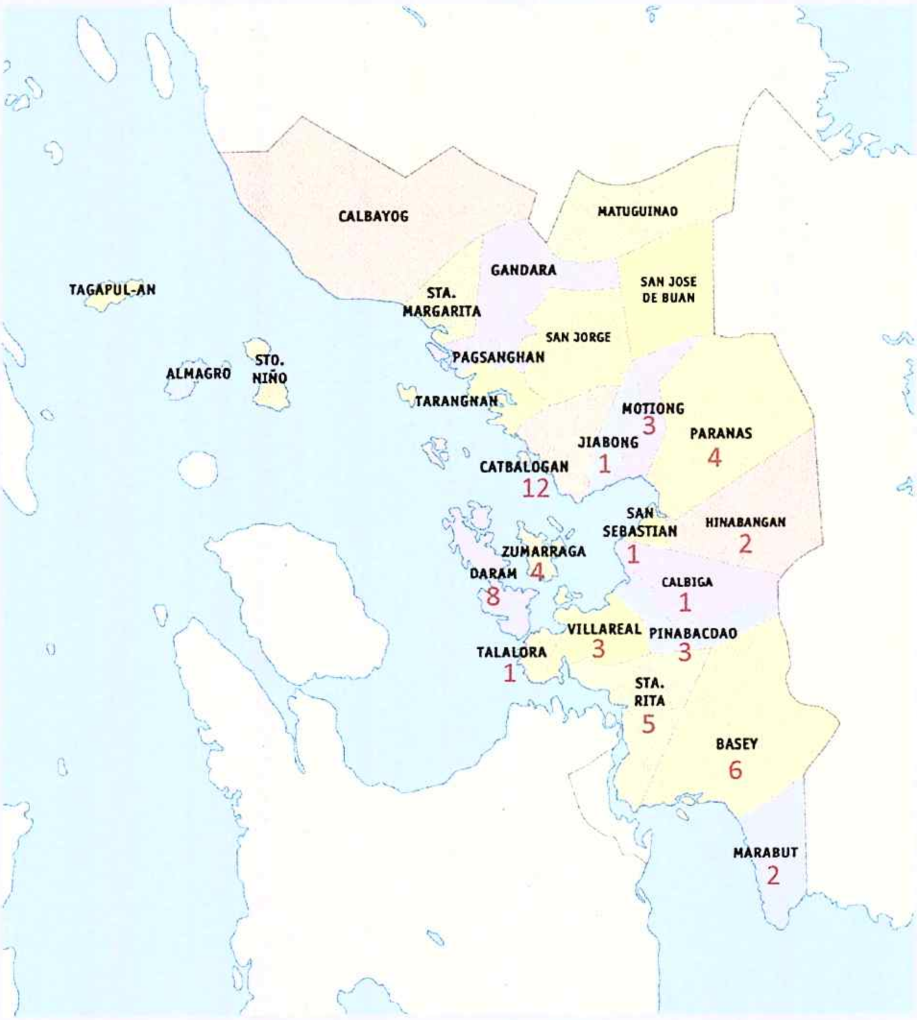


Figure 12. Locale of the study.
(Number below town name indicate number of schools sampled)

<u>**Instrumentation and sources of data.**</u>

The main instrument used was a checklist complemented with researcher-made forms to record the specific details of the building such as but not limited to column and beam sizes, type of ceiling and its joist, roof and roof framing, walls, etc. Record notes, camera, and an engineer's tape measure, were used in gathering information. The use of a computer simulator to determine possible earthquake hazard was also used. Building plans and other building documents were also examined to gather building information that cannot physically be observed such as foundation and reinforcement details.

<u>**Documents**</u>. The researcher utilized available documents such as zoning documents of the Province of Samar, weather forecast documents from PAGASA, available assessment of Samar's vulnerability to disasters from DOST, and most importantly, blueprint, layouts, and structural plans of the public school buildings from the Department of Education, to secure data on the profile of the different public elementary schools as regards their technical aspects on building design and purpose, construction materials used, construction cost, and methods of construction and maintenance, and non-technical aspects on aesthetics and disaster/risk reduction measures.

<u>**Forms and Checklist.**</u> A researcher-made checklist was used to categorize each building components compliance to the preferred dimension and materials used. The researcher personally visited school sites and gathered information about the buildings.

Record Notes. Some other information not contained in the researcher made forms and checklist was recorded using notes. Observations like the topography in the area, drainage condition, state of the structural members, and other information shared by the key informants such as building officials of the Department of Education, school principals, some teachers and other resource persons were also recorded using record notes.

Maps. The researcher used disaster maps from Department of Science and Technology (DOST) - Philippine Institute of Volcanology and Seismology (PHIVOLCS), DOST - Philippine Atmospheric, Geophysical and Astronomical Services (PAGASA), Department of Environment and Natural Resources - Mines and Geosciences Bureau (DENR-MGB), DENR - National Mapping and Resource Information (NAMRIA), and other published geohazard maps from agencies like the United States Geological Survey (USGS), United Nations International Strategy for Disaster Reduction (UNISDR), National Geographic, etc. Some maps generated used the Rapid Earthquake Damage Assessment System (REDAS) software.

Camera. The researcher likewise used this instrument to capture the physical characteristics of the buildings.

Measuring Instruments. The main measuring instrument used was the engineers tape and the rebound hammer. The engineer's tape was used to measure dimensions of building members while the rebound hammer was used to measure the strength of concrete.

Handheld Global Positioning System (GPS). The instrument was used to locate the exact position of the campus which is necessary in the use of REDAS software.

Validation of Instrument

The research only utilizes a checklist and complemented with record notes. The instrument used does not require validation. The researcher himself was the only person who gathered the data.

Sampling Procedure

The study was purposive. It selected secondary and integrated schools in the second district of Samar. The school sites and the buildings inside them were the primary subject of this study.

In gathering other qualitative information, key informants were also considered. They were the engineers and planners of the Department of Education (DepEd), particularly in the Schools Division of Samar, and the Schools Division of Catbalogan City. Also included were the Provincial and Municipal Planning and Development Officer, particularly those in charge of the mapping of the different localities, experts in weather and other related topics from the Department of Science and Technology, and engineers from the Department of Public Works and Highways. In addition, school principals, head teachers, and teachers-in-charge were also included as respondents. The key informants of the study were selected because of their expertise on the topic in the case of engineers and weather experts, and their function/designation in office such as in the case of development planners and school principals.

Sampled Schools, Buildings and Rooms

Sixty four (64) junior and senior high schools, integrated schools and some elementary schools in Catbalogan City were considered in the study. Out of 64 only 46 schools with 544 buildings and 1,161 rooms were surveyed due to factors such as school heads or in-charge of the data needed were not available or the data is not accessible during the conduct of the study. Makeshift classrooms and structures were noted but not included in the study.

Table 4. Sampled schools, buildings and rooms.

LGU	Name of School	No. of Bldgs.	No. of Rooms
Basey	Valeriano C. Yancha Memorial Agricultural School	17	50
	San Fernando National High School	8	11
	Old San Agustin National High School	12	16
	Simeon Ocdol National High School	11	22
	Burgos Integrated School	14	27
Calbiga	Calbiga National High School	17	57
Daram	Daram National High School	12	28
	Bagacay National High School	6	11
	Birawan National High School	7	15
	Parasan National High School	8	12
	Bakhaw National High School	6	11
	Baclayan National High School	6	10
	Cabiton-an Integrated School	3	7
	Sua National High School	10	16

earthquakes; and i) compliance with the National Structural Code of the Philippines (NSCP) 2010 (Llego, 2016). Some illustrations were shown in Appendix C of this document. The minimum sizes, recommended materials and construction methodology used were the basis of determining what is standard and what is not.

Statistical Treatment of Data

The data were organized in tabular form and illustrated using graphs and other charts. Frequency count, relative frequencies, means, and weighted means were used to summarize data gathered.

Computer Generated Risks Maps

Data gathered such as building characteristics and location were used as inputs to REDAS software. Simulated earthquake was inputted and examined the possible exposure of the campuses to such events such as landslide, earthquake intensity and tsunami. Number of damaged buildings for such hazard was not included in the analysis.

Project NOAH (nationwide Operational Assessment of Hazards) simulations were also used in the determination of the potential hazards. Some of its capability includes mapping weather related hazards like heavy rains, floods, and storm surges. It also provides hazard information from landslides, earthquakes, tsunami, and volcanic eruption as well as dengue monitoring.

Other online simulators such as tsunami mapper were also used in this document. The mapplet shows how a local beach could be affected by a tsunami from an specified source location, tsunami intensity, range and height.

Chapter 4

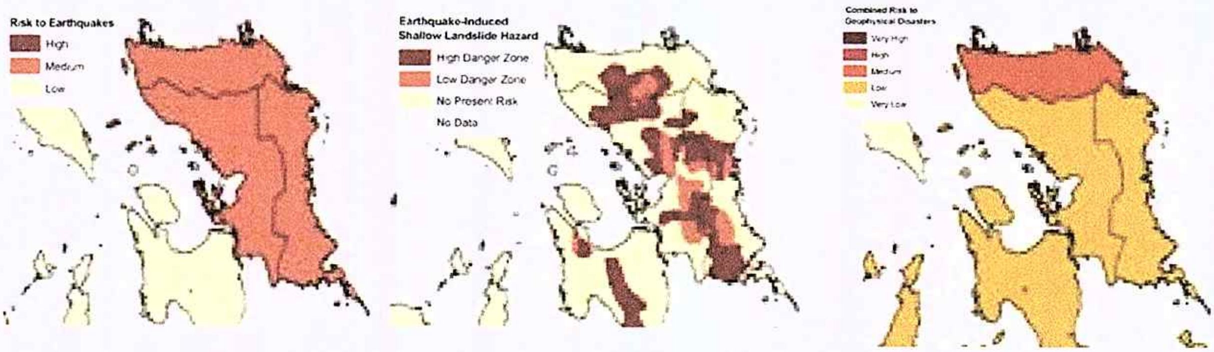
PRESENTATION, ANALYSIS AND INTEPRETATION OF DATA

This chapter presents the data collected based on primary and secondary information generated as well as the analysis and interpretation made. Also included are discussions on the critical areas for disaster in the Province of Samar, the profile of the public school buildings and the structural integrity of the public school buildings in Samar. Observations of key informants were also presented to give qualitative insights to the readers.

Critical Areas for Disaster in the Province of Samar

The following discussions focus on the critical areas for disaster in the Province of Samar in terms of geologic disasters, water related disasters, and fire related disasters.

Geophysical Risk. Geophysical events specifically earthquake occurs unannounced and in several cases are very destructive. Included in this group of risks are volcanic eruption, tsunami, earthquake-induced landslide and the triggering earthquake. Figure 2(a) shows that the risk to earthquakes is medium and the impact of these earthquakes to cause landslide varies depending on the location. Earthquake-induced landslide ranges from low to high danger zone. There is little danger from volcanic eruption and risk to tsunami if an earthquake is also low.



$$\sum R_G = R_{EQ} + R_{LS} + R_{TS} + R_{VO}$$

Figure 2. (a) Risk to Earthquakes (b) Risk to Earthquake-induced Landslide (c) Combined Geophysical Disaster Risk

Source: Climate Studies Division Manila Observatory

Figure 13. Geophysical Risks

Tsunami may occur on every coastal area and river estuary, but it is more likely to occur on shores facing a megathrust directly (UNESCO-ITIC, nd; Singapore Observatory, nd). It is estimated that almost 75% of tsunamis around the world occur in the Pacific Ocean where the subduction zones are common (Singapore Observatory, nd). The Philippines is one of those countries that is likely to experience tsunami together with countries like Japan, Chile, Alaska, Aleutian Islands to name a few. Tsunami can also be caused by underwater volcanic eruption or those very adjacent to water body such as what happened in Indonesia (Wei-Haas, 2018) and the Philippines (Volcano Live, nd).

Potential source of tsunami is if the Philippine Fault Zone fronting the Samar Island is triggered. However, the Philippine Fault Zone is a strike-slip faults (William & Rutland, 1967; Acharya, 1980) where movement is predominantly horizontal – where portions of tectonic plates grinding laterally past one another – and may not cause tsunamis (Earth Magazine, 2012). The central Philippine Fault Zone where Samar is very adjacent is found to be the locus of great earthquakes, slow events and creep activity (Besana & Ando, 2014).

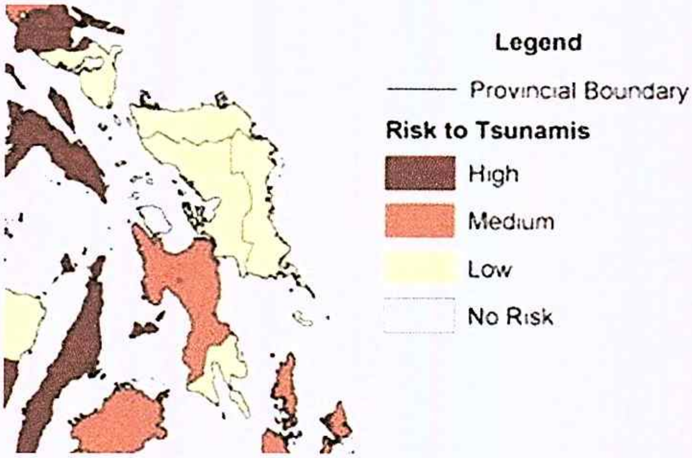


Figure 14. Tsunami Risk (Source: Manila Observatory & DENR)

Figure 14 shows that Samar has low tsunami risk according to the Manila Observatory and DENR. A different simulation by ThinkHazard (nd) rated Samar risk level at high. The high rating suggests that there is more than 20% chance of a potentially damaging tsunami occurring in the next 50 years.

Climate and Weather Related Risks. Shown on Figure 15(c), Samar has a very high combined risk to climate disaster. Risk was calculated as a summation of individual risks from typhoon (R_{TY}), increased in rain (R_{RC}), El Nino (R_{EL}) and Temperature increase (R_{TI}) impact. This means that all of Samar will experience heavy precipitation and/or typhoon. Influencing the very high risk rating is the very high risk to increased rain. This type of risk will result into flooding or rain-induced landslide. Also, typhoons may expose roof to damage during high winds attached to a strong typhoon. Secondary effect of strong wind like uprooting of trees which may eventually fall into buildings may also occur. The combined risk calculation included risk due to El Niño and temperature increase. The last two risks were not given emphasis in the study as it has little effect on the integrity of buildings and of the school in general.

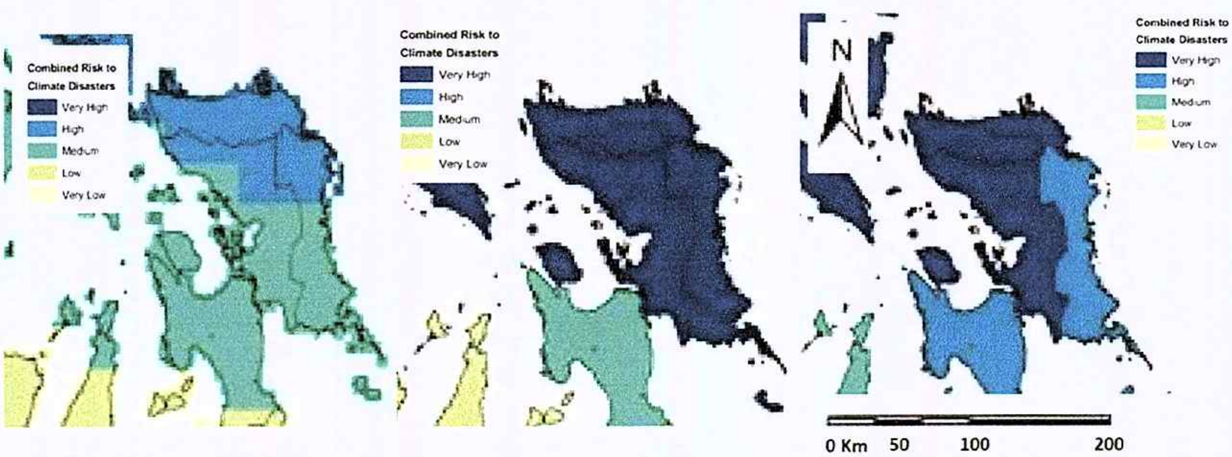


Figure 1. (a) Risk to Typhoons (b) Risk to Increased Rainfall (c) Combined Climate Disaster

$$\sum R_C = R_{TY} + R_{RC} + R_{EL} + R_{TI}$$

Source: Climate Studies Division Manila Observatory

Figure 15. Climate and weather related risks

Another type of risk is storm surge. It is an abnormal increase of coastal water level primarily due to the storm's strong winds. These winds push the water from the sea towards the shore resulting into the accumulation of water along the coast (NDRRMC f, nd). A simulation run through Project NOAH of the coming typhoon Ruby in 2014 showed a grim situation on several coasts of Samar. The DOST forecast focused on the coastal towns of Catbalogan, Taranganan, Gandara and Sta. Margarita, all in Samar (Sabillo, 2014). In that simulation it showed that storm surge may reach as high as 3.6m to 4.6m. After Typhoon Ruby (Hagupit) has passed, storm surges in the area were very minimal.

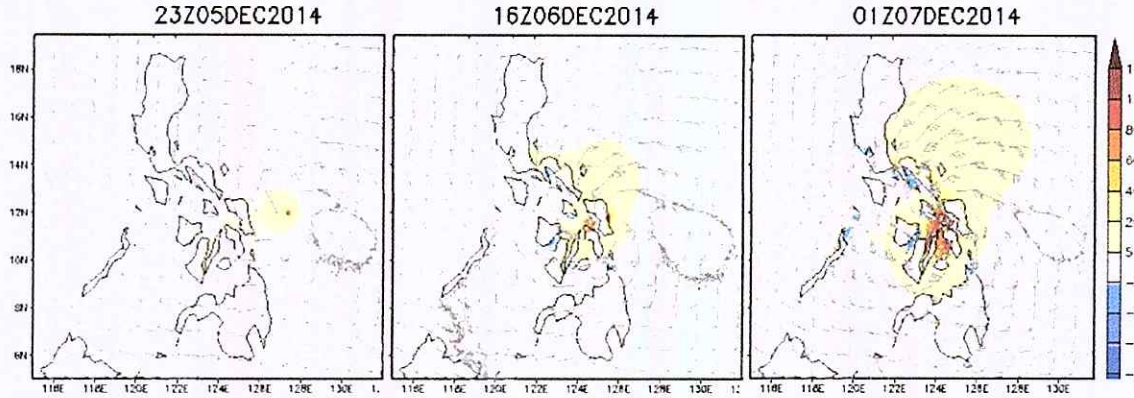


Figure 16. Project NOAH simulation run due to TS Ruby (2014).

Other Risks. Most of disasters are associated to geophysical causes which the government or people have little capacity to control. Other risks include wildfire risks, biological risks/health risks, safety hazards, risk to projected temperature increase, water scarcity, drought, river flood, urban flood, and others. Some of these risks have no serious impact to the infrastructures and thus will not be considered in this document. Discussions will only focus on fire hazard where risk levels are affected by long duration drought and higher temperature which causes vegetation to dry-up. Fire may occur due to man-made or natural causes such as wildfires.

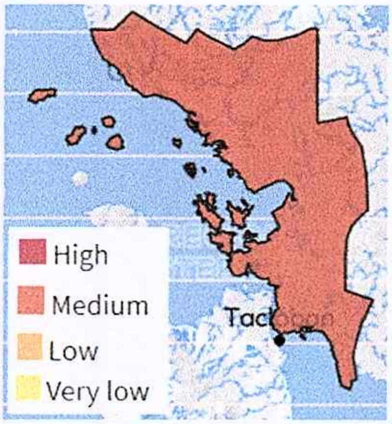


Figure 17. Fire hazard in Samar (Source: Thinkhazard.org)

Wildfire hazard risk in Samar is rated medium as shown in Figure 17; there is a 10% to 50% chance of experiencing weather that could support wildfire posing risk of life and property loss in any given year (www.thinkhazard.org, nd). The estimation used projections of future climate identification. It will likely increase fire weather frequency of occurrence in Samar. The temperature is expected to increase greater variance in rainfall. The drought will increase the likelihood of fire duration and extent of areas affected specially because of longer periods without rains. In the study of Orale (2015), the 2010-2014 data showed that about 42% of days are without rains as per PAGASA-Catbalogan station records.

Schools Exposure to Different Disaster Risks

The foregoing presentation is based on computer simulation, actual observations, review of literature and secondary information available and interviews with key informants. Some are based on previous experiences of key informants while others are based on secondary information available.

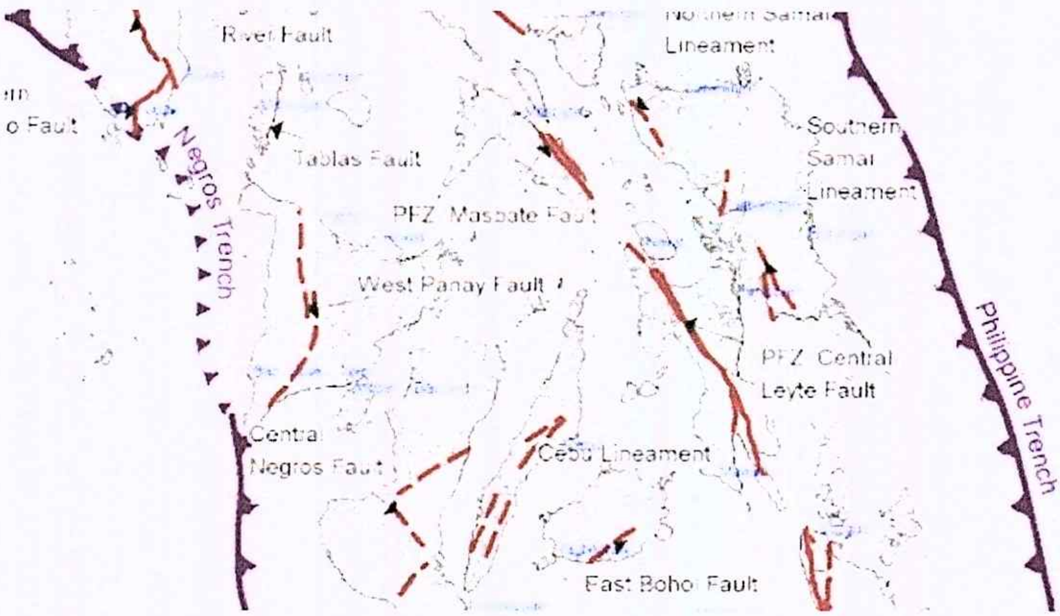


Figure 18. Philippine trench, active fault and lineament near Samar island
Source: DOST, 2000

Schools Exposed to Fault Lines. There is medium risk of earthquake in Samar as shown on Figure 18. Samar Island is very adjacent to the Philippine Trench which is found about 60 km in width and 1,400 km long (Alpha and Galloway, 1996). Figure 18 shows that the Philippine Fault Zone traversing Leyte Island to Masbate and beyond is found on the western part of the Samar Island.

The fault system is about 70 km from the nearest coast of Catbalogan City. There are also some lineament found in the Samar Island, the Southern Samar, the Northern Samar and the Central Samar lineament found near Catbalogan City as shown in Figure 18. These trench, fault and lineament are potential sources of earthquakes (USGS b, nd; Vashchilov & Kalinina, 2008).

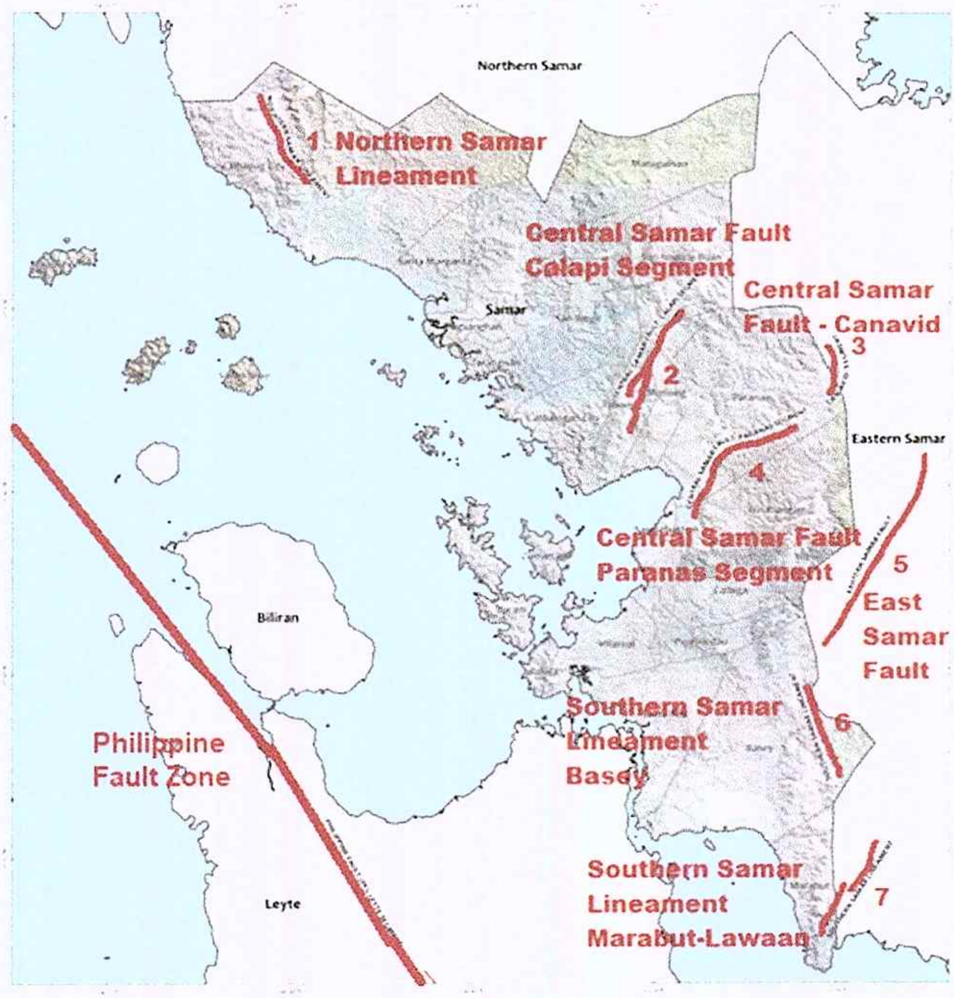


Figure 19. Active faults map – Province of Samar (DOST-PHIVOLCS, 2018)

A more recent map of the DOST-PHIVOLCS shows the active fault in (Western) Samar. It identified at least 7, a slight change in its year 2000 map. The provincial-scale active faults map for the province of Samar was generated using geomorphic evidence of active faulting using satellite images. The map has shown certain and approximate location of active faults where the (1) Northern Samar Lineament is extending to Calbayog City, (2) Central Samar Fault - Calapi Segment; (3) Central Samar Fault - Canavid Segment; (4) Central Samar Fault-Paranas Segment; (5) Eastern Samar Fault; (6) Southern Samar Lineament –Basey and the Southern Samar Lineament - Marabut Lawaan section.

Figure 20. Left: Fault line traversing a basketball court in Ormoc (www.interaksyon.com, 2017). Right: A school building above a fault line in Leyte)

Buildings or structures directly above a fault line (Figure 20) are at greater risk than those that are on it. Buildings built above it will experience greater stress which may lead to its collapse. Existing design criteria discourages building above a fault line, no amount of material strength is capable of standing against the strength of a rapturing ground. If cannot be avoided, structures on two sides of a fault line must be constructed independently from another. This is to allow the segments to move independently avoiding undue stress to the members of the structure. Figure 21 presents a conceptual design for structures built along fault lines. It features bridge like members to allow it to just sway, move to any direction without entailing various forms of structural stresses such as extreme tension, shear and torsional stresses.

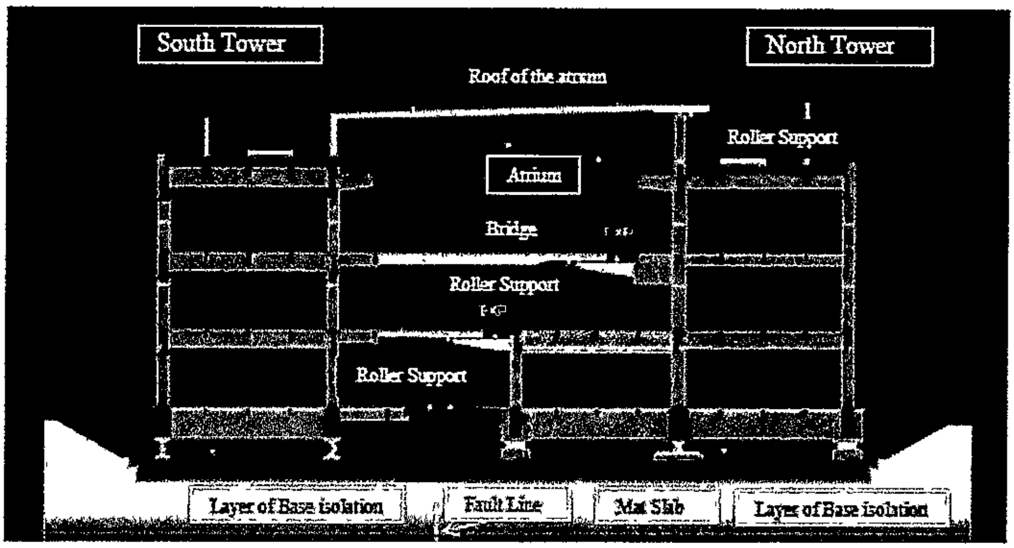


Figure 21. Conceptual design for buildings above a fault line (Nishizawa, et. al.)

<u>**Schools Exposed to Earthquake Hazards**</u>. Earthquake in Samar Island in the past two years (2016-2018) is shown on Figure 22. Earthquake intensity ranges from Magnitude 4.2 to 5.0 with depth epicentre found up to 150 km from surface. There are minor fault systems within Samar, areas near this fracture zones are potential epicentres of earthquakes. The second longest fault is called the Southern Samar Lineament that runs 30.5 km long which is also located near Basey and Marabut. The third fault called the Central Samar Lineament is about 29.5 km and

runs from Darahuway Islands of Catbalogan City to mainland Catbalogan City and San Jorge town.

These fault lines/lineament or fractures on the ground are risky areas not only in terms of potential epicentre for earthquakes but for structures stability. Structures built on top of a lineament may fail not because of shaking but of tearing. Damage potential to structures above a fault line is very high even for smaller magnitude earthquakes.

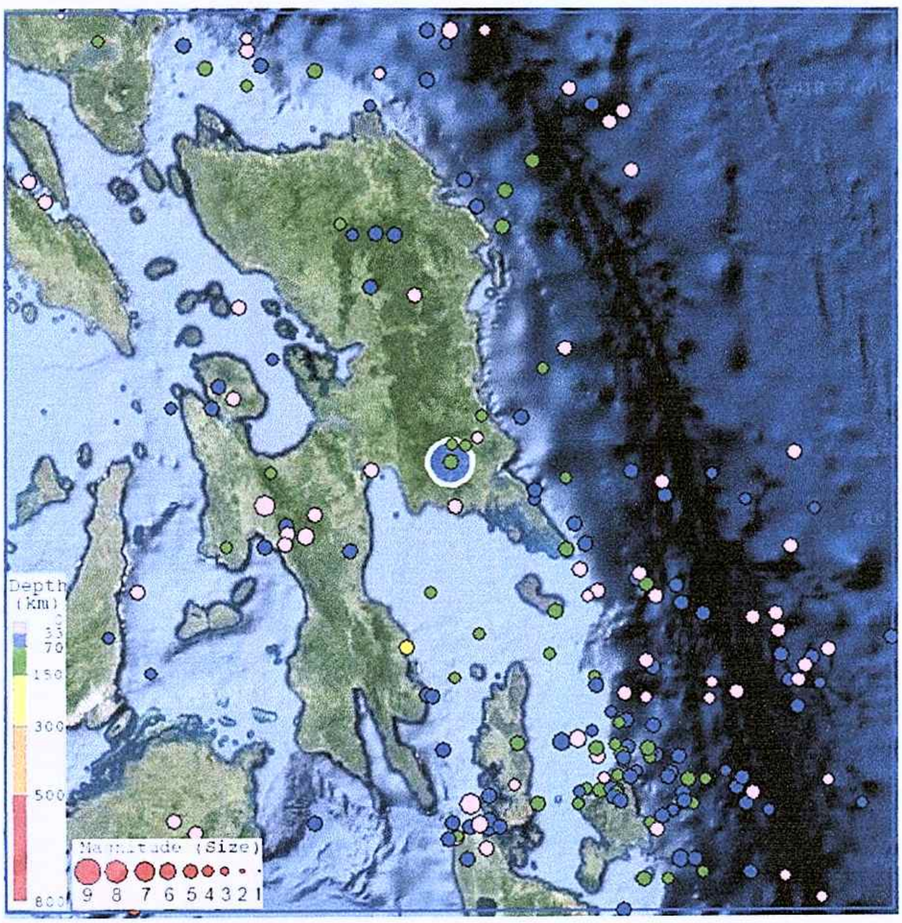


Figure 22. Earthquake profile near Samar Island (2016-2018)

A simulated magnitude 7 earthquake with epicentre found 5 km below the surface near the vicinity of the Central Samar Lineament (Catbalogan City) will result in a magnitude 6 to 7.5 earthquake. As shown in Figure 23 and summarized in Table 5, about 46 schools (88.46%) are to experience magnitude 7.0-7.5 earthquake and the remaining six (11.54%) are expected to experience a magnitude 6.0-6.9 earthquake. This distribution will change if the epicentre is at a different location. If the same earthquake occurred in Pinabacdao, Samar which is close to the South Samar Lineament, it will result into a lesser number experiencing higher intensity. Some 36 (69.23%) schools will feel the magnitude 7.0 – 7.5 and the rest (30.77%) will experience magnitude 6.0 – 6.9.

Table 5. Earthquake exposure of school campuses in Samar.

Level of Vulnerability to Ground Shaking during Earthquake	**Frequency**
Magnitude 7.0 with Epicentre at Catbalogan City (Central Samar Lineament, 5km from Surface)	
Magnitude 7.0 – 7.5	46
Magnitude 6.0 – 6.9	6
Total	**52**
Magnitude 7.0 with Epicentre at Pinabacdao, Samar (Central Samar Lineament, 5km from Surface)	
Magnitude 7.0 – 7.5	36
Magnitude 6.0 – 6.9	16
Total	**52**

A magnitude 6.1 to 6.9 earthquake is considered strong and may cause a lot of damage in very populated areas (MTU, nd). Though damage is dependent on many other variables like distance from the earthquake, type of soil and others, usually, damage occur when the magnitude reaches somewhere 4.0 or 5.0 (USGS c, nd).

For the first case (Figure 23), schools that will experience larger magnitude are those closer to the Central Samar Lineament. Schools that will experience lower magnitude (Magnitude 6.0 to 6.9) are schools in Marabut Samar (Marabut NHS and Osmeña NHS), Basey, Samar (Basey NHS, Old San Agustin NHS, San Fernando NHS) and Hinabangan, Samar (Bagacay NHS). The rest of the sampled schools will experience Magnitude 7.0 – 7.5 earthquakes.

Casimpan (2012) reported that 29 towns in Eastern Visayas were identified as earthquake high-risk areas. Philippine Volcanology and Seismology (PhilVocs) in Eastern Visayas identified the towns of Marabut, Basey, Pinabacdao and Hinabangan, Samar as subject to jolts by the movement of the lineament found in the area (ibid). The second case of earthquake shown on Table 5 and Figure 24 where the epicentre is in Pinabacdao, Samar will result into exposure to a strong earthquake (16 schools) and major earthquake or magnitude 7.0 – 7.9 earthquakes will affect 36 of the 52 schools sampled.

These 16 schools which will receive lower magnitude (6.0 – 6.9) are those found in Daram, Samar (all 8 schools), Sta. Rita (2 schools), Zummaraga, Samar (1 school), Motiong, Samar (1 school), Hinabangan (1 school), Marabut, Samar (1 school), Catbalogan City (1 school), and Talalora (1 school). The rest of the 36 schools are expected to experience 7.0 to 7.5 magnitude earthquake because of their proximity to the stretch of the Southern Samar Lineament which traverses about 60 degrees northwest from Basey, Samar.

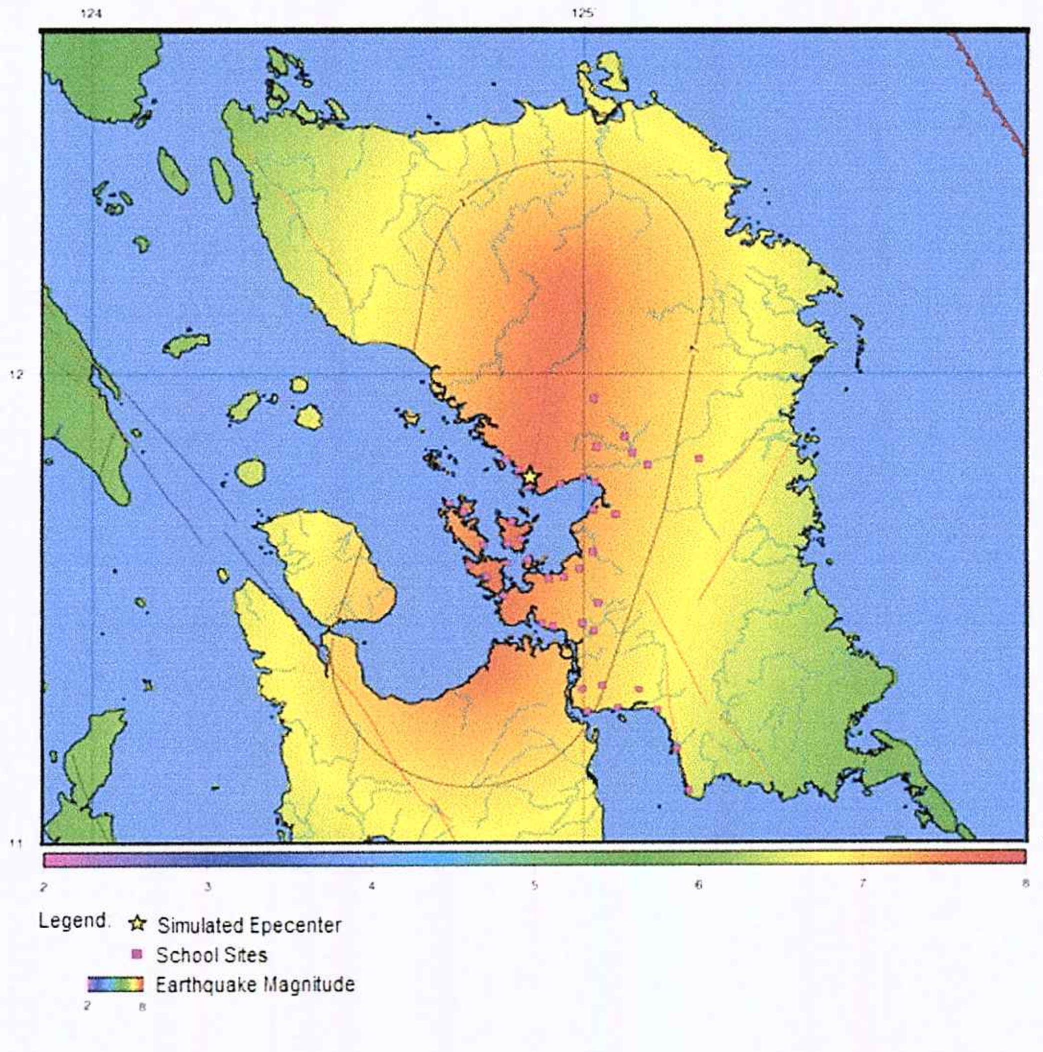


Figure 23. Magnitude felt by school campuses from a magnitude 7.0 earthquake with epicentre found 5.0 km depth in Catbalogan City

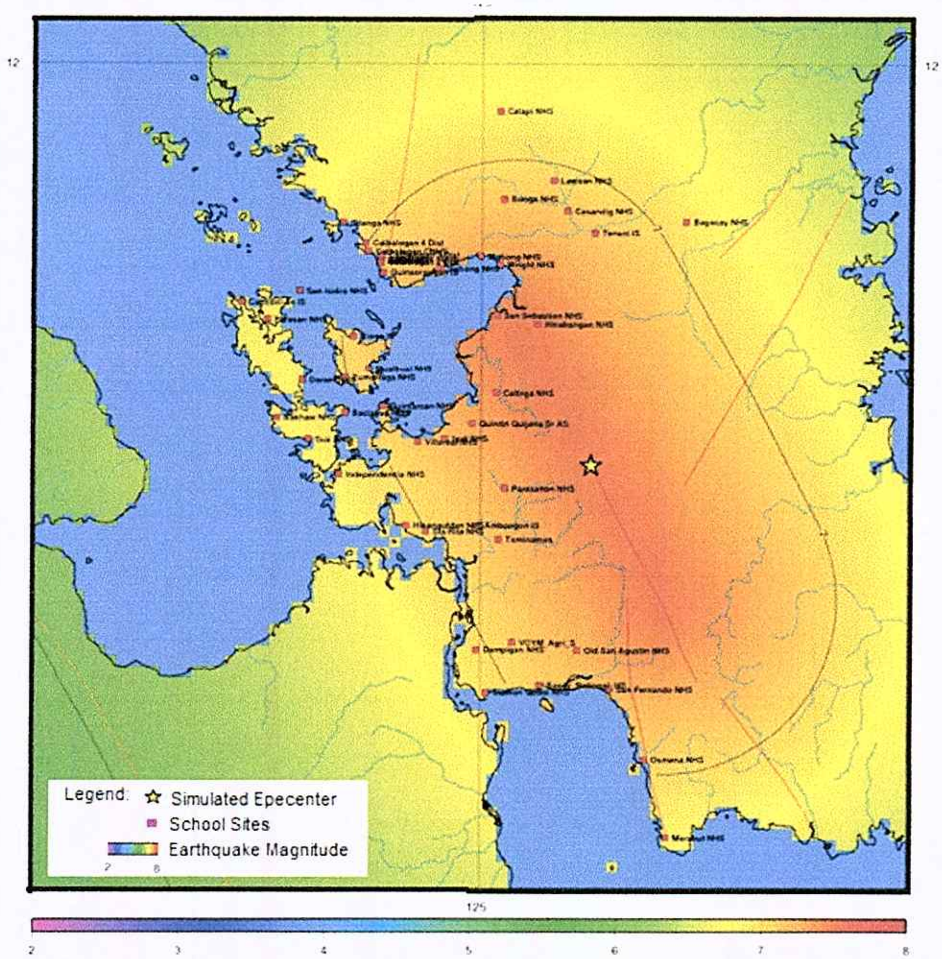


Figure 24. Magnitude felt by school campuses from a magnitude 7.0 earthquake with epicentre found 5.0 km depth in Pinabacdao, Samar

The Earthquake Tracker (nd.-a) database reports that the largest earthquake in Samar Island was a magnitude 7.2 with epicentre 20km from the surface sometime in 1994 in Eastern Samar and another in Northern Samar sometime in 1925. A magnitude 7.0 was recorded in 1946 and 1936 with epicentre near the Philippine Fault Zone fronting (Western) Samar. Using the same database, it showed that the most recent earthquake with magnitude above 6.0 occurred near Samar Island in 2003 with recorded magnitude of 6.5.

Mapping out where the fault line actually passes and designing buildings to withstand the strength of expected earthquakes even for one-storey buildings should seriously be considered. Even if structural members are sturdy constructed if the soil where the foundation stands is weak, failure from uneven settlement may pose greater danger to the structure itself. Soil investigation to determine bearing capacity, liquefaction potential and others must be studied.

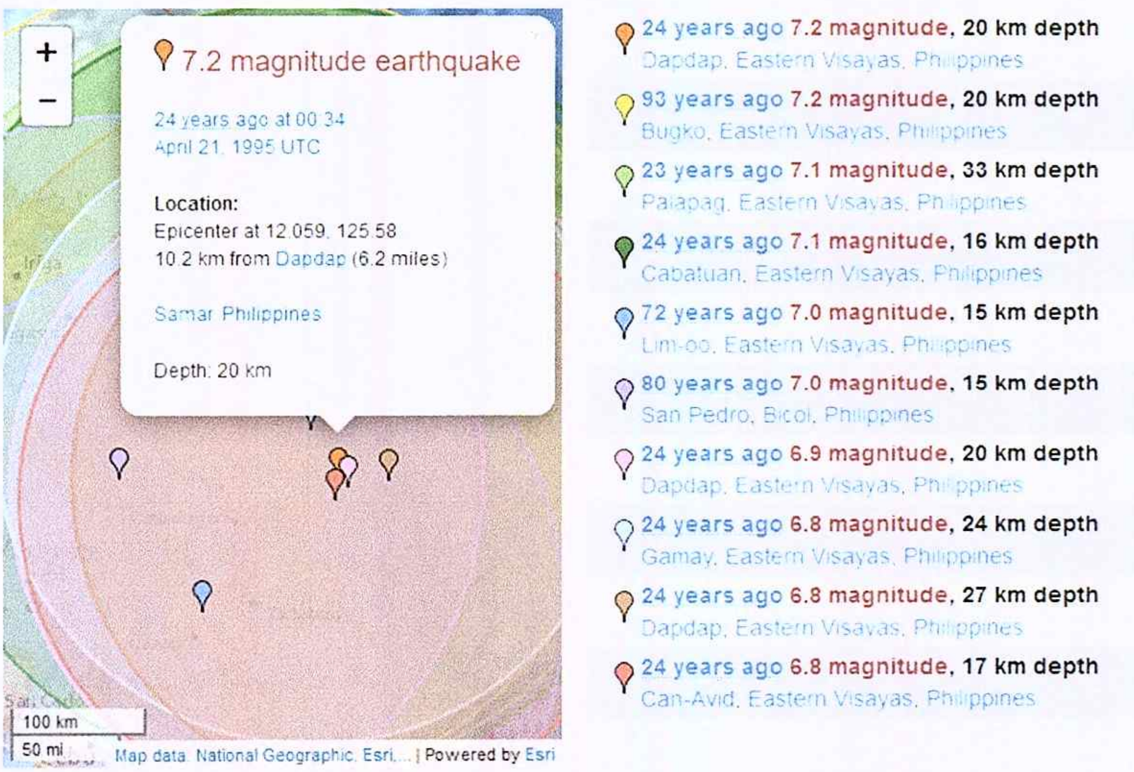


Figure 25. Largest earthquakes near Samar Island.
(Source: Earthquake Tracker,nd-a)

Table 6. Earthquake larger than magnitude 6.0 near Samar Island.
(Source: Earthquake Tracker, nd-b)

Magnitude	Depth	Year	Location
7.1	33 km	1995	Palapag, Northern Samar
6.5	35 km	2003	Can-Avid, Eastern Samar
6.4	33 km	1996	San Julian, Eastern Samar
6.4	12 km	1994	Hernani, Eastern Samar

This information suggests the vulnerability to ground shaking of the Island of Samar. This is attributed to the presence of active fault and lineament in the Island and nearby provinces like Leyte. In Samar Island, the longest fault line called the Southern Samar Lineament 1 spanning about 48 kilometers is located at the southern portion of the province near the municipalities of Marabut and Basey. The second longest fault is called the Southern Samar Lineament 2 that runs 30.5 kilometers long which is also located near Basey and Marabut. The third fault called the Central Samar Lineament and about 29.5 kilometers long runs from Darahuway Islands to Catbalogan City and San Jorge (Samar LGU, nd).

Schools Exposed to Landslide Risk. Landslide (technically known as mass wasting) is mostly triggered by hazards such as earthquake and heavy rainfall but places will not experience the same due to varying geological conditions, slope condition, the ground cover as well as human activities (Orale, 2006). In an inventory derived from high resolution satellite photos, around 12,588 landslides were recorded as of October 1, 2014 in the entire Philippines. About 614 (4.9%) are for Eastern Visayas. Of that, 614, 98 was from Samar and have been validated to be accurate (DOST, nd).

<u>Schools Exposed to Earthquake Induced Landslide.</u> Figure 26 shows the landslide prone areas in Samar when an earthquake of magnitude 7.0 occurs in Pinabacdao, Samar which was illustrated in Figure 27. There are about 3 and 8 schools found in highly and moderately vulnerable areas to landslide, respectively, due to an earthquake occurrence.

Table 7. Schools in critical areas for earthquake-induced landslide.

Level of Vulnerability to Earthquake-Induced Landslide	Frequency
a) Magnitude 7.0 with Epicentre at Catbalogan City (Central Samar Lineament, 5km from Surface)	
High	1
Medium/Moderate	0
Low	5
None	46
Total	**52**
b) Magnitude 7.0 with Epicentre at Pinabacdao, Samar (Central Samar Lineament, 5km from Surface)	
High	3
Medium/Moderate	8
Low	0
None	41
Total	**52**

A simulated magnitude 7.0 earthquake with epicentre in Catbalogan City will result in landslides in various campuses as shown on Table 7 (a). Only one (1.9%) school is located in a highly vulnerable to landslide zone which is the

Marabut National High School. Lawaan National High School, Casandig National High School, Tenani Integrated School, Bagacay National High School in Hinabangan, Samar and Hinabangan National School are in low vulnerable areas to landslides as an aftereffect of an earthquake in Catbalogan City, while the remaining 46 (88.46%) are not to expect landslides.

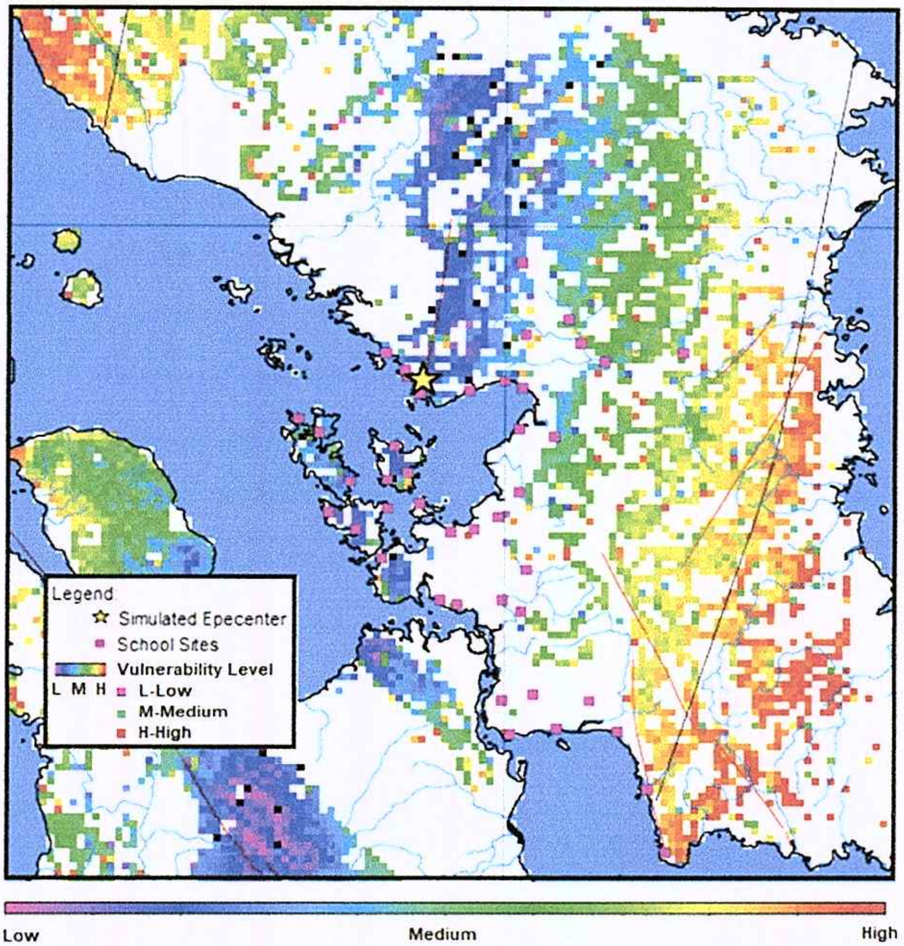


Figure 26. Earthquake induced landslide susceptibility map
(Magnitude 7.0 with epicenter at Catbalogan City, 5km from surface)

If the same earthquake occurs in Pinabacdao, Samar, the number of schools safe from an earthquake induced landslide is reduced to 41 (78.8%). However, the number of schools that are highly vulnerable to landslide due to an earthquake in Pinabacdao, Samar was increased to 3 (5.7%).

Table 7 (b) and Figure 27 show that majority or 41 public schools in the Province of Samar are not vulnerable to earthquake-induced landslides caused by magnitude 7 earthquake at five kilometres depth, with the epicentre near Pinabacdao, Samar. Some of these areas which are not susceptible to earthquake-induced landslide include Basey National High School, Valeriano C. Yancha Memorial Agricultural School, San Fernando National High School, Old San Agustin National High School, Simeon Ocdol National High School, Calbiga National High School, Parasan National High School, and others, as shown in the map.

The table likewise shows that eight public schools are vulnerable to earthquake-induced landslide to a moderate level. These include Sua National High School, Bonga National High School, Casandig National High School, Tenani National High School, Lawaan National High School, Catbalogan 5 District, Mualbual National High School, and Guinsorogan National High School.

Moreover, the table likewise shows that there are three highly critical areas to earthquake-induced landslide. These include Daram National High School, Bagacay National High School of Hinabangan, Samar and Calapi National High School.

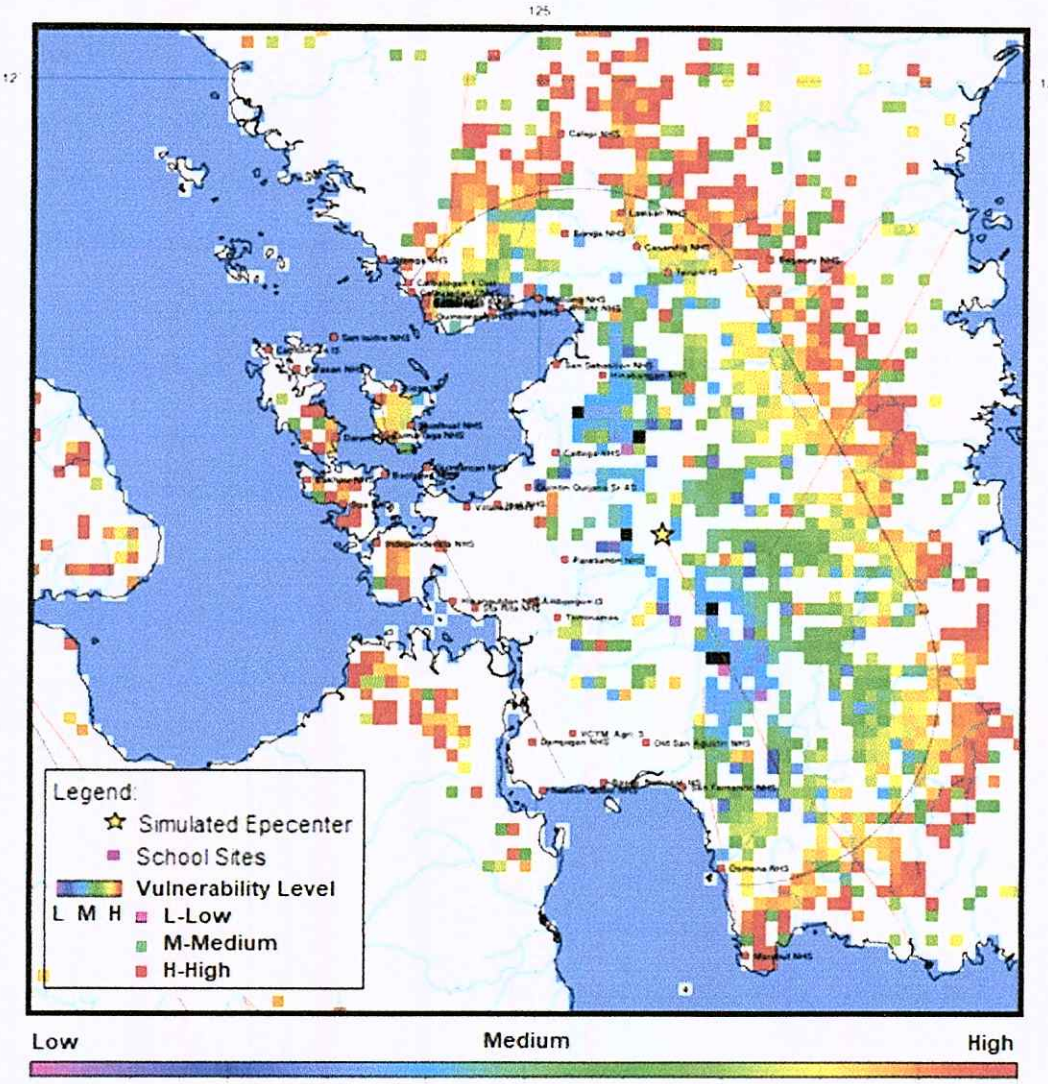


Figure 27. Earthquake induced landslide susceptibility map
(Magnitude 7.0 with epicenter at Pinabacdao, Samar, 5km from surface)

These schools, rated high and moderate to earthquake induced hazards, are located beside or on a sloping terrain. There are about 14 types of landslides identified that were associated with earthquakes; the most abundant of these were rock falls, disrupted soil slides, and rock slides. The greatest losses of human life were due to rock slides (Keefer, 1984). Each type of earthquake-induced landslide occurs in a particular suite of geologic environments such as overhanging slopes of well-indurated rock to slopes of less than one degree underlain by soft, unconsolidated sediments (ibid). Weakly cemented rocks, more-indurated rocks with prominent or pervasive discontinuities, residual and colluvial sand, volcanic soils, granular alluvium, granular deltaic deposits, and granular man-made fill are prone to landslides caused by earthquake (ibid).

Schools Exposed to Rainfall Induced Landslide. Another cause of landslide is attributed to too much water in the soil, primarily due to extreme precipitation or other means. Water alone do not cause landslide as it occurs together with other factors such as soil type and slope. Mass of soil sliding is attributed mainly due to gravity, when the intact strength of the soil is surpassed with the pull of gravity, the soil will slide or fall.

Mountains and other slopes are stable on normal condition. When these normal conditions are altered by natural or man-made causes, the stability is affected, soil shearing resistance is affected. Earthquakes often cause the soil or rocks to fracture or to be sheared resulting in instability and block of soil or rock slides or fall (Keefer, 1984). On the other hand, shear strength of soils is highly affected by the amount of water it carries especially when the soil is clay (Blahova, K. et al., 2013). Soils with higher water content tend to have lower shear strength capacity, while cohesion of soil increases at a small amount of water but decreases very rapidly after its optimal moisture content is reached (Huang et al., 2012). Most of the landslide in Samar occurs after heavy rainfall. The sudden drop in the mechanical properties (shear strength, cohesison) of the material associated with an increase in water content results into landslide.

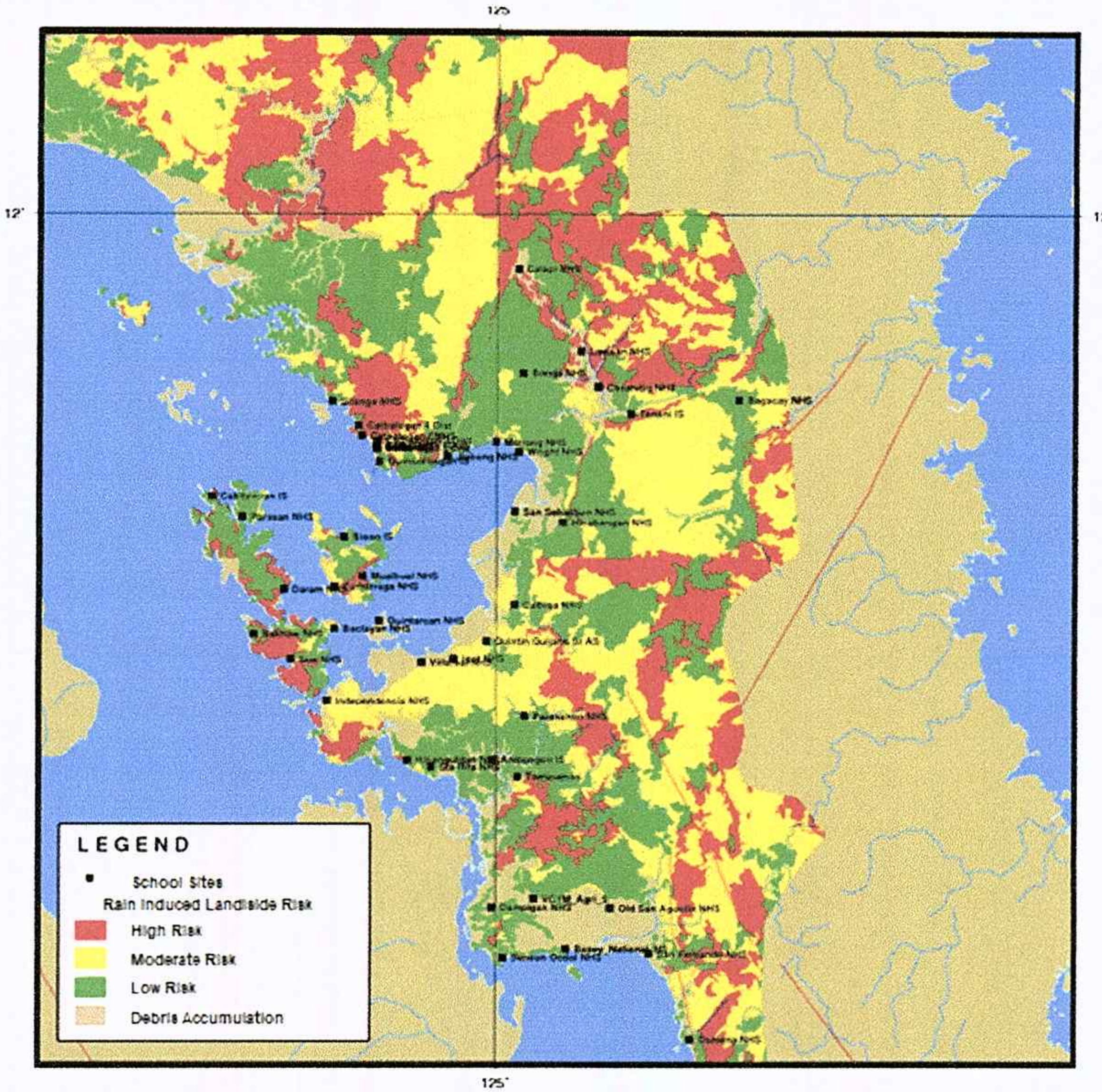


Figure 28. Rainfall-induced landslide exposure of school buildings.

Samar Island's risk to increased precipitation is categorized as very high according to the Climate Studies Division of the Manila Observatory (2005). In the study of Orale (2015) he reports that there were two days (excluding prior day's continuous rain) wherein the precipitation has reached to more than 300mm. It was during December 2014 when 20 people perished due to a landslide primarily attributed to extreme precipitation (NDRRMC, 2015).

Shown in Figure 28 are the sites where landslides are expected to occur due to extremely high precipitation. Table 8 categorized a number of schools exposed to different level of risks. There are about six schools which are highly critical to landslides while only 16 have low risk.

Table 8. Schools in critical areas for rain-induced landslide.

Level of Vulnerability to Rain-Induced Landslide	Frequency
High	6
Moderate	4
Low	16
Debris	26
Total	**52**

Table 8 presents the vulnerability of school buildings to rain-induced landslide. The six (6) public schools identified to be within the high vulnerability for rain-induced landslides are: Mualbual National High School, Sua National High School, Cabiton-an National High School, Daram National High School, Catbalogan 4 District and Catbalogan 5 District.

The four (4) public schools which were identified to be within the moderate level of risk for rain-induced landslide are: Baclayan National High School, Zumarraga National High School, Independencia National High School, and Igot National High School.

Table 8 likewise shows that 16 public schools are located in low level of vulnerability to rain-induced landslide. These schools are the Calbiga National High School, Parasan National High School, Bakhaw National High School, Hinabangan National High School, Bagacay National High School of Hinabangan, Samar, Tenani National High School, Bonga National High School, Parasanon National High School, Sta. Rita National High School, Tominamos Integrated School, Hinangutdan National High School, Bioso Integrated School, Silanga National High School, Guinsorongan National High School and Simeon Ocdol National High School.

On the other hand, the remaining 26 areas are expected to receive debris accumulation as a result of rain-induced landslide. Some of these areas include Basey National High School, Valeriano C. Yancha Memorial Agricultural School, San Fernando National High School, Old San Agustin National High School, Osmena National High School, Motiong National High School, Calapi National High School, Wright National High School, Casandig National High School, Tenani Integrated School, Lawaan National High School, and others, as shown in the map. Some of those who perished in the Catbalogan City landlside in December 2014 was outside of the susceptible slope but were very near. A zone very close to landslide susceptible slopes is equally exposed to the risk.

The susceptibility assessment is entirely based on the general information used by DOST. Landslide risk level can be magnified when there is alteration of the natural conditions, and these are very dynamic and ever changing. These sometimes are not incorporated in the landslide susceptibility assessment. A more adept landslide susceptibility calculation focusing on actual data on site, taking into consideration the current slope condition (the one used in the assessment are based on old maps, not real time), actual geotechnical properties of soil (one used in the assessment are based on indirect information about soil condition, i.e. , type of plants and color of the plants from a remote sensed image), drainage condition, ground cover and many more must be conducted.

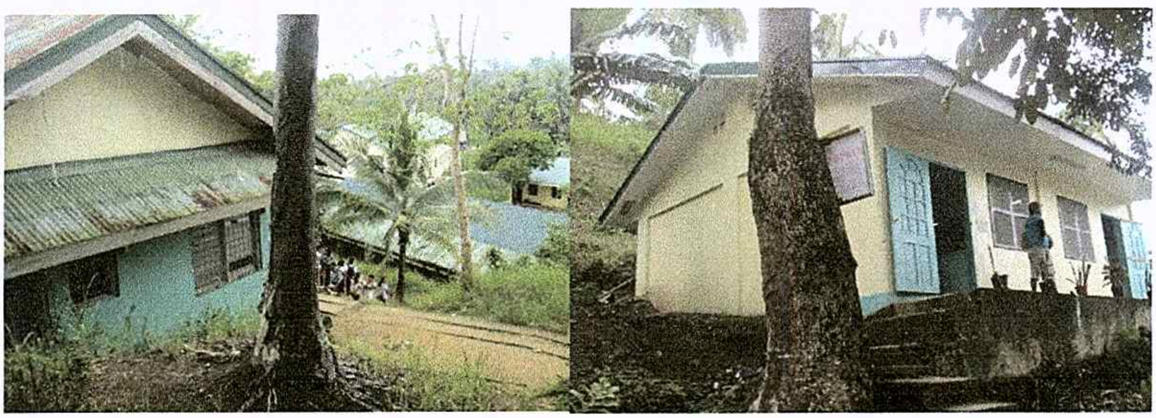


Figure 29. School buildings along slopes (L) School building along slopes in Sta. Rita National High School (Low susceptibility to rain-induced landslide); (R) Sua National High School (High susceptibility to rain-induced landslide).

Since gravity is the main ingredient to landslide, mountainous/hilly areas with steep slopes are the at risk zones to landslides. Many of the campuses visited are built along or on slopes. As shown in Figure 29, some buildings of the Sta. Rita National School are also found in slope but are rated low in terms of susceptibility while the left picture shows a building in the same condition in Sua National High School but it is rated to be highly susceptible to rain-induced landslide. This difference in vulnerability is due to varying condition other than slopes. Soil type, condition of the soil layers, weight of building, water drainage, ground cover and the surrounding slope conditions are just some of the factors to be considered. The Sta Rita National School as a whole is rated low in terms of susceptibility only talks about the entire campus as such but building location spells the difference. It does not mean that when a school is found in low risk area to landslide that any building there has the same rating. As pointed out, buildings erected along slopes increase the risk to landslide. This risk however can be mitigated through engineering approaches.

This suggests that decisions based solely on susceptibility map are not enough. Generic designs being implemented currently by the DepEd and DPWH needs to be revisited according to the site conditions. Some additional structures maybe necessary or redesign of some structural members must be conducted to make the building responsive to conditions of the site. Some sites no matter how adjacent areas are may have different soil profile and problems, too. This can only be achieved through an actual geotechnical assessment.

Schools Exposed to Hydrologic Disasters. The succeeding discussions present the vulnerability of some public schools to hydrologic disasters such as floods and tsunamis.

Schools Exposed to Tsunami. Figure 30 shows the impact of an 8.5 magnitude earthquake with epicentre located in waters between Leyte and Masbate. The simulation showed that there is no tsunami risk in any of the towns/city samples. No schools are expected to experience a tsunami as a result of an earthquake anywhere near Samar. Various other scenario was tested (earthquake occurring at different waters fronting Samar), but no tsunami risk was identified. These do not however mean that the risk to tsunami is zero; the result of the assessment is attributed to the information used by REDAS that earthquake occurrence in the simulated zones are strike-slip in nature. Having a strike-slip type of fault movement may still result in tsunami on certain occasions as observed in some areas with similar earthquakes. Legg et al. (2003) listed two occurrences of tsunamis from strike-slip fault zones such as the 1906 San Francisco California, 1994 Mindoro, Philippines and 1999 Izmit, Turkey earthquakes. They theorize that there was an after event that may have occurred such as underwater landslide or huge chunk of sea floor was displaced as a result of the strike-slip movement (ibid). A simulation of an earthquake with epicentre along the Philippine Trench threatens the coastal towns of Eastern Samar and Northern Samar for tsunamis but not Western Samar.

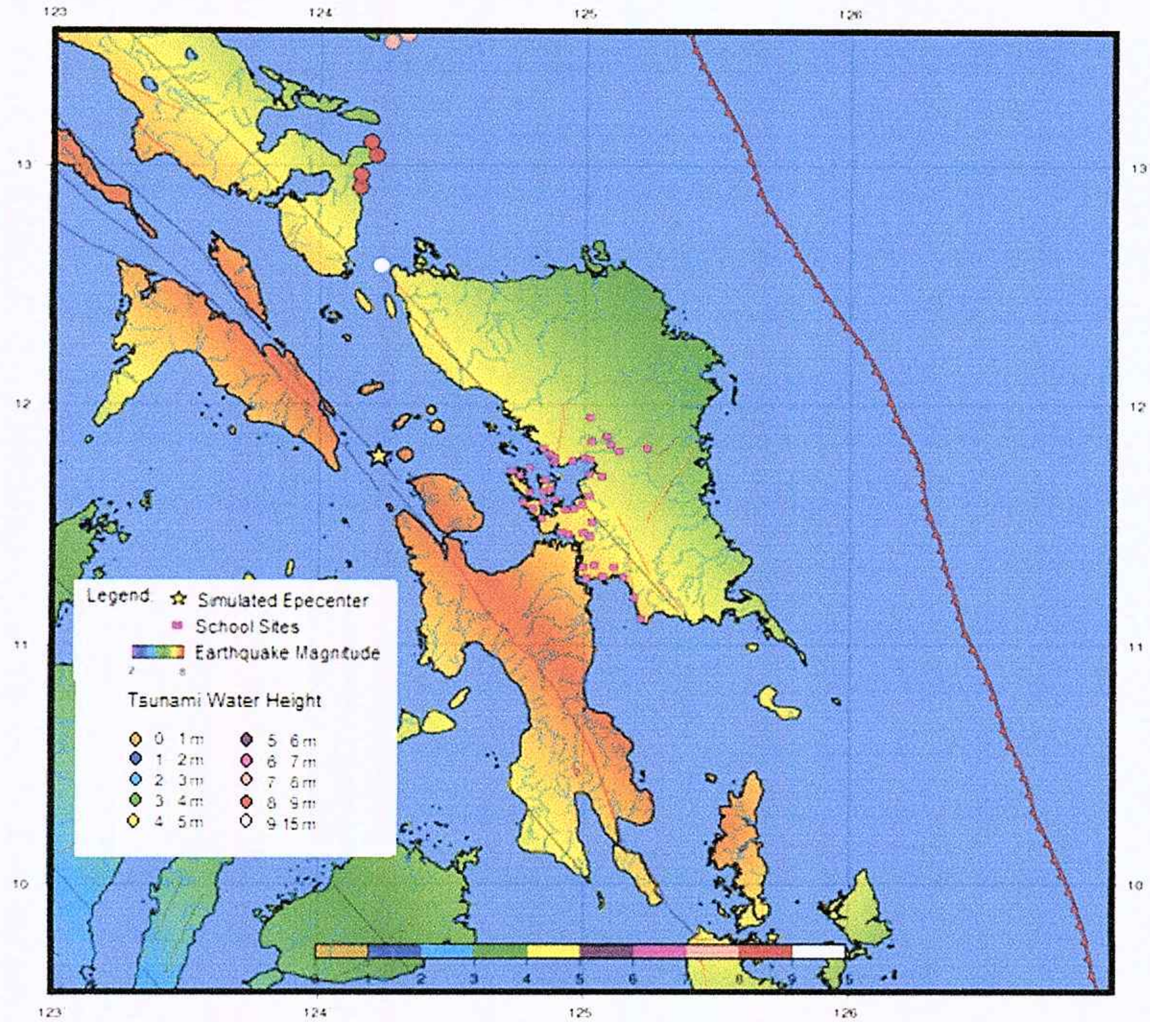


Figure 30. Tsunami hazard map from a magnitude 8.5 along Philippine Fault Zone between Leyte and Masbate.

A different simulator (Tsunami Mapper) suggests an intensity XI with qualitative descriptor of "devastating" and a tsunami range of 100km with up to 16m wave height will affect parts of Calbayog City, Pagsangjan, Santa Margarita, Tarangnan, Daram, and Catbalogan City. This scenario is however less likely.

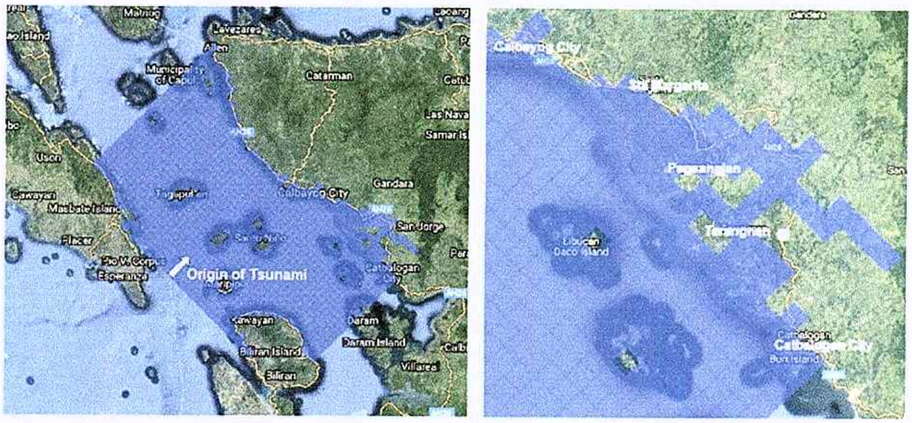


Figure 31. Tsunami affected areas (Intensity XI Tsunami from a source at Central Philippine Fault Zone).

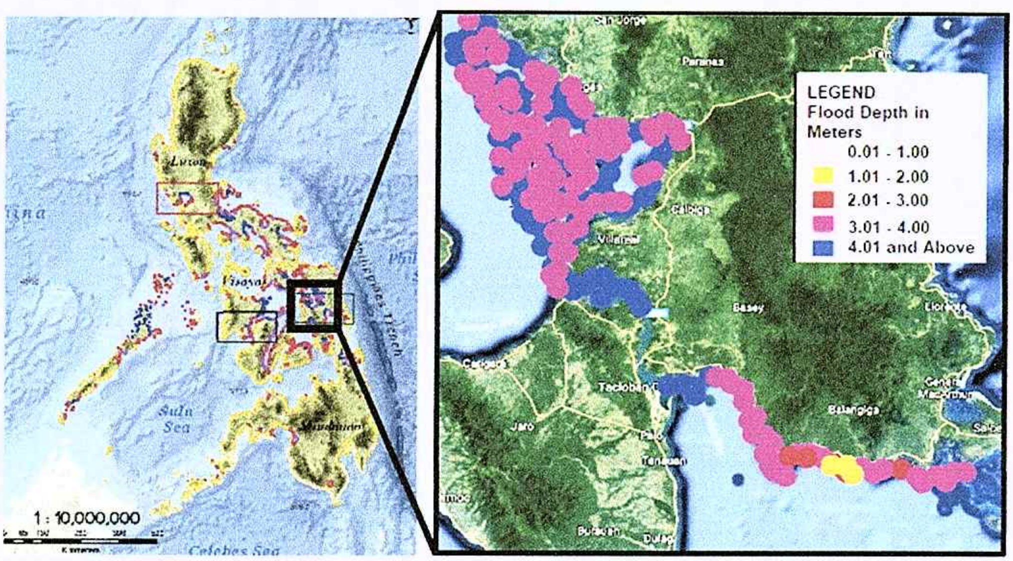


Figure 32. Storm surge areas (Lapidez et. al.).

<u>Schools Exposed to Storm Surge.</u> Schools along the coast are exposed to the coastal waters that surges specifically during weather disturbance with strong winds. In the study of Lapidez et al. (2013), they claim that Samar ranks first in terms of maximum surge height of 7.45 m among the 30 provinces assessed. Leyte which was heavily hit by storm surge during TS Yolanda is just second with expected height of about 6.84 m (ibid). As shown in Figure 32, all coastal towns specifically the islands of Daram and Zummaraga are expected to experience storm surge.

Using the Nationwide Operational Assessment of Hazards (NOAH) simulating Super Typhoon Yolanda strength, many of Samar towns are expected to experience storm surges which means schools found very close to the coast and have elevations lower than 1.5 m are likely to experience water surging from the sea during an inclement weather.

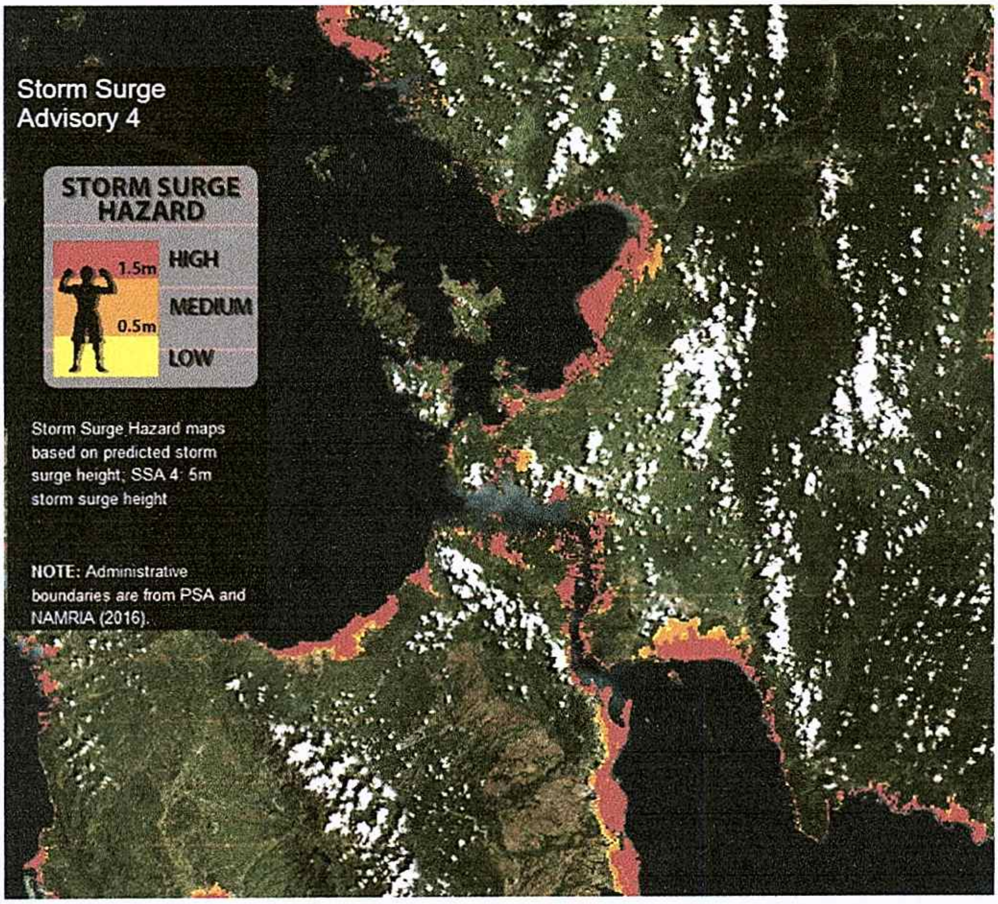


Figure 33. Storm surge areas in Samar (SSA 4, NOAH).

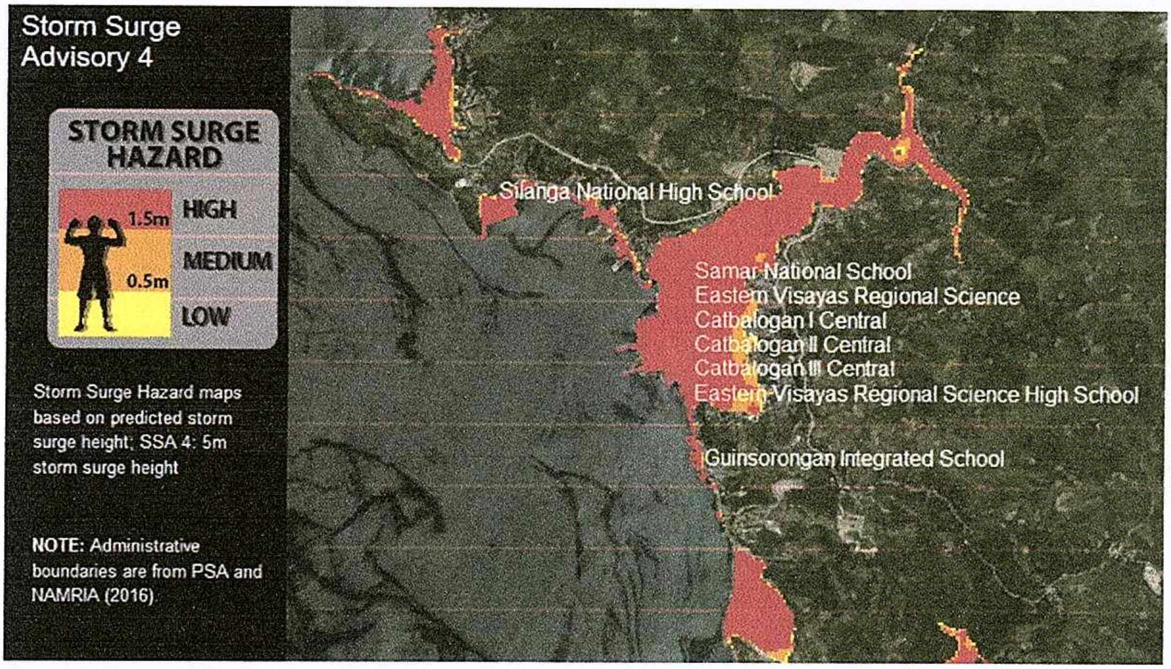


Figure 34. Storm surge areas in Catbalogan (SSA 4, NOAH).

Shown on Figure 34, all of downtown Catbalogan is to be covered by about 1.5m of water after a 5m storm surge occurs. The water will extend up to the extent of Antiao River in Brgy San Andress of Catbalogan City. This scenario is similar on all coastal towns, with most of downtown areas expected to be under 1.5 m depth of water. Only schools found upland are safe from storm surge. These are Calapi National High School, Lawaan National High School, Bonga National High School, Casandig National High School, Bagacay National High School, Tenani National High School, Calbiga National High School, Hinabangan National High School, Parasanon National High School, Valeriano C. Yancha Memorial Agricultural School, and Old San Agustin National High School.

<u>Schools Exposed to Flooding</u>. Floods in the Samar Province are rain induced and through typhoons or onshore winds pushing water inland resulting in coastal waters surge. Unusually heavy rains results into swelling of rivers and other waterways that later on floods low lying areas. A short-period but heavy rain coupled with poor drainage condition and poor ground covering results into higher risk to flooding. In the study of Orale (2015), he states that around 8.3% of Catbalogan City is bare soil due to farming activities. Data from that study suggests that only 19.45% of the mountains/slopes are covered with woods/forest, the rest are coconut plantation (27.78%), grasses (43.54%) or bare soil (9.28%). This ground condition allows more water runoff, resulting into flooding. The ground cover of Catbalogan City slopes is somewhat similar to the rest of Samar or even worse.

In Table 9 and illustrated in Figure 35 are schools vulnerable to different level of flood risks. About 17 schools are located in high susceptible areas to flooding and seven (7) in low susceptible to flood zones. The remaining 28 are not expected to experience flood. These schools are on higher elevation and runoff waters are easily drained to rivers, into the sea or other low lying areas/zones.

Table 9. Schools in critical areas prone to flooding.

Level of Vulnerability to Flooding	Frequency
High Susceptibility to Flooding	17
Low Susceptibility to Flooding	7
No Flood Risk	28
Total	**52**

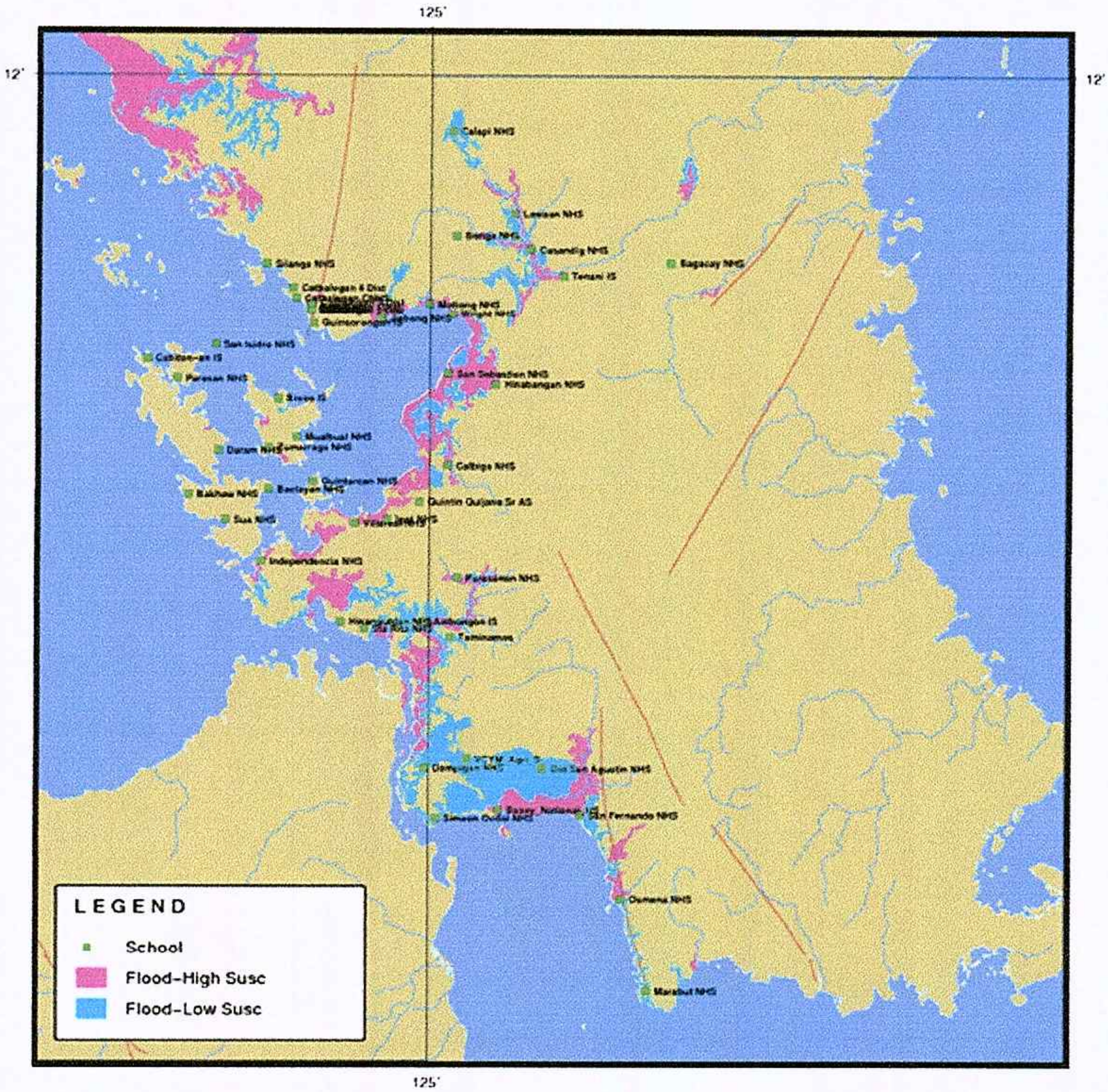


Figure 35. Flood exposure of public schools in Samar.

Schools that are found in areas considered highly vulnerable to floods are: Lawaan National High School, Casandig National High School, Tenani Integrated School, Motiong National High School, Jiabong National High School, Wright National High School, San Sebastian National High School, Hinabangan National High School, Calbiga National High School, Anibongon Integrated School, Parasanon National High School, Villareal National High School, Igot National High School, Independencia National High School, Anibongon Integrated School, Basey National High School, and Osmenia National High School.

Schools which are located in areas with low susceptible to flooding are: Marabut National High School, Old San Agustin National High School, Dampigan National High School, Simeon Ocdol National High School, Tominamos National High School, Calapi National High School, and Valeriano C. Yancha Memorial Agricultural School. The remaining 28 schools are found in safe zone against flooding.

In Figure 36 are campuses found to be at high risk to flooding. These areas are found to be low lying and drainage (both natural and built) is poor. San Sebastian NHS is adjacent to the mangroves and is less than 0.5 m from the mean sea level. Most of the schools visited have no functional drainage system. Water is drained through small canals measuring less than 300 cm square.

Figure 36. Low lying campus of San Sebastian NHS (L) and Anibongan Integrated School (R).

Almost all campuses does not have functional drainage system capable of carrying high volume of water. Some of the campuses are the catch basin of the area (see left picture of Figure 37). Meaning, these campuses are found at the lowest elevation of the area and runoff waters run towards the campus.

Figure 37. Flooded campus of San Fernando NHS (L) and Guinsorongan NHS (R)

Schools Exposed to Fire. Fire risk is not a major concern for many administrators in the past. However, development in many parts of the country enables many school campuses to acquire electrical equipment to help facilitate learning. Most schools are now equipped with computers and accessories. The heating of the environment as an effect of climate change has also forced many schools to include electrically driven ventilation such as electric fans and air-conditioning units. Many offices also are equipped with photocopying machines, printers, audio-video facilities and other kitchen equipment such as hot and cold water dispensers, coffee machines and refrigerators. The education sector has also increased its investments on laboratories, many of which uses electrical power;

some uses fire to perform exercise. The increased use of these facilities in the campus increases fire risks.

All schools which were visited have these facilities with varying quantities and electrical loads. The newer structures are designed to handle such electrical loads but the older structures are not. Out of the total building sampled, it appears that old buildings are prone to fire as their structures are made of flammable materials such as wood and plywood; some makeshift structures are even made of bamboo and nipa shingles. Of the total 585 buildings from 45 schools evaluated, around 44.4% are relatively safe from fire risk while the remaining 55.6% are fire risky due to its physical condition.

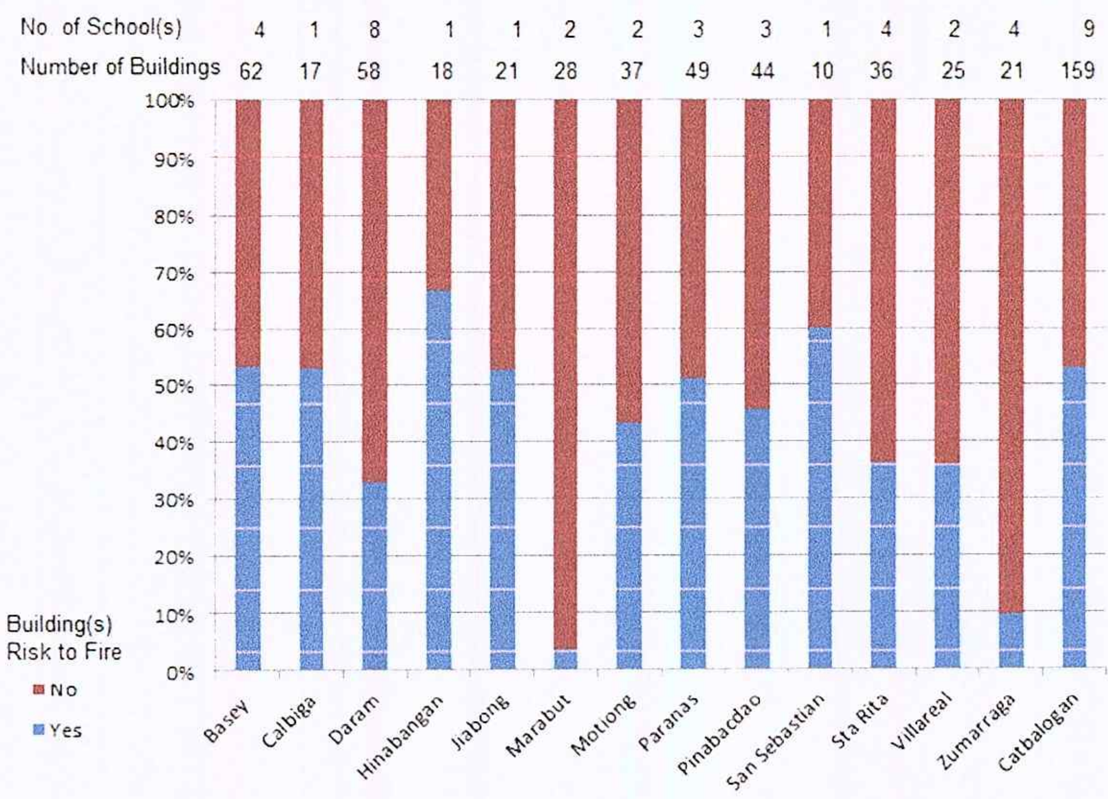


Figure 38. Proportion of schools in Samar with fire risk.

Shown in Figure 38, the school in Hinabangan has the highest number of buildings prone to fire. The two school campuses visited with 28 buildings are the least in terms of fire susceptibility. The newer buildings are constructed using fire resistive materials such as metals, cement board and concrete and less on wood. The only wooden members are the door jamb and the door itself. However a large number of buildings in many schools are quite old and the materials used can easily catch fire. Many electrical wiring of the old structures appear sub-standardly installed.

Another risk to fire which was not incorporated in the assessment is the closeness of the building to ignition sources such as but not limited to a gasoline station, a commercial building with establishments like restaurant, or even houses in villages/communities. In the Philippines, a total of about 4,151 fires recorded during the first quarter of 2017, 2,207 are from structures (BFP, 2017). For the entire year, around 14,000 fires were recorded nationwide that burned PhP 7.8 billion worth of properties and killed about 304 civilians (ABS-CBN, 2018). These fires are caused primarily by faulty electrical connections, lit cigarette butts, and open flames from unattended stoves (ibid).

The risk to fire of school campuses may be attributed to the faulty electrical wiring electrical overload, or activities (like laboratory exercise or office appliances overheat) left unsupervised. However, when a school is somewhere near a gasoline station or a village/barangay there will be an increased fire risk level to school buildings. The higher fire risk is attributable to the more frequent exposure to the source of fire wherein residential, commercial and industrial zones are more vulnerable to. Informal settlements serve as breeding grounds of fire hazards (Rini, 2018; Villamente, 2017; Orale & Nacario, 2004). BFP records showed that most fire incidents all over the country struck densely populated areas of informal settlers (Villamente, 2017). This is attributed to faulty electrical connections, building materials used, access to these areas, and safety practices.

Figure 39: Fire risky makeshift Structures. Top Left: Bagacay NHS; Top Right: Calapi NHS; Bottom Left: Motiong NHS; Bottom Right: Samar National School

Fire can also be triggered from forest/bush fires. These however is less likely as grasses and trees, are most of the time, can hardly catch fire except on occasions where there is severe drought, and grasses are dry. The continued practice of slash and burn (kaingin) in the countryside like Samar may pose danger from fire when the activity is conducted near schools. Many schools in Samar are surrounded by grassland, potential sites for slash and burn practices.

Material used in building structures affect vulnerability to fire risks. Old buildings such as shown in Figure 40 have high risk to fire; it only needs fire source to start the fire as these materials are flammable.

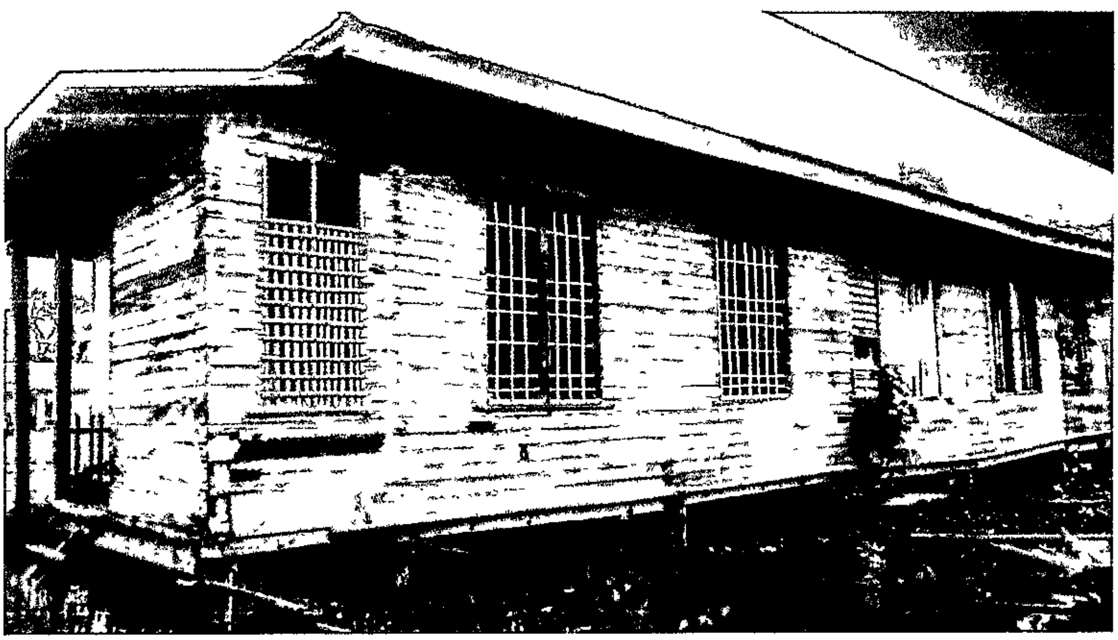


Figure 40: Typical fire risky wooden structures (San Fernando NHS Administration Building).

Profile of the Public School Buildings in the Province of Samar

The profile of the public school buildings in the Province of Samar is presented in terms of their technical aspects such as building design and purpose, construction materials used, construction cost, and methods of construction and maintenance and non-technical aspects in terms of aesthetics, disaster risk/reduction measures and location of building. Most schools were poorly planned. Many have no campus land use plan and new structures are built all over the place. Most new building (2015 to 2018) structures are built using the new DepEd building standards. Old structures and makeshift buildings are still used to augment classroom limitations; many are in poor (substandard) conditions.

Technical Aspects of Schools. The technical aspects of the public school buildings include type of building and purpose, construction materials used, methods of construction and maintenance.

Table 10. Technical sspects of the school building in terms of building design and purpose.

Purpose	Type of Building				Total	Percent
	Standard		Substandard			
	f	Percent	f	Percent		
Classroom	121	22.2	286	52.6	407	74.8
Office	3	0.6	48	8.8	51	9.4
Stage	1	0.2	20	3.7	21	3.9
Comfort Rooms	6	1.1	36	6.6	42	7.7
Others	7	1.3	16	2.9	23	4.2
Total	**138**	**25.4**	**406**	**74.6**	**544**	**100**

Table 10 summarizes the purpose of buildings and the compliance to design standards. There were a total of 544 classrooms visited for the evaluation. About three quarters of the rooms are for classroom purposes while about a tenth are used as offices. Despite the construction of newer buildings, it is still glaring that close to three quarters of the rooms are sub-standard. This means the design;

dimensions of structures and the building itself and the materials used are not compliant to DepEd standards.

Shown in Figures 39 and 40 are substandard structures. The first are makeshift rooms and the latter is an old building that has not been retrofitted to be considered safe. Figure 41 shows relatively new built structures but are of poor condition due to workmanship issues and substandard materials. Most of these structures are comfort rooms; some are classrooms, offices and activity areas.

Figure 41. New but substandard structures: Top Left: Catbalogan III Office Room (2017); Top Right: Calapi NHS Classroom (2016); Bottom Left: Baclayan NHS Office (2016); Bottom Right: Parasanon NHS Reading Center (2015)

Table 10 shows that majority of the school buildings in the Second District of the Province of Samar are poorly constructed and do not comply with the standards set by the department. Some of the makeshift structures were constructed using bamboo, coco-lumber, and other lightweight materials which are weak and flammable. This condition makes the structures vulnerable to the many hazards the campuses are expected to experience. Most of the buildings considered in this assessment as substandard are the old buildings still being used to date. Most of the newer buildings are compliant to the stipulated standards but notably, there are newer buildings that are not compliant to some standards as shown in Figure 41.

Table 11 shows the profile of the school buildings in terms of construction materials used. Structures considered concrete are buildings where majority of the materials used are concrete while the rest are mostly made of other materials other than concrete.

Most new buildings are made primarily of concrete main structures, CHB walls, GI roofing, steel trusses and rafters and jalousie type glass windows. Older buildings and makeshift structures are mixed type of structures using lumber, plywood, some bamboos and other lightweight materials. Most of the older buildings are not compliant to the design specifications for disaster-resilient school buildings. There is a need to retrofit those structures to comply with the requirements for roofing, ceiling, roof framing, beams, columns, tie beams and footing.

Table 11. Technical aspects profile of the school building in terms of the construction materials used.

Construction materials Used	f	Percent
Concrete	301	55.33
Semi-Concrete	243	44.67
Total	**544**	**100**

Figure 42. One of the 15 buildings of Osmeña NHS compliant to DepEd/DPWH standards.

Makeshift structures are common to many campuses primarily because of limited funds. Lately, there is an aggressive effort to address the gap says a DepEd engineer interviewed; *"the government through DepEd is very aggressive in building new infrastructures to address the much needed rooms for various purposes so that makeshift classrooms and the old structures be replaced."* Based on the survey conducted, there are about 46 makeshift buildings/rooms or about 8.46% of all buildings examined. The school with the most number of makeshift structures/rooms is the Parasanon National High School wherein 40% of its buildings are categorized as makeshift structure. Also, Parasanon NHS has the most number (73%) of structures that is considered sub-standard.

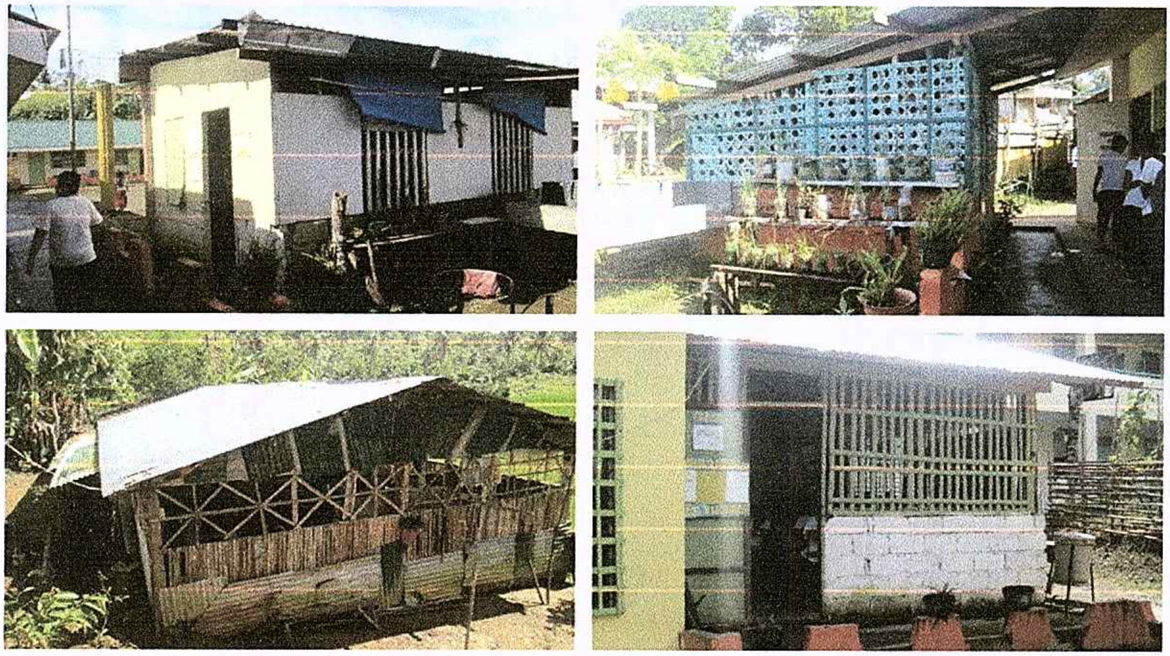


Figure 43. Makeshift rooms/structures of Parasanon NHS (Top Left: Reading Center; Top-Right: Washing Room; Bottom Pictures: Classrooms).

<u>Methods of Construction/Project Implementation and Monitoring</u>. As regards to methods of construction, most of the school buildings are constructed through public bidding and through the Department of Public Works and Highways (DPWH). According to a DepEd engineer from the Catbalogan City Division, if the funds were downloaded to DepEd (in their case to the Catbalogan City Division), it will be DepEd's responsibility. They will undertake the project through public bidding. On the other hand, there are many projects where funds are downloaded to the DPWH, the implementation is carried out jointly by them and DepEd with the former having the most responsibility in ensuring the buildings are carried out according to plans.

Local DepEd units follow ready made plans from the DepEd National. Local engineers have limited authority to review the plans or make revisions to them. However, when asked about foundations, the local DepEd engineer said that when the soil test (which is a required test) showed that the soil bearing capacity is poor, *"we redesign the foundation."* He further said that *"Our participation in the construction process/project implementation is not intense because it's the DPWH who is in-charge of the project."* When asked about their way of project monitoring and quality control, they shared that they do site visits every other week or when the contractor requests it. A DepEd engineer expressed that inspection of delivered materials is performed perhaps visually as *"they don't have testing tools to ensure quality of the structures."* This may imply that there is unclear protocol or likely the protocol is lightly followed (i.e., materials testing, project monitoring) for various reasons such as manpower and monitoring tools scarcity such as rebound hammer, etc. The building shown in Figure 44 should have not have been damaged if basic building protocols were followed.

Many makeshift structures are constructed locally sometimes through "bayanihan," as projects of Parents-Teachers-Association, or through the efforts of the teachers themselves. As shown in Figure 43, these makeshift classrooms/other rooms are unsafe.

Maintenance Program. Life of structures is lengthened when there is maintenance program regularly implemented throughout the entire period the building is in use (Othuman Mydin, 2017). Included in the maintenance program are repairs. In the study of Dias (2013), he reports that many old structures last well even beyond their life because of repairs. These repairs varies from site to site, some requires major repairs such as those near or exposed to sea, or in heavily humid areas, such as schools in Samar, Philippines.

Though aware of the need to conduct regular maintenance activities, it is evidently wanting. Interview with key informants specifically teachers of every campus visited reveal that maintenance programs are just on papers and are not implemented primarily due to lack of funds. There are minor interventions made to repair small defects in some of the buildings but not major ones. Major repairs will wait for DepEd Central funding using the Basic Education Facilities (BEFF). According to the building officer of DepEd, new buildings have five years warranty for structural defects after which the repairs and maintenance becomes the responsibility of the school or DepEd.

According to a key informant *"we have MOOE funds where we can use them for maintenance (minor repairs) of our buildings; these funds however are more needed in other areas."* This statement is almost similar to all campuses visited. Funds are hard to juggle as it is very limited. Another key informant shared *"oftentimes we run to the parents and some external benefactors for help. There are some though who are generous and provide many types of support."* DepEd has a regular activity called

Brigada Skwela which is a nationwide initiative which mobilizes people from the school (students and teachers), its alumini, various groups/organizations and individual volunteers to do repairs, maintenance work and clean-up public elementary and secondary schools in the country (DepEd, DepEd, 2018). Brigada Skwela was launched in 2003 through DepEd Memorandum No. 79, s. 2003 as part of its National Schools Maintenance Week, a week-long event to encourage local communities and parents to volunteer time to do minor repairs on their children's schools in time before the class starts. It is the goal of the program to get the much needed physical and financial support for all types of maintenance work for the school. The program envisioned that a total of PhP 40 million would be saved from DepEd/school's MOOE for similar work (DepEd, 2003). These saved funds can now be used for other more important purposes.

Brigada Skwela can just do so much depending on the kind and level of support it gets. The program is successful specifically in big cities where there are generous companies such as Telus, ABS-CBN, Aboitiz, Pru Life UK, Holcim Cement, Australian Embassy and many others. According to then Secretary of Education Armin Luistro, the Brigada Skwela program generated a total of about PhP 1.5 billion and some six million volunteers giving various forms of physical help (Ronda, 2013). In rich Makati, a volunteer for many years in the program expressed that a single individual was PhP 1,000 and some even give 25 cents (Carreon Jr., 2015). There are certain communities where their financial support is scarce like impoverished towns in the countryside. Most that is offered are physical support such as manual labor for about six days.

As per DepEd Memorandum in 2003, the program focuses only on minor repairs such as painting the roof and class room walls, cement path walks, repair leaking water pipes, comfort rooms/toilets, perform minor repair works on buildings, chairs, tables and other school furniture, clean up gardens and many others (DepEd, 2003). For Davao del Sur division of DepEd, participation of stakeholders to different school-initiated activities was rated moderate including Brigada Eskwela activities (Cabardo, 2016).

Figure 44. Damaged building #6 and building #8 as a result of the construction of building 7 in Motiong NHS

The scarce funds result in failure to repair major defects in school buildings such as the one shown in Figure 44. This 2011 built school building was damaged due to the construction of building 7 of Motion National High School in 2016. This should have been repaired immediately by the contractor of building 7 because its poor construction methodology may have caused the damaged of building 6 and building 8. The structure shown in Figure 44 has never been repaired since its partial collapse in 2016. Many of the buildings specially those declared to be substandard needs immediate repair, while some needs replacement.

Non-Technical Aspects of Public Schools.

The non-technical aspects of the school are presented here in terms of aesthetics (properly designed or not), disaster/risk reduction measures and location of the building.

Architectural Design (Aesthetic) of Buildings. Properly designed structures pay for them; poorly designed structures will be considerably more costly in the long run due to constant correction and the unwritten cost of impact to people (specifically building users) well-being and psychological health (UK Construction Online, nd). A lack of natural light, poor ventilation and frustrating functionality in a building can quickly bring its inhabitants down, while those that are properly designed and built can boost well-being of a person (ibid).

Building architectural designs also affect costs. With this limitation, most school buildings in the Philippines have simple architectural designs to minimize cost. Building designs also depends on the era it was built (i.e., Gabaldon Buildings built during American colonial rule, Bagong Lipunan classroom, Marcos type classroom which were built during the leadership of President Marcos, etc.) and who funded it. Due to age of buildings coupled with poor maintenance activities, structures are less appealing, structurally unsafe, and are not any more conducive to learning. Almost all of the old buildings are no longer compliant to the new standard design of buildings of DepEd.

The DepEd issued an administrative order to establish minimum performance standards and specifications (MPSS) for its schools. It mandated to have well-designed school buildings that consider ergonomics, anthropometrics, thermal comfort, illumination, ventilation, acoustics, color, and compliance with the law, contribute to improve student performance, and make a lasting impression on the community with regards to importance of education. These building designs were presented during the 1st National Conference of the DepEd Engineers and Architects.

Figure 45. Building design according to funder and time constucted. Left: Building funded by LGU Sta Rita (Sta Rita NHS), Right: Building constructed during Marcos Era (Catbalogan V ES)

Table 12. Aesthetic Quality of the School Building

Category	f	Percent
Compliant to DepEd Architectural Design	299	55.0
Non-compliant	245	45.0
Total	**544**	**100**

Table 12 summarizes the number of school buildings that are compliant to (architectural) design standards prescribed by DepEd. Around 55% of the school buildings were compliant to the 2016 designs provided by DepEd, while around 45% are not. Only the more recently constructed school buildings are compliant to the design requirements. Some of those included in the 55% are not compliant in terms of paint color and roofing sheets used. This however did not affect the overall functionality of the building. It is also apparent that as designs, color, and materials used are compliant, building conditions were not maintained properly. Some of the buildings appeared dirty, access ways are lined with dirt, perhaps due to the dirty road or access ways going to these buildings. Shown in Figure 46 is a standard building but other structures to support the functionality of the building are absent such as access road, and drainage. Some buildings were compliant to architectural designs but were located or built in areas making them generally poor in overall aesthetics.

Figure 46: Design and placement deficiency. Left: Front ground absent in a Bagacay NHS building main entrance building, Right: Standard building of Catbalogan III ES but aesthetically sub-standard.

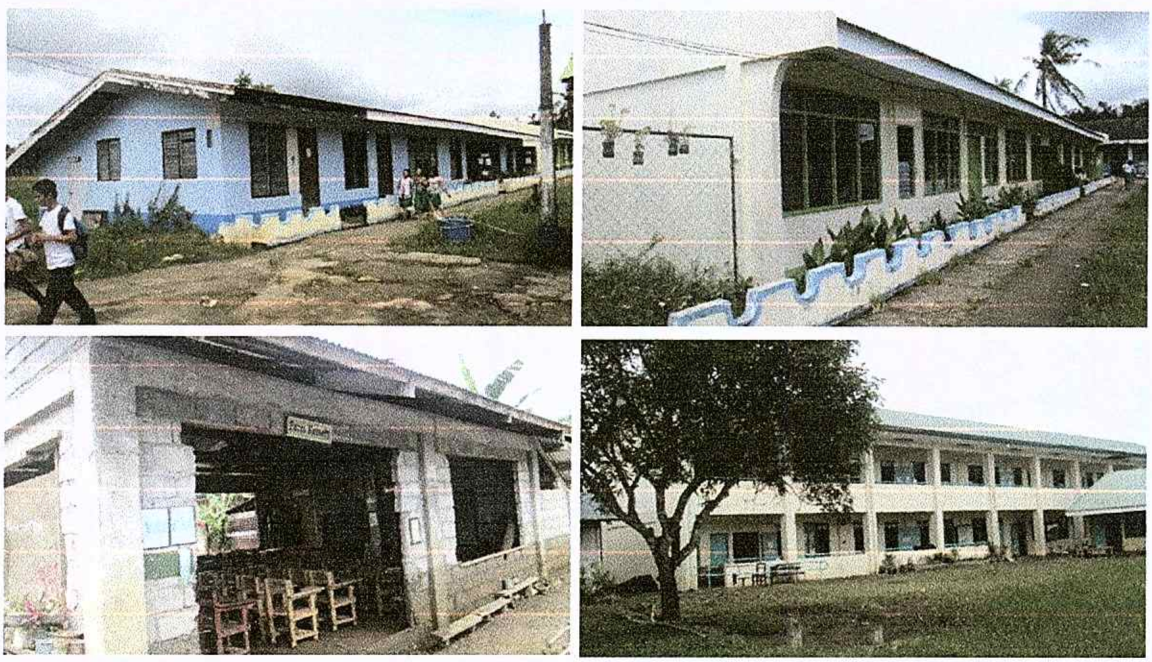


Figure 47. Example of compliant and none compliant structures. Top pictures are VCYMAS buildings (Left: not compliant, Right: compliant). Bottom pictures are Quintin Quijano Sr. Agricultural School Buildings (Left: not compliant, Right: compliant)

The buildings considered standard or astatically pleasing are made of concrete main structures, CHB walls with GI sheet gabled roofing. Exterior walls are painted with cream-toned colors (pearled ivory or crisp ecru), with beams and columns darker (ivory cream or yellow rain). Interior wall is lighter cream (pearled ivory or bright wonder). Ceiling is painted with white tone (brilliant white, DepEd White, or white flat enamel). Roofing and other accessories are painted with lighter green tone (foam green or aqua paradise) while doors are painted with bright green (jasmine green or temptation). Illuminating means, sockets, chalk boards were also specified. Windows recommended are jalousie blades on a shutter type window holder with fixed glass transoms and concrete jambs. Doors are swing-out with lever type lockset and fixed glass transom in concrete jambs/frames.

Most of those non-compliant are older buildings as well as makeshift classrooms and buildings. Figure 47 presents examples of compliant and not compliant to DepEd requirements in terms of architectural designs.

Campus Layout and Site Development Plan. Significant number of schools in Samar have no campus lay-out when they were built. Most often these schools started with one or two classrooms, when enrolment increased, new buildings were constructed wherever it is possible. This type of practice had led to crowded campuses, poor access, poor surrounding conditions and poor school campus environment. It is only recently that campus lay-out or campus land use planning was given emphasis. However, because of limited resources, the relocation of school buildings like those improperly positioned, or those that are located in hazardous areas, have not been significantly addressed yet.

Although school administrators are tasked to formulate School Improvement Plan (SIP) as per DepEd Order 44, Series of 2015, site development plans are not greatly emphasized. Participation of various stakeholders in the formulation of SIP is expected. The SIP is a roadmap that lays down specific interventions that a school will undertake within a period of 3 years. The focus of SIP is more on activities that affects learning and development of student. It does not include how properly constructed building and properly planned campus affects student learning.

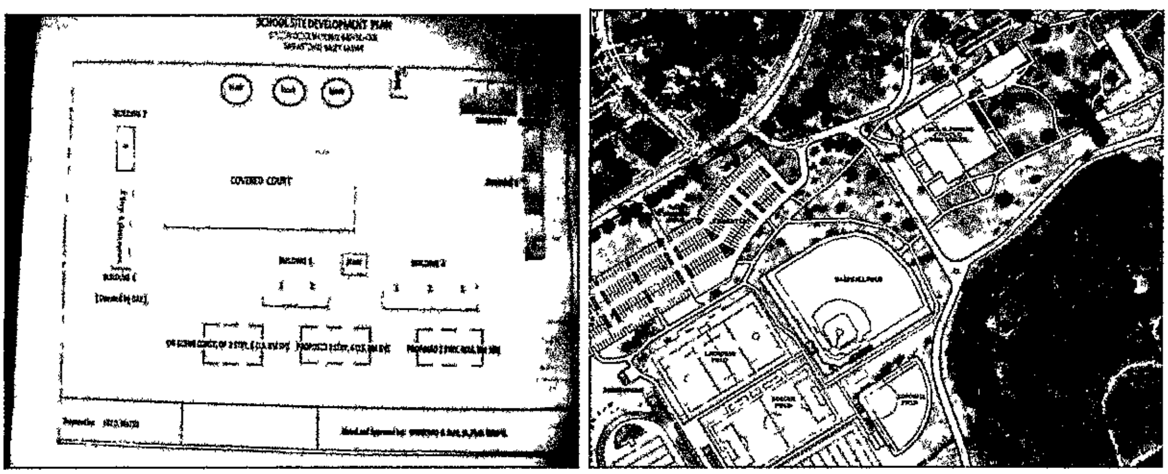


Figure 48. The Semion Ocdol National High School Site Development Plan (Layout). Right: Concept Master Site Plan of an American secondary school (MLive.com)

Schools administrators are required to have a Site Development Plan of their respective schools. Examination of their plans reveals those are simply layout. The plans (or layout) only showcased the location of buildings but never the appropriate site development plan where the required facilities, utilities such as water and electricity, as well as drainage and accessibility/road network are absent. The plans were developed by a non-planner, non-engineer or an untrained campus planner. Site development plans presented such as what is shown in Figure 48 did not even have measurements.

A complete site development plan should contain the actual geometry of the lot (with geodetic description of boundaries). It must contain the actual position of the buildings and everything in the premises such as roads and other built structures. The plan also contains site contour with elevations for readers/plan users to visualize the slope of the natural grade lines which are very necessary in drainage planning, slope protection, and others.

The future of the site is also part of the site development plan. It shall also present the location of the proposed buildings, the access roads, drainage, vegetation planning, and many others. Traffic flow, route to safety during disasters, open spaces, recreational/activity areas, various zones and many more is in the plan. In short, the plan considers everything not only of the current situation but more importantly of the future condition considering all risks identified. Most of these site development plan requirements are absent in the plans of DepEd schools in Samar.

A development plan is not formulated by one or two; it is a collaborative undertaking with various stakeholders present to gather as much information as possible. This information is very crucial in developing a functional site development plan. Ideally plans must undergo a certain process to ensure its functionality and compliance to standards. It is subjected to different layers of plan review including public hearings until the plans are accepted by the stakeholders (Nelson Mandela Bay, nd; Pataki and Treadwell, nd).

All these required protocol in making site development plan have not been considered. The kind of campus site development planning is not unique to Samar as documents from other DepEd schools in the entire Philippines have similar site development plan documents. Campus development planning requires basic understanding on how these documents are prepared. This can better be prepared by civil engineers and/or architects with backgrounds in rural and urban planning and school management.

Building Site Selection and Considerations. The absence of functional site development plan causes buildings to be constructed anywhere the engineer or administrator decides. According to DepEd Engineers, *"we conduct site visit and decide where the building is to be erected, this is also validated by DPWH."* The left picture shown on Figure 49 is a four storey building constructed behind a one storey classroom. On the right are several school buildings of Catbalogan National Comprehensive High School that are constructed very close to each other. These examples are common to many government schools specifically those with scarcity of space. The Catbalogan National Comprehensive High School for example is occupying a space which is part of the Samar State University – Mercedes Campus. Many school campuses in the Philippines including those in Samar are congested. Asia Foundation reports that almost 18% of students in the elementary and secondary schools are forced to attend extremely overcrowded public schools (Jones, 2017).

Figure 49. School buildings constructed near another building. Left: Guinsorongan NHS. Right: Catbalogan NCHS.

The limited spaces in some campuses also become an issue. Shown on Figure 50 is an aerial view of Catbalogan I ES and a typical crowded campus like Catbalogan I ES and Catbalogan III ES. For both campuses, the alleys are small and cannot accommodate vehicles. These alleys are crowded with students as students enter and leave their classes. Technically, the crowded condition violates some of the requirements of new school buildings as cited in the DepEd Order 64, s. 2017 which requires well-designed school buildings that consider among others thermal comfort, ventilation and illumination, to name a few. For crowded campuses, illumination and ventilation will be sacrificed together with safety and sanitation. Expansion to accommodate growing number of students is a huge issue of space. These can be done by removing substandard or old school buildings and replace it with new multi storey buildings.

Figure 50. Limited spaces in school campuses. Left: Areal view of crowded Catbalogan I ES (GreenTravelStock, 2017). Right: Dim Alleys of Crowded with school buildings of Catbalogan III ES.

Figure 51. School buildings in hazardous areas. Left: Areal shot of San Sebastian NHS found in a marshland (Google Maps). Right: Mangroves/marsh land behind one of the classrooms in San Sebastian NHS

Some of the buildings are also found in areas that are basically hazardous like the San Sebastian NHS which is found in a low-lying area very adjacent to a marsh land. Marsh lands are critical zones for regular flooding during high tides and soil in the area is likely not suited for taller structures. Marsh lands are typically liquefaction zones (USGS k, nd) and have low bearing capacity (ASCE, nd).

A DepEd engineer revealed that _some schools are now being considered for relocation._ *"For example, there is a plan to relocate San Andres Elementary School in Catbalogan City which is prone to flood or build school buildings considering floods like raising the elevation of the building."* The elevation may not be ideal as the campus has experienced up-to roof flooding more frequently. San Andres Elementary School is not included as sampled campuses in this study.

Disaster Risk Reduction Measures. Schools are expected to formulate and implement a school disaster risk reduction management action plan which is submitted to the Division Disaster Risk Reduction and Management Officer. The action plan consists of the following activities: a) development of evacuation plan to locate open space as evacuation area and to sketch routes of students, teachers, personnel, and visitors to the evacuation area; b) reorganization of the school disaster risk reduction and management council; c) student-led school watching activity through the Supreme Student Government officers; d) correct unsafe zones; e) observation and celebration of the National Disaster and Consciousness Month Celebration; f) conduct earthquake drill; and g) integration of DRRM to some lessons in all learning areas (Division Disaster Risk Reduction and Management Action Plan, 2017-2018).

It however appears that most schools have not formulated Education and Information Campaign (EIC) materials nor conducted an aggressive campaign. Many schools have not conducted some of the expected DRRM directed activities such as the drill. If they do, it is likely not seriously practiced. Many campus layouts are in itself contributor to risk. All schools have no functional site development plan and many buildings are erected anywhere at the convenience of the engineer or the administrator or based on some incomplete, more site specific geohazard assessments. It is the Mines and Geosciences Bureau (MGB) that is authorized by the government to perform geohazard risk assessment for its projects.

Upon examination of the 544 school buildings visited, none have fire hydrants. It is also noted that the standard building design as recommended by DepEd do not require such facility. Almost all have no markings for escape route, no precautionary measures/information, no warnings as to hazards the school campus is exposed too. Schools with disaster risk plan are not known to all, in fact only the top management know there is such a plan but have not been cascaded to all members of the school community. In short, the DRRM activities of schools are poorly practiced.

Apparently, even unfinished school buildings are being used, construction sites are not secured, no safety measures provided such as perimeter fence and some warnings. Contractors of these buildings clearly violated a basic requirement in the contract.

Figure 52. Buildings without construction safety measures. Top Pictures: Under construction buildings of Calapi NHS with no construction safety measures. Bottom Left: On-going construction at QQSAS NHS without construction safety measure. Bottom Right: Utilized unfinished building of QQSAS NHS.

Structural Integrity of Public School Buildings in the Province of Samar

The structural integrity of the public school buildings in Samar is presented in this part in terms of the characteristics of the building. It specifically looked into the foundation design (for buildings with available plans), basement/crawl space water, framing, roof, interior/exterior and general building structural integrity.

Foundation. Building plans were scrutinized and interview with those involved in building construction or those who have seen the construction was done. Since the actual foundation condition is not visible, result of the study is not very conclusive. Newer structures are built based on the DepEd standards.

Assuming that the contractor followed accurately the plans, and then the building foundations are assumed to be of standard. Interview with those who have been involved in the construction revealed that many times the soil conditions were not studied prior to the construction. They assumed soil's bearing capacity without on-site validation. The soil bearing calculation may not be very important for one-storey buildings but are critical for taller and bigger structures such as covered courts and three storey buildings. The size of the foundation changes depending on the soil bearing capacity which is at the same time variable as it is also affected by the presence of water. Such information can only be determined through on-site soil testing which requires laboratory tools or onsite testing facilities. The strength of the soil cannot be assumed.

Table 13. Structural integrity of the public school buildings in terms of its foundation.

Category	Dimensions of Building Foundation							
	Column		Beam		Tie Beam		Footing	
	f	Percent	f	Percent	f	Percent	f	Percent
Standard*	161	29.6	373	68.6	199	36.6	405	74.4
Substandard	380	70.4	171	31.4	345	63.4	139	25.6
Total	**544**	**100.0**	**544**	**100.0**	**544**	**100.0**	**544**	**100.0**

**Assessment used the specifications of buildings suggested during the 1st National Conference of DepEd engineers and architects at the Development Academy of the Philippines.*

Figure 53. Damaged classrooms of Motiong NHS (top pictures)

Uneven settlement of soil may result into major structural failures of the buildings. Foundation stability is also greatly affected by the stability to which the foundation is resting. Foundation constructed in sloping grounds is particularly at greater risk than those along flat areas. Slopes have the tendency for soil movement, such as landslides. Small movement of foundation can cause due harm to concrete structure.

Figures 53 indicate weak soil capacity. The construction of the three storey building in Motiong National High School has caused the nearby structures partial collapse. The foundation was too weak to cause this much damaged to the existing buildings nearby. The foundation design of three storey building must have been reconsidered and the generic building design provided not have been directly followed.

Columns. Columns of buildings were physically examined. The assessment limited on the sizes of the columns and compared it with the specified DepEd standard. Table 13 shows that less than a third of the buildings passed the required dimensions and more than majority are substandard. Some of the newly constructed columns are substandard at least in terms of dimensions. This may be due to the fact that the standards were developed in 2016 and many of the buildings were constructed way before 2016.

Columns are particularly important for taller buildings. This member of the building structure carries the entire load of the floor it carries and transferred to the foundation. Columns are essentially a compression member of the structure. It is however likely to fail due to flexure. Some of the reasons for the column to fail include: (1) The material of which the column is made, (2) The shape of cross-section of the column, and (3) the end constructions of the column (Mrema, 2011).

Beams and Tie Beams. As regards beams, 373 or 68.6 percent school buildings have standard or strong beams, with 171 or 31.4 percent substandard or weak beams. The information about tie beams is non-conclusive due to absence of physical examination if such really existed. The DepEd engineer however has given assurance that when plans and specification requires the presence of tie-beams, they made sure it is present. These tie-beams are part of the requirements of DepEd for new buildings to make it more resilient. Tie beams specifically are important to areas where there are variable soil characteristics. It allows the entire foundation system which is composed of isolated footing to act as one, minimizing potential uneven settlement (Almasmoum, 2009).

As a whole, the public school buildings have strong structural integrity in terms of foundation, except for the column which registered the weakest. The results further imply that majority of the public school buildings in the province are resilient to disasters on the basis of their foundation. This conclusion however is based on the premise that the plans for the newer buildings were religiously followed as specified.

Basement/Crawl Space Water. Crawl space is not any more common. Its purpose is to allow cooling air to circulate throughout the home and acts as storage areas but cannot be used as living space/activity area. It is short of being a basement. Almost all buildings do not have crawl space for most buildings have their ground floors on the ground. The ground floor elevation of most buildings is not high from natural grade line. Crawl space is not part of the specifications of DepEd buildings, but many schools can use this idea to be more adaptive to flooding when filling-up is not an option. Table 14 summarizes the risk to water entry when extreme precipitation occurs in the area or when schools are flooded.

Table 14. Buildings needing crawl space.

Category	f	Percent
Has Risk of Water Entry	323	59.4
No Risk of Water Entry	221	40.6
Total	**544**	**100**

Not all buildings in school listed as flood prone will be submerged in water. Some of the school buildings were constructed above the flood elevation, thus, the rooms will not be flooded. Based on assessment per school visited, around 221 or 40.6 percent of school buildings are not at risk of water entry. On the other hand, around 323 or 59.4 percent of the buildings are expected to be flooded at different height of water. Some water intrusions may be in terms of thin sheet of water or submerged the entire building up to the roof. School buildings that are likely to be flooded frequently and at larger intensity need to be relocated to higher elevation. Those campuses that experience low level flooding should consider raising the ground floor level elevation including pathways/access ways or roads to a height higher than the height of flood waters.

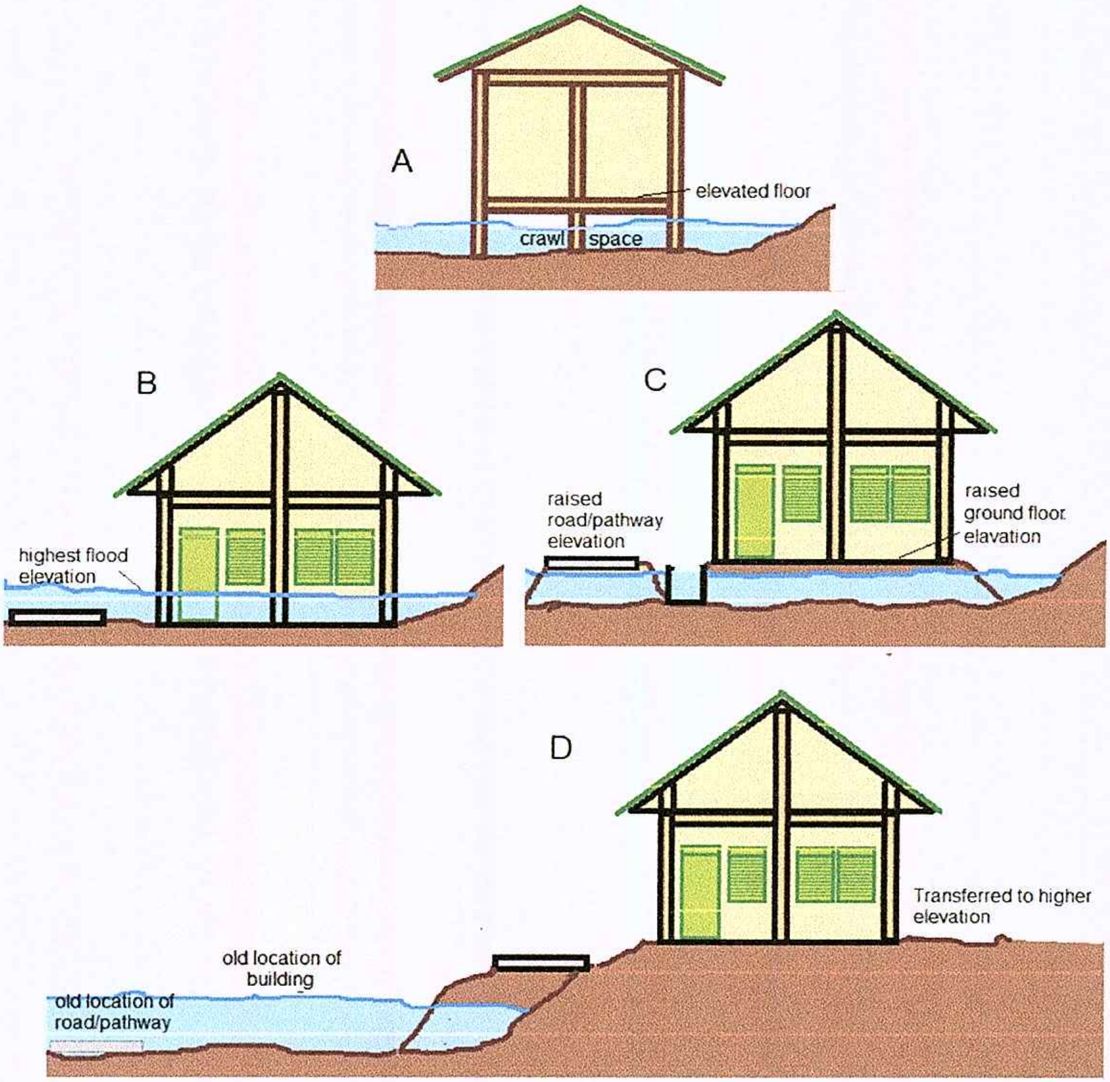


Figure 54. A) School building with crawl space; B) Flooded school building; C) Raised ground level of building and road; D) Transferred building to higher elevation.

<u>Framing and Roof</u>. Roof framing is crucial in ensuring sturdiness of the roof especially against strong winds. Samar is located in typhoon built and it has received the strongest typhoons that ever hit the Philippines.

The assessment done to examine roof framing is entirely based on what can be seen (for buildings without ceiling/or has an opening in the ceiling) and based on information expressed by those who have seen the construction and the plans in itself. There is however huge proportion of the data presented in Table 12 that was based solely on plans and assurance provided by the key informants.

Table 15 shows that 325 or 59.7 percent of the public school buildings followed the required framing systems while the rest (219 or 40.3%) did not. The standard framing is a truss type roof framing made of angular bars, with C-channel purlins. Most of these structures that were built in 2014 onwards funded by DepEd and implemented by the DPWH or DepEd are compliant to standards set. Almost all old buildings including makeshift buildings were considered to be substandard.

Table 15. Structural integrity of the public school buildings in terms of its framing and roof.

Category	Framing		Roofing	
	f	Percent	f	Percent
Standard	325	59.7	456	83.8
Substandard	219	40.3	88	16.2
Total	544	100.0	544	100.0

DepEd requires a gabled roof design using 0.4mm thick base metal and must be pre-painted long span corrugated GI sheet fastened into a C purlin. Based on these criteria, about 456 or 83.8 percent follow the standard with only 88 or 16.2 percent public school buildings are substandard. However, there are roofs which are not pre-painted which were included in the list of compliant roofs; these roofs were installed before the standards were released.

Contrary to the recommended designs of DepEd, the DILG proposed a different type of roofing structure. The roof in the DILG design is protected by a concrete parapet and slope of roof is minimized. The main cause of roofing failure is the uplift force generated which is a factor of roof geometrical design, structural integrity of the roof framing itself, building opening and type of materials used. A hip roof (four sided roof) is better than a gable (two sided) roof (Prasad et al., 2009) which is the recommended roof type of DepEd. The presence of eaves or overhang which is also recommended design of DepEd increases its risk to uplift forces.

It is therefore important that the recommended design by DepEd must be revisited and concepts presented and DILG's proposal be considered.

Interior/Exterior Aspects. This section refers to the exterior and interior walls and ceiling including the attached features of the school buildings. A little more than half (57.0%) of school building ceiling and over two/thirds (79.2%) of walls are compliant to DepEd established standards. Those identified to be substandard are in varied state of deterioration, some needs immediate repairs like those buildings in Motiong National High School which has a damaged CHB wall. Other buildings which are not compliant are those incomplete structures but are already being used such as those shown in Figure 55.

Figure 55. Highly critical to failure buildings (Top-Left) Makeshift classroom of Anibongan NHS; (Top Right) Unfinished school building of Bakhaw NHS; (Middle Left) No ceiling classroom of Calbiga NHS; (Middle Right) Bricked wall of Calbiga NHS; (Lower Left) Deteriorating CHB Wall of Catbalogan III; (Lower Right) Unfinished school building of Samar NS.

The lower left picture in Figure 55 is highly critical to failure. The picture shows that the CHB is deteriorating and needs immediate intervention. The unfinished rooms such as what is shown on the top and bottom right pictures in Figure 55 may not be structurally weak and only lacks painting. On the other hand, brick walls may not be structurally strong as there is no reinforcement in its structure.

Table 16. Structural integrity of the public school buildings in terms of its interior/exterior aspects.

Integrity Level	Exterior/Interior Aspects			
	Wall		Ceiling	
	f	Percent	f	Percent
Standard	431	79.2	310	57.0
Substandard	113	20.8	234	43.0
Total	**544**	**100.0**	**544**	**100.0**

<u>**General Building Structural Integrity**</u>. The general building structural integrity is based on the over-all compliance to the stipulated standards of school buildings which was presented during the 1st National Conference of DepEd Engineers and Architects specifically in terms of buildings' foundation, beams, columns, roof and its framing as well as its walls. Having substandard main structural members cannot be considered structurally stable.

Table 17. General structural integrity of the public school buildings.

Structural Integrity Level	f	Percent
Standard	138	25.4
Substandard	406	74.6
Total	**544**	**100.0**

Table 17 shows that only 138 of 544 or 25.4 percent of the public school buildings examined are compliant to design standards. The rest (74.6%) are not compliant to at least one of the six criterion considered. Those that have qualified are newly constructed buildings. However if the DILG recommended building specification is to be considered, less than 2% is compliant. Most of the deficiencies would be in terms of its roof design and lack of wind shutter for the windows and other openings.

<u>General Building Structural Integrity by Municipality</u>. Figure 56 shows the general building structural integrity of the public school buildings in the Province of Samar by municipality. The said data are not representative of the entire school buildings of the government but only for the school campuses visited. Schools in Marabut, Samar have the most number of buildings considered having an acceptable general building structural integrity followed by those in the island town of Zumarraga, Samar. The Marabut, Samar schools are newly constructed buildings in replacement of those buildings damaged by Super Typhoon Hayian. Schools in Hinabangan, Samar have buildings considered to be substandard or do not possess the desired structural integrity. There are a total of only about 309 buildings of the 544 schools or 56.8% surveyed having the ideal structural integrity. This number excludes those which have been declared unsafe or those temporary structures built to augment classroom shortage.

The risk to damage and danger to users of the buildings are emphasized when the level of structural integrity is taken into the equation. A building that is considered not very good in terms of structural integrity located in a high risk to different hazard worsens the case. Below is the vulnerability rating considering the two variables, the exposure risk and the integrity of the structure.

Building Vulnerability. Shown in Figure 57 is the percent of buildings that has no to low vulnerability to hazard like earthquake, typhoon and fire. The vulnerability rating considered the structural integrity of the buildings, type of materials used and the design of building to be responsive to the risk like flooding.

Similar to Figure 57, Marabut, Samar and Zumarraga, Samar schools surveyed are the less vulnerable to earthquake, typhoon and fire. On the other hand, Catbalogan City, Hinabangan and San Sebastian school buildings surveyed received one of the highest vulnerability ratings. Buildings considered less vulnerable are the recently constructed structures which are compliant to the specifications recommended by DPWH and DepEd Engineers. About 85% of the buildings in Catbalogan are relatively old, with roofing needing rehabilitation, some are dilapidated that they can easily be damaged with high winds.

Old buildings built with wood are buildings with high risk to fire. Schools near communities where fire can start are also reason for higher risk score. Most of the old building electrical systems were not upgraded hence may become a potential source of fire.

Schools without good drainage and has no basement or crawl space for water are those that received higher flood risk scores.

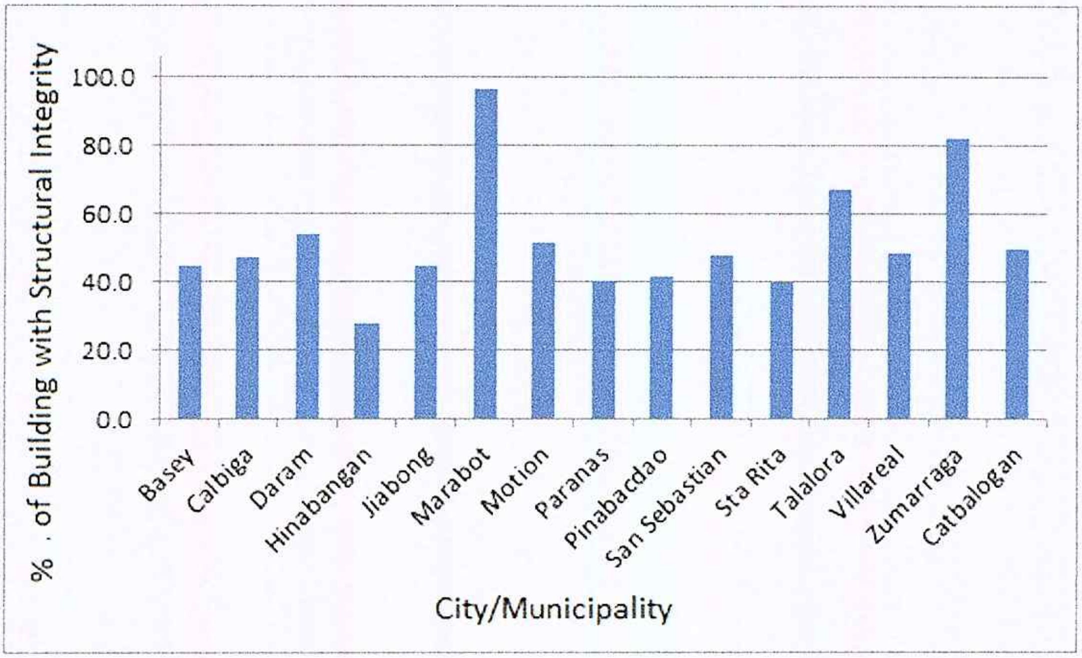


Figure 56. Distribution of buildings with acceptable structural integrity.

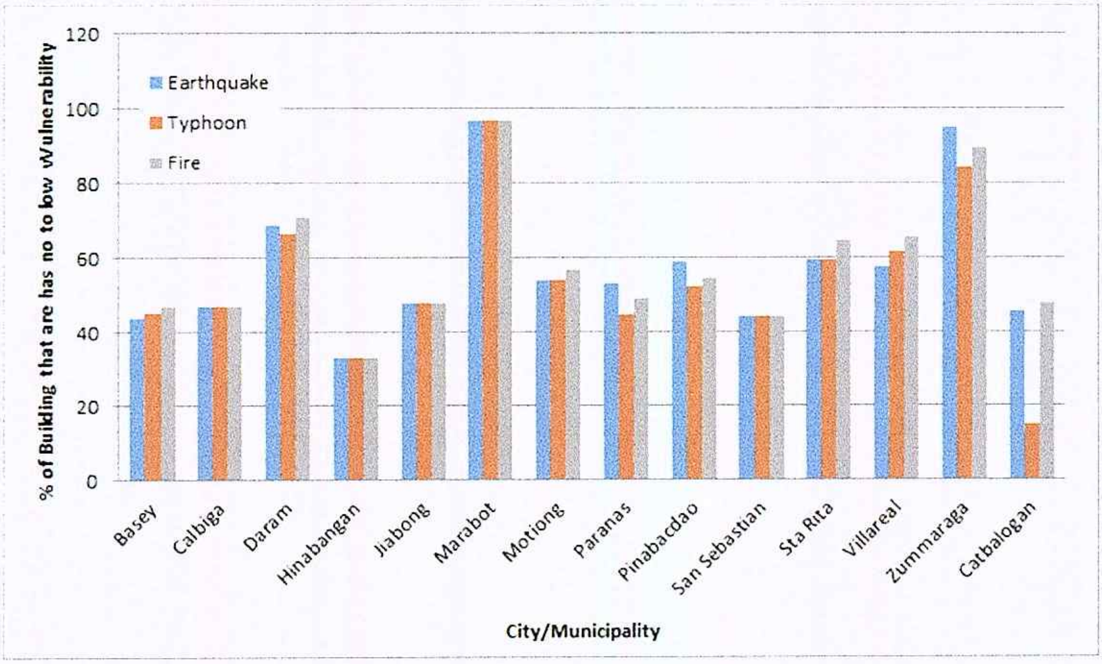


Figure 57. Vulnerability of buildings to hazard.

Summary of Schools Highly Vulnerable to Risk School Buildings. Of the 49 schools subjected to assessment, almost all are exposed to varied types of disasters, from geologic or natural hazards and human induced hazards like fire. Table 18 summarizes the number of schools as well as buildings in the survey that are exposed to disasters. Table 18 shows that all school surveyed are vulnerable to earthquakes. The effect of earthquake as a triggering factor to mass wasting event is low but rain-induced mass wasting event is higher wherein more than half of the surveyed schools are likely to experience it. Almost all of the schools surveyed are likely to be submerged in water when a tsunami of up to 15m height occurs. Almost half of the schools are vulnerable to flooding. Almost half of the school buildings are on fire risk due to the type of materials used. Most, however, are far from fire triggering sources like gasoline stations or households.

Table 18. Highly vulnerable schools/buildings to risks.

Type of Hazards/Event	Frequency	Percent exposed
Earthquake-Induced Landslide	4 schools	7.69
Magnitude 7-7.5 Earthquake	50 schools	96.15
Magnitude 6.0-6.9 Earthquake	19 schools	36.54
Rain-Induced Landslide	6 schools	11.54
Buildings that are Fire Risk	243 school buildings	44.67
Tsunami	47 schools	95.92
Flooding	323 school buildings	59.40

The analysis made in this paper requires specific sites validation before any new development is proposed. Campus to campus geohazard risk assessment must be performed to identify the safe zone areas and the danger zones. The DepEd engineers need to tap experts in producing site development plans and specific interventions in addressing the problems identified. There is no cure-all solutions to hazards.

Managing potential disasters in schools in the Province of Samar requires thorough investigation by experts in hazard identification and hazard mitigation. The proposed structure and corresponding activities to address the problem is proposed in Chapter VI of this document.

Chapter 5

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the summary of the major findings, the conclusions made on the basis of the findings and the recommendations derived from the conclusions of the study.

Summary of Findings

The salient findings of the study are as follow:

1. Samar has geophysical, climate and weather related risks. Based on secondary data, Samar is likely to experience earthquakes and other after effects of such phenomenon such as tsunami, liquefaction, and earthquake induced landslide. The existence of fractures on the ground (lineament) also poses dangers to buildings constructed above it. It is also frequently visited by typhoons carrying with it heavy precipitation and strong winds. The heavy precipitation may result into flooding specifically of low lying areas and rainfall induced landslides. Strong winds may also result into sea water surge (storm surge) which may cause coastal flooding and damage to coastal houses as well. Samar may likely experience drought. This drought may result into scarcity of water for various purposes and drying of trees and bushes/grasses. These drying-up of vegetation and scarcity of water increase the risks to wild fires or fire in general.

2. All schools are likely to experience earthquake due to its proximity to the active Philippine Fault Zone (PFZ) and several confirmed and suspected

lineaments of Samar. The effect of earthquake will vary depending on where the schools are found. The exposure of schools to risk in terms of earthquake-related occurrence is dependent on where the epicentre of earthquakes is and its magnitude. Major earthquakes nearby Samar with damaging earthquake magnitude of above 6 were about 24 years ago in Can-Avid Eastern Samar (6.8) and in Dapdap Eastern Samar (7.2).

The PFZ is found about 70 km from the nearest coast of Catbalogan City. There are some lineament found in the Samar Island; these are the Southern Samar (Basey, Marabut-Lawaan Segment), Northern Samar and Central Samar (lineament) (Calapi Segment, Paranas Segment).

3. A simulated Magnitude 7 earthquake with epicentre found 5 km below the surface near the vicinity of the Central Samar Lineament (Catbalogan City) will result in a magnitude 6 to 7.5 earthquake. As shown in Figure 23 and summarized in Table 5, about 46 schools (88.46%) are to experience magnitude 7.0-7.5 earthquake and the remaining six (11.54%) are expected to experience a magnitude 6.0-6.9 earthquake. This distribution will change when and if the epicentre is at a different location. If the same earthquake occurred in Pinabacdao, Samar which is close to the South Samar Lineament, the magnitude will result in a lesser number experiencing higher intensity. Some 36 (69.23%) schools will feel the magnitude 7.0 – 7.5 and the rest (30.77%) will experience magnitude 6.0 – 6.9. An earthquake occurring near Pinabacdao will result into exposure to a strong

earthquake (16 schools) and a major earthquake or magnitude 7.0 - 7.9 earthquakes will affect 36 of the 52 schools sampled.

4. A simulated magnitude 7.0 earthquake will expose Marabut National High School others will experience low susceptibility and majority, (46) campuses, are not to expect landslides. On the other hand, an earthquake in Pinabacdao, Samar will expose three campuses into high landslide risk and 8 to medium/moderate risk and 41 estimated to be safe from earthquake induced landslide. The three campuses are Daram National High School, Bagacay National High School of Hinabangan, Samar and Calapi National High School.

5. There are about six schools which are highly critical to rain-induced landslides. These are Mualbual National High School, Sua National High School, Cabiton-an National High School, Daram National High School, Catbalogan 4 District and Catbalogan 5 District. The four (4) public schools which were identified to be within the moderate level of risk for rain-induced landslide are: Baclayan National High School, Zumarraga National High School, Independencia National High School, and Igot National High School.

6. REDAS simulation shows that there is no tsunami risk to any area of Samar primarily because the likely earthquake is of strike-slip in nature. Other simulator however suggests that an intensity XI tsunami as a result of an earthquake between Leyte and Masbate will affect parts of Calbayog City, Pagsangjan, Santa Margarita, Tarangnan, Daram, and Catbalogan City.

7. Schools along the coast are exposed to storm surges during typhoons with strong winds. A NOAH simulation will submerge low lying area of downtown Catbalogan which will submerge most schools with at least up to 1.5 m height. Only schools found in upland are safe from storm surge. These are Calapi National High School, Lawaan National High School, Bonga national High School, Casandig National High School, Bagacay National High School, Tenani National High School, Calbiga National High School, Hinabangan National High School, Parasanon National High School, Valeriano C. Yancha Memorial Agricultural School, and Old San Agustin National High School.

8. Seventeen school buildings have high susceptibility to flooding. These schools include Lawaan National High School, Casandig National High School, Tenani Integrated School, Motiong National High School, Jiabong National High School, Wright National High School, San Sebastian National High School, Hinabangan National High School, Calbiga National High School, Anibongon Integrated School, and others. On the other hand, there are 7 schools which are low susceptible to flooding. These schools include Marabut National High School, Old San Agustin National High School, Dampigan National High School, Simeon Ocdol National High School, Tominamos National High School, Calapi National High School, and Valeriano C. Yancha Memorial Agricultural School.

9. All school samples have these facilities with varying quantities and electrical loads. The newer structures are designed to handle such electrical loads but the older structures are not. Out of the total building sampled, it appears that

old buildings are prone to fire as their structures are made of flammable materials such as wood and plywood; some makeshift structures are even made of bamboo and nipa shingles. Of the total 585 buildings from 45 schools evaluated, around 44.4% are relatively safe from fire risk while the remaining 55.6% are fire risky due to its physical condition. Almost half of buildings in the towns of Basey, Calbiga, Hinabangan, Jiabong, Paranas, San Sebastian and Catbalogan City are fire risky. The fire risks may come from faulty electrical wiring, buildings being so close to residential and commercial centers or near a grassy or forested zones which when experiencing long term drought or from slash and burn farming practice may expose further schools to fire.

10. Of the total 544 school buildings, there were 138 (25.4% of all buildings visited) standard buildings. There were likewise 406 (74.6% of all buildings visited) substandard school buildings. Of the 138 standard school buildings, there are 121 classrooms, 3 offices, 1 stage, 7 other buildings and 6 comfort rooms that are of standard based on specifications of DepEd. Of the 406 substandard school buildings, there are 286 classrooms, 48 offices, 20 stages, 16 other buildings, and 36 comfort rooms.

11. Majority or 301 (55.33%) of the school buildings are made of concrete materials while there are only 243 (44.67%) which are made of semi-concrete materials. All buildings funded by DepEd or DPWH followed the required materials but older structures and the makeshift/temporary buildings are not. School with the most number of makeshift structures/rooms is the Parasanon

National High School wherein 40% of its buildings are categorized as a makeshift structure. Also, Parasanon NHS has the most number (73%) of structures that is considered sub-standard.

12. As regards methods of construction, project implementation and monitoring, the school buildings are constructed through public bidding and through the Department of Public Works and Highways (DPWH). There is a uniform design that the local DepEd must follow. Designs are configured based on the site conditions in terms of soil bearing capacity, ground terrain, etc. DepEd engineers visit construction sites as they are available or when their presence is requested by the contractors. DepEd engineers monitors quality but admit they do not have scientific tools to quantify compliance to standards and rely on contractor materials testing reports. Some buildings implemented by the school funded by LGUs or from other sources (except those funded by multinational organizations/countries) are not built using the same review and monitoring. There are makeshift structures allowed to be constructed and are found to be substandard.

13. New buildings implemented by contractors have one year warranty for minor repairs and five years warranty for structural defects. Schools use their Maintenance and Other Operating Expenses (MOOE) for minor defects and DepEd Central implements major repairs through its Basic Education Facilities Funds. Every year, schools in Samar participate in the six day Brigada Eskwela, where various stakeholders and benefactors including school officials do minor

repairs, maintenance work and clean-up public elementary and secondary schools in Samar and the entire country.

14. About 299 (55%) of all buildings visited are compliant to DepEd architectural design standards while 245 buildings (45.0%) are not. Only the more recently constructed school buildings are compliant to the design requirements. It is also apparent that as designs, color, and materials used are compliant, building conditions were not maintained properly. Some of the buildings appeared dirty; access ways are lined with dirt as they are substandard. Some buildings were compliant to architectural designs but were located or built in areas making it generally poor in overall aesthetics. The buildings considered standard or astatically pleasing are made of concrete main structures, CHB walls with GI sheet gabled roofing. Exterior walls are painted with cream-toned colors (pearled ivory or crisp ecru), with beams and columns darker (ivory cream or yellow rain). Interior wall is lighter cream (pearled ivory or bright wonder). Ceiling is painted with white tone (brilliant white, DepEd White, or white flat enamel). Roofing and other accessories are painted with lighter green tone (foam green or aqua paradise) while doors are painted with bright green (jasmine green or temptation). Illuminating means, sockets, chalk boards were also specified. Windows recommended are jalousie blades on a shutter type window holder with fixed glass transoms and concrete jambs. Doors are swing-out with lever type lockset and fixed glass transom in concrete jambs/frames.

15. Significant number of schools in Samar have no campus lay-out when they were built. Most often these schools started with one or two classrooms; when enrolment increased, new buildings were constructed wherever it is possible. This type of practice has led to crowded campuses, poor access, poor surrounding conditions and poor school campus environment. It is only recently that campus lay-out or campus land use planning was given emphasis. However, because of limited resources, the relocation of school buildings like those improperly positioned, or those that are located in hazardous areas have not been addressed. Campus lay-out was formulated poorly and not in accordance to the ideal development planning standards. Its formulation is not based on intensive stakeholders' consultation.

16. There is no functional site development plan making decision wherein to build a new infrastructure is an unclear procedure. Decision where to erect the building is left to the decision of DpWH and DepEd Engineers. Some of schools visited are frequently flooded, some are found in highly liquefiable zones such as the San Sebastian National High School which is situated in a marsh land.

17. As regards the disaster risk reduction measures, the schools formulate and implement a school disaster risk reduction management action plan which is submitted to the Division Disaster Risk Reduction and Management Officer. The action plan consists of the following activities: a) development of evacuation plan to locate open space as evacuation area and to sketch routes of students, teachers, personnel, and visitors to the evacuation area; b) reorganization of the school

disaster risk reduction and management council; c) student-led school watching activity through the Supreme Student Government officers; d) correct unsafe zones; e) observation and celebration of the National Disaster and Consciousness Month Celebration; f) conduct earthquake drill; and g) integration of DRRM to some lessons in all learning areas. These DRRM activities however are not fully implemented. Almost all schools do not have visible evacuation plan, designated evacuation areas, no DRRM related warning, etc. All campuses visited do not have fire hydrants, few has fire fighting equipment/facilities. Most school campuses are not accessible by fire trucks or emergency vehicles, access ways and even gates are narrow. As observed, on-going construction activities are not properly secured, no occupational and health safety hazard measures implemented. There are campuses found along slopes and near marsh lands or rice fields considered to be hazardous.

18. As to columns of school buildings, there are 161 or 29.6 percent schools with standard or strong columns, with 380 or 70.4 percent having substandard or weak columns. As regards beam, 373 or 68.6 percent school buildings have standard or strong beams, with 171 or 31.4 percent which have substandard or weak beams. As regards tie beam, 199 or 36.6 percent of school buildings have tie beams, with 345 or 35.4 percent without tie beams. As for the footing, 405 or 74.4 percent of the school buildings have standard or strong footing with only 139 or 25.6 percent with substandard or weak footing.

19. About 221 or 40.6 percent of the public school buildings are not at risk of water entry, while 323 or 59.4 percent are at partial risk of water entry. The framing of school visited, around 325 or 59.7 percent are standard, while 219 or 40.3 percent are substandard. Roofing of 456 school buildings or 83.8 percent follow the standard while 88 or 16.2 percent are substandard. About 431 school buildings or 79.2 percent are compliant to the specified DepEd standard and the rest of the 113 schools (or 20.8 percent) are substandard. As for the ceiling of the public school buildings, 410 or 57 percent are considered made of standard materials while 234 or 43 percent are substandard. Except for the unfinished school buildings and the damaged buildings at Motion National High School, all new buildings are compliant to the standards for roofing and roof framing, walls, finishing/painting, and ceiling. A significant number of older buildings are not compliant and makeshift classrooms are all rated substandard.

20. Considering all criterion used for structural integrity, about 138 or 25.4 percent of the public school buildings are compliant to building standards specified by DepEd while more than majority (406 or 74.6 percent of public school buildings) are deficient in one criterion or more.

21. Schools in Marabut Samar has the most number of buildings considered having an acceptable general building structural integrity followed by those in the Island town of Zumarraga, Samar. The Marabut, Samar schools are newly constructed buildings in replacement of those buildings damaged by Super Typhoon Hayian. Schools in Hinabangan, Samar have buildings considered to be

substandard or do not possess the desired structural integrity. There are a total of only about 309 buildings of the 544 schools or 56.8% surveyed having the ideal structural integrity. This number excludes those which have been declared unsafe or those temporary structures built to augment classroom shortage

22. The Marabut, Samar and Zumarraga, Samar schools surveyed are the less vulnerable to earthquake, typhoon and fire. On the other hand, Catbalogan City, Hinabangan, Samar and San Sebastian, Samar school buildings surveyed received one of the highest vulnerability ratings. Buildings considered less vulnerable are the recently constructed structures which are compliant to the specifications recommended by DPWH and DepEd engineers. About 85% of the buildings in Catbalogan are relatively old, with roofing needing rehabilitation; some are dilapidated that they can easily be damaged with high winds. Old buildings built with wood are buildings with high risk to fire. Schools near communities where fire can start is also reason for higher risk score. Most of the old building electrical systems were not upgraded; hence they may become a potential source of fire. Schools without good drainage and have no basement or crawl space for water are those that received higher flood risk score.

23. Based on REDAS, NOHA, and other computer simulations almost all school campuses surveyed are exposed to varied types of disasters, from geologic or natural hazards to human induced hazards like fire. The effect of earthquake as a triggering factor to mass wasting event is low but rain-induced mass wasting event is higher wherein more than half of the surveyed school are likely to

experience it. Almost all of the schools surveyed are likely to be submerged in water when a tsunami of up to 15m height occurs. Almost half of the schools are vulnerable to flooding. Almost half of the school buildings are at fire risk due to the type of materials used. Most however are far from fire triggering source like gasoline stations or households.

Conclusions

On the basis of the major findings of the study, the following conclusions are made:

1. The entire island of Samar is highly vulnerable to various types of risks such as geophysical, climate and weather related, and other risks like fire.

2. All schools are exposed to one or several disaster risks. All are expected to experience earthquakes. Samar has several lineaments and is very proximate to major fault systems in the country, the Philippine Fault Zone and the Marianas Trench. Historically, Samar has experienced up to 7.2 magnitude of earthquake; the likelihood that a similar earthquake may occur again is high.

3. An earthquake with origin between Catbalogan and Marabut like the Pinabacdao area will result in higher number (up to 21%) of schools vulnerable to an earthquake-induced landslide versus 2% if an earthquake occurs in Catbalogan City.

4. Schools in Samar are more prone to rain-induced landslide. The probability of risk occurrence is higher as Samar is likely to experience higher intensity precipitation than high intensity earthquake.

5. Simulations provided different tsunami risk quantification. REDAS software suggests there is no direct threat of tsunami to Samar areas but Tsunami Mapper suggests Samar towns are likely to receive up to 4m tsunami height.

6. Project NOAH simulation suggests that coastal towns are expected to be flooded from seawater surge. At storm surge advisory level 4, it's going to cover Samar towns Jiabong, Motiong, Paranas, San Sebastian, Villareal Samar, Santa Rita, Basey, Marabut, and Catbalogan City with up to 1.5 m of flood water.

7. Around 32.7% of school campuses are highly exposed to flooding. These are schools found in low lying areas or catch basins, nearby rivers or found nearby the coast. More than half of schools are not susceptible to flooding.

8. All campuses have fire risks. This risk is attributed to faulty electrical wiring, proximity to high risk zones like residential and commercial areas of the towns, nearby highly vegetative areas which may turn dry during long duration drought and the slash and burn practices of farmers.

9. Most at risk are makeshift classrooms using flammable materials such as used/old lumber and other light materials coupled with poor electrical wiring.

10. About a quarter of school buildings in Samar is compliant as to design and purpose.

11. A little more than half of school buildings are made of mainly concrete materials, most of which are the newer school buildings constructed.

12. Most new buildings are implemented by DepEd and DPWH using uniform designs as specified by DepEd Central Office. Makeshift buildings/classrooms are implemented locally through "bayanihan" or "pintakasi" or by administrators through paid laborers/carpenters.

13. Only the Brigada Eskwela is the regular maintenance activity of almost all schools. These maintenance activities are minor repairs and general clean-up activities.

14. Aesthetic quality of a little more than half of all buildings are compliant to DepEd standards.

15. School development plans are not studied well and are improperly prepared.

16. In the absence of functional site development plan, location of buildings is decided by DepEd engineers validated by DPWH during ocular inspection.

17. The office of the DepEd in-charge on physical plant and facilities lacks manpower to monitor construction activities and assessment of building conditions for appropriate action.

18. Some campuses are crowded, no ideal road network, most access ways are narrow pathways and alleys.

19. Some campuses are located in disaster risk areas specifically to flood and weak foundations.

20. There is a disaster risk management plan, implementation of such is wanting.

21. Only one in five school buildings are totally compliant to DepEd standards

22. Those school campuses re-built after typhoon Yolanda have the most number of schools compliant to DepEd building standards.

23. Flooding is the most likely hazard to be experienced by schools followed by fire risk. All schools are expected to be subjected to earthquake but are less likely to be damaged.

Recommendations

The study hereby gives the following recommendations on the basis of the conclusions made in this study:

1. It is highly recommended that site specific geohazard risk be conducted and be performed by a competent authority such as the Mines and Geosciences Bureau of the Department of Environment and Natural Resources or academic institutions like SSU who can conduct risk assessment.

2. Ensure that all buildings are designed considering the risks identified such as earthquake, landslide, flood, storm surge, liquefaction, and fire. Proximity to fault line and lineaments must be taken into consideration in location planning.

3. All makeshift buildings must be replaced with standard buildings. Other substandard aspects of buildings need to be repaired or retrofitted.

Chapter 6

PROPOSED DISASTER RISK MANAGEMENT PLAN FOR A RESILIENT PUBLIC SCHOOL BUILDING

Introduction

The Philippines ranks third among the most disaster-prone countries in the world primarily because of its frequent exposure to tropical storms, presence of tectonics fault and active volcanoes all over the country (World Vison, 2017). This disasters according to World Bank (2015) have destroyed human, social and physical capital, and derailed social and economic development. Reducing the risk of disasters is an important intervention in order for the Philippines to achieve its development goals.

Of the 81 provinces of the Philippines, Samar is considered to be one of the most exposed to disasters. Western Samar ranks 13th at risk provinces in the Philippines considering all climate and weather related risks (Center for Environmental Geomatics, 2005). Before the end of 2017, Samar is one of the most hit by Typhoon Urduja with unusually heavy precipitation, causing flooding to a lot of communities and experiencing mass wasting events (NDRRMC, 2017). The impact of the disaster is magnified in the poorer communities of Samar, with little resources available, thereby relying on external help during disasters.

The United Nations Development Program (UNDP) in the Asia and the Pacific has conducted some intervention to make schools resilient to disasters. The 2018 UNDP activity reveals that while there is an existing enabling policy towards resiliency, there is still a huge gap in terms of policy implementation. It was revealed in their assessment that there is still low level of awareness, preparedness and readiness to respond to phenomena like earthquake-induced tsunamis. This is even if the schools surveyed are the same schools that have experienced the storm surge during Tropical Storm Yolanda.

Purpose of the Plan

This plan aims to make public schools in Samar resilient. Being resilient means having the capacity to recover quickly from the effects of disasters or the ability to spring back to the conditions prior to the disaster exposure. In this paper, resiliency is about anticipating, planning and reducing disaster risk to effectively protect the people using the government school buildings and other infrastructure including the resources in it.

Disaster Risk Profile

Of the 49 schools subjected to assessment, almost all are exposed to varied types of disasters, from geologic or natural hazards and human induced hazards like fire. Table 19 summarizes the number of schools as well as buildings in the survey that are exposed to disasters. Table 19 shows that all school surveyed are vulnerable to earthquakes. The effect of earthquake as a triggering factor to mass wasting event is low but rain-induced mass wasting event is higher wherein more than half of the surveyed school are likely to experience it. Almost all of the schools surveyed are likely to be submerged in water when a tsunami of up to 15m height occurs. Almost half of the schools are vulnerable to flooding. Almost half of the school buildings are at fire risk due to the type of materials used. Most however are far from fire triggering sources like gasoline stations or households.

Table 19. Highly vulnerable schools/buildings to risks.

Type of Hazards/Event	Frequency	Percent exposed
Earthquake-induced landslide	4 schools	7.69
Magnitude 7-7.5 earthquake	50 schools	96.15
Magnitude 6.0-6.9 earthquake	19 schools	36.54
Rain-induced landslide	6 schools	11.54
Buildings that are fire risk	243 school buildings	44.67
Tsunami	47 schools	95.92
Flooding	323 school buildings	59.40

Plan of Action

The first step is to prioritize which among the hazards identified requires the most urgent attention. Hazards are prioritized according to the severity of the resulting injury, potential damage, and the probability of occurrence (CSU, nd). Below is the recommended prioritization of hazards according to the Environmental Health and Safety of the California State University in Fullerton.

Emergency hazard is any condition where the chances of occurrence is almost certain and its occurrence is expected to cause serious damage to property, loss of life or will be an environmental problem. Appropriate intervention to all priority 1 hazards must be instituted at the soonest possible time.

Table 20. Hazard prioritization

Priority		Description	Correction Date
1	Emergency hazard	Emergency hazards threatens life safety or health, property damage, and critical research	Immediately
2	Urgent hazard	Urgent Hazards under the right circumstances will cause severe injury, illness, property damage, equipment damage	48 hours from date requested
3	Identified hazard	Identified hazards under the right circumstances could cause minor injuries or illnesses, property damage or equipment damage	Agreed upon date
4	Code compliance	Building code of the Philippines	Dependent on severity. Agreed upon schedule

Table 20 can be used by school administrators in evaluating which among their physical plant and facilities needs immediate action.

The management of identified hazards are site and situation specific. There is no general recommended solution to risks. Some of the solutions on one site may not be applicable to another.

<u>1.0 Landslide Risk</u>. In this paper, landslide are to be triggered by either too much rain or high intensity earthquake. Of the two triggering factors, rain-induced hazard will be the more likely caused by landslide. This is because rains in Samar are evenly distributed all throughout the year. In the recent events, Samar has experienced record breaking unusually heavy precipitation, most of which have caused a number of mass wasting events.

Interventions include but not limited to:

a) Slope stability analysis – For a fact-based intervention, a site specific assessment on landslide susceptibility must be conducted. A geotechnical engineer or a geologist may be tapped to perform said test. The assessment will provide the school administrator the type of intervention appropriate to his/her school.

b) Unloading – The slopes prone to landslide must be de-loaded. There are structures on top of the slope, those must be removed. If it cannot be removed, retaining wall or structural support must be constructed to increase resistance to soil shear.

c) Construction of retaining wall – Retaining walls may be very expensive and massive. The wall must be designed to prevent mass of soil potentially failing. The wall maybe useless when a deep seated mass wasting happens.

d) Drainage – Water is one of the most frequent reasons of mass wasting in Samar (Orale, 2006). Construction or diversion of water flowing into the critical slopes will reduce chances of weakening of shearing resistance of slopes. Water increases loading and decreases shearing resistance of soil.

e) Avoidance – When the nature of mass wasting is regional in nature, meaning area wide damage, the best option is relocation of the building site or of the school campus. If transfer of school campus is not possible, avoidance during occasions of high precipitation may be practiced. In this case, a protocol on when the said intervention will be implemented needs to be formulated and disseminated widely.

Table 21. Possible hazard interventions.

Type of Hazards/Event	Priority	Possible intervention	Correction Date
Landslide	1	Conduct slope stability analysis to identify specific intervention, if risk is very high, hazard avoidance is preferred	Immediate
Earthquake	1	Conduct detailed structural integrity assessment. Retrofit. If cost of retrofitting is high, replacement of building is preferred	Immediate
Tsunami	2	Establish a functional early warning system for emergency evacuation. Construction of taller buildings as evacuation facility	Functional early warning system – the soonest.
Flooding	3	Construction of two storey buildings instead of 1 is recommended	As soon as funds become available
Fire	4	Check possible presence of triggering factors such as faulty electrical wiring, laboratory safety	As soon as funds

		procedure strict compliance and replacement of fire risk buildings	become available
Typhoon	1	Construction of roofing with concrete facia is necessary to protect roofing. Equipment must be installed far from windows to avoid exposure to wind and rain. Roof framing must be durable, made of steel.	As soon as funds are available

2.0 Earthquake. The Philippine Volcanology and Seismology (Philvocs) identified at least 20 towns and cities as high risk areas due to its proximity to the active Philippine Fault zone and lineaments. In Samar, the towns of Marabut, Basey, Pinabacdao and Hinabangan are subject to jolts by the movements of the Southern Lineament (Reliefweb, 2012). These towns are expected to feel larger intensity than the rest of Samar. This means that school buildings in these towns are to withstand the strength of those earthquakes. Earthquakes turn into major disasters due to unsafe structures such as poorly designed structures, poorly built, built in inappropriate places and others (Reliefweb, 2013). The following are the possible intervention that school administrators can implement.

a) Thorough technical review on structural integrity of buildings – To identify specific weaknesses of the building, a detailed site inspection per building is necessary. It will provide the school administrator the specific action that needs to be implemented. It shall only be conducted by a civil engineer more specifically a structural engineer.

b) Seismic retrofitting of buildings – When the replacement of the building is not possible, retrofitting may be explored. Retrofitting can be very expensive depending on the level of deficiency of the structure. Seismic retrofitting is the modification of existing structures to make it more resistant to earthquakes.

c) Replacement of buildings/construction of earthquake proof buildings - When retrofitting cost is close to the value of the building, replacement or construction of new building may be more preferred. Compliance to the new design standards in the National Structural Code of the Philippines and the National Building Code of the Philippines must be strictly followed. In the same manner, strict monitoring during the construction stage must be instituted to ensure compliance to standards.

d) Earthquake drills – If retrofitting or replacement of old building with new ones is not yet possible due to reasons not within the control of the school administrator, the institutionalization of earthquake drill can save lives.

3.0 Tsunami. Tsunamis are generated from a large, shallow earthquakes with an epicentre or fault line near or on the ocean floor. According to World Data, there have been a total of 18 tidal waves classified as tsunami since 1749 where a total of 4,868 people have died. The frequency of occurrence is more than average but still moderate (ibid). The last event was in 1979 that have killed more than 4,300 people. Since tsunami occurs only due to an earthquake of shallow epicentre in the ocean floor, the likelihood of it happening in Samar may be very small. As shown on Table 19, almost all of the schools maybe submerged in a 15 m depth of water. The highest recorded is only 7m tall. This is beside the fact that Samar is basically shielded from any tsunami from the ocean. Tsunami in Samar may only occur when a shallow earthquake occurs along the Philippine Fault System off shore of the Samar Island; this scenario however may not be too huge unlike when tsunami origin starts far from the landmass (National Geographic, 2004).

The best option is for schools located in disaster free areas. To avoid tsunami means it must be found in higher elevations. These however is very impossible. The doable option to mitigate risk attributed to the occurrence of tsunami is an earthquake drill in response to a possible tsunami.

4.0 Flooding. Flooding is caused by too much rain, poor ground cover, non-functioning drainage system (natural or man-made) and low lying location. Precipitation cannot be controlled but its effects can be mitigated.

a. Improve ground cover – The most doable activity that the school administrator can do is to conduct reforestation or ground cover improvement in the local watershed. Aside from unusually heavy pouring of rain (which cannot be controlled), the state of the ground cover enhances the flood risks. This is primarily because of higher volume of runoff. Enhanced ground cover will increase water infiltration rate, reducing the amount of runoff. Improved ground cover will also minimize erosion which leads to clogging of waterways causing flooding. Together with the ground cover initiative, a massive information drive on the importance of protecting ground cover must be instituted.

b. Construction of drainage systems and/or maintaining functionality of existing drainage system – If absent, construction of new canal is necessary to drain the water in flooded zones of the school campus. On the other hand, old canals needs management or enhancement to ensure its functionality. Management may include, declogging or increasing of capacity.

5.0 **Fire.** The most likely cause of fire in the school premise is through faulty electrical wiring, from unattended laboratory experiment or garden activities which may include burning of school wastes. The following may be implemented to minimize the risks.

a) Through review of electrical wirings – These is primarily true for old buildings especially those constructed using light materials. A thorough review will identify building specific interventions.

b) Replacement of faulty electrical wiring – There is an immediate need to replace the damaged electrical wiring to minimize it as a triggering factor to fire.

c) Organizing room to secure flammable materials – When an electrical spark or unattended laboratory or other activities occur, disaster can only happen when a flammable material is nearby.

d) Construction of fire proof buildings - To date, buildings constructed are already fire proof through use of non-flammable materials such as concrete boards, metal framing, concrete and steel. Not all however have fire sprinkler systems.

6.0 **Typhoon.** The intensity of typhoons passing Samar has gone down. To date, the most at risk provinces are Cagayan, Albay, Ifugao, Sorsogon and others. Samar is ranked 20 in the list of DENR and the Center for Environmental Geomatics. Risk associated to typhoons are the high winds and the precipitation.

a) High precipitation - Effect of excessive rainfall can be mitigated using the same recommendations for flooding.

b) High/strong wind – The most at risk portion of the infrastructure is the roofing. The construction of a concrete facia is one major recommendation in the Build Back Better manual recommended by RDC panel. The use of more rabid material for roofing is essential. Metal roof truss, stronger roofing and proper fastening must be followed. Very high pitched roofing must likewise the reduced to minimize wind strength impact to roofing.

(Disaster) Risk Management Unit

The Department of Education shall create a committee who will undertake the detailed assessment or look for consultants to do the job of analysing appropriate intervention. It shall be composed of civil engineers of the Division. Assistance will come from institutions such as the College of Engineering of Samar State University, specialists from the Mines and Geosciences Bureau of the Department of Environment and Natural Resources, Department of Public Works and Highways, the Department of Science and Technology and the Bureau of Fire

Protection to provide the technical advices on how to go about making public schools less susceptible to the identified risks.

Figure 58 is the recommended composition of the team who shall visit every site for evaluation. The current practice of DepEd is to require the school head self-assessment on the potential risk. Those who did the assessment have no technical background therefore the information is only based on perception.

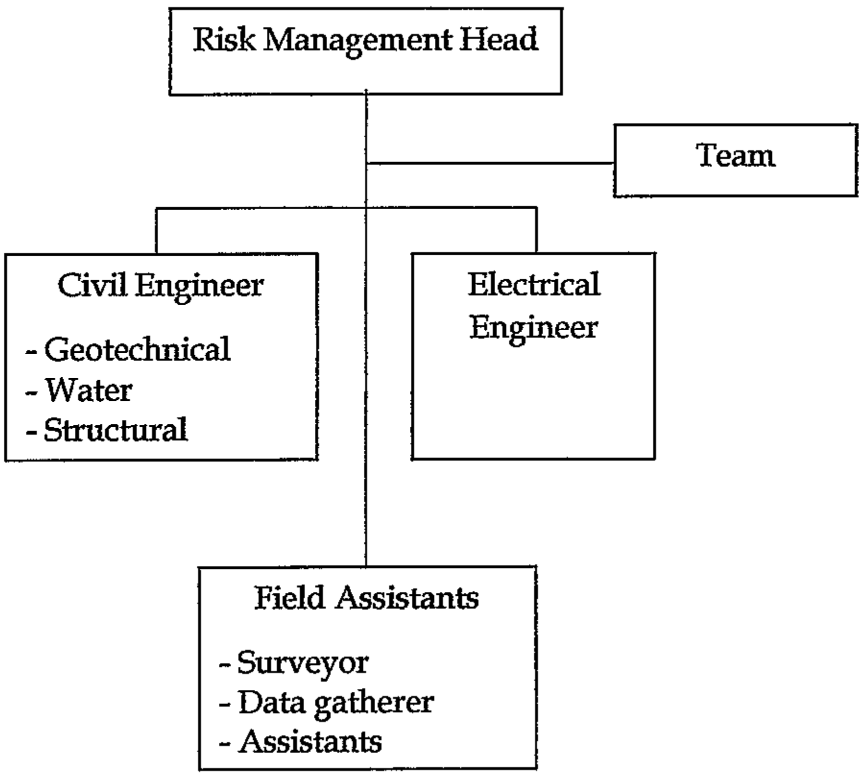


Figure 58. The Risk Management Unit Organizational Structure

The Risk Management Unit shall be composed of at least two engineers, one civil engineer and an electrical engineer or an electrician. The civil engineer must be knowledgeable on geotechnical, water and structural engineering. As much as possible, he/she must have experience in assessing structural integrity of buildings, flood risk assessment and slope stability analysis. In case the civil engineer lacks the said skills, DepEd may hire services or partner with agencies who have experts in the above mentioned areas. The civil engineer may also act as the risk management head. The engineers shall be assisted by field workers.

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APPENDICES

APPENDIX A

Assignment of adviser

Republic of the Philippines
SAMAR STATE UNIVERSITY
Office of the Dean I College of Graduate Studies

We Innovate. We Build. We Serve.

JAS-ANZ

AJA

Certificate No. AJA17 1013

ASSIGNMENT OF ADVISER

November 15, 2017

DR. RONALD L. ORALE
Vice President for Planning, Research & Extension
This University

Dear Dr. Orale:

The undersigned would like to inform you that you have been designated as dissertation adviser/consultant of **RENE B. NOVILLA**, candidate for the degree of DOCTOR OF PHILOSOPHY in TECHNOLOGY MANAGEMENT, who proposes to write a dissertation entitled DISASTER RISK MANAGEMENT FOR RESILIENT PUBLIC SCHOOL BUILDING IN SAMAR.

Hoping for an approval of this request of the above-mentioned student for discipleship.

Thank you very much for your cooperation.

Very truly yours,

FELISA E. GOMBA, Ph. D.
Vice-President for Academic Affairs/
Acting Dean, College of Graduate Studies

CONFORME:

DR. RONALD L. ORALE
Adviser

____
Date

APPENDIX B

Letter Request for the Schools Division Superintendent, DepEd, Division of Samar

Republic of the Philippines
SAMAR STATE UNIVERSITY
Catbalogan City

January 3, 2018

MARIZA S. MAGAN, Ph.D., CESO V
Schools Division Superintendent
Department of Education, Division of Samar
Catbalogan City, Samar

Dear Madam:

Warm greetings!

The undersigned is a graduate student taking up Doctor of Philosophy, major in Technical Management. Further, the undersigned is currently conducting a research entitled **"Disaster Risk Management for Resilient Public School Building in Samar"** in partial fulfilment of the requirements for the said degree. Thus, the undersigned would like to respectfully request for the following data which are necessary for the conduct of the present study:

- Inventory of school buildings in the different public schools in the DepEd, Division of Samar, including the list of classrooms per school, and among others;
- The technical aspects of the school buildings, if available, such as the building design and purpose, construction materials used, construction cost, methods of construction and maintenance;
- Non-technical aspects of the schools such as the aesthetic improvements made as well as the disaster/risk reduction measures;
- Lay-out of the school buildings; and
- All other pertinent documents pertinent to the resiliency of public school buildings in DepEd Schools Division of Samar.

Rest assured that the following requested data shall be used solely for research purposes only. Moreover, a copy of the final output of the research will be provided to your office for reference.

The undersigned hopes for immediate and affirmative response on the said request. Thank you very much and God bless!

Very truly yours,

RENE B. NOVILLA
Researcher

Noted:

RONALD L. ORALE, Ph.D.
Vice-President, Planning, Research and Extension, SSU
Research Adviser

Recommending Approval:

FELISA N. GOMBA, Ph.D.
Vice-President, Academic Affairs, SSU
Acting Dean, College of Graduate Studies

Approved:

MARIZA S. MAGAN, Ph.D., CESO V
Schools Division Superintendent, DepEd Samar

APPENDIX C

Letter Request for the Schools Division Superintendent, DepEd, Catbalogan City Schools Division

Republic of the Philippines
SAMAR STATE UNIVERSITY
Catbalogan City

January 3, 2018

CRISTITO A. ECO, CESO VI
Schools Division Superintendent
Department of Education, Schools Division of Catbalogan City
Catbalogan City, Samar

Dear Sir:

Warm greetings!

The undersigned is a graduate student taking up Doctor of Philosophy, major in Technical Management. Further, the undersigned is currently conducting a research entitled **"Disaster Risk Management for Resilient Public School Building in Samar"** in partial fulfilment of the requirements for the said degree. Thus, the undersigned would like to respectfully request for the following data which are necessary for the conduct of the present study:

- Inventory of school buildings in the different public schools in the DepEd, Schools Division of Catbalogan City, including the list of classrooms per school, and among others;
- The technical aspects of the school buildings, if available, such as the building design and purpose, construction materials used, construction cost, methods of construction and maintenance;
- Non-technical aspects of the schools such as the aesthetic improvements made as well as the disaster/risk reduction measures;
- Lay-out of the school buildings; and
- All other pertinent documents pertinent to the resiliency of public school buildings in DepEd, Schools Division of Catbalogan City.

Rest assured that the following requested data shall be used solely for research purposes only. Moreover, a copy of the final output of the research will be provided to your office for reference.

The undersigned hopes for immediate and affirmative response on the said request. Thank you very much and God bless!

Very truly yours,

RENE B. NOVILLA
Researcher

Noted:

RONALD L. ORALE, Ph.D.
Vice-President, Planning, Research and Extension, SSU
Research Adviser

Recommending Approval:

FELISA N. GOMBA, Ph.D.
Vice-President, Academic Affairs, SSU
Acting Dean, College of Graduate Studies

Approved:

CRISTITO A. ECO, CESO VI
Schools Division Superintendent
DepEd Schools Division of Catbalogan City

APPENDIX D

Pictorial Representations of Disaster Resilient Classrooms

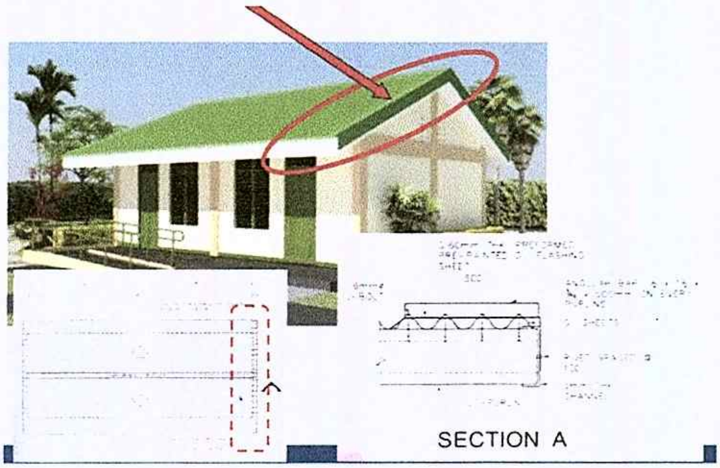


Figure 1. Roofing Design for Resilient School Building

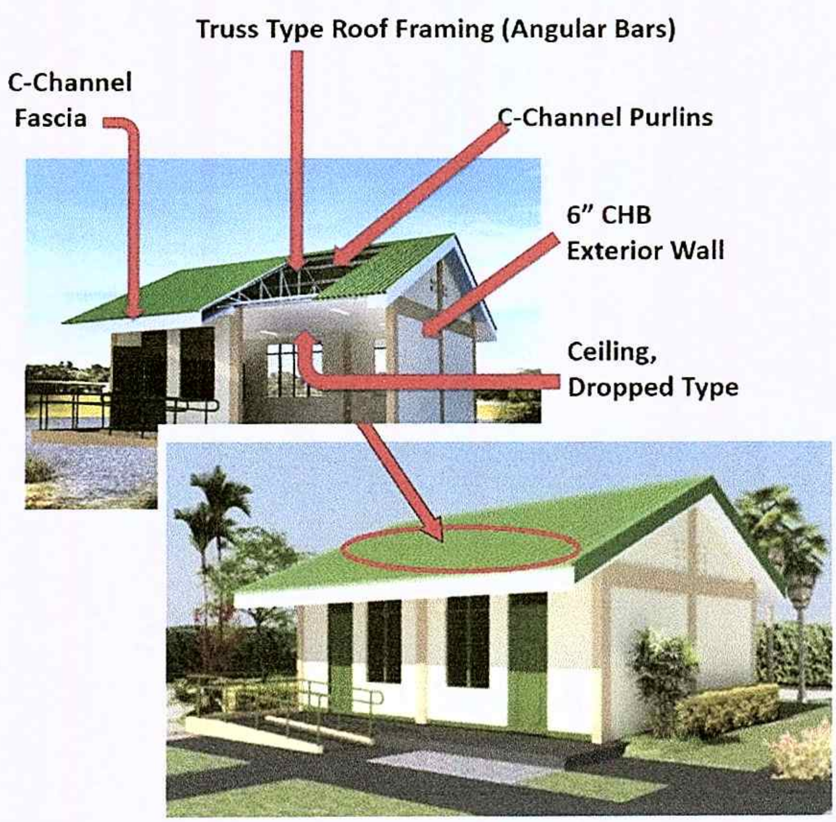


Figure 2. Roof Framing Design for Resilient School Building

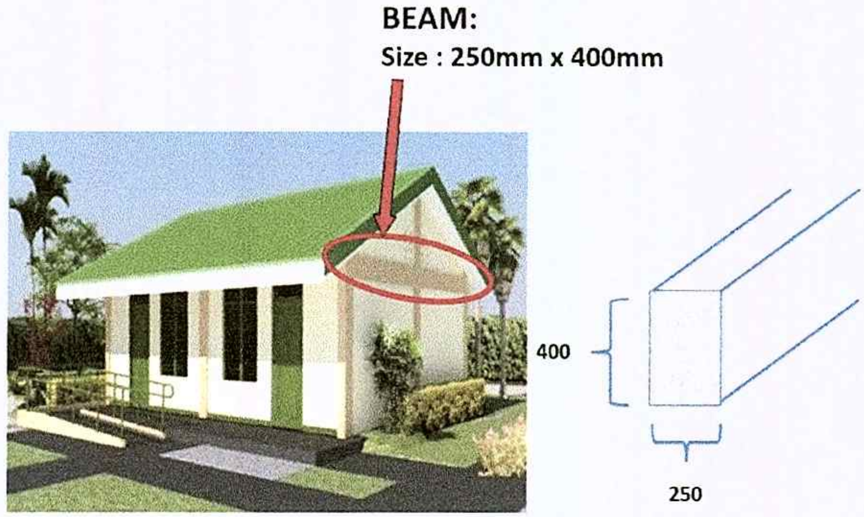


Figure 3. Beam Structural Design for Disaster-Resilient School Buildings

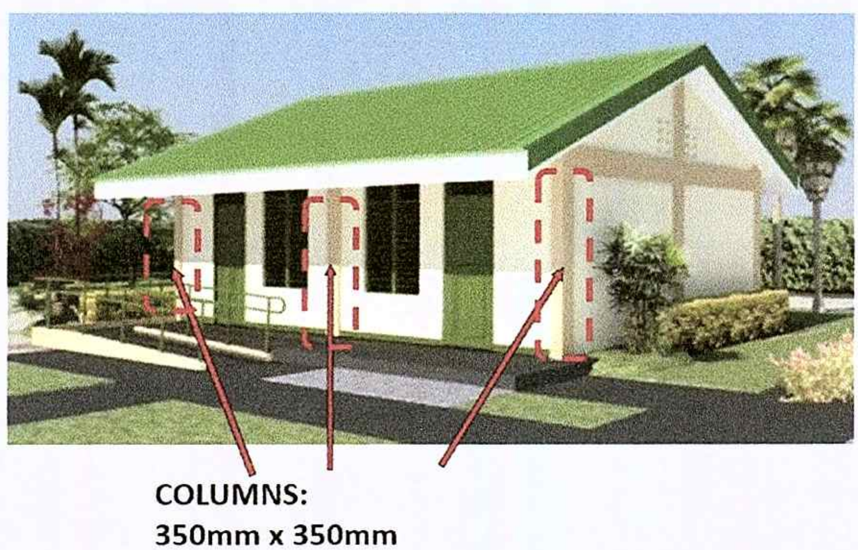


Figure 4. Column Design for Disaster-Resilient School Buildings

Figure 5. Window Design for Disaster-Resilient School Buildings

Figure 6. Door Design for Disaster-Resilient School Building

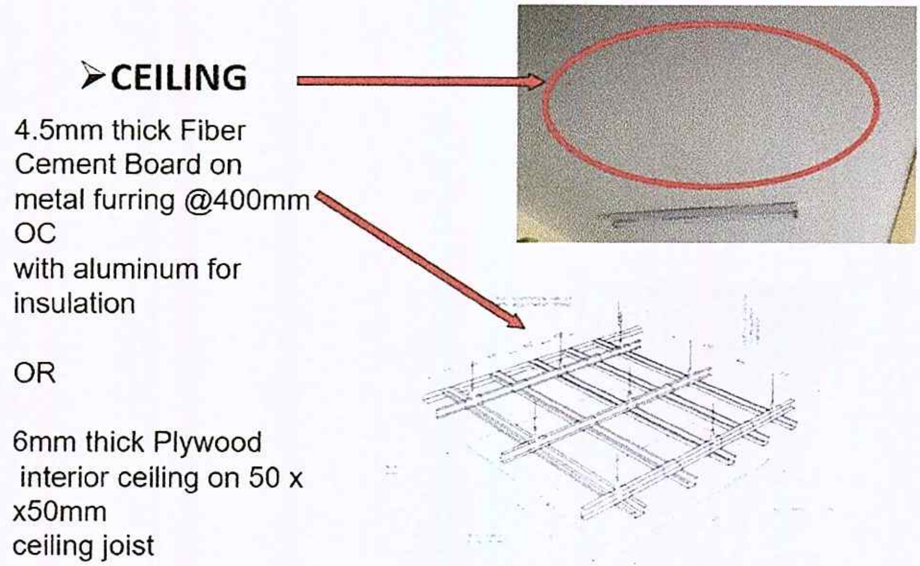


Figure 7. Ceiling Design for Disaster-Resilient School Building

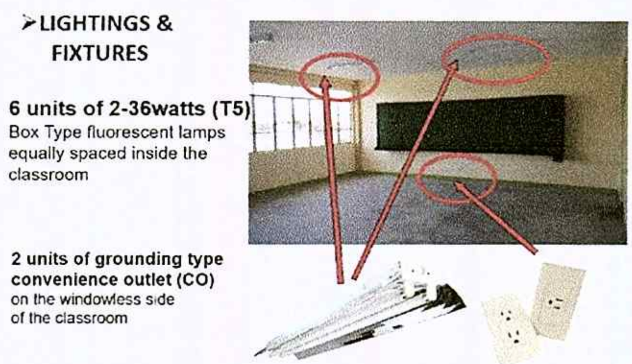


Figure 8. Lightings and Fixtures of Disaster-Resilient School Buildings

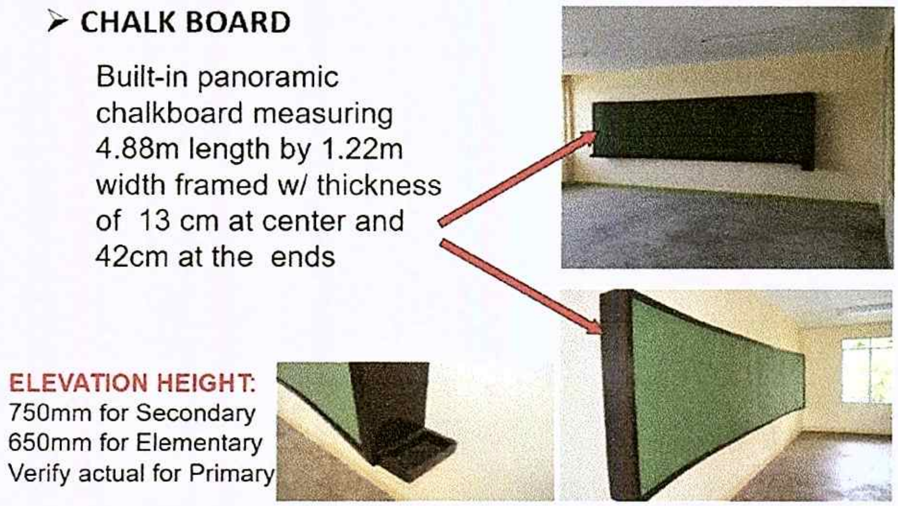


Figure 9. Chalkboard Design for Disaster-Resilient School Buildings

APPENDIX E

Summary of the Structural Components of Disaster-Resilient School Buildings

Structural Components	Design Specifications
Roofing Sheet	0.40mm thick, pre-painted long span corrugated GI roofing sheet
Roofing Frame	Truss Type
Purlins	LC-150x65x20x2.0mm purlins spaced @500mm OC
Sagrods	12mmØ sagrods
Cross Bracing	16mmØ cross bracing with standard turn buckle
Roof Connection	J-bolt
Beams	
Beam Size	250mm x 400mm Rebars: Ø16mm
Columns	
Size and Rebars	350mm x 350mm Rebars: Ø16mm
Tie Beam	
Size and Rebars	250mm x 400mm Rebars: Ø16mm Bar
Footing	
Size and Rebars	1200mm x 1200mm Rebars: Ø16mm Bar

APPENDIX F

Maps Showing Vulnerability of Provinces in the Philippines to Disasters

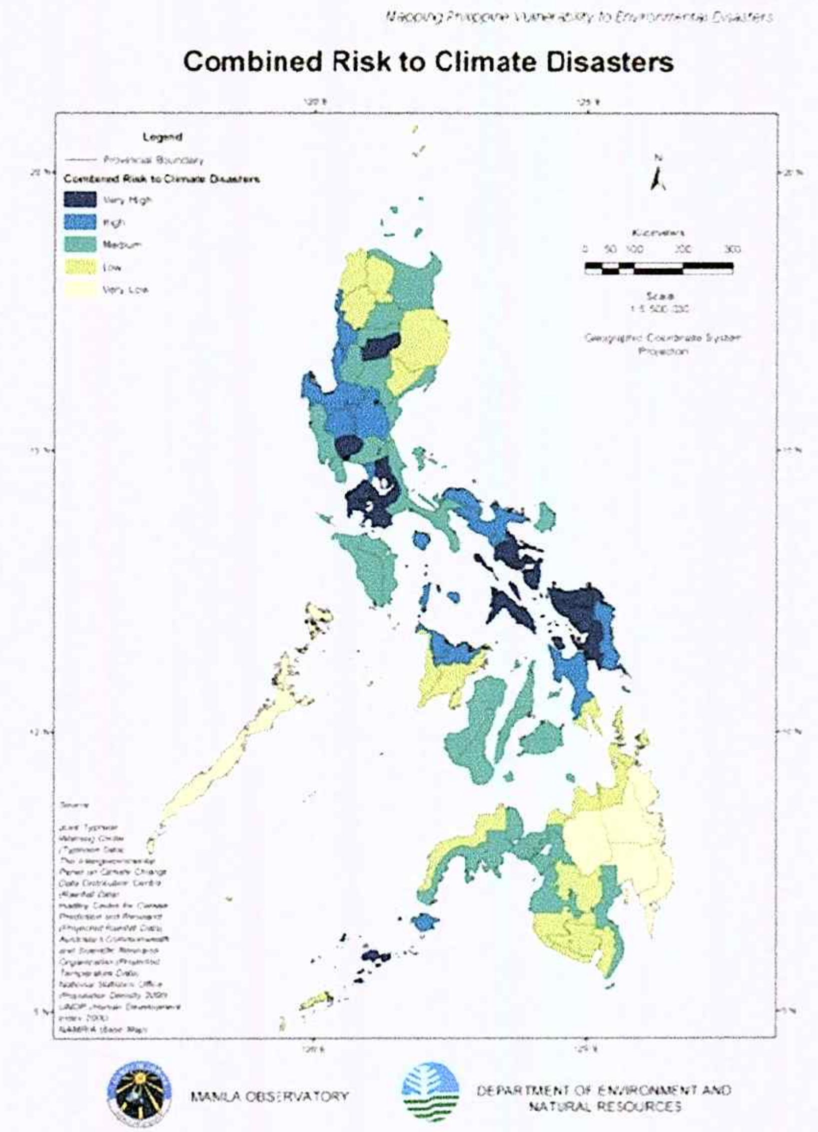


Figure 1. Combined Risk to Climate Disasters of Provinces in the Philippines

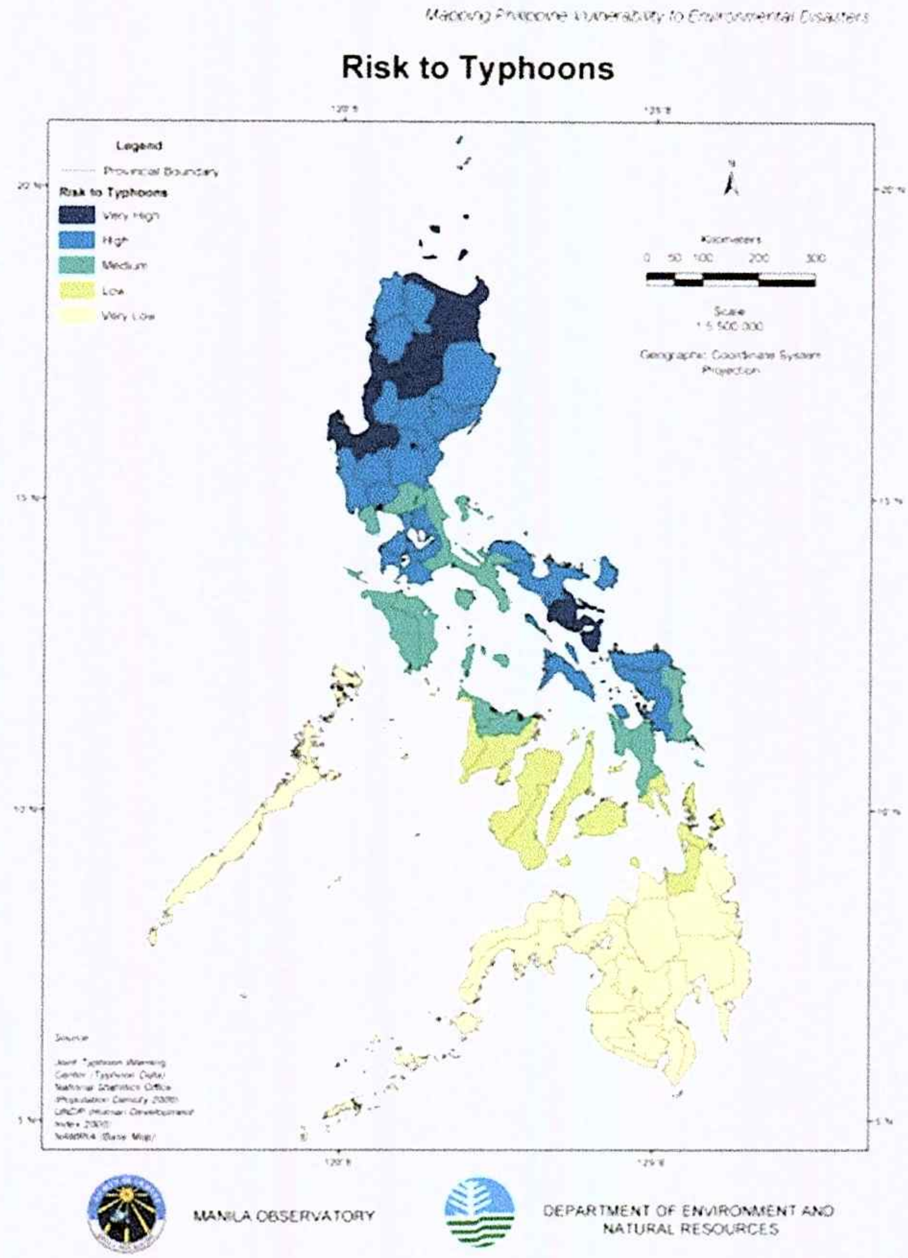


Figure 2. Risk to Typhoons of Selected Provinces in the Philippines

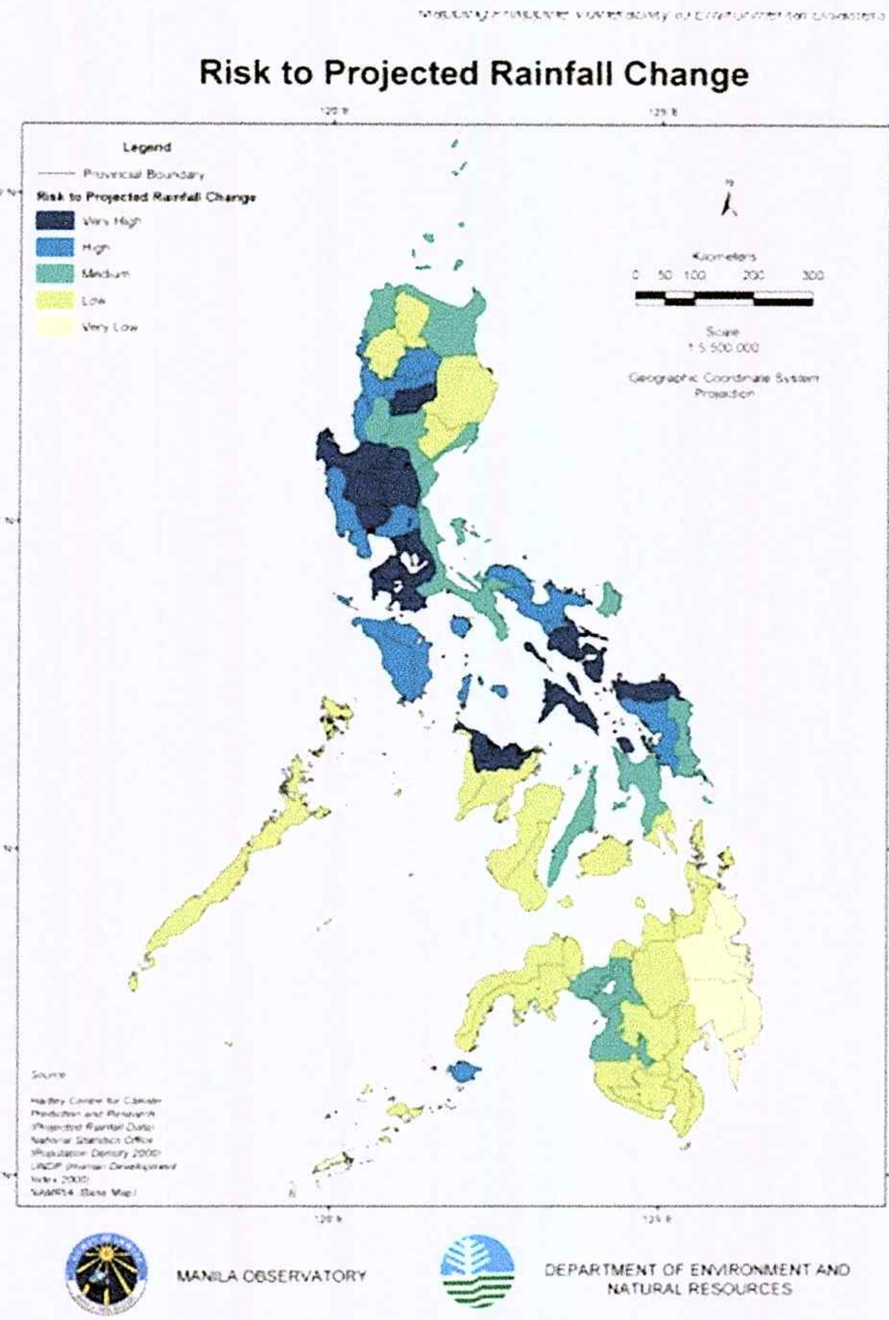


Figure 3. Risk to Typhoons of Selected Provinces in the Philippines

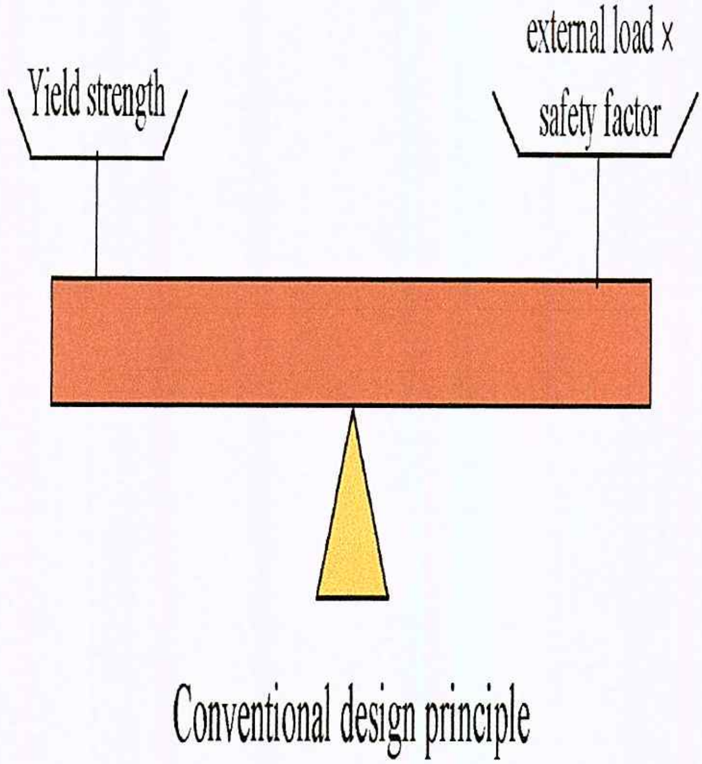
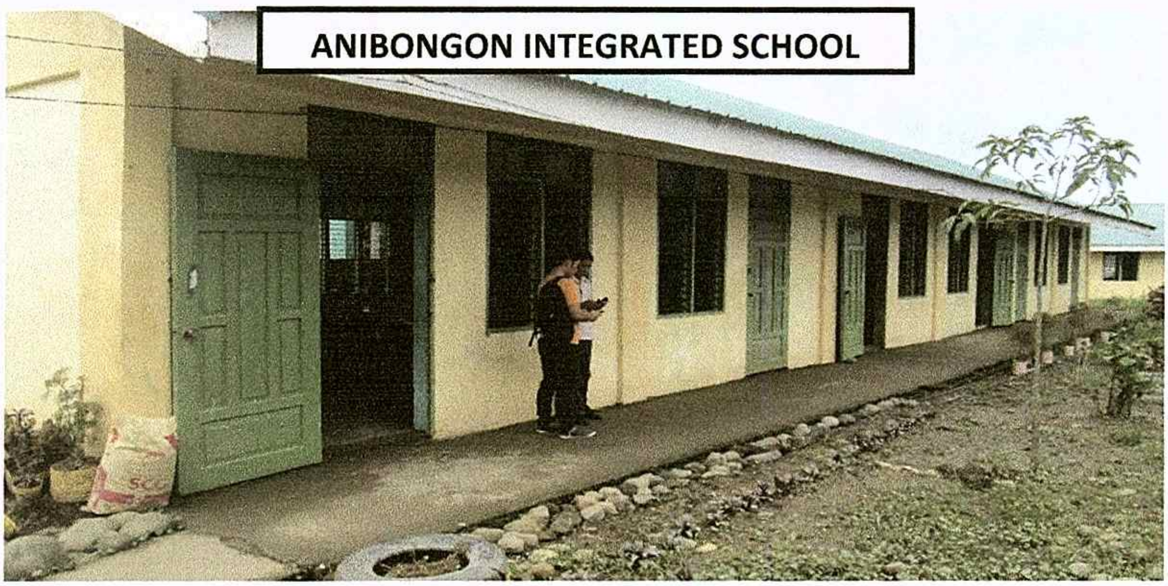


Figure 4. Conventional Design Principle

APPENDIX G

Pictures of Buildings of the Different Secondary Schools of the Second District of Samar including the Five Districts of Catbalogan City.



Building 1

Building 2

Building 3

Anibongon Integrated School (AIS) campus is prone to flood

AIS campus is prone to flood

AIS campus is prone to flood.

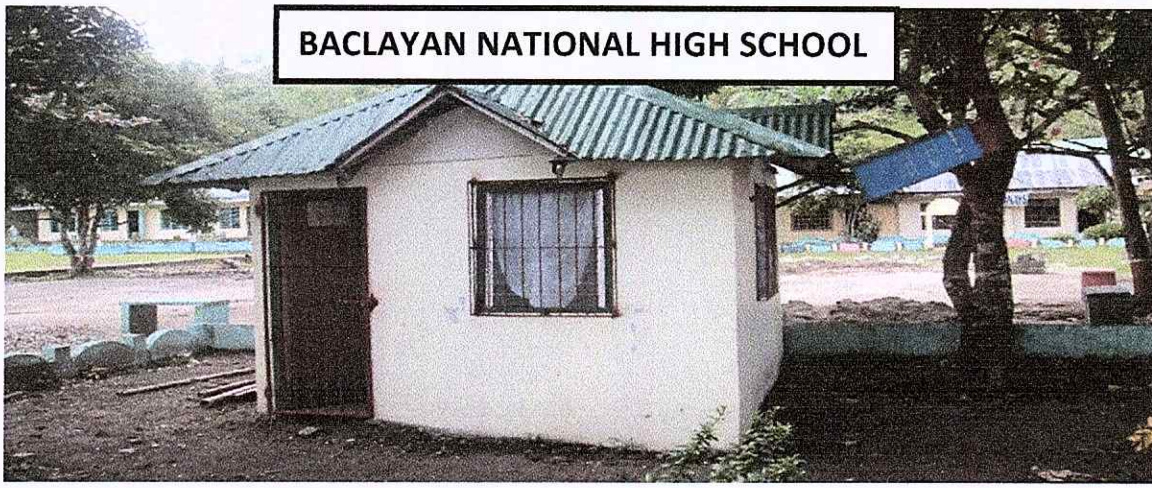
AIS campus is prone to flood

AIS campus is prone to flood.

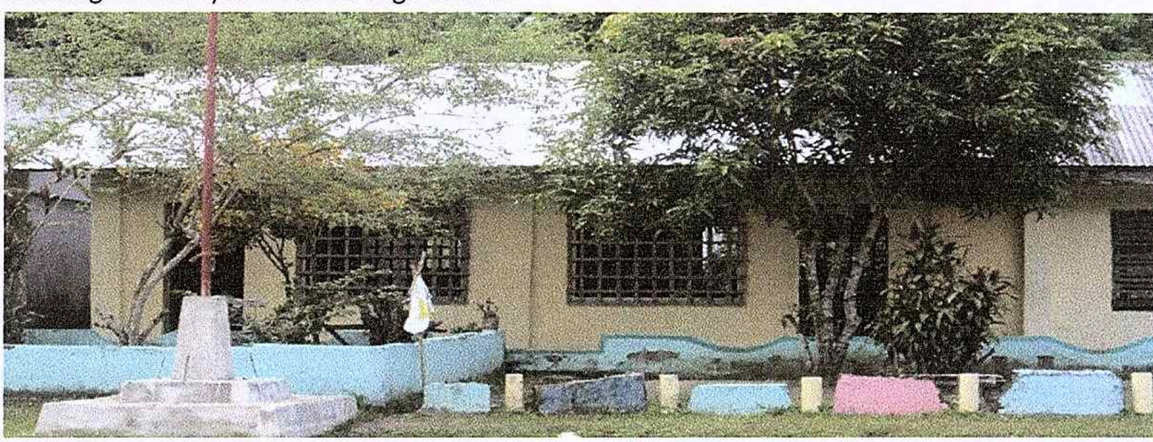
AIS campus is flood prone

AIS campus is low laying.

BACLAYAN NATIONAL HIGH SCHOOL



Building 1. Baclayan National High School



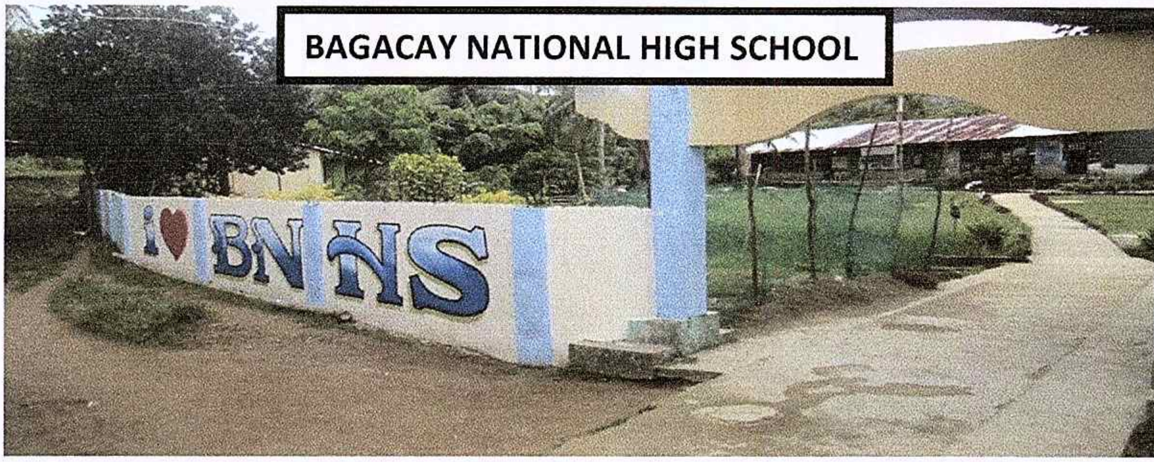
Building 2

Building 3.

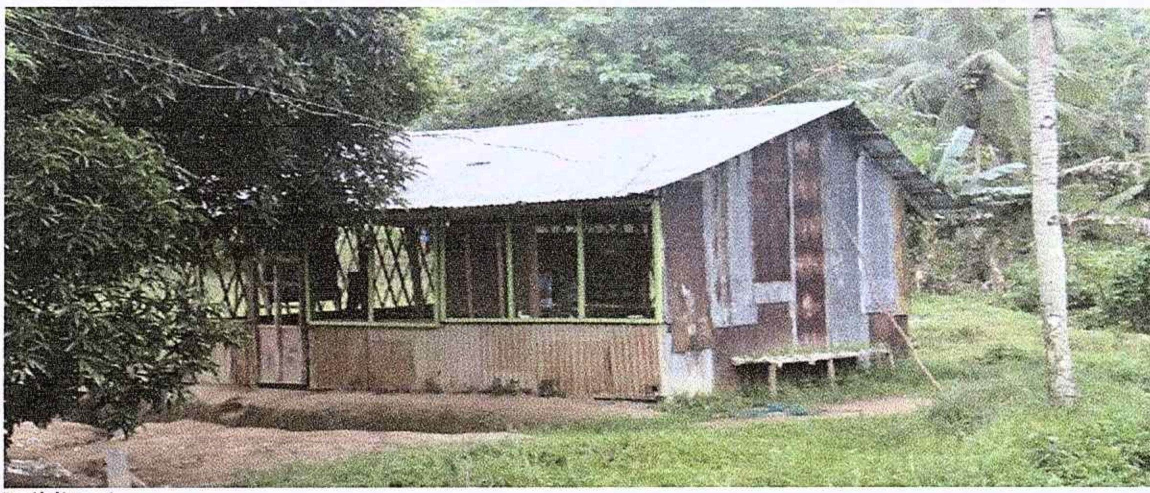
Building 4

Building 5

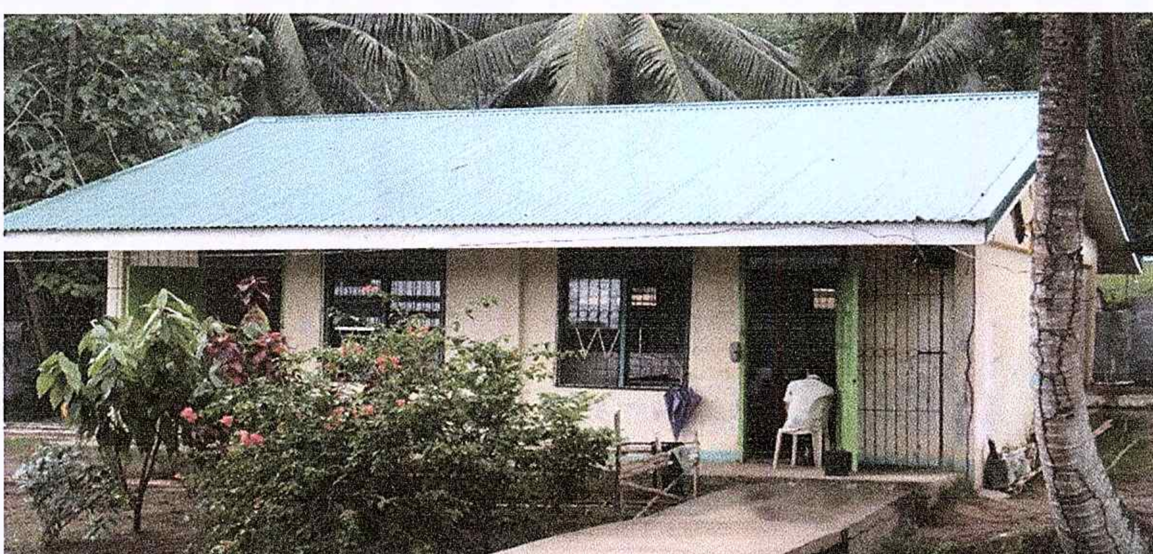
Building 6



Main Entrance to Bagacay National High School



Building 1

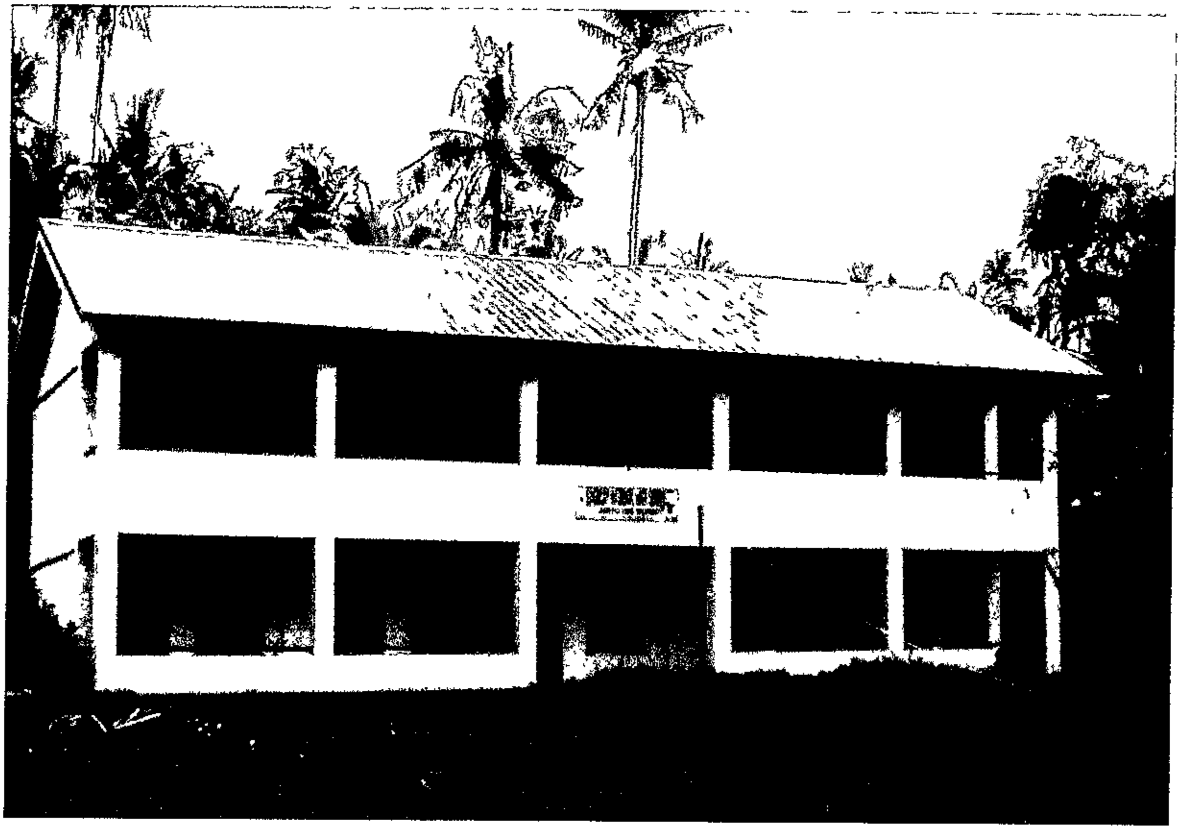


Building 2

Building 3

Building 4

Building 5



Building 6

BAKHAW NATIONAL HIGH SCHOOL

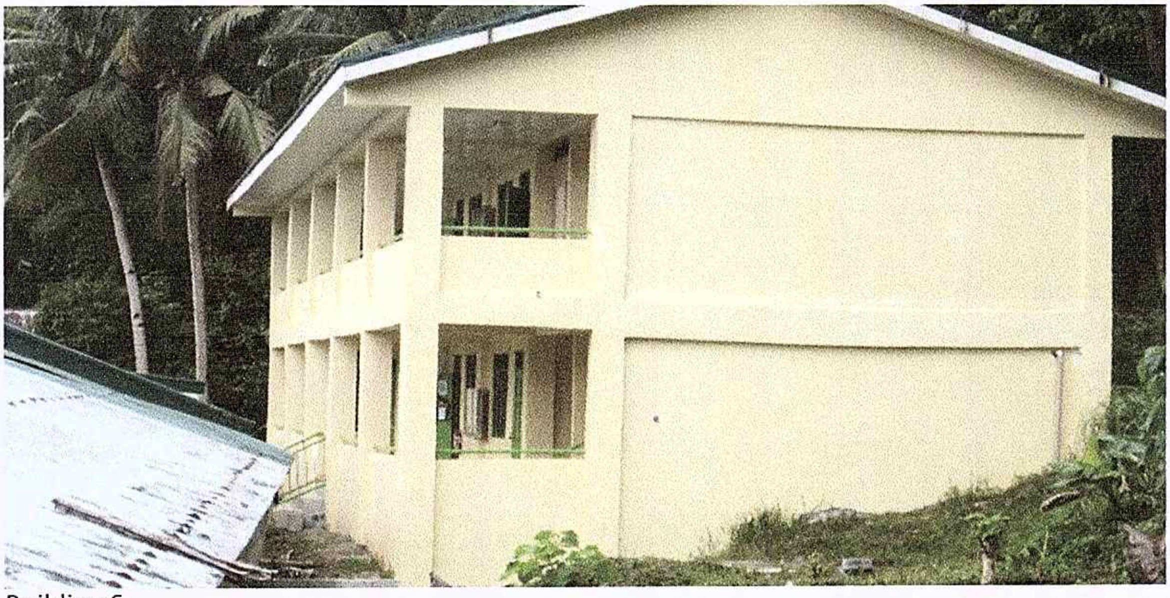
Building 1. Bakhaw National High School

Building 2

Building 3

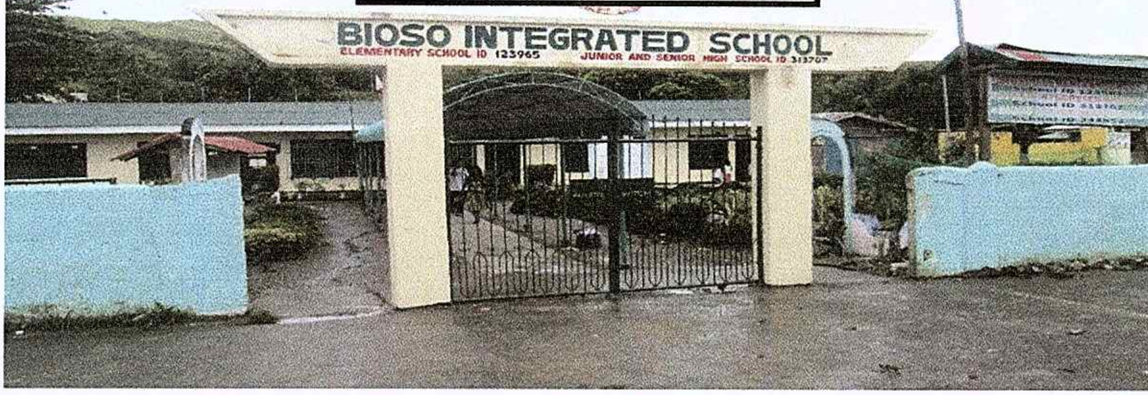
Building 4

Building 5



Building 6

BIOSO INTEGRATED SCHOOL



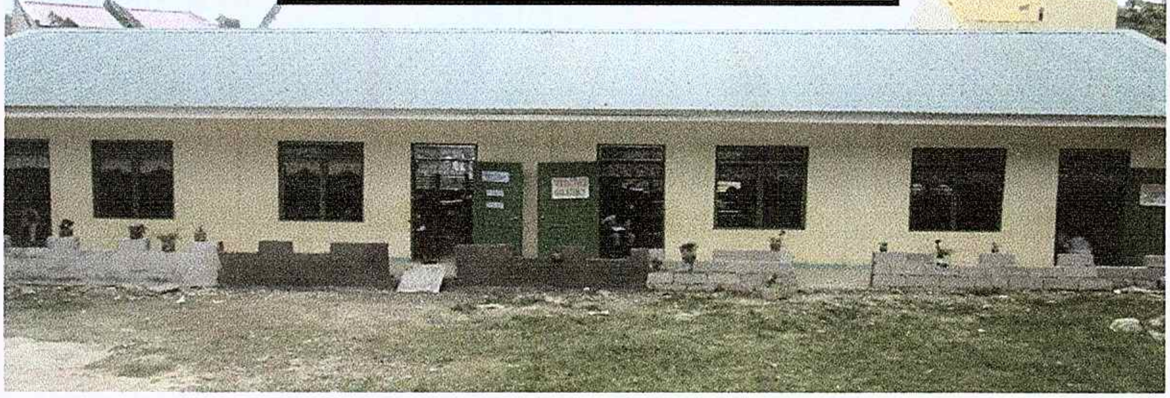
Main Entrance to Bioso Integrated School

Building 1. SHB

Building 2. JHB

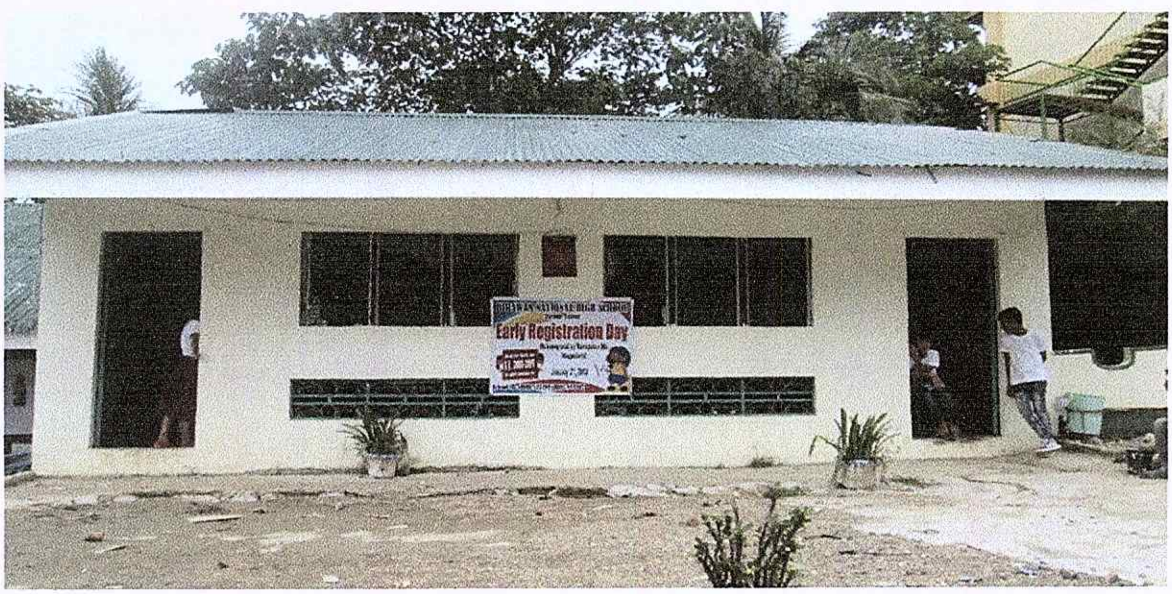
Building 3

BIRAWAN NATIONAL HIGH SCHOOL



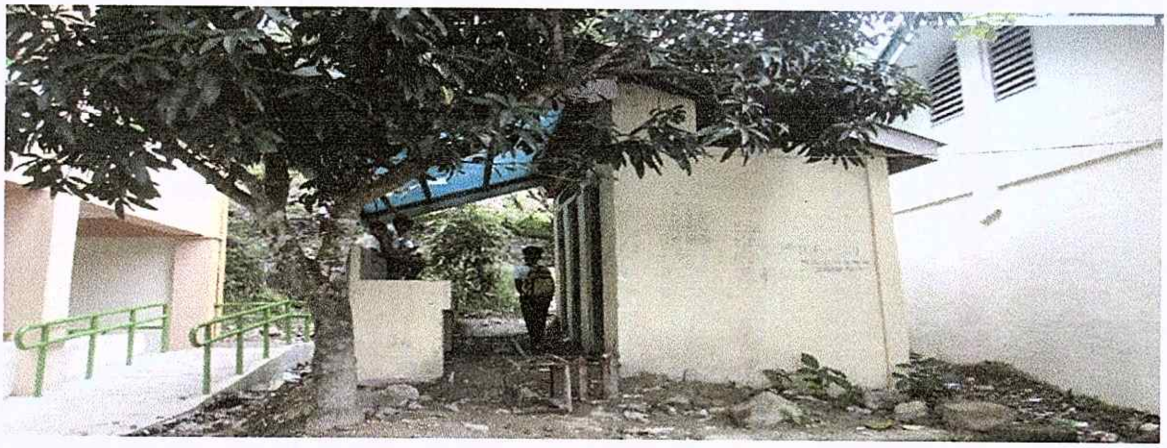
Building 1. Birawan National High School

Building 2



Building 3

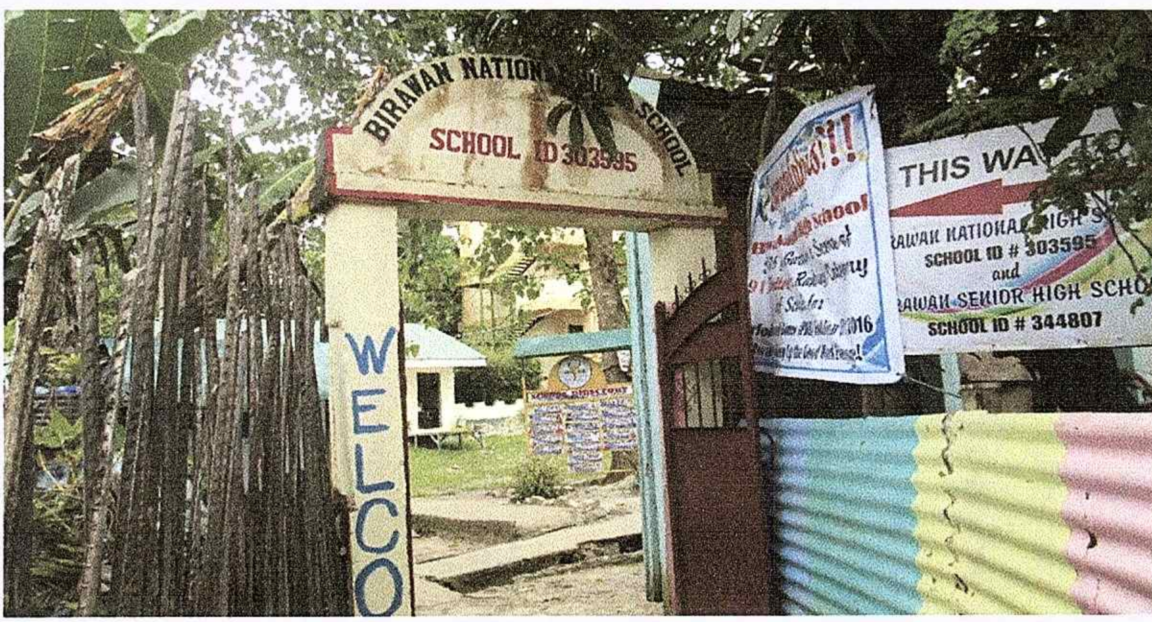
Building 4



Building 5

Building 6

Building 7



Main Entrance to BNHS.

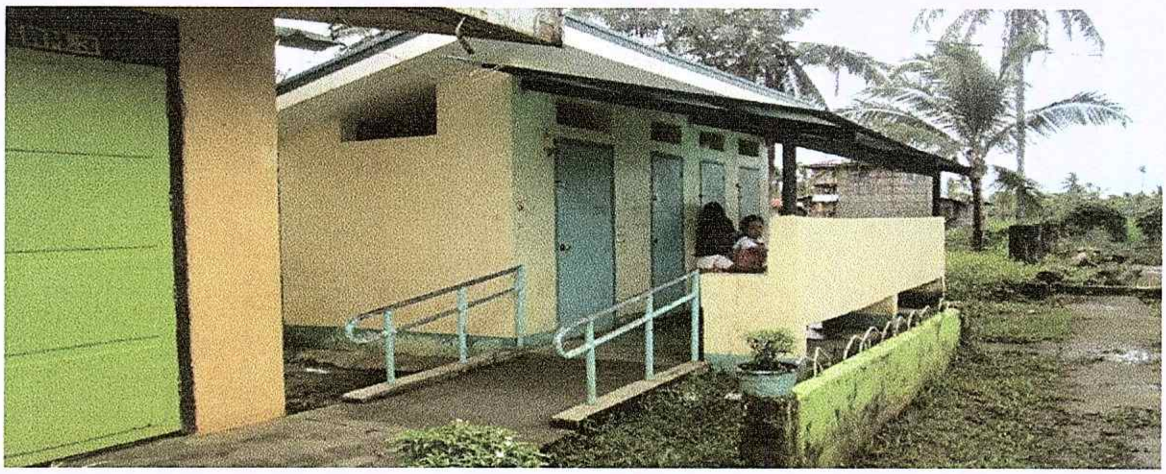
BURGOS INTEGRATED SCHOOL

The school entrance to Burgos Integrated School (BIS)

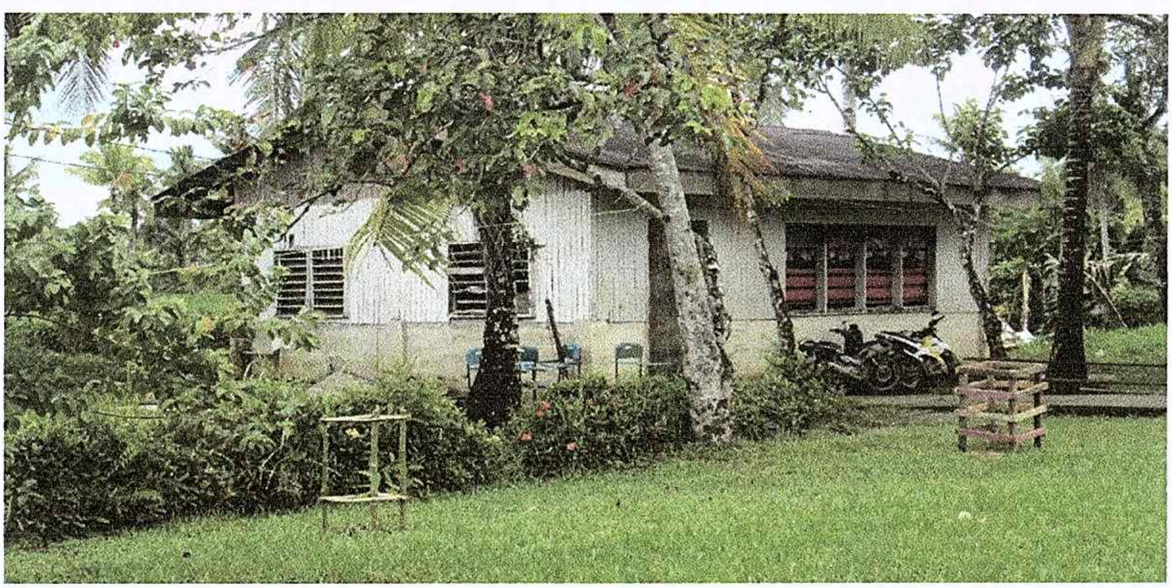
Building 1. The Administration Building

Building 2. The covered court

Building 3. The school stage



Building 4. Comfort Room



Building 5

Building 6. The school canteen

Building 7. Sr. High Building

Building 8

Building 9

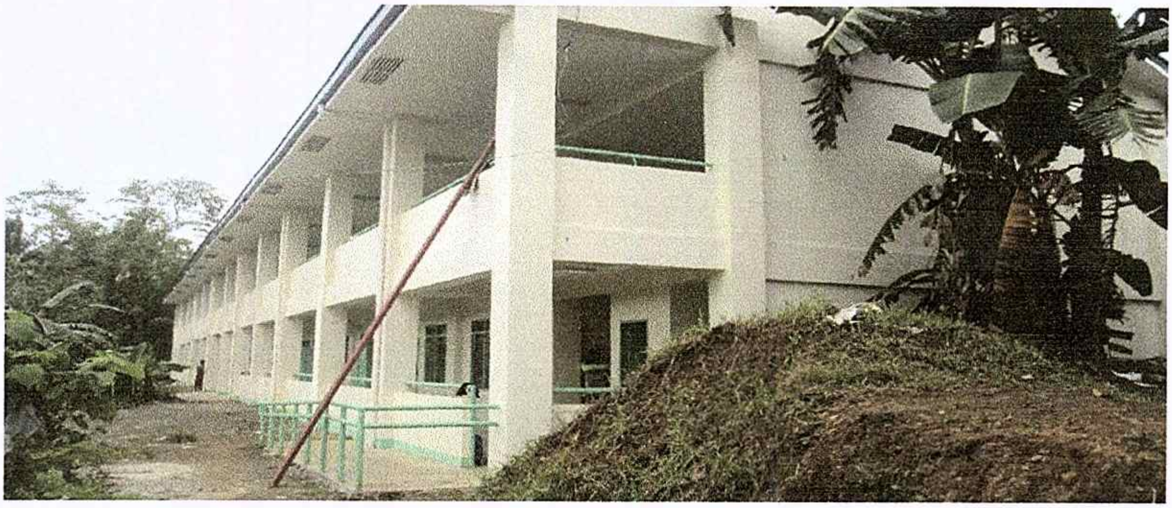
Building 9 and Building 10 left of Building 9

Building 10 (G9-Lake) right of Building 11 and Building 12

Building 12

Building 13

Building 14

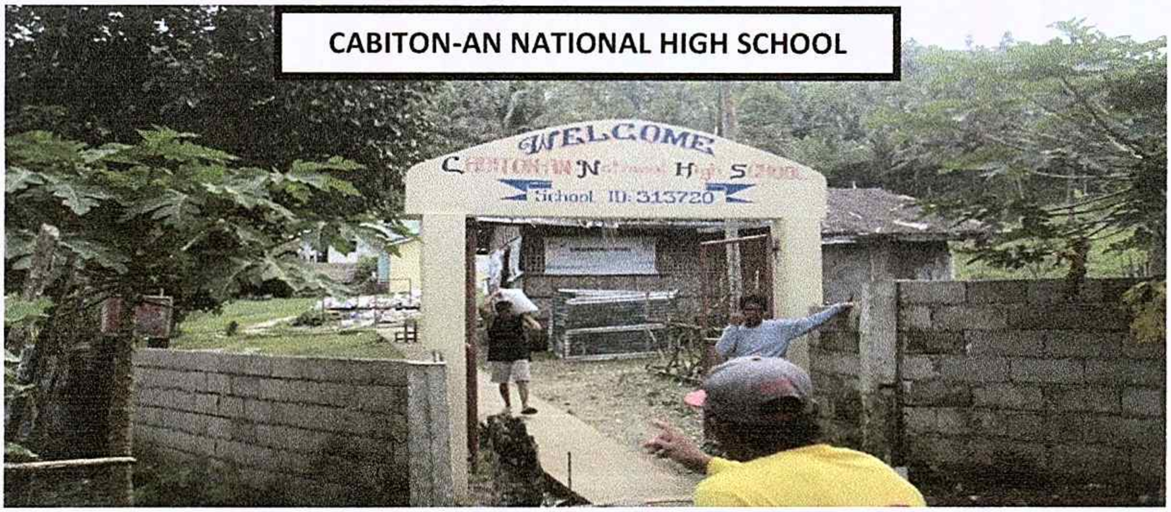


Building 15. Sr. High Building

A photo shot from Building 15 showing the BIS campus.

A photo shot from Building 15 showing from L-R: Building 14 & Building 13.

CABITON-AN NATIONAL HIGH SCHOOL

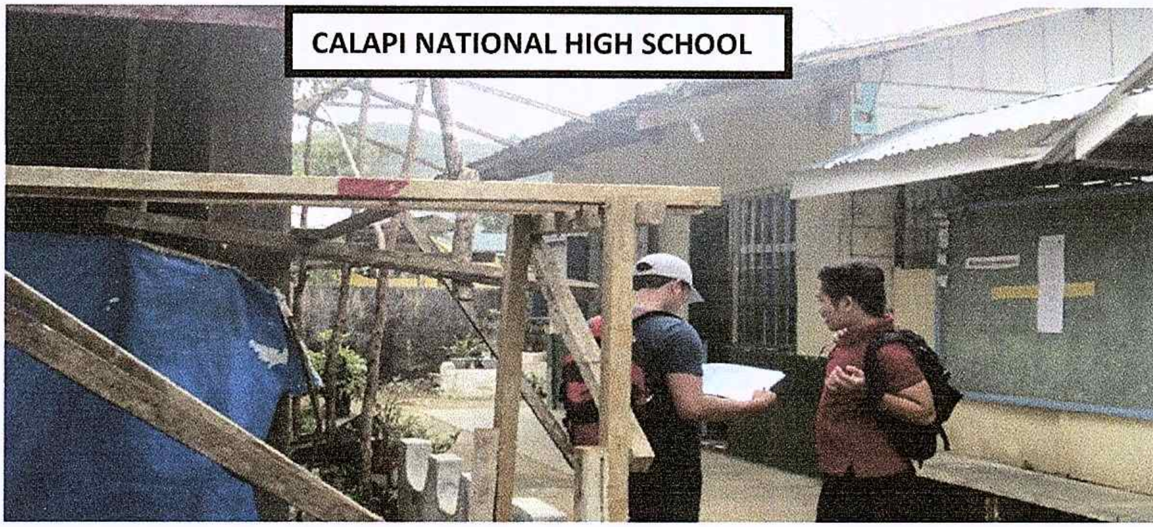


Entrance Gate to Cabiton-an National High School

Building 1

Building 2

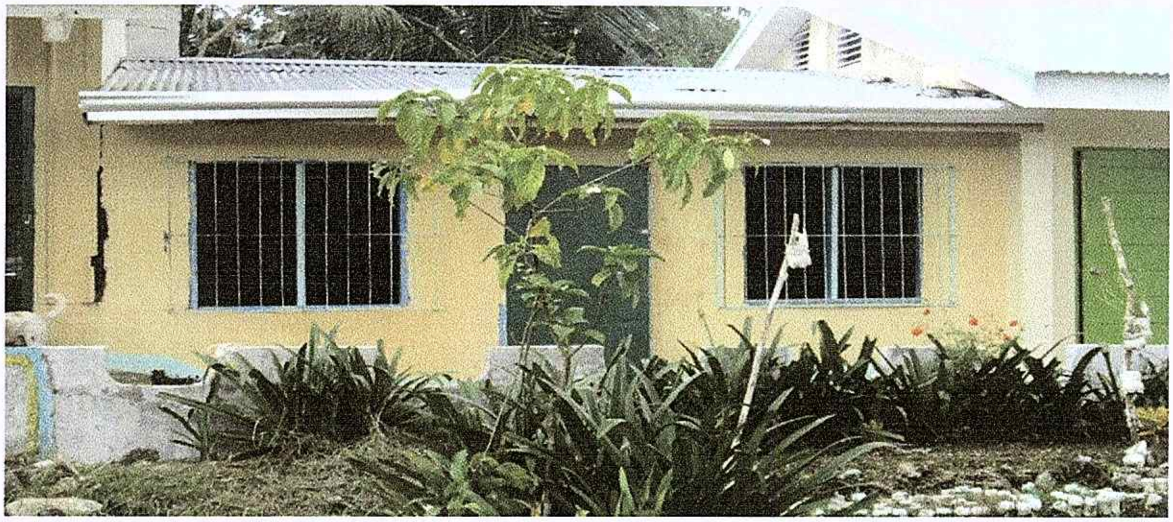
Building 3



Building 4. The Principal's Office

Building 5. The SBM Hub

Building 6



Building 7. Makeshift No. 1

Building 8

Building 9

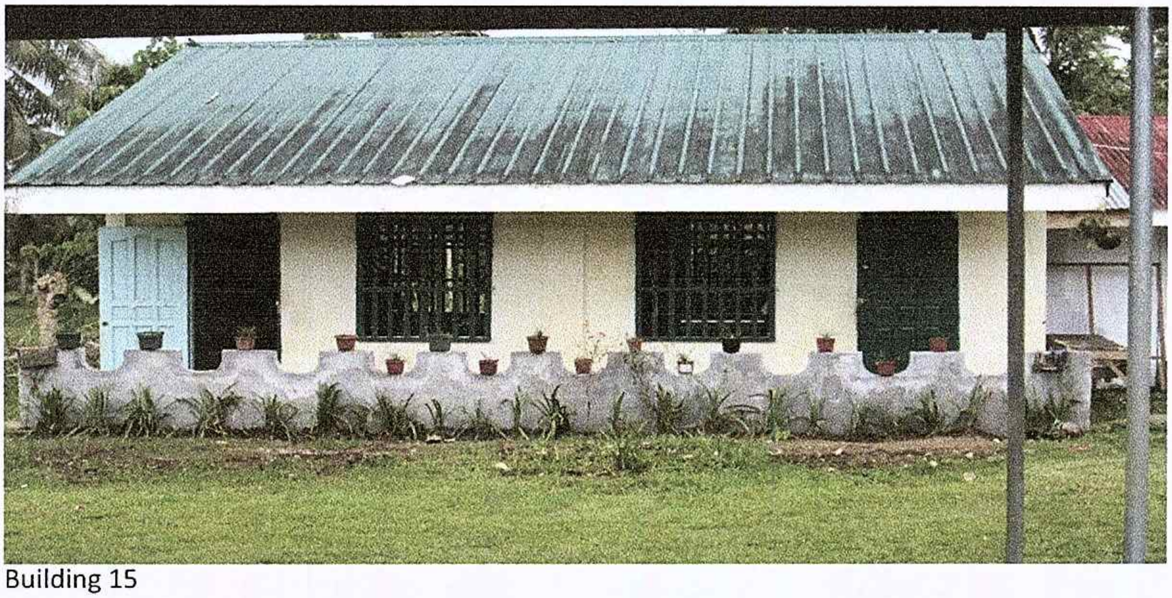
Building 10

Building 11

Building 12. Makeshift

Building 13. Sr. High Building

Building 14. Sr. High Building



Building 15

Building 16

Building 17. The comfort room.

Building 18

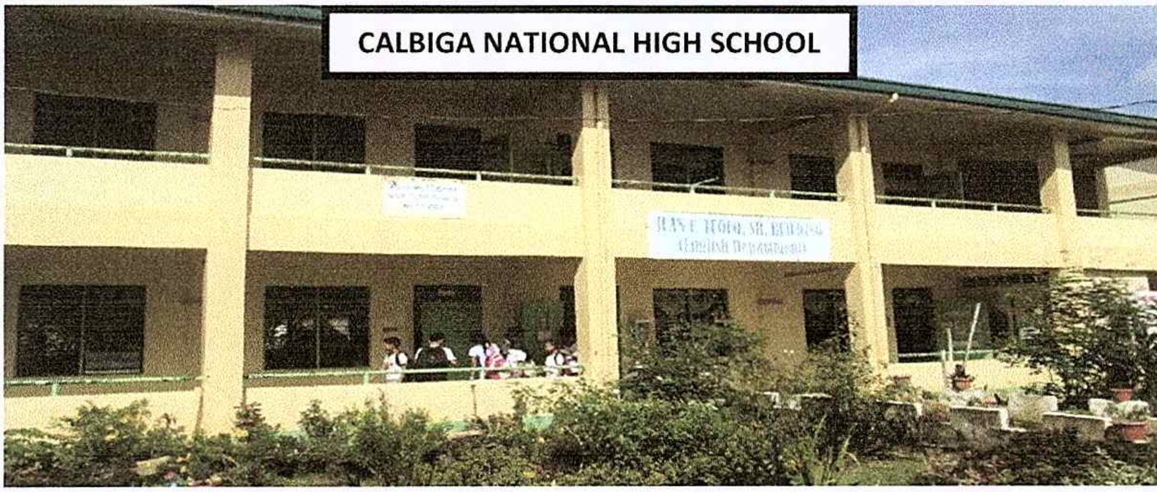
Building 19

Building 20.

Building 21. The guard house

Building 22. The on-going project

Building 23. The school stage



Building 1

Building 2

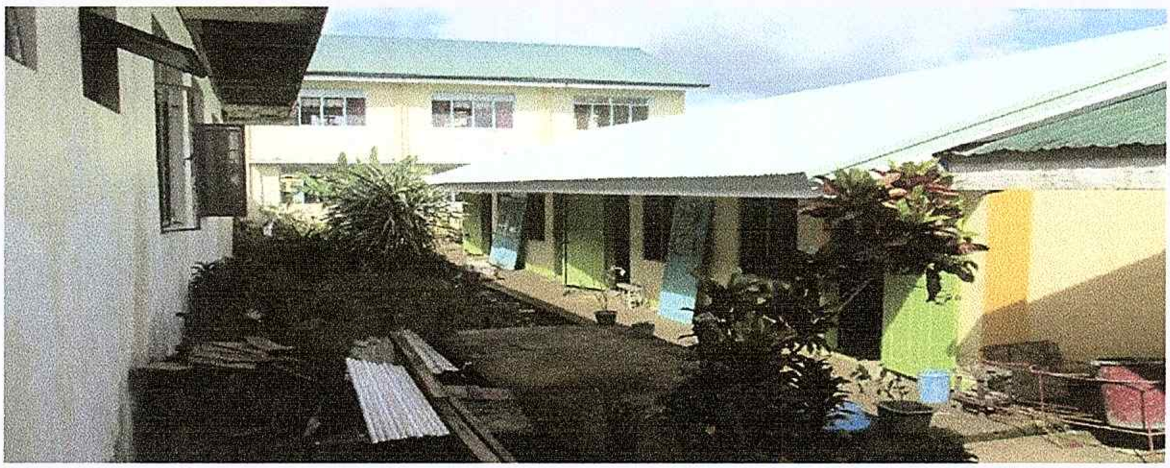
Building 3

Building 4

Building 5 the Canteen.

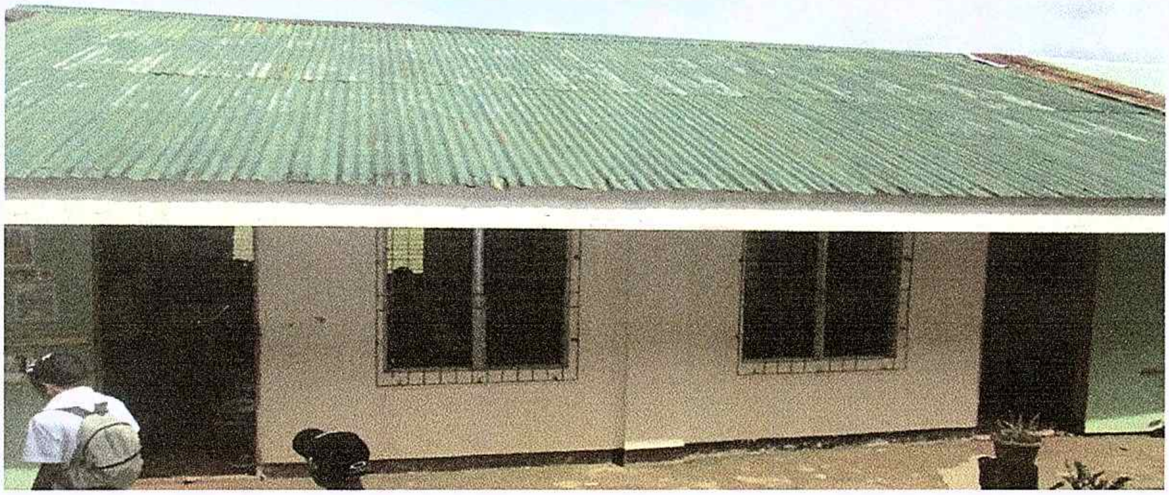
Shown in the picture is the wooden truss and wooden purlins as will as the ceiling of Building 5.

The window of Building 5.



Building 6

Behind Building 6 is a rice field.

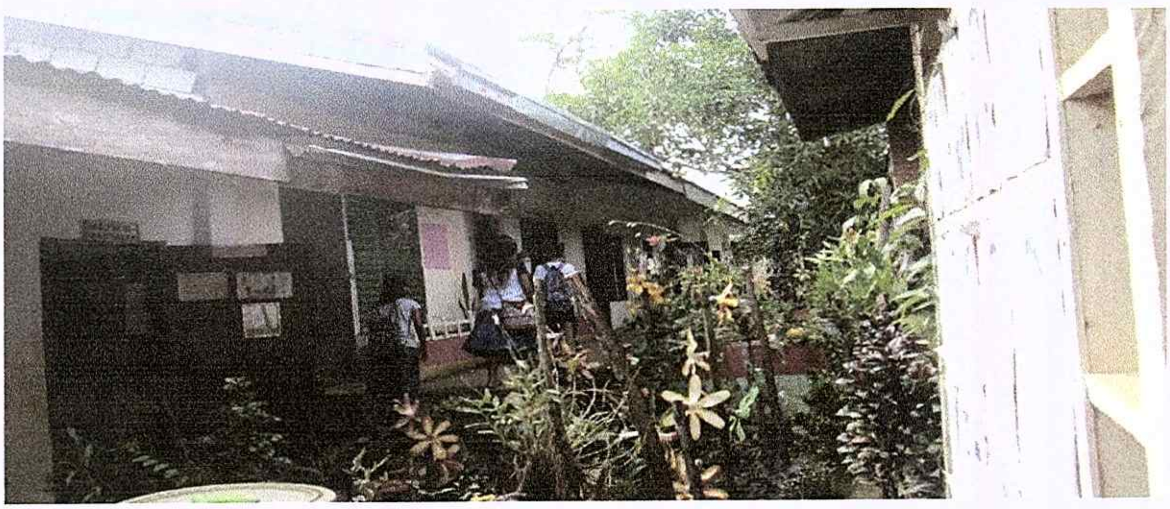


Building 7

Building 8

Building 9

Building 10



Building 11

Building 12

Building 13

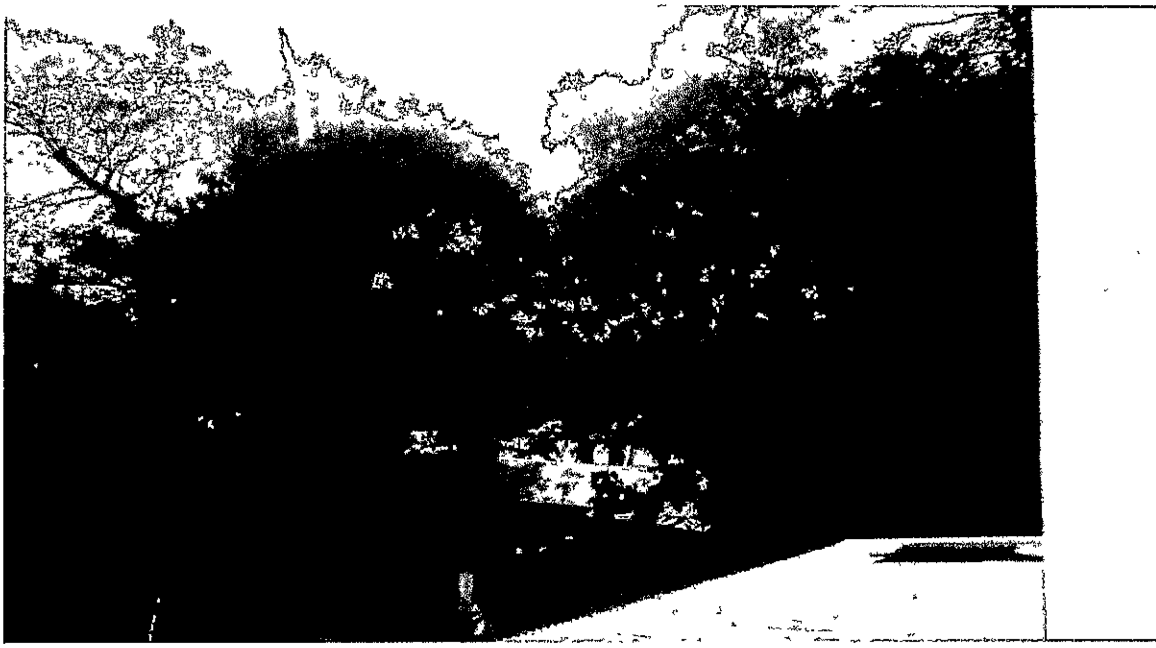
Building 14

Building 15

Front view of Building 16.

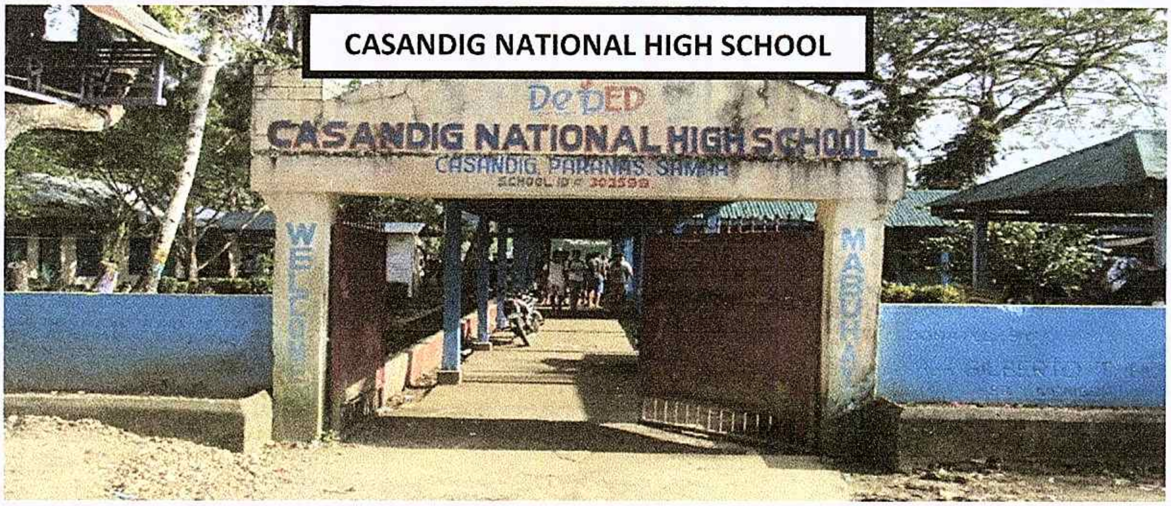
The hallway of Building 16 showing the opening at the front of the building.

Building 17



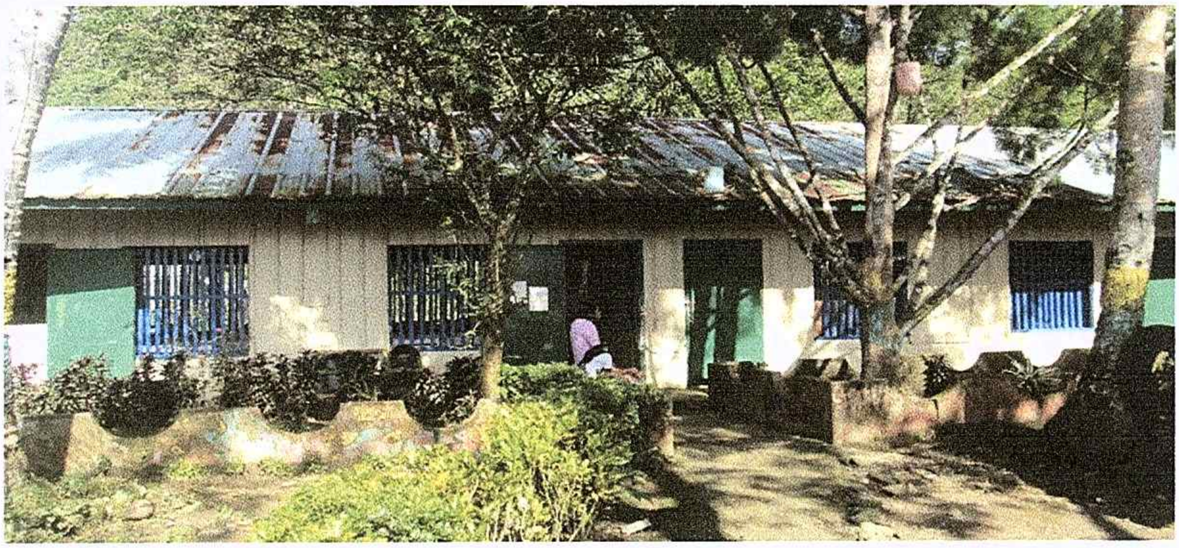
An overlooking shot from Building 17 showing the adjacent river.

CASANDIG NATIONAL HIGH SCHOOL



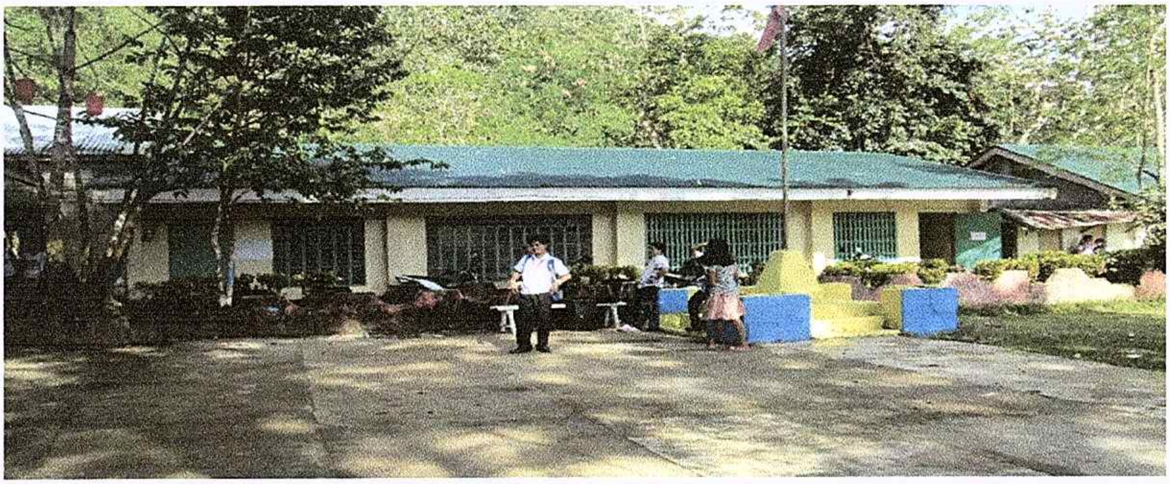
The main entrance of Casandig National High School (CNHS)

Building 2

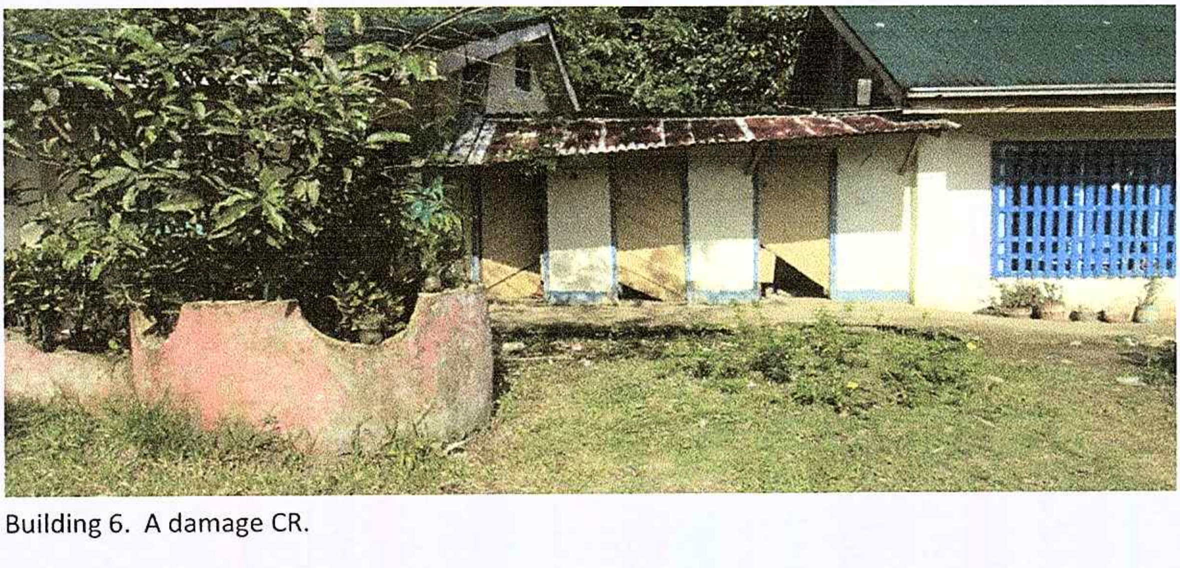


Building 3

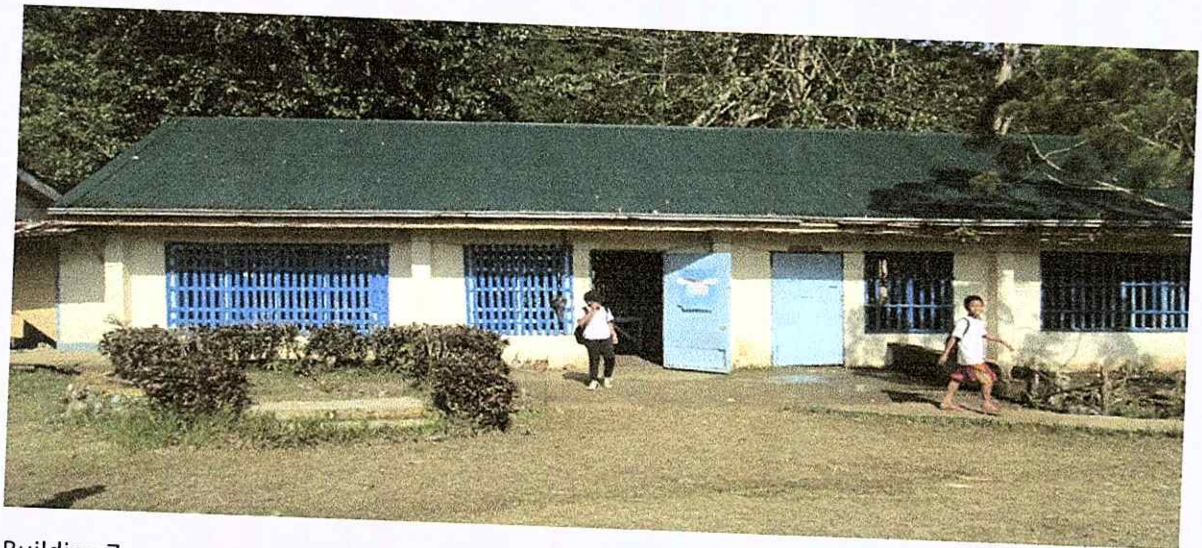
Building 4 is under construction with the students.



Building 5

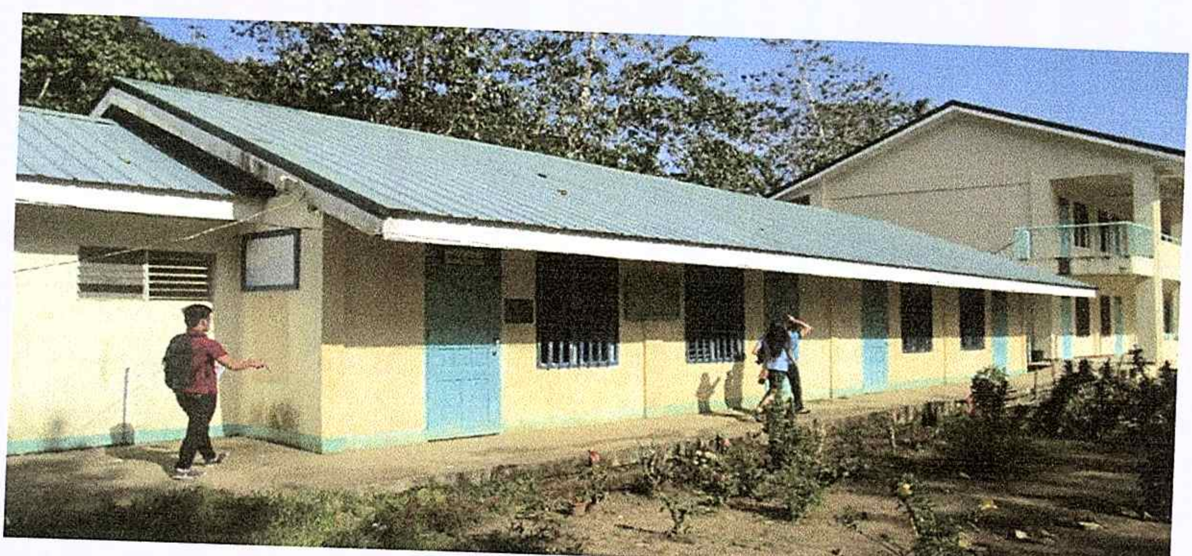


Building 6. A damage CR.



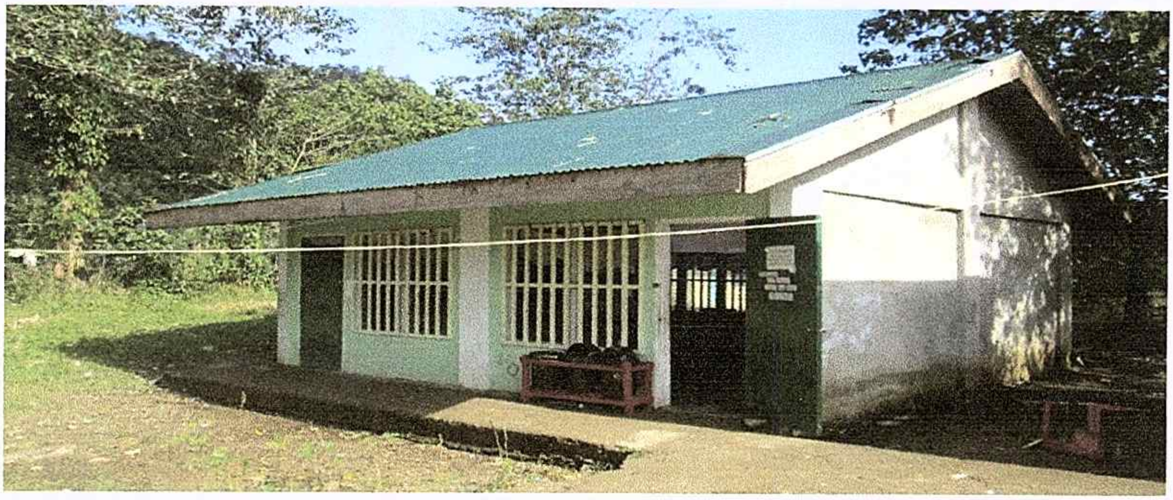
Building 7

Building 8. Comfort Room

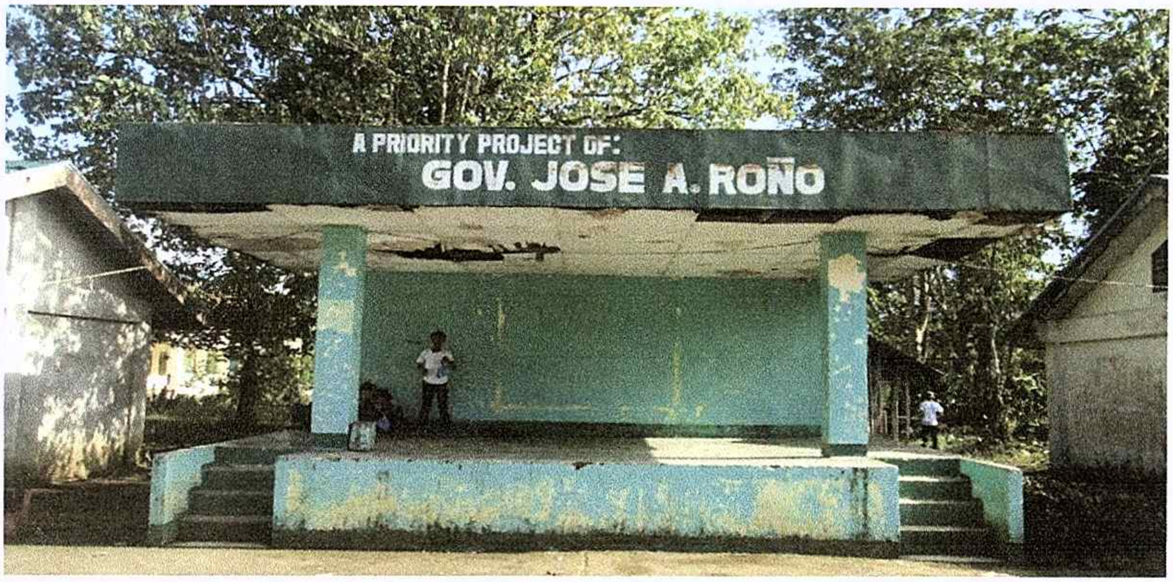


Building 9

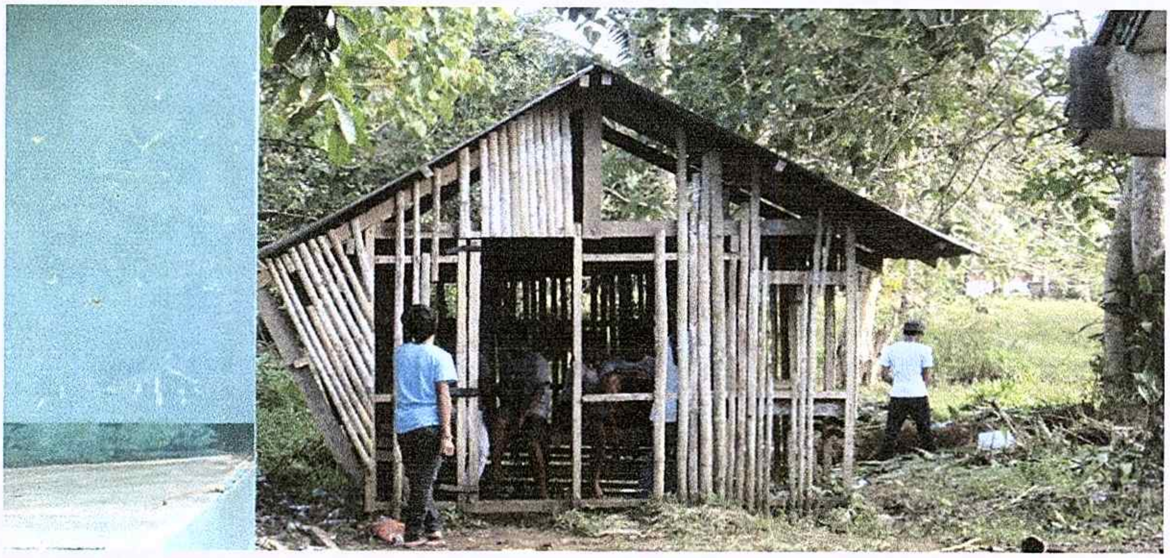
Building 10.



Building 11

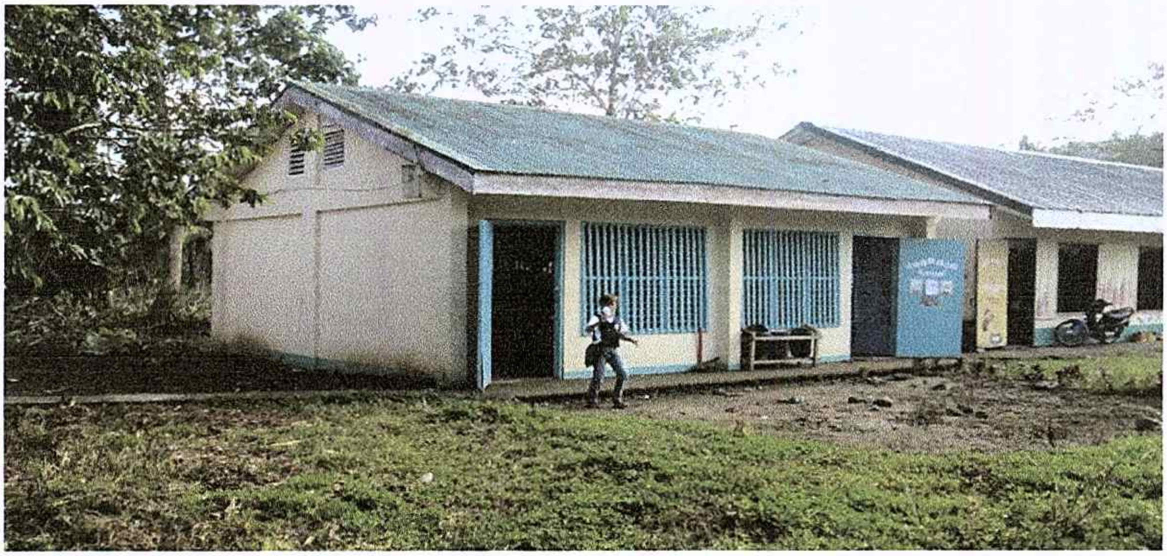


Building 12. The school stage.

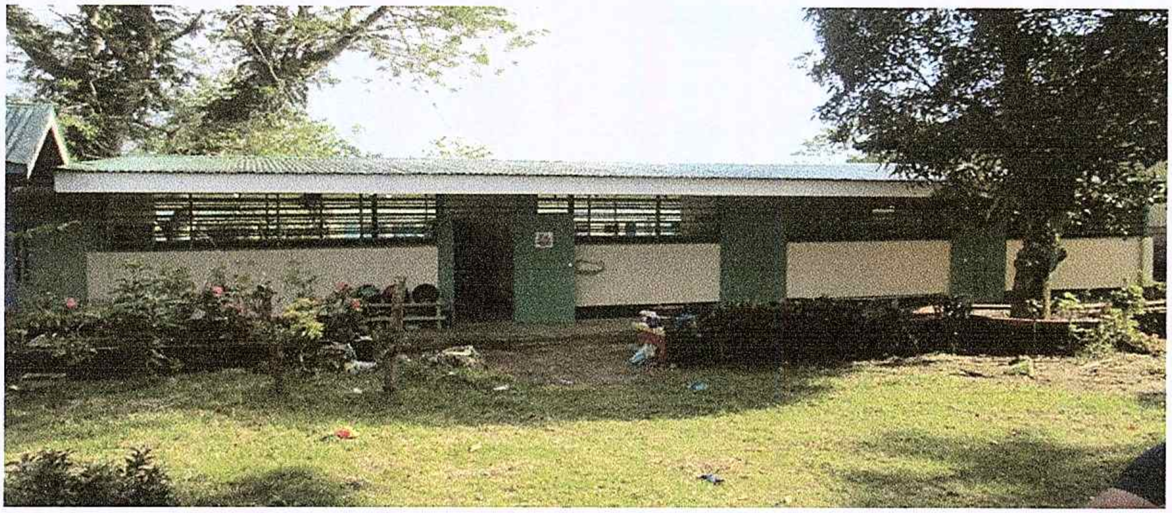


Building 13. Makeshift

Building 14.



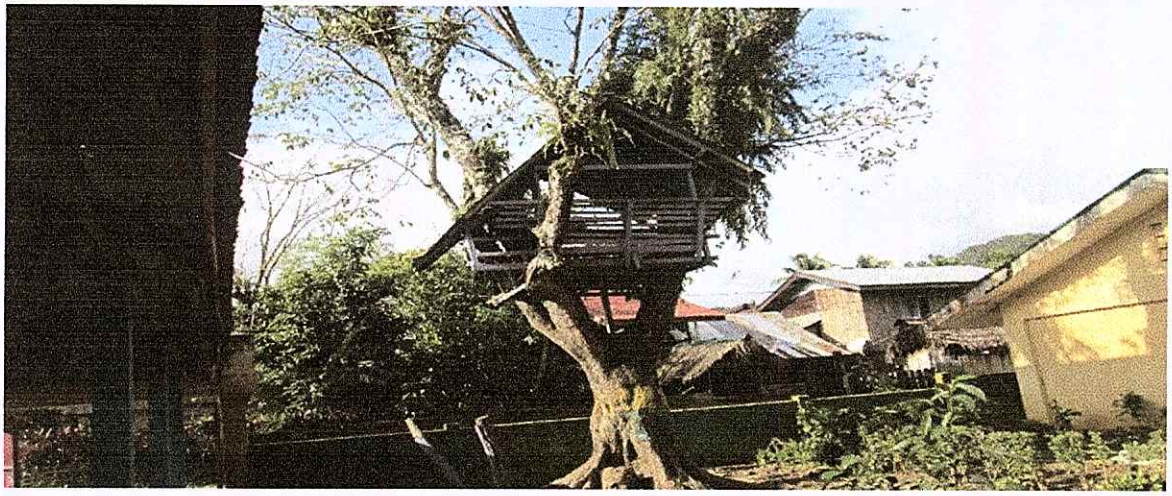
Building 15



Building 16

Building 17. The faculty room.

Building 18.

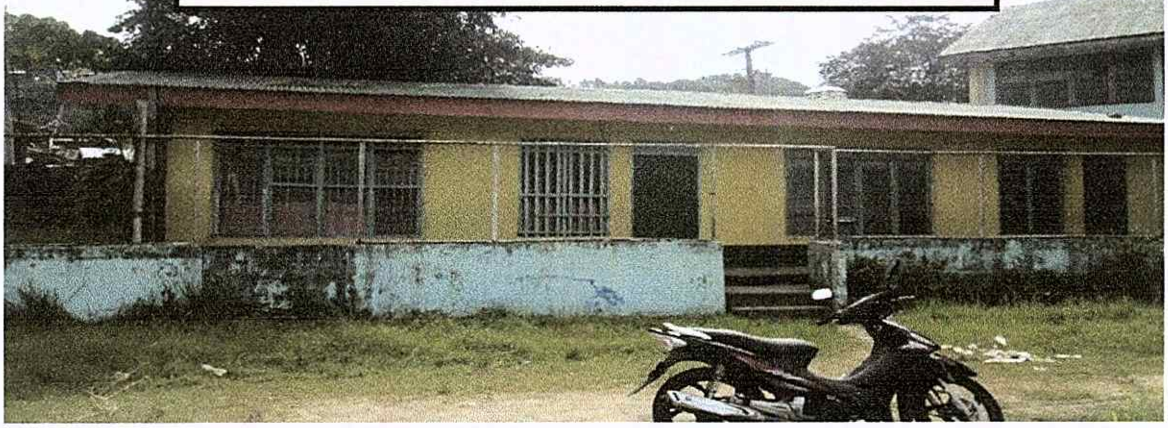


Building 1 in the site development plan is the tree house.

The school ground

Behind Building 9 and Building 10.

CATBALOGAN II CENTRAL ELEMENTARY SCHOOL



Building 1

Building 2

Building 3

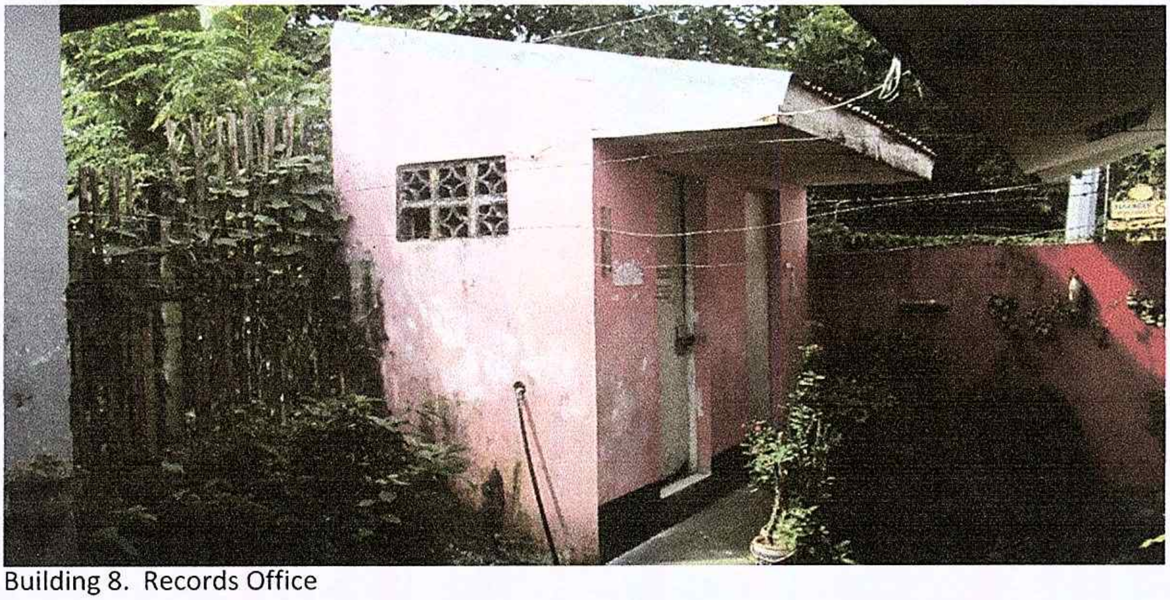
Building 4. Canteen

Building 4. The Principal's Office

Building 5

Building 7

Building 6. Comfort Room



Building 8. Records Office

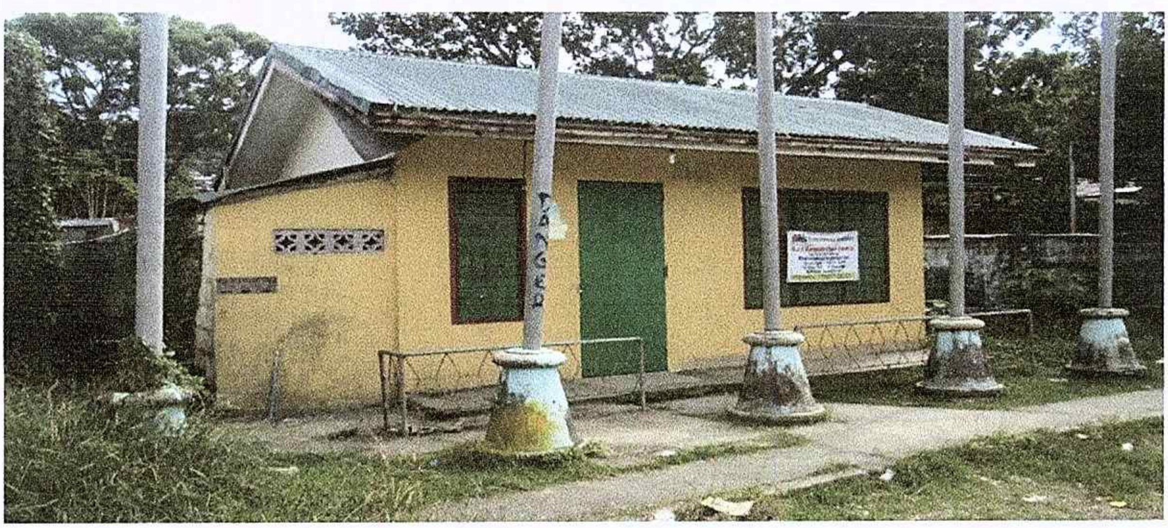
Building 9. The school stage.

Building 10

Building 11

Building 12. Comfort Room

Building 13



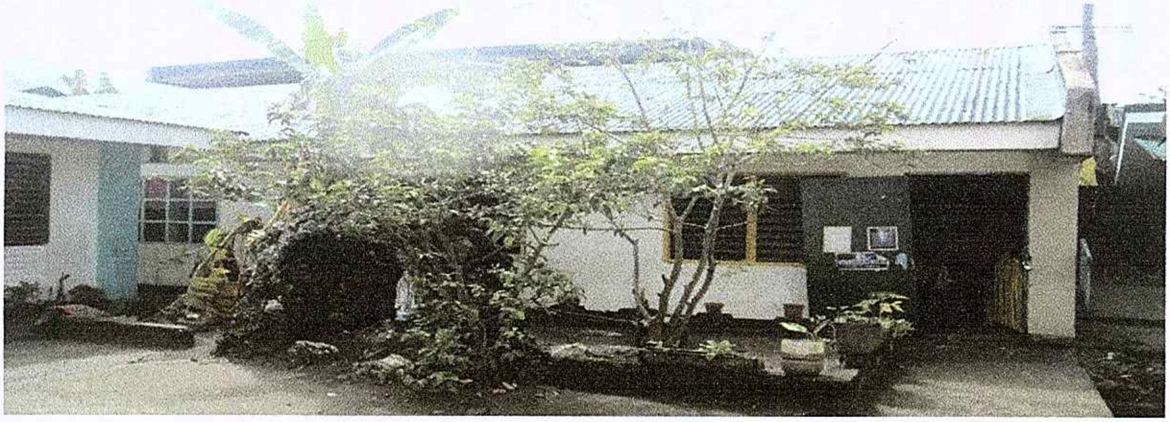
Building 14

CATBALOGAN III CENTRAL ELEMENTARY SCHOOL

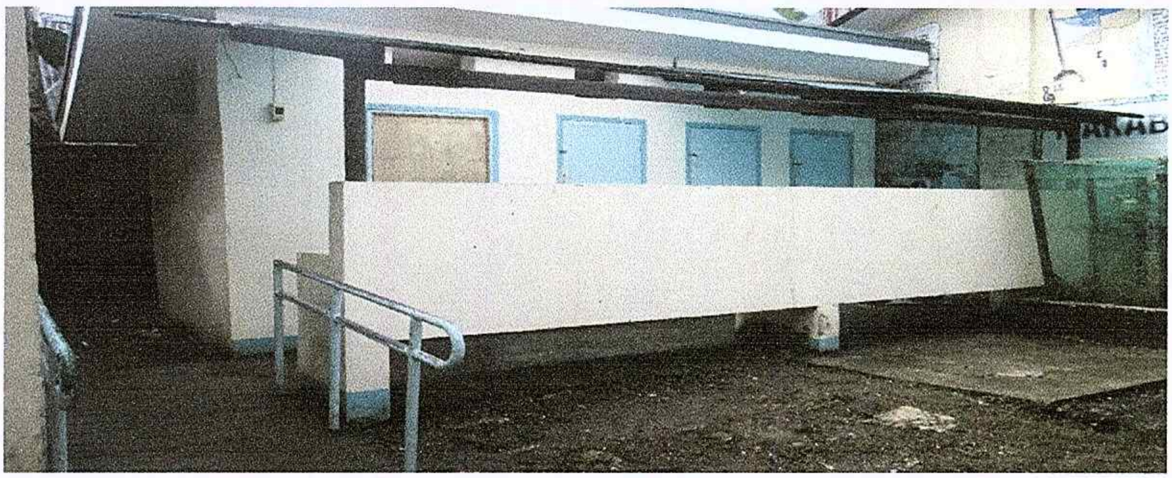
Building 1. Guard House

Building 2. Canteen

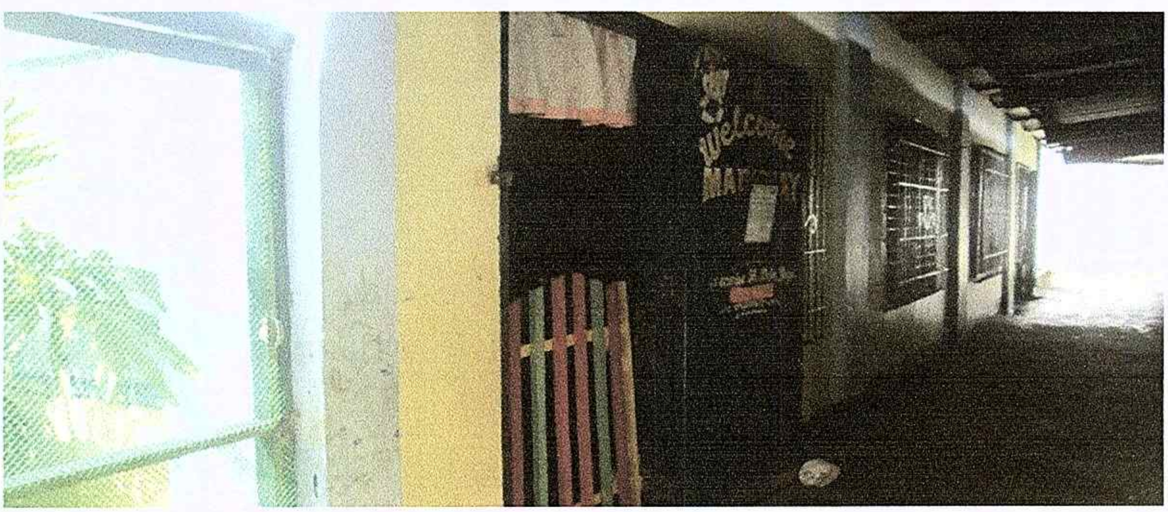
Building 3. Classroom



Building 4. Classroom



Building 5. Comfort Room



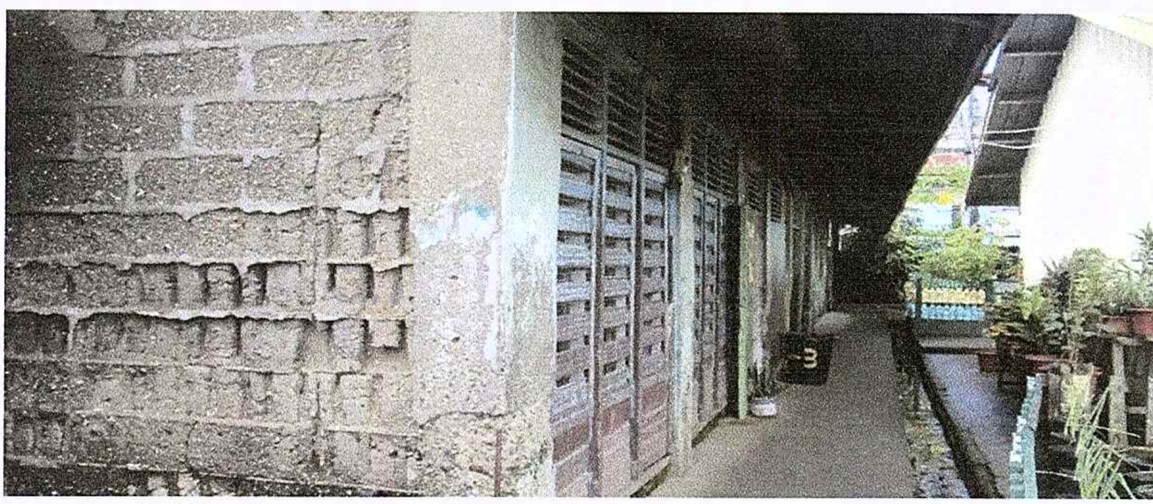
Building 6. Classroom

Building 7. Comfort Room

Building 8. Classroom

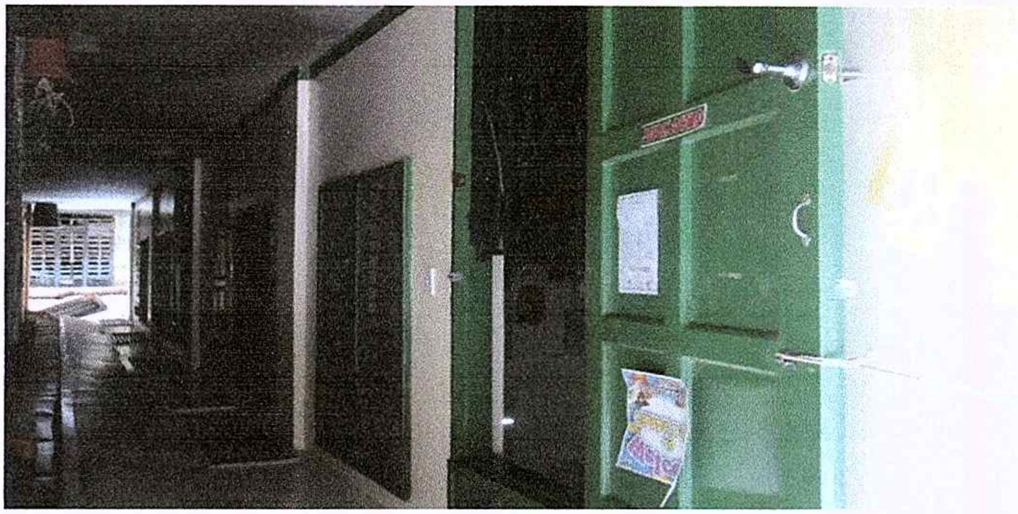
Building 9. Comfort Room

Building 10. Classroom



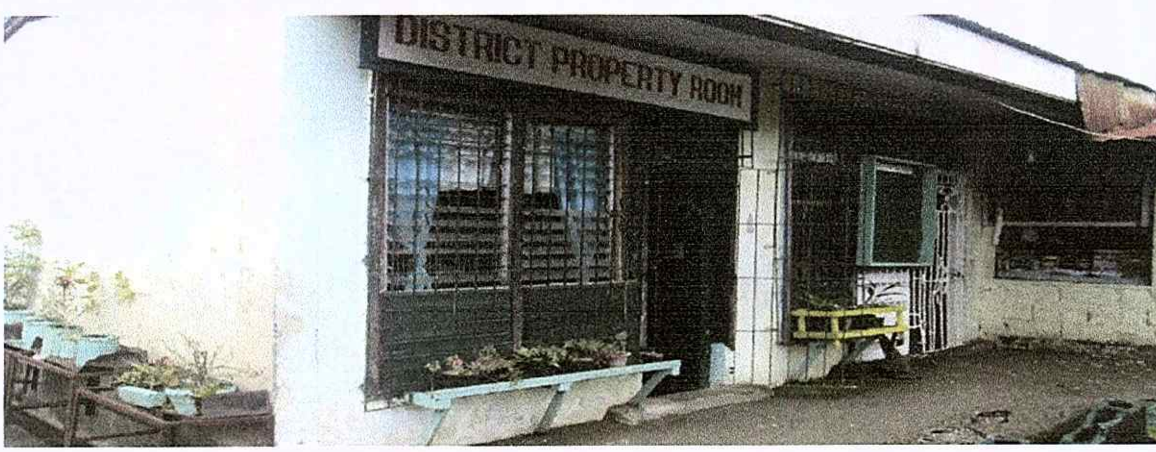
Building 11. Classroom

Building 12. Comfort Room



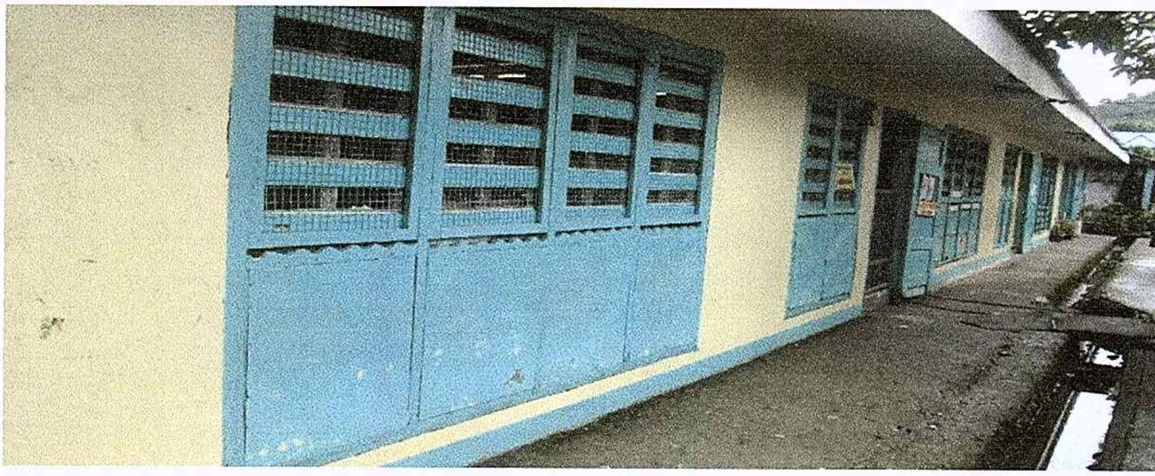
Building 13. Classroom

Building 14. Comfort Room



Building 15. Property Room

Building 16. Canteen



Building 17. Classroom

Building 18. Guidance Office

Building 19. Classroom

Building 20. Classroom

Building 21. Classroom

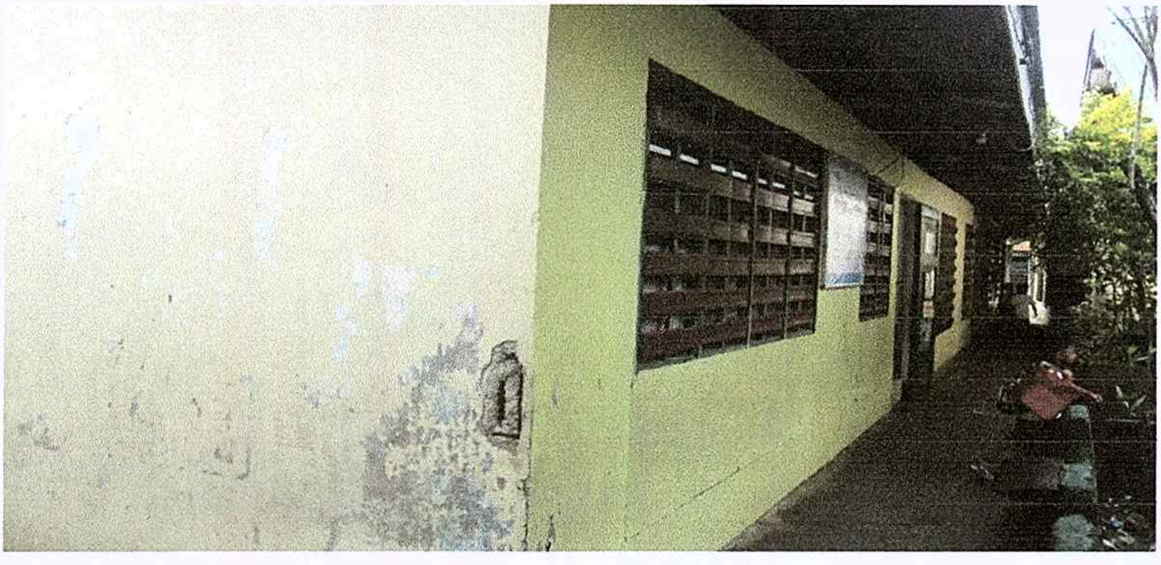
Building 23. Classroom

Building 24. Classroom

Building 25. Classroom

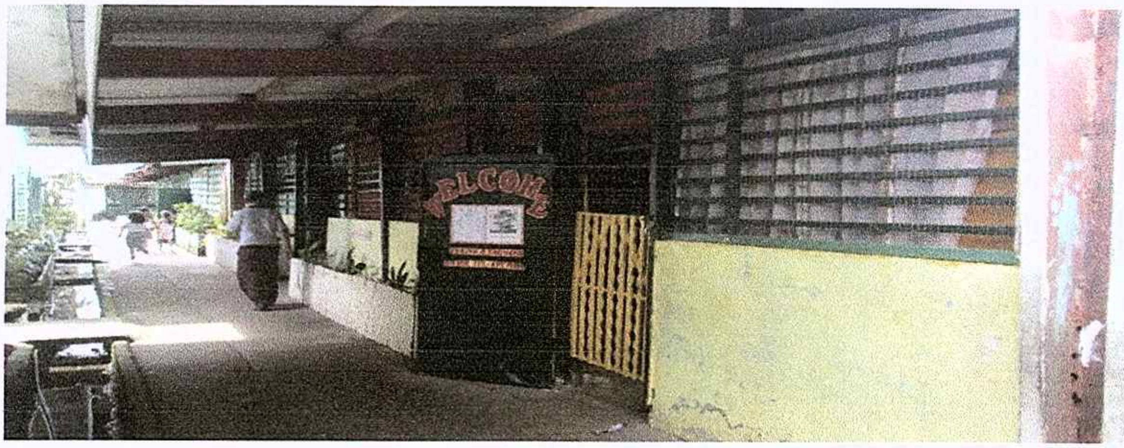
Building 26. Classroom

Building 27. Classroom



Building 28. Classroom

Building 29. PTA Office



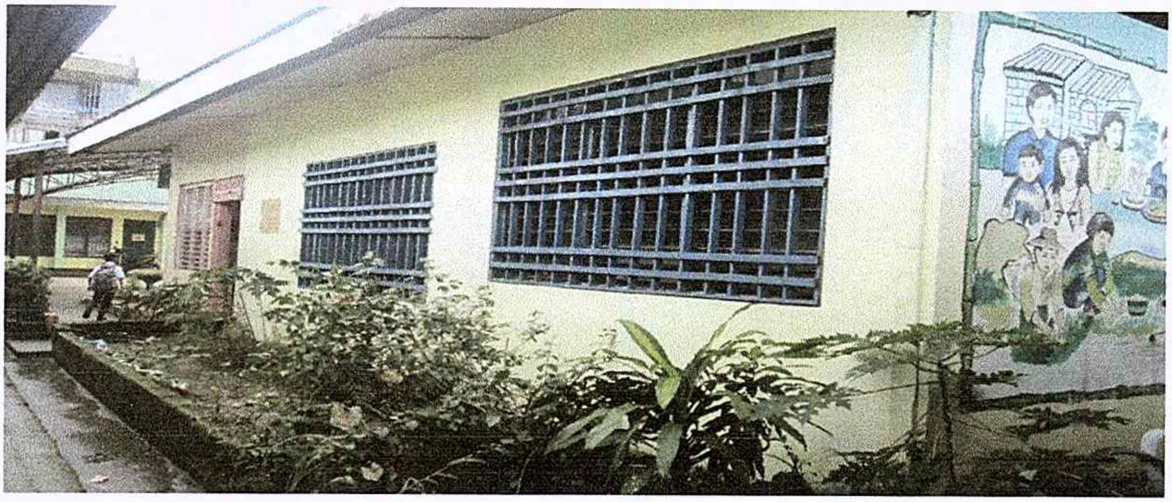
Building 30. Classroom

Building 31. Classroom

Building 32. Multi-Purpose Covered Court

Building 33. Classroom

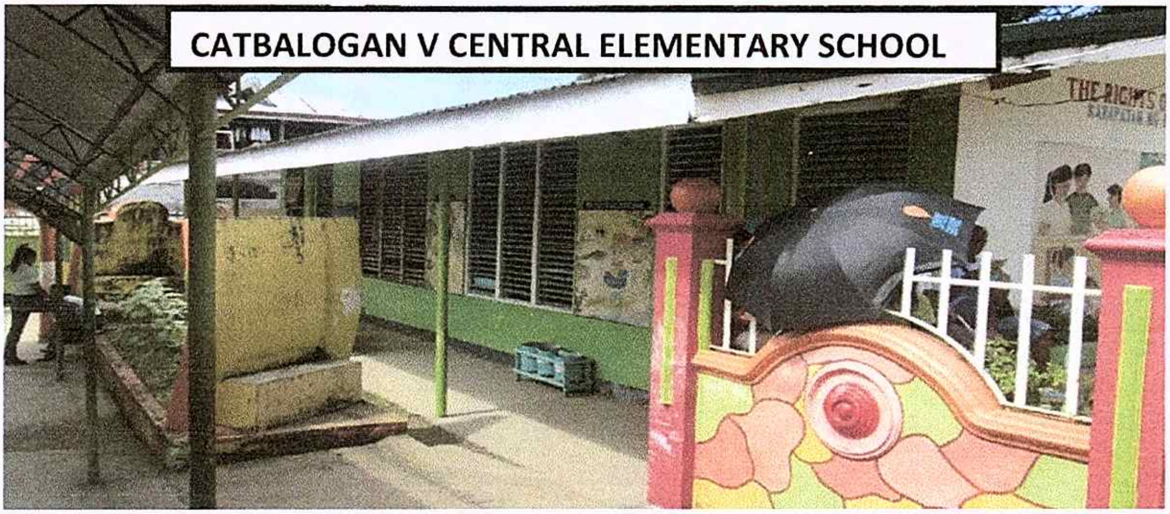
Building 34. Classroom



Building 35. Classroom

Building 36. Stage

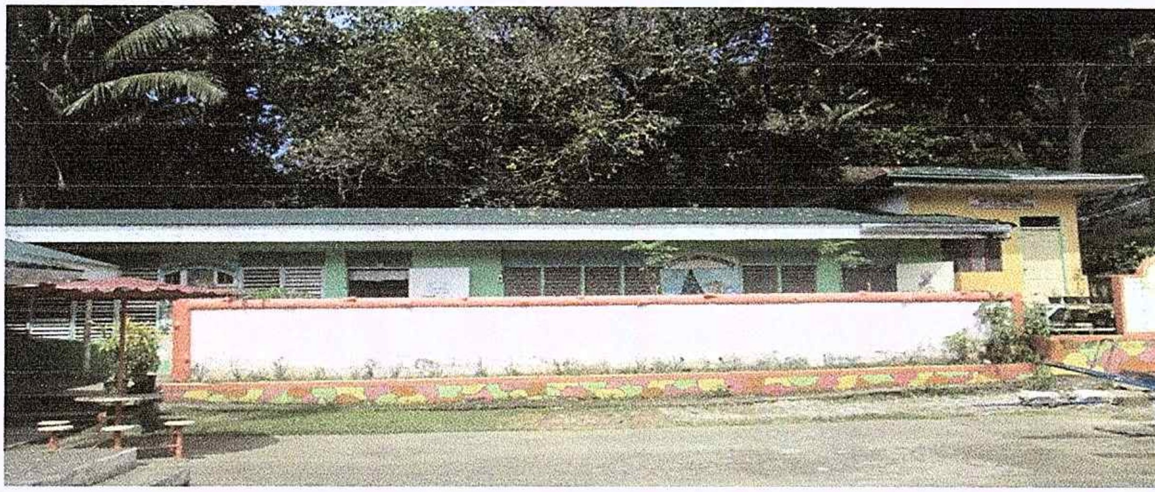
CATBALOGAN V CENTRAL ELEMENTARY SCHOOL



Building 1

Building 2

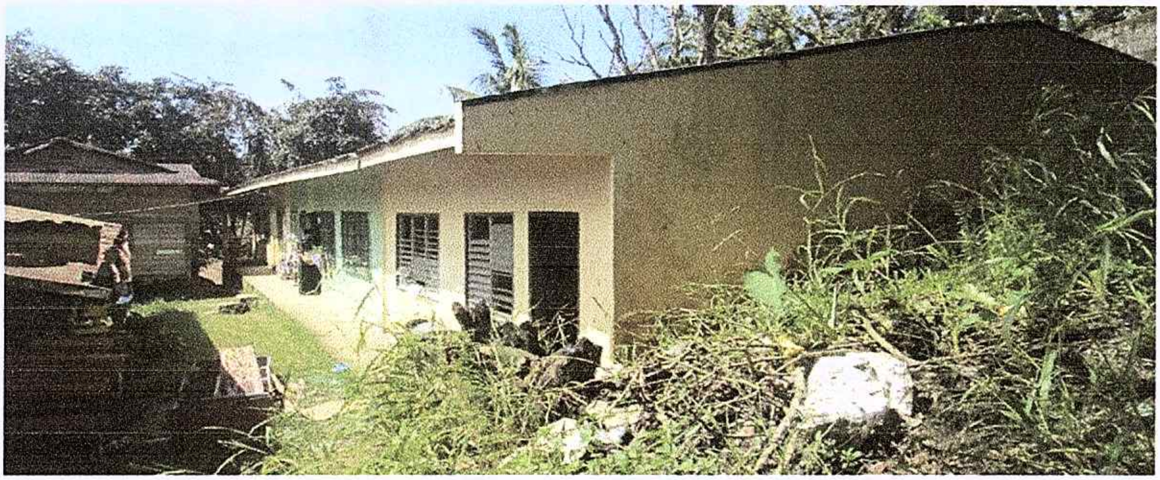
Building 3



Building 4 and PTA Building

Building 5

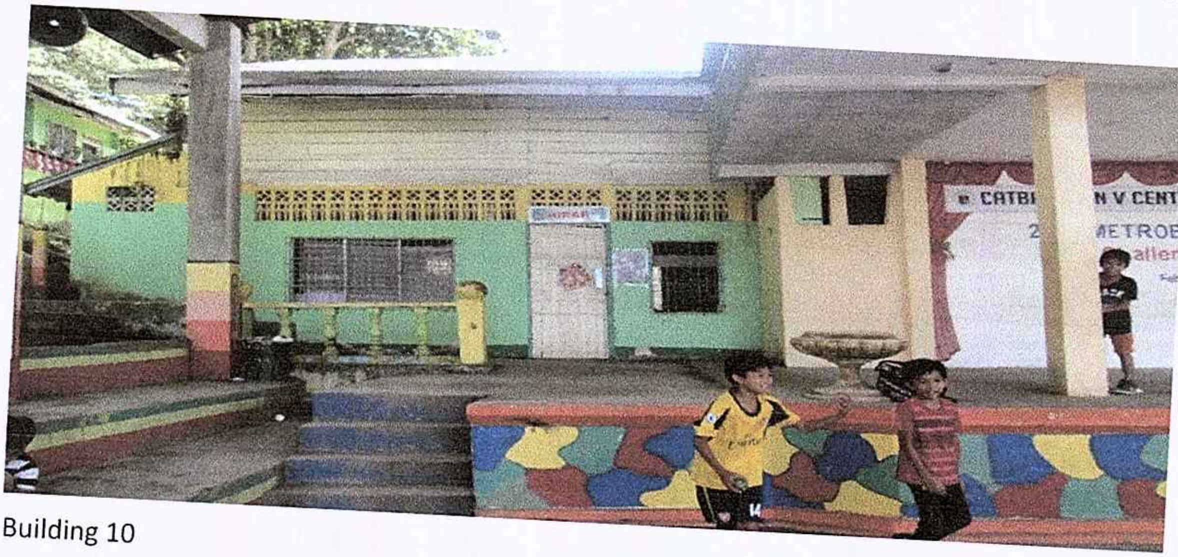
Building 6



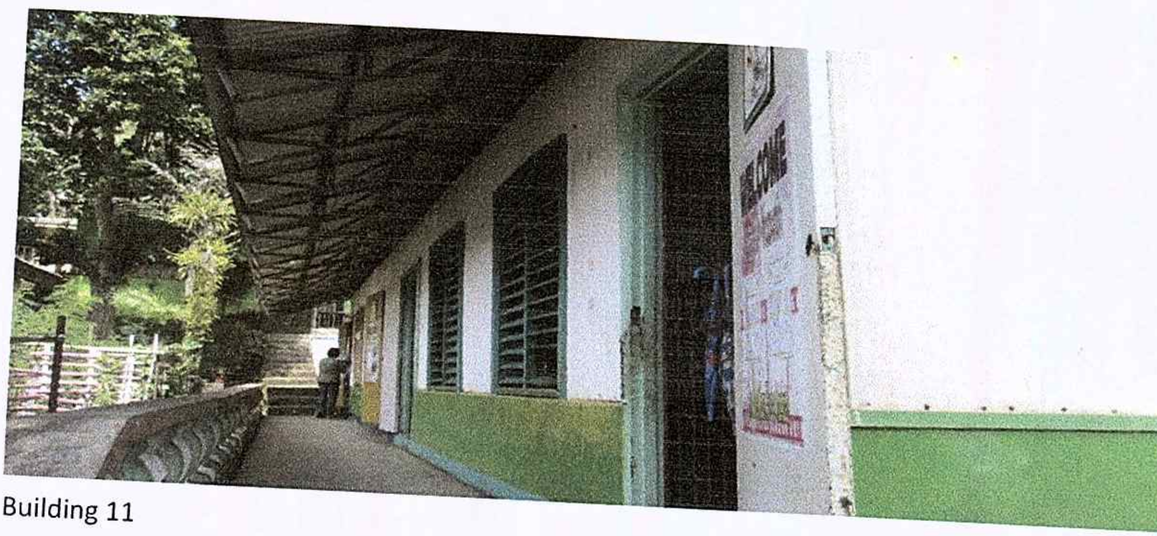
Building 7

Building 8

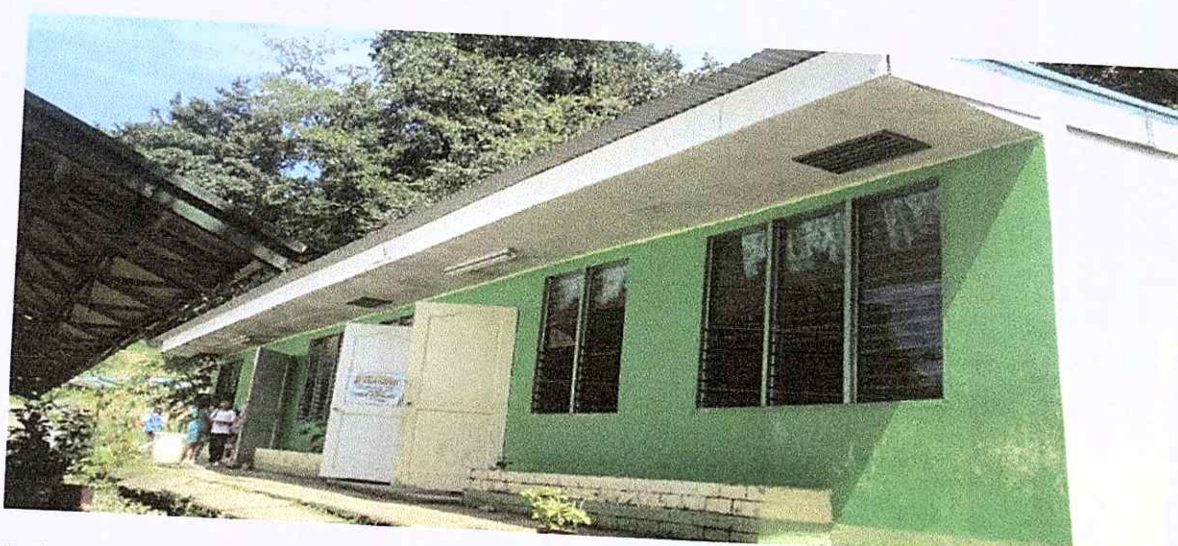
Building 9



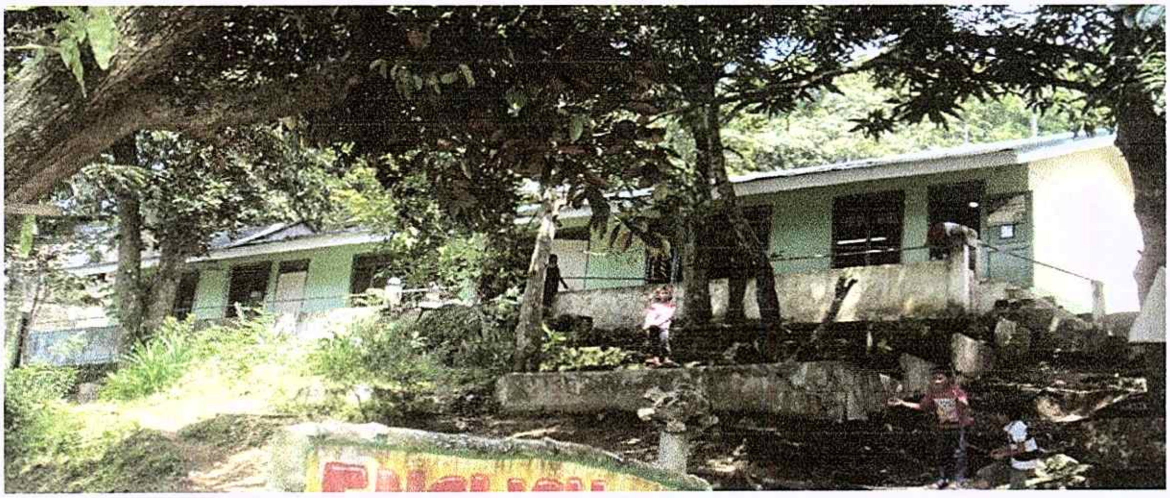
Building 10



Building 11



Building 12

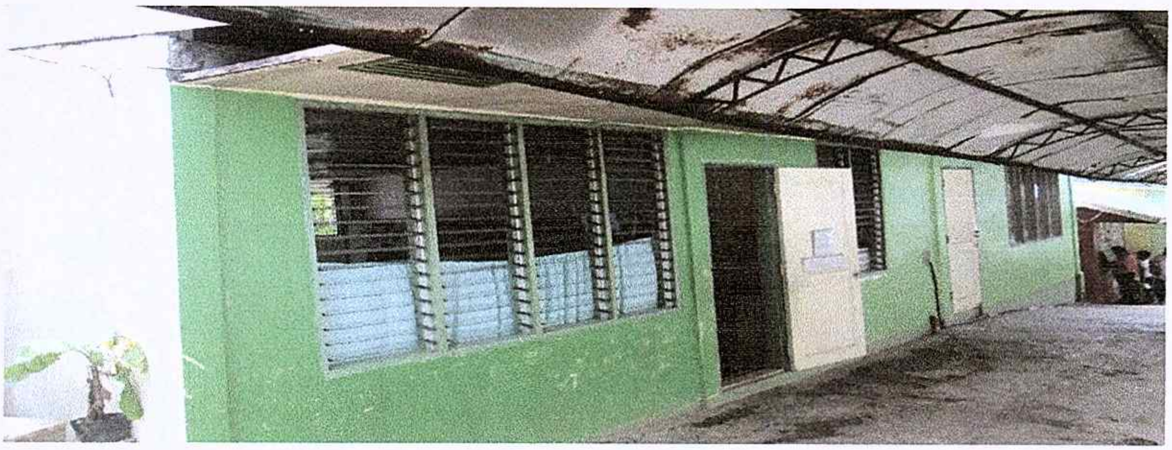


Building 13

Building 14

Building 15

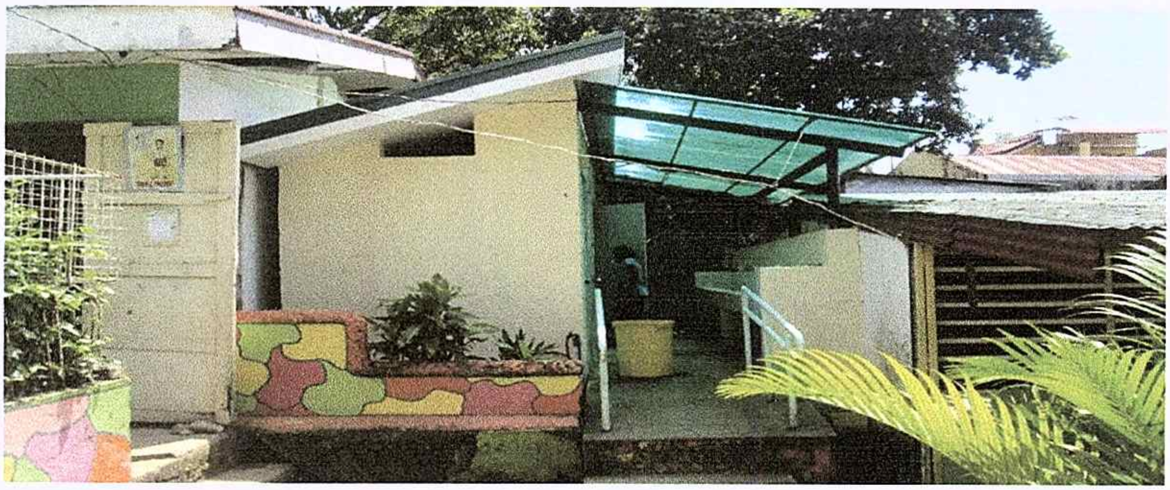
Building 16



Building 17

Building 18

Building 19



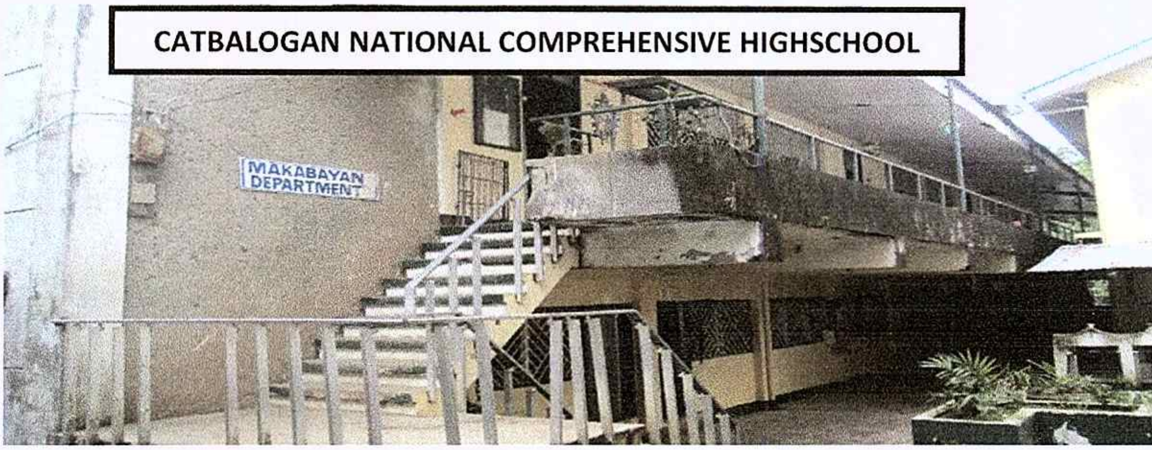
Comfort room

Building 20

Covered Court

The main entrance to Catbalogan V Central Elementary School.

CATBALOGAN NATIONAL COMPREHENSIVE HIGHSCHOOL

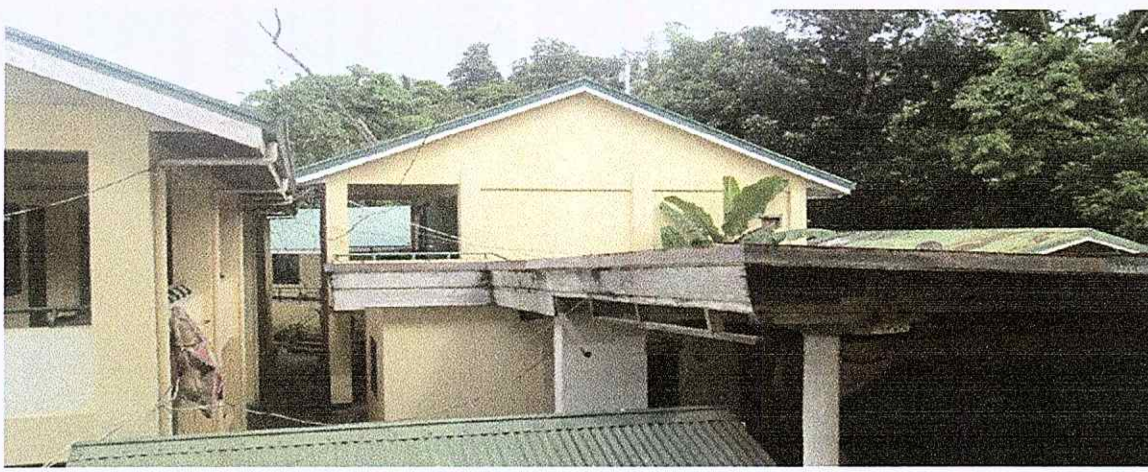


Building 1

Building 2

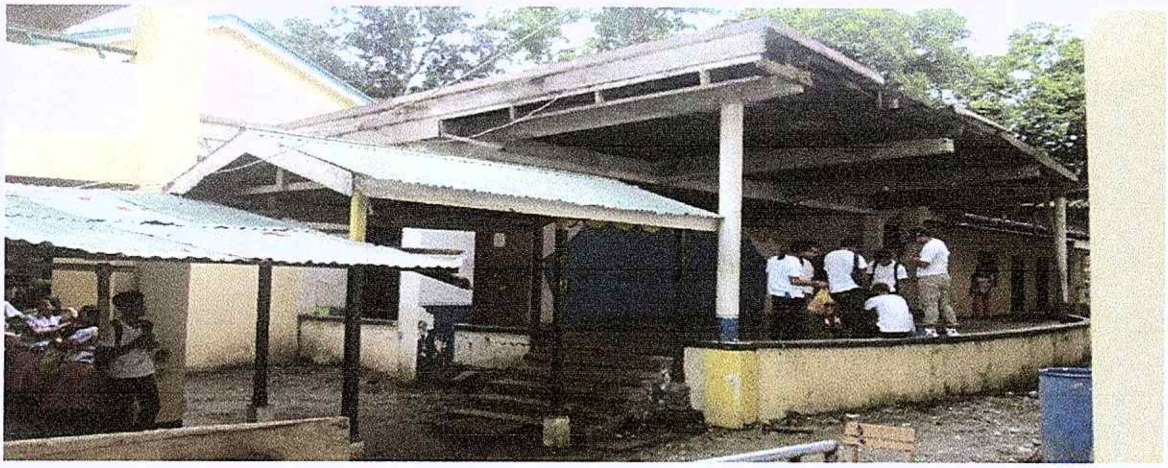
Building 3

Building 4



Building 5. The SBM Hub

Building 6



Building 7. The school stage

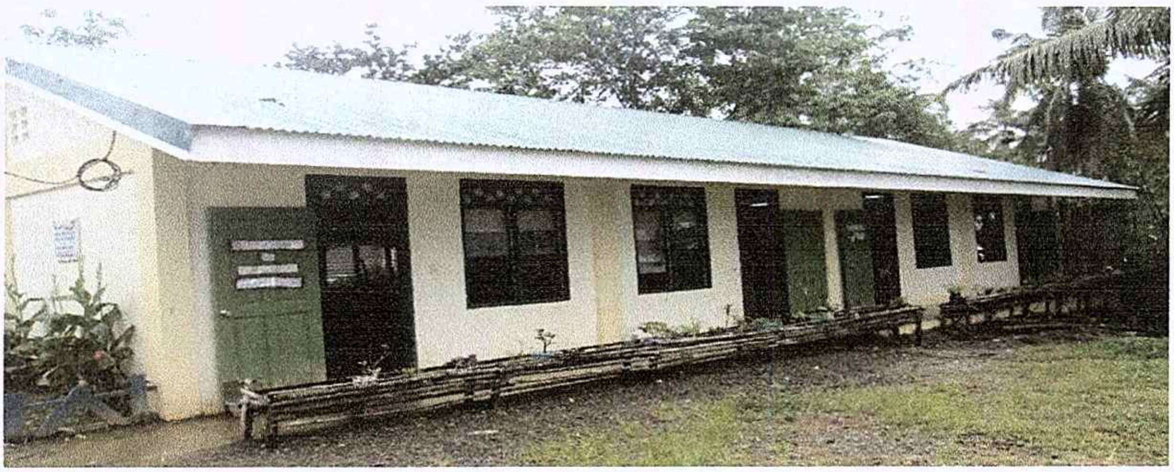
Building 8

Building 9. Sr. High Building

Building 10

DAMPIGAN NATIONAL HIGH SCHOOL

The main entrance to Dampigan National High School.



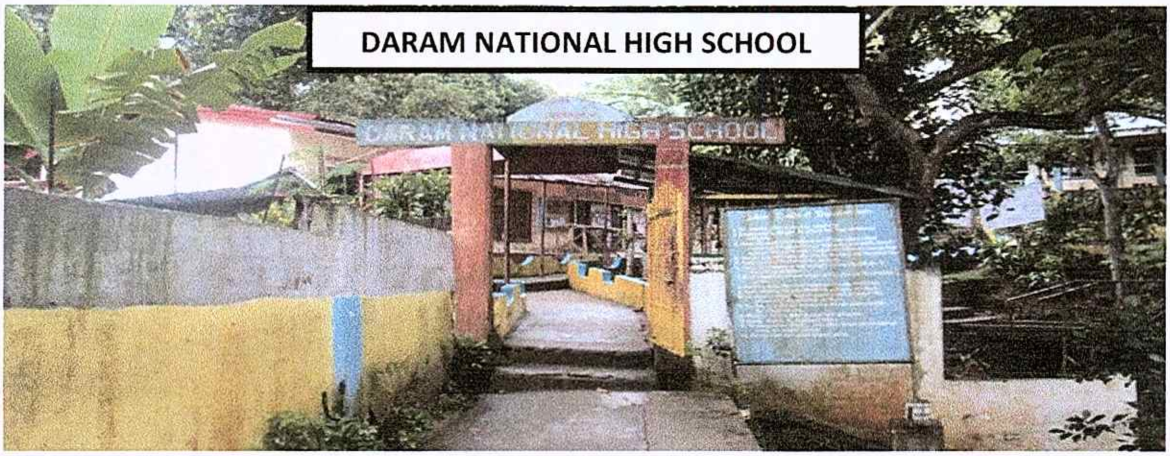
Building A. The world vision building.

Building B. The municipal building.

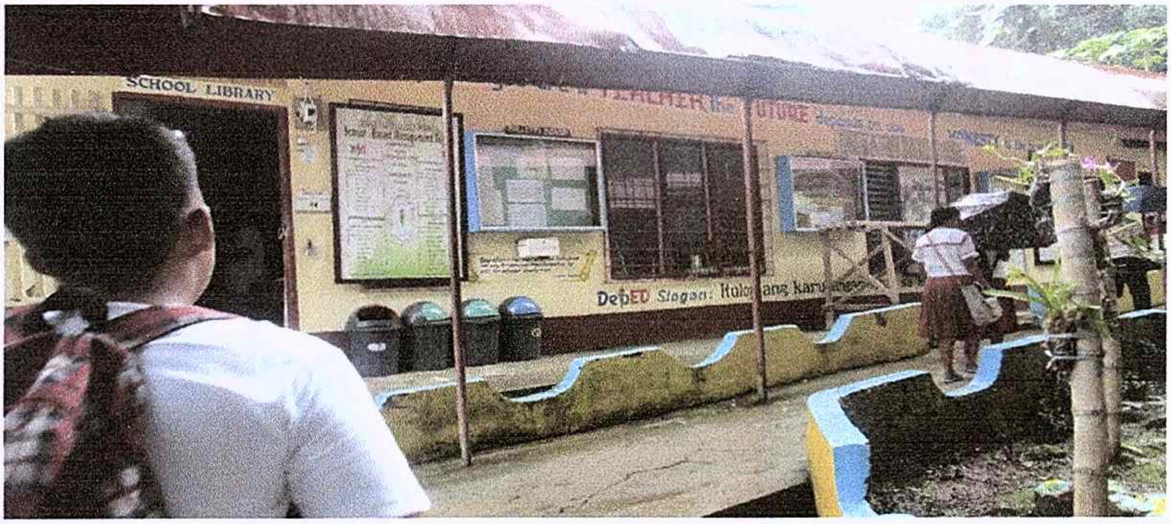
Building C. The DEPED standard school building.

Building D. Municipal building

Building E. The USAID building

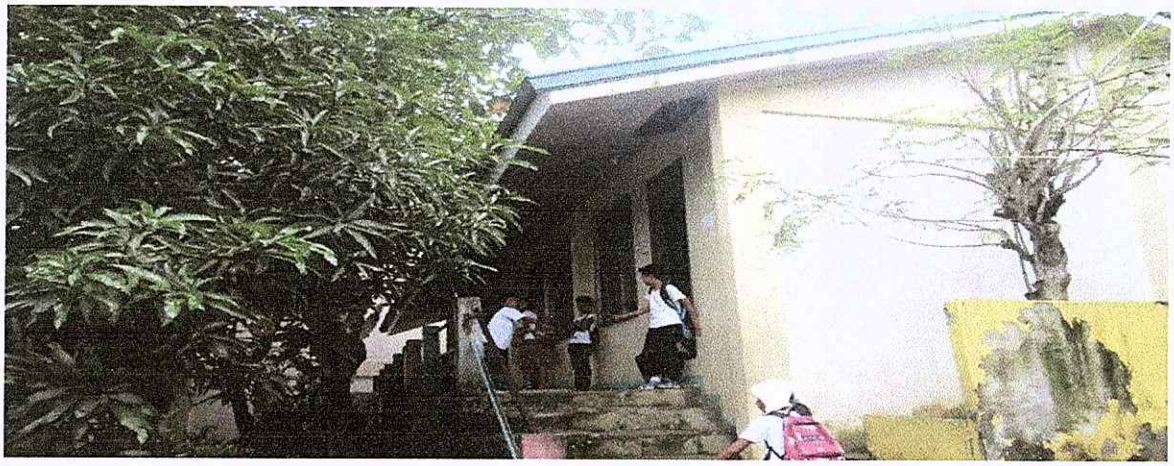


Main Entrance to Daram National High School



Building 1

Building 2



Building 3

Building 4

Building 5

Building 6

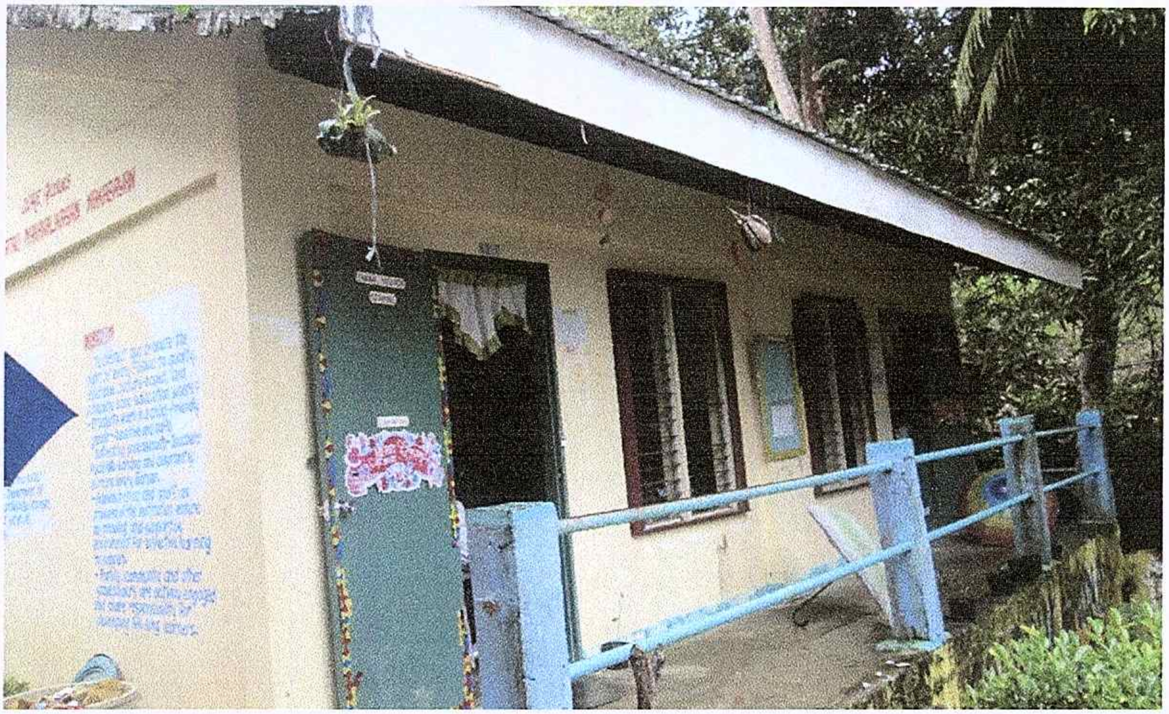
Building 7

Building 8

Building 9. Stage

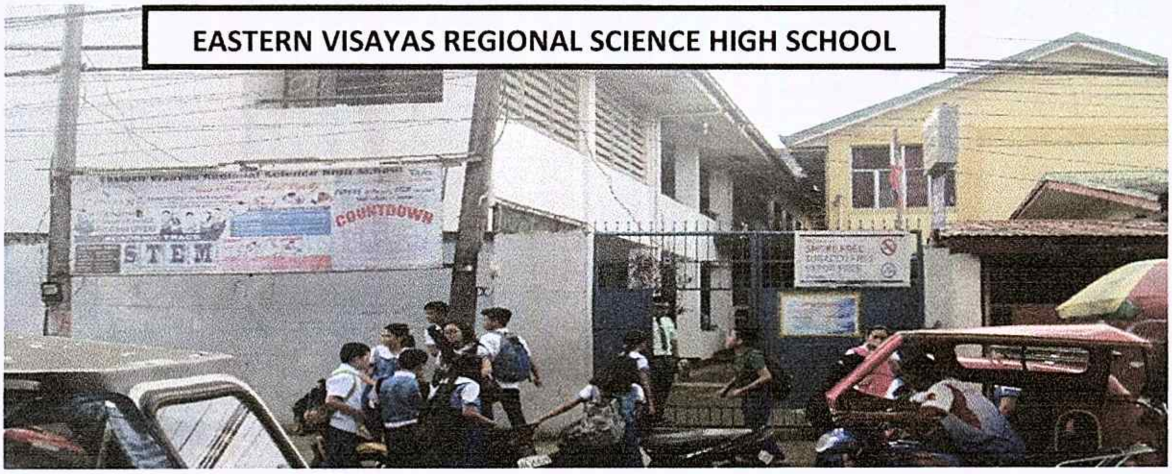
Building 10. Classroom

Building 11. Classroom



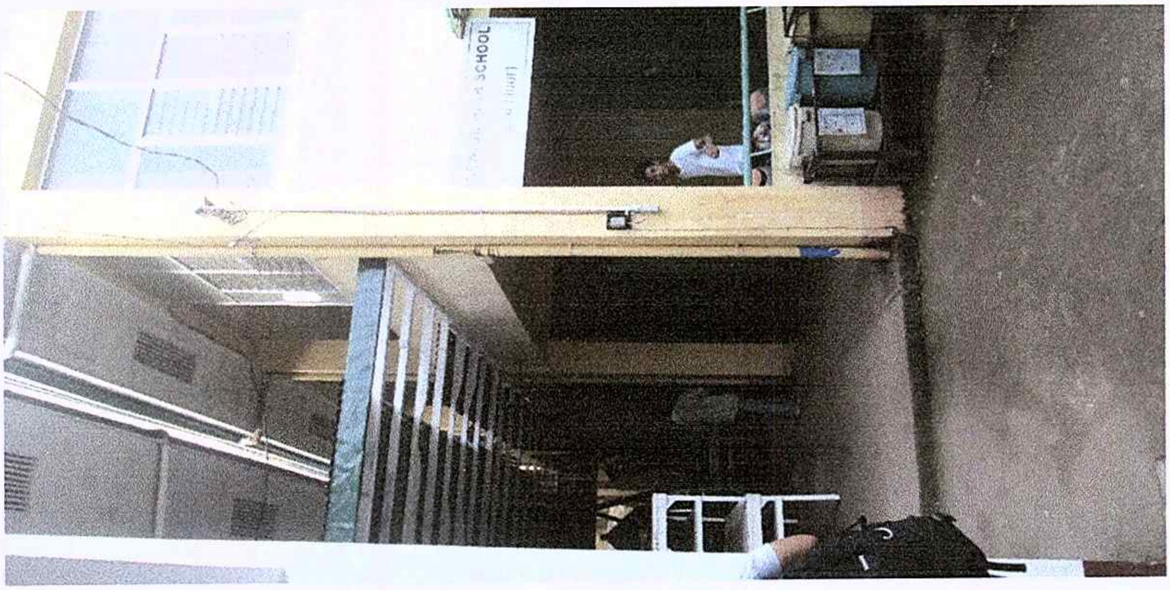
Building 12. Classroom

EASTERN VISAYAS REGIONAL SCIENCE HIGH SCHOOL



The main entrance to EVRSHS

Building 1



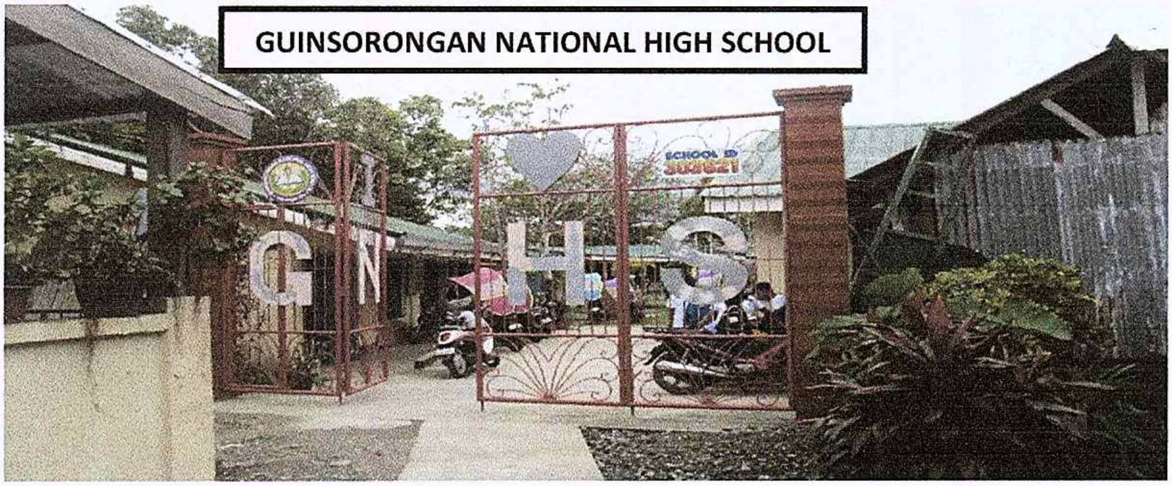
Building 2

Testing the strength of the beam of Building 1.

A photo taken from Building 1 to Building 2.

At Building 2

GUINSORONGAN NATIONAL HIGH SCHOOL

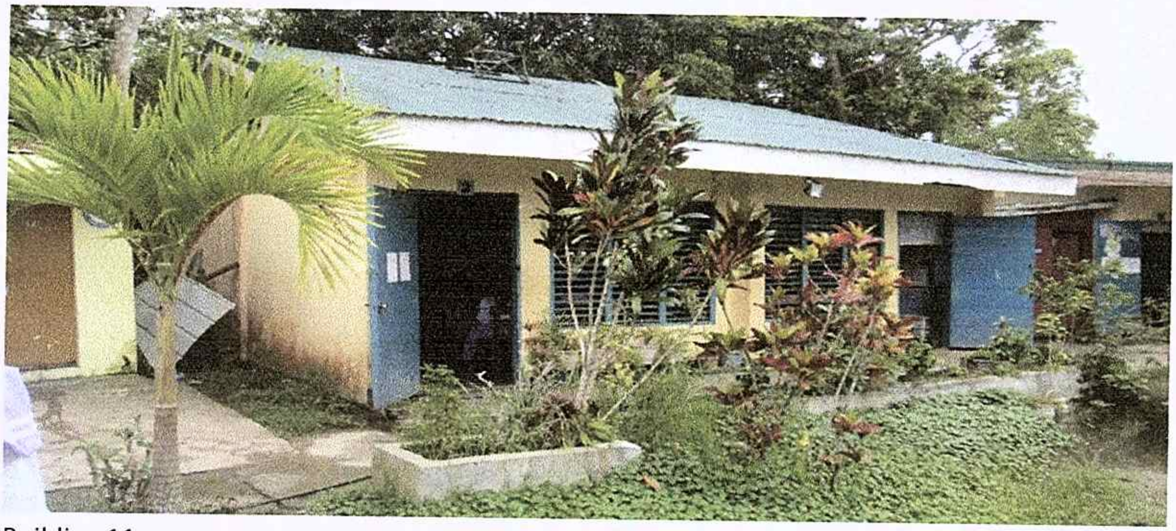


The main entrance to (GNHS).

Building 7

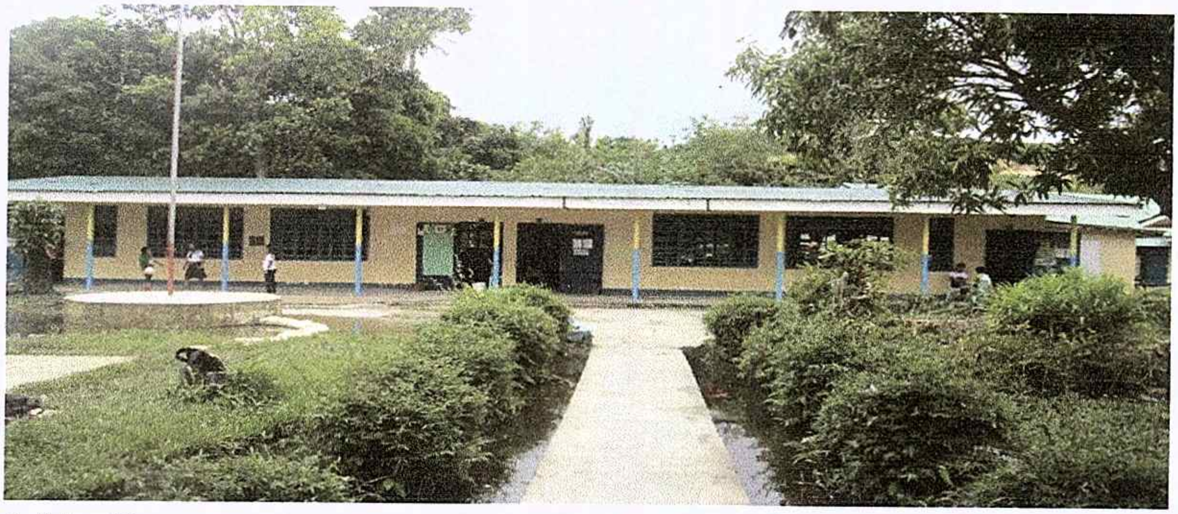
Building 9

Building 10



Building 11

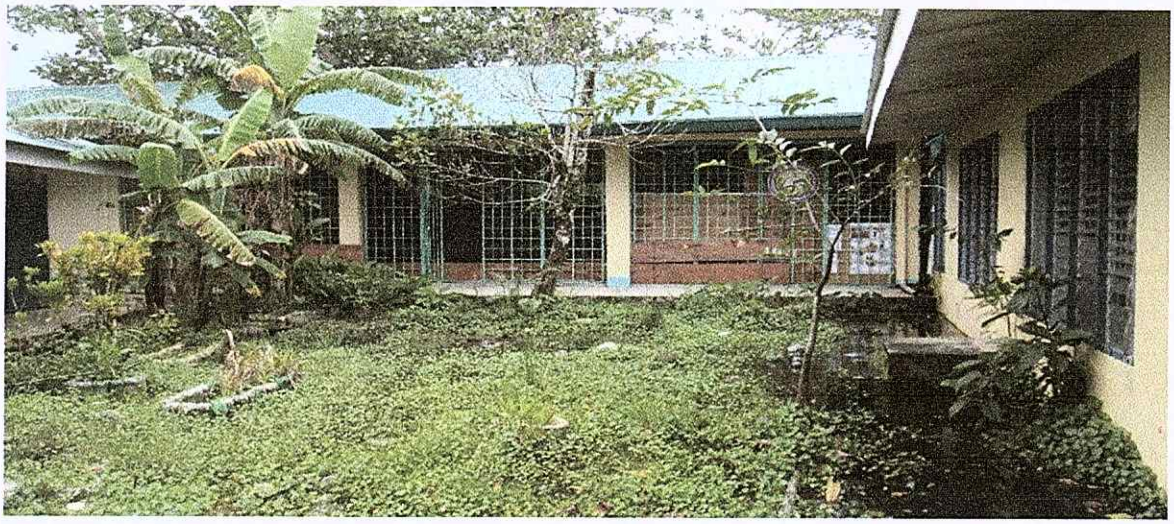
Building 12



Building 13

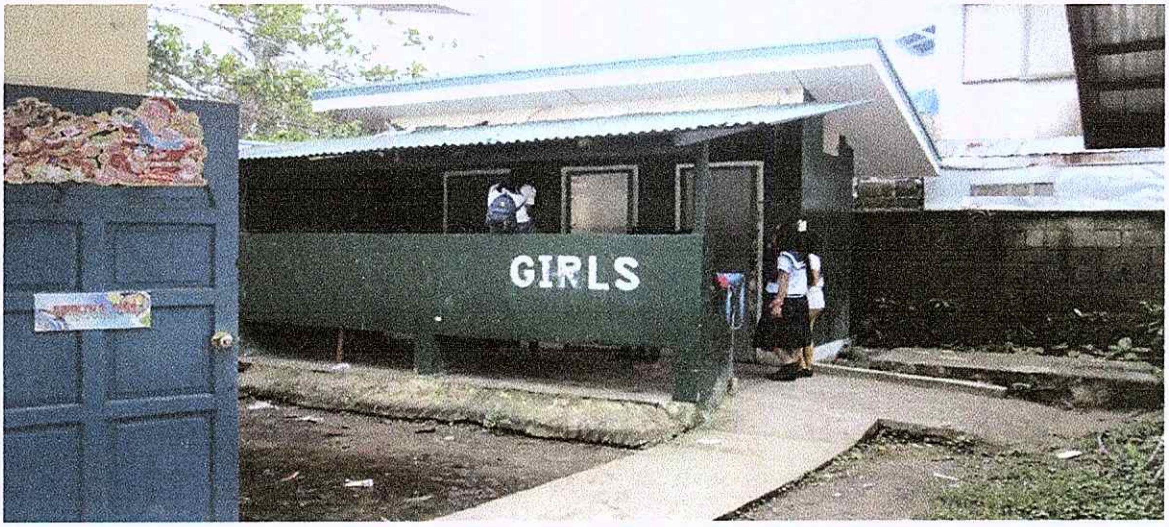
Building 14

Building 15



Building 16

Building 17



Building 18

Building 20

Building 30

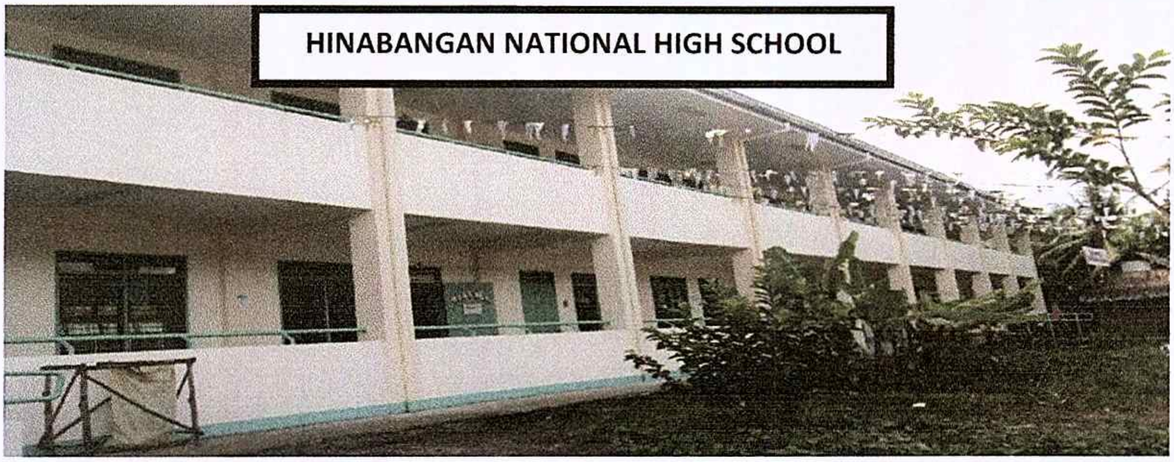
Building 32

GNHS is prone to flood due to none existence of drainage.

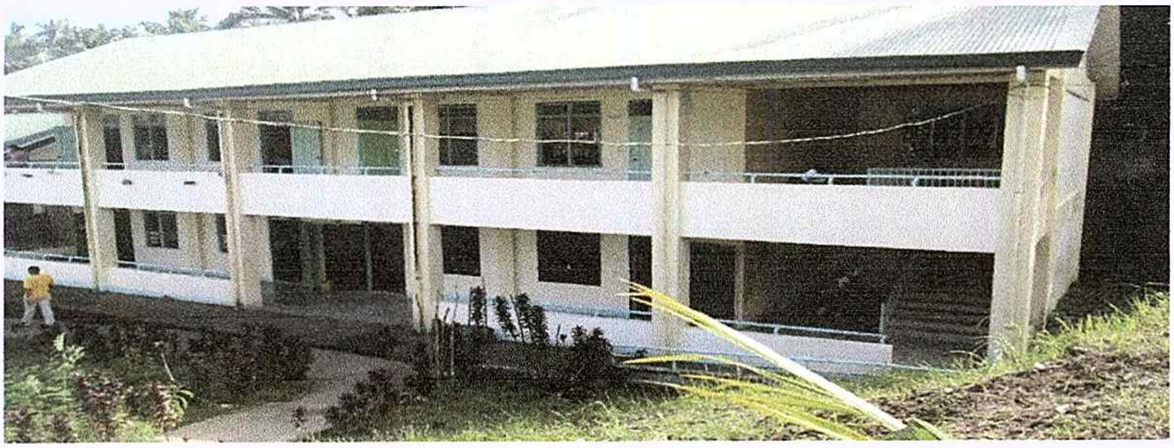
The plaza at GNHS is flooded.

The flooded plaza of GNHS.

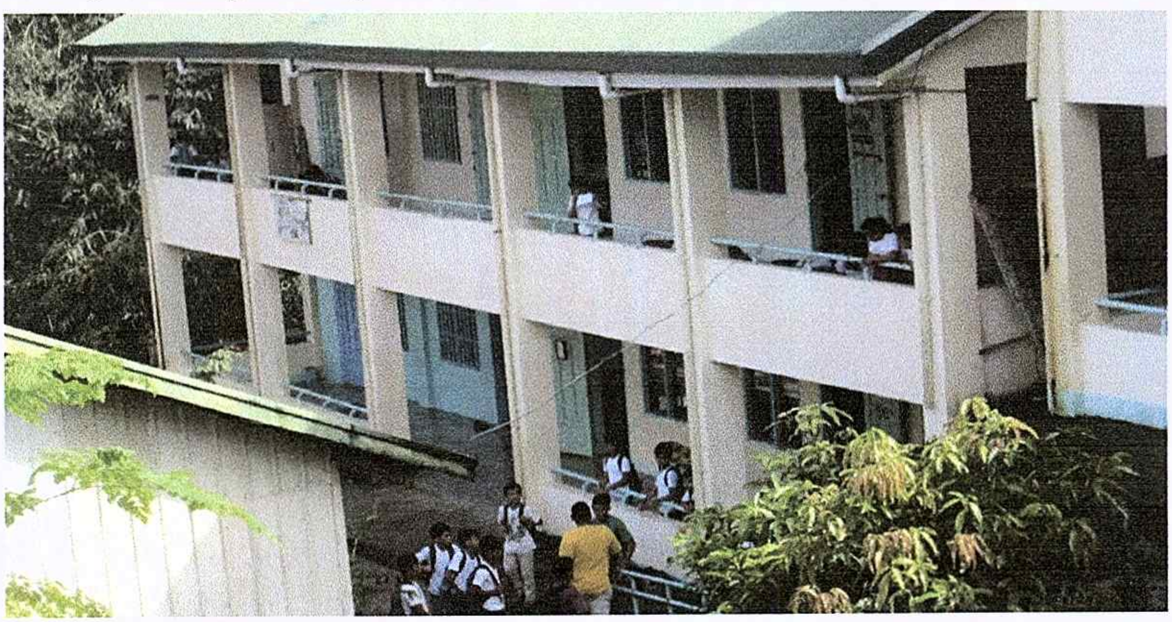
HINABANGAN NATIONAL HIGH SCHOOL



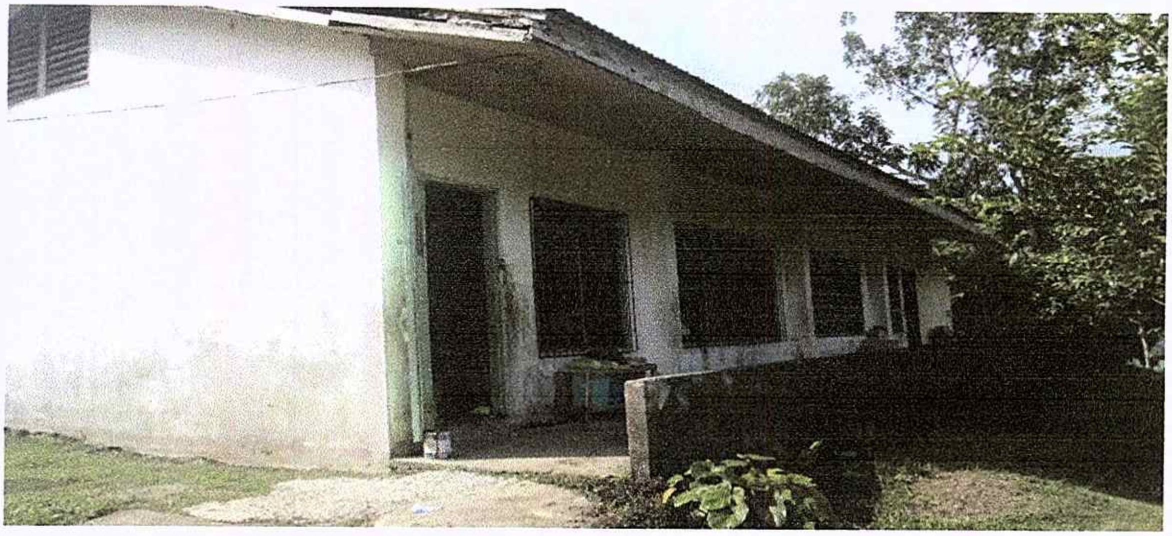
Building 25. Sr. High Building 8 rooms.



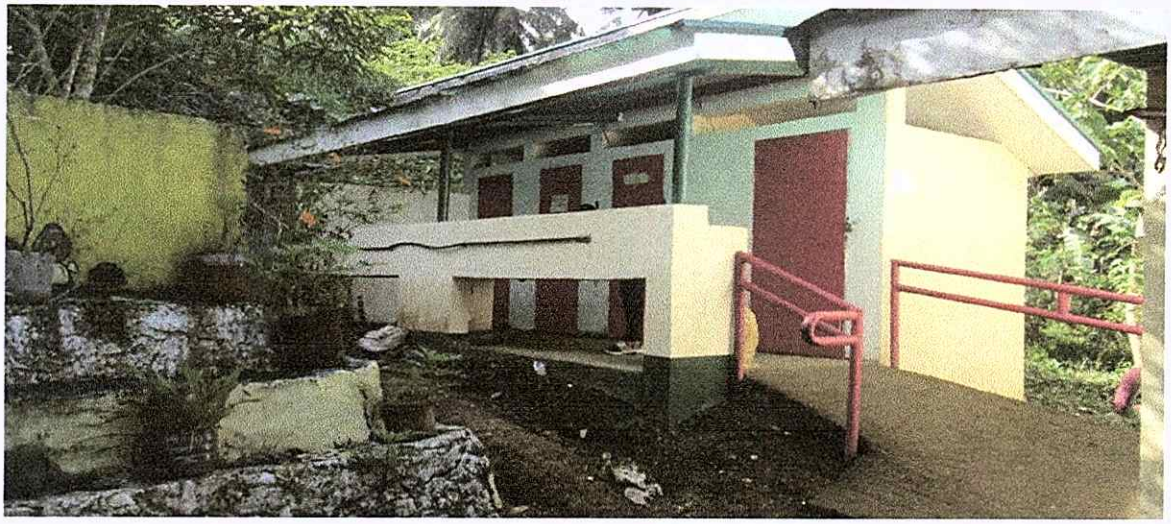
Building 10. Sr. High Building



Building 9. Sr. High Building

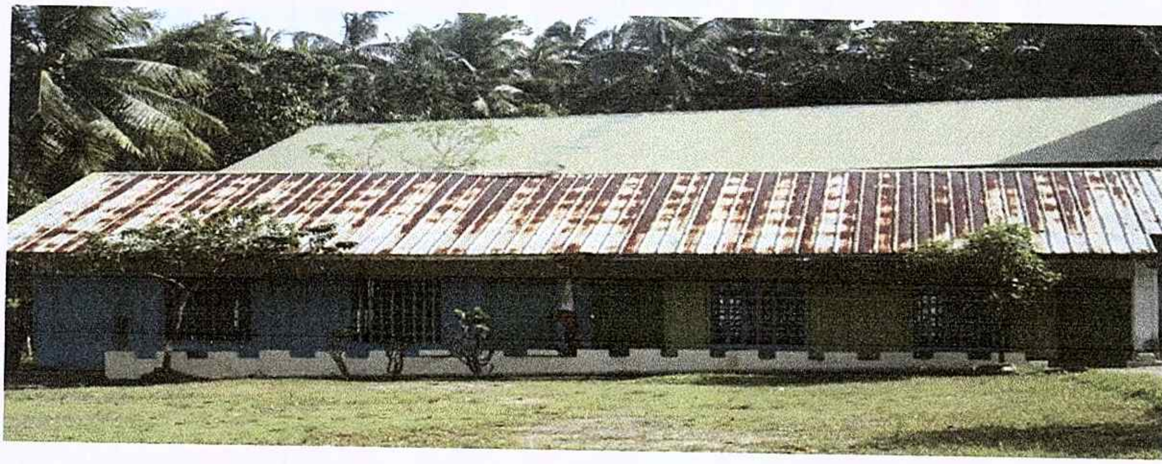


Building 21



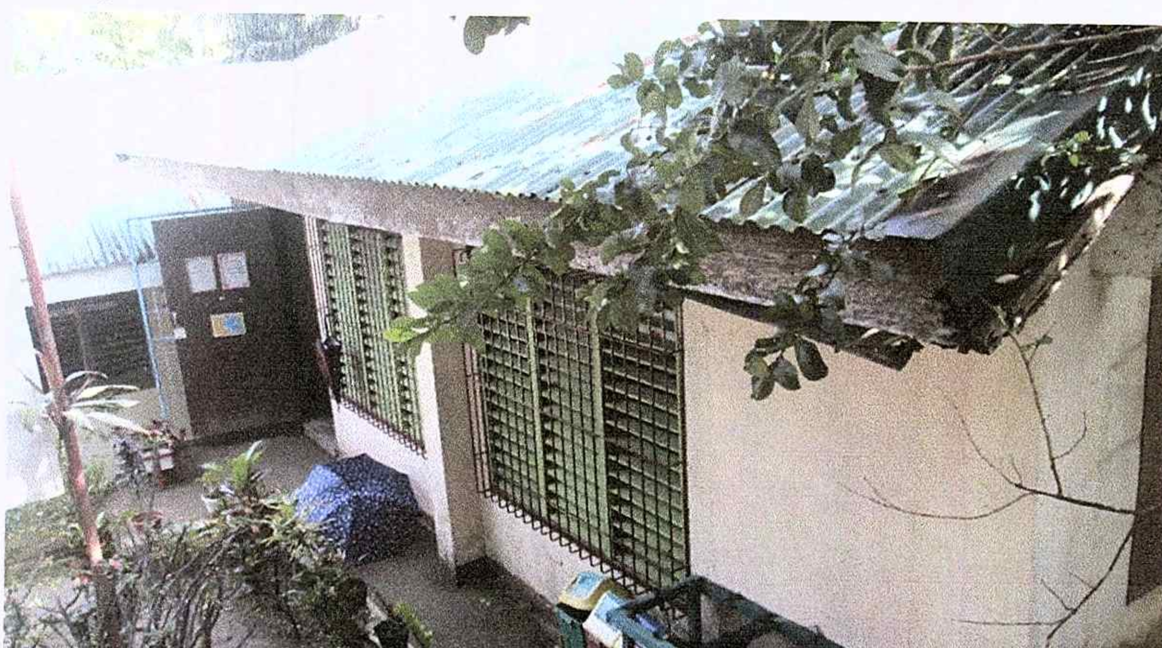
Building 12

Building 13

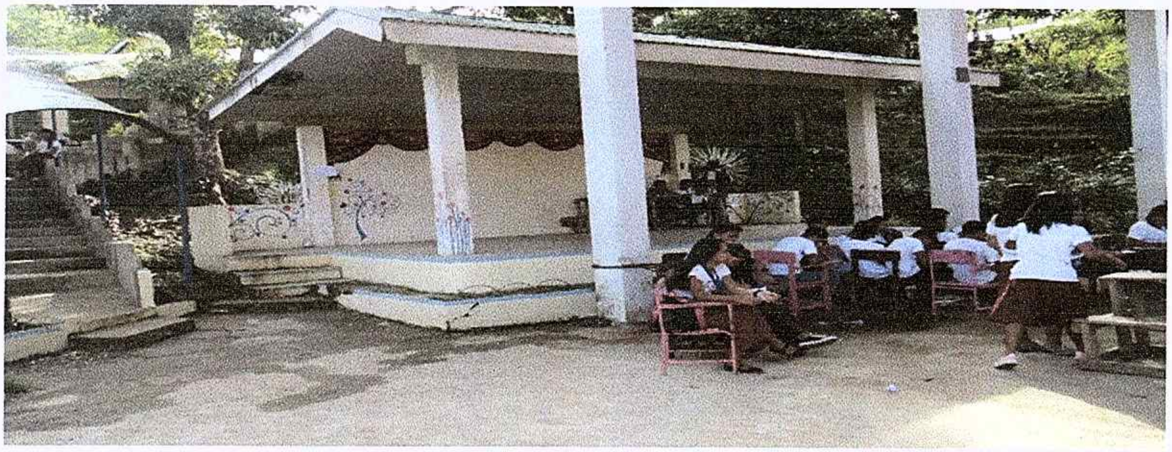


Building 8

Building 7



Building 6

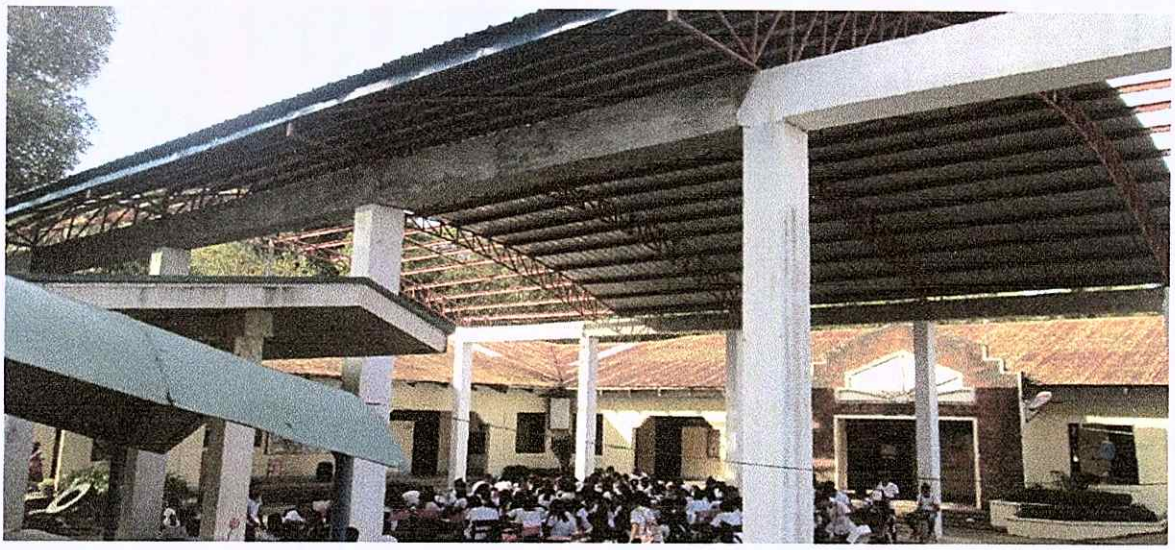


Building 5

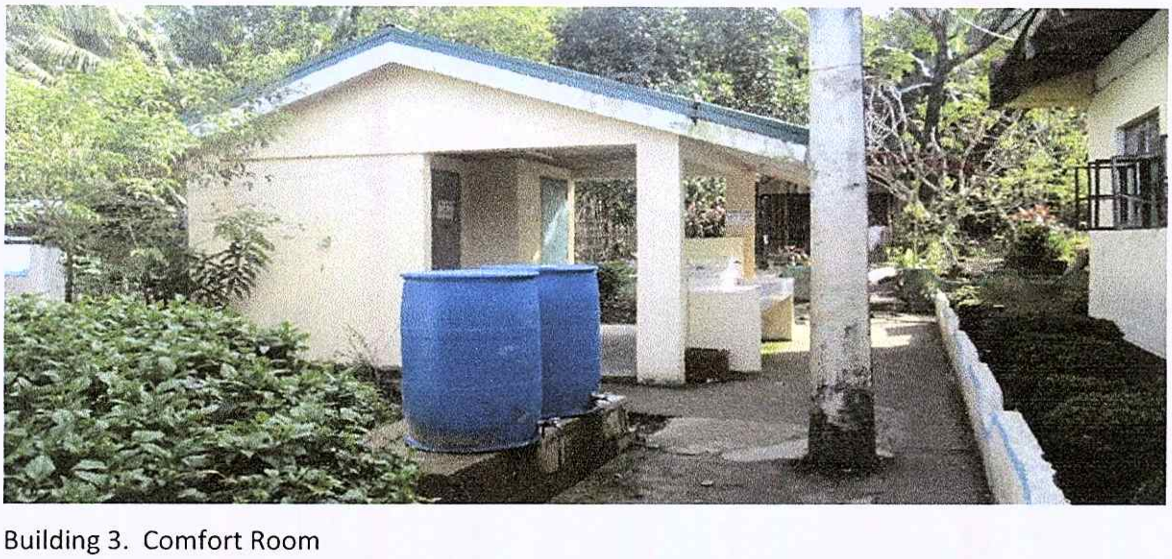
Building 4

Building 17. School Stage

Covered court.



Covered court



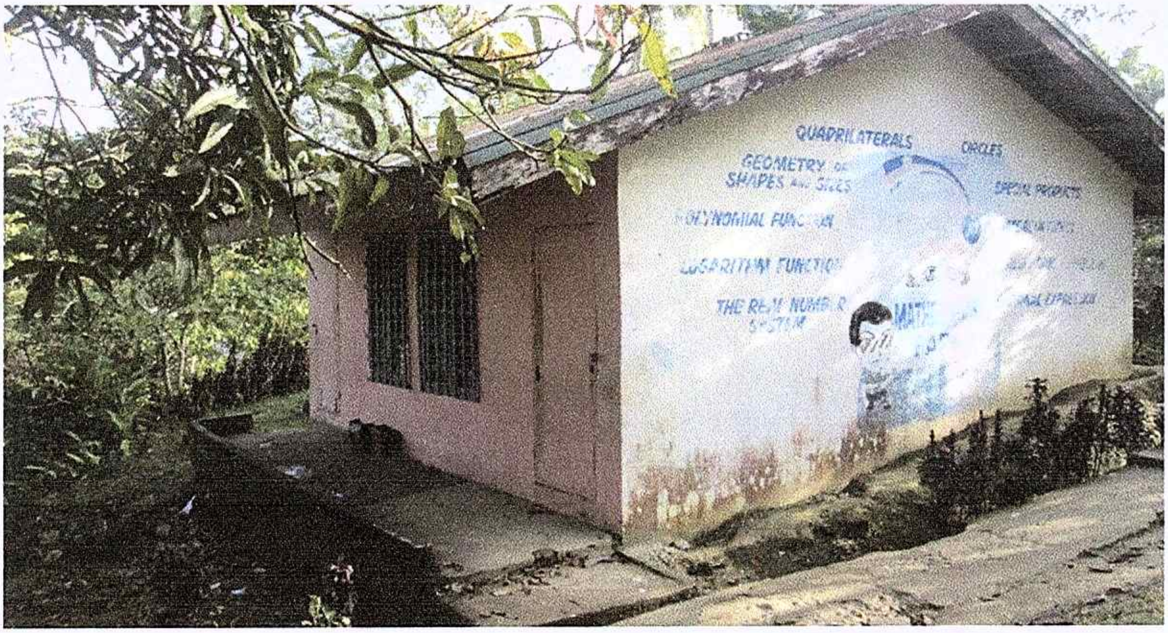
Building 3. Comfort Room

Building 2

The school stage, the covered court and Building 16.

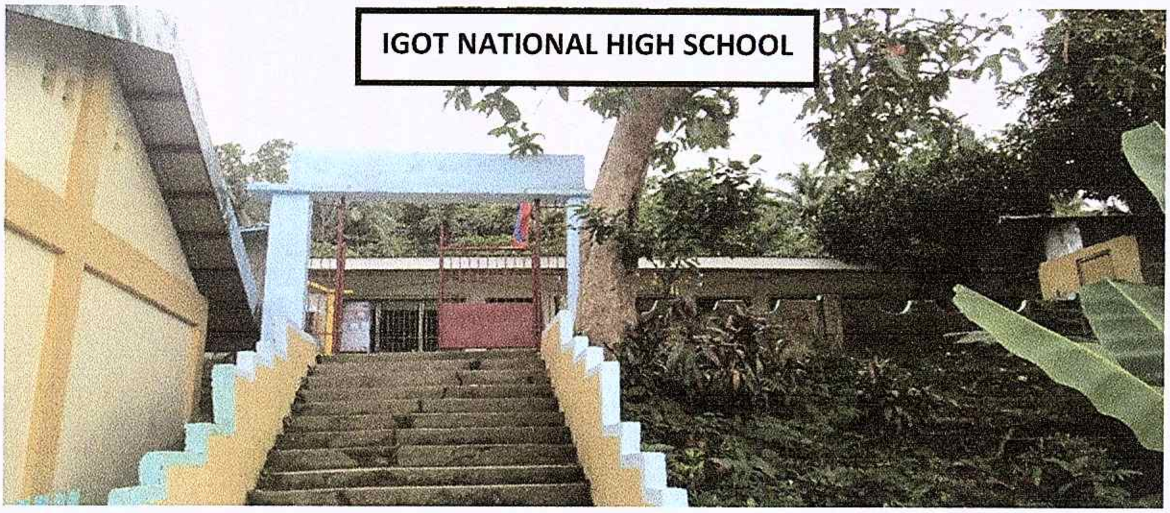
Building 1

Building 15



Building 14

IGOT NATIONAL HIGH SCHOOL



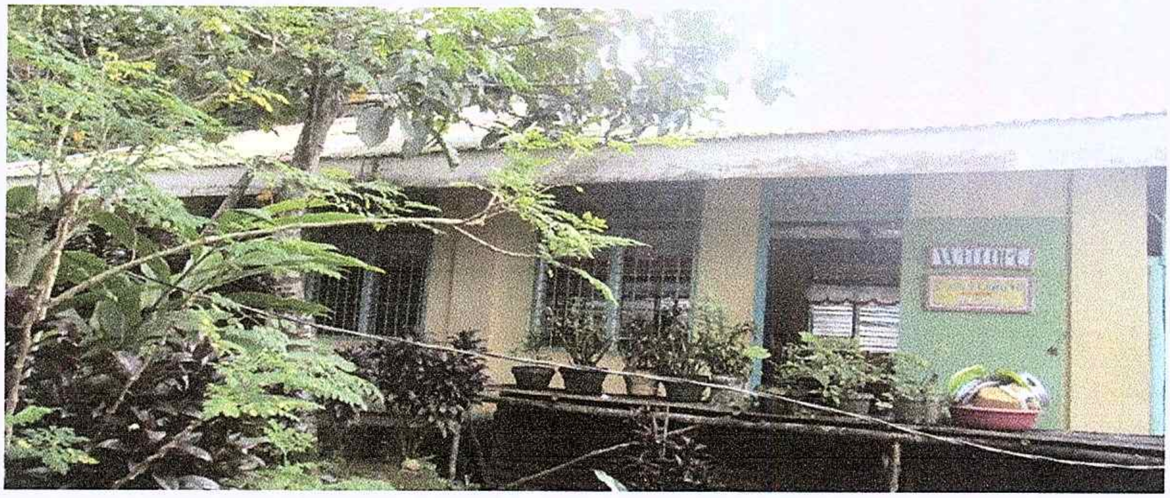
The main entrance to Igot National High School.

Building 1. The Principal's Office at the left side of the building.

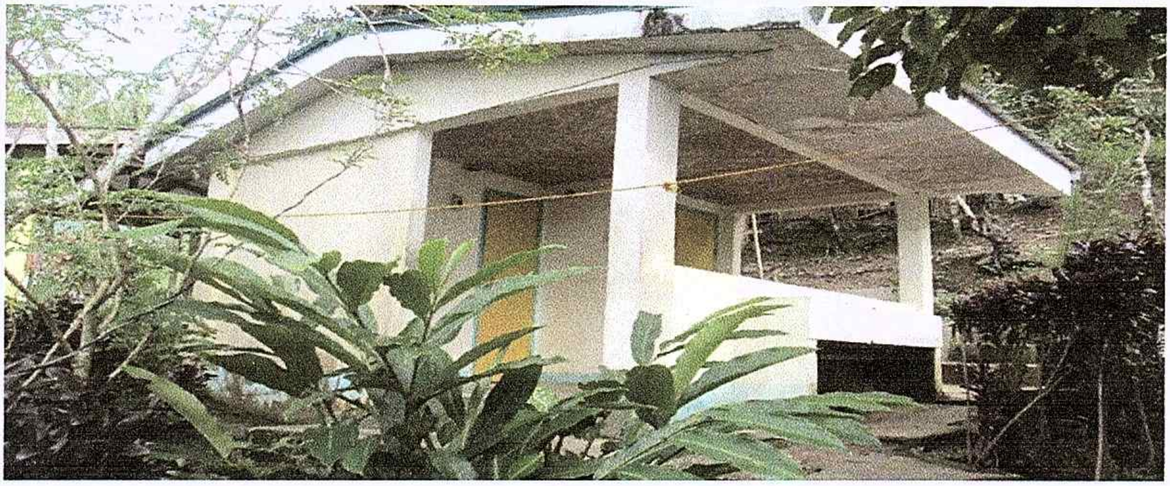
Building 2 at the right side of the Principal's Office.

Building 3

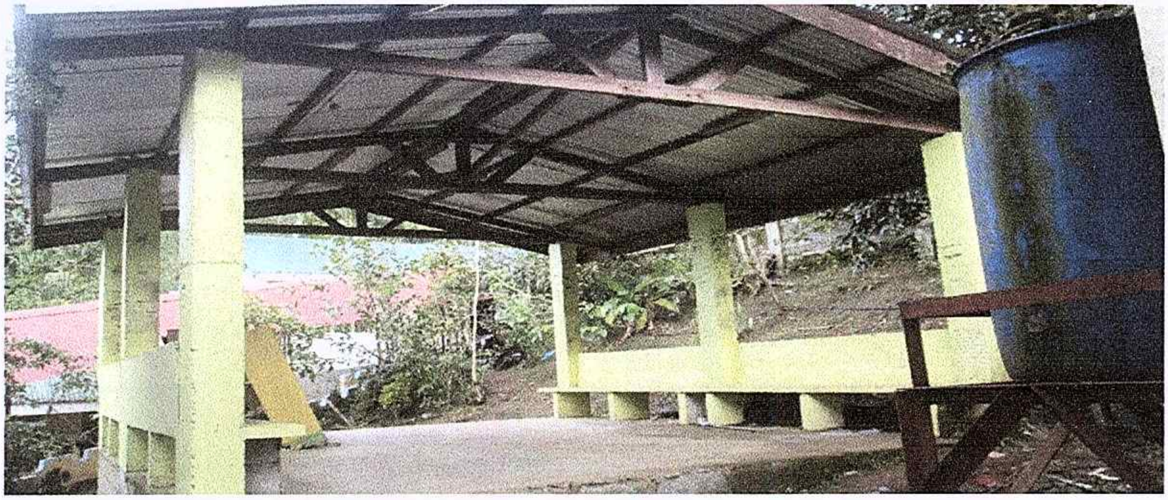
Building 4



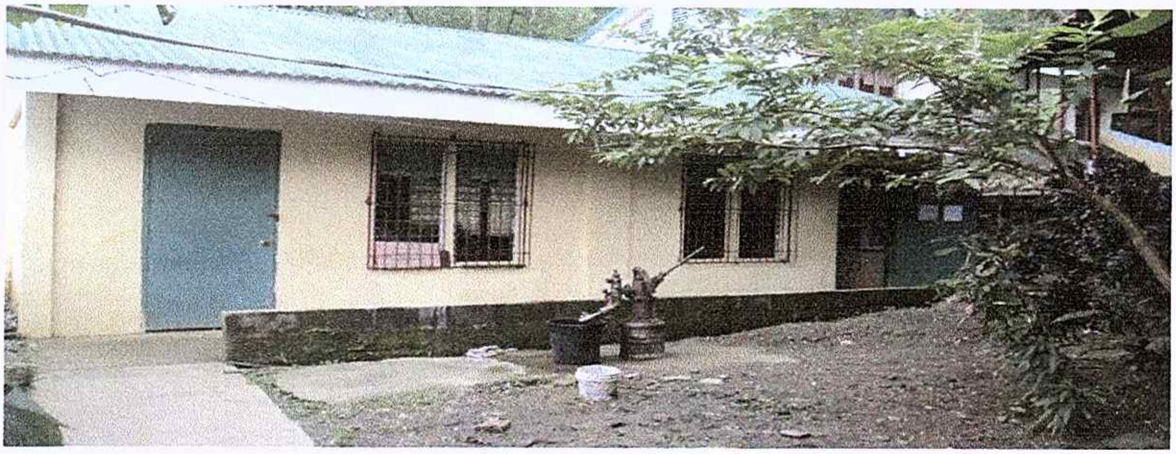
Building 5



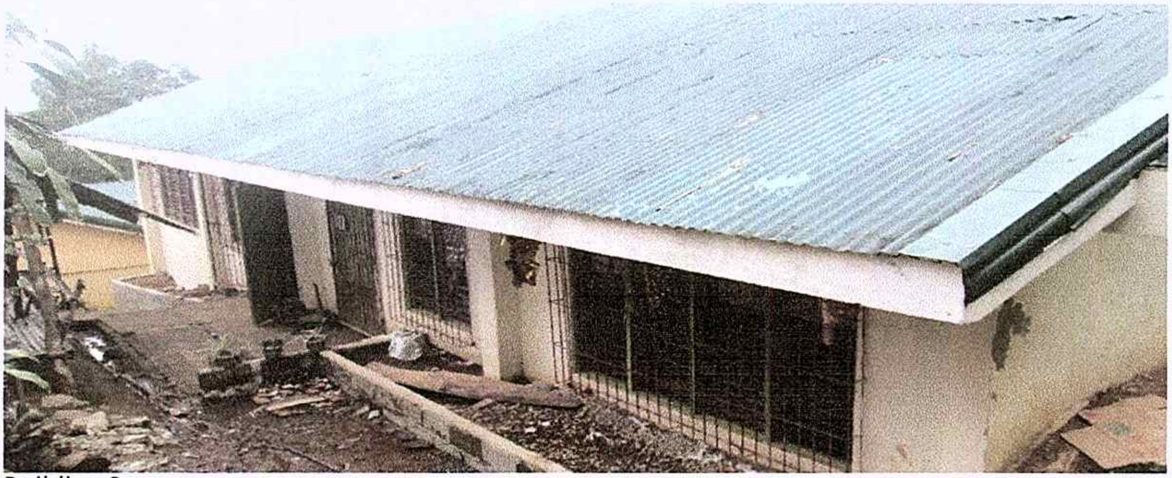
Building 6. The comfort room.



Building 7



Building 8



Building 9

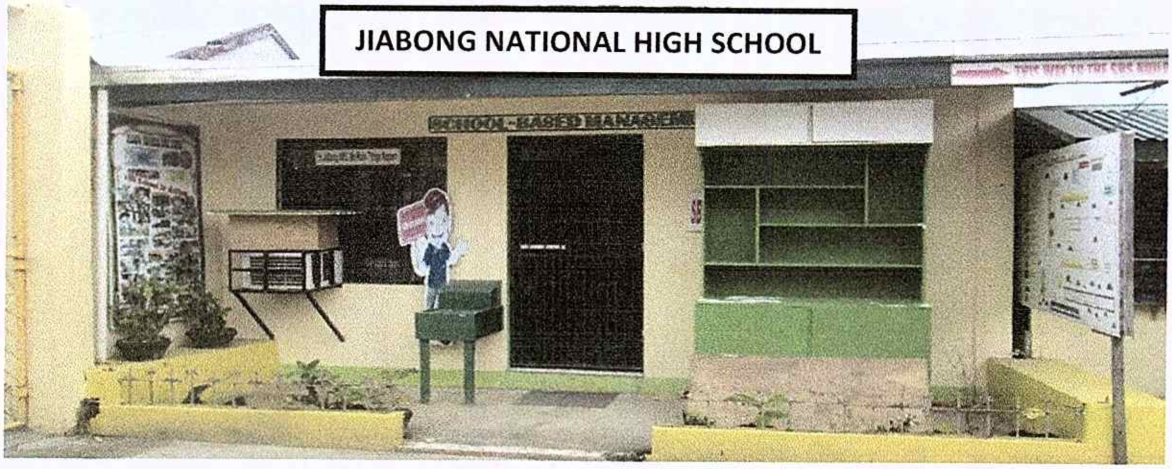
Building 10

The   hill where INHS is situaTted.

The terrain of INHS campus.

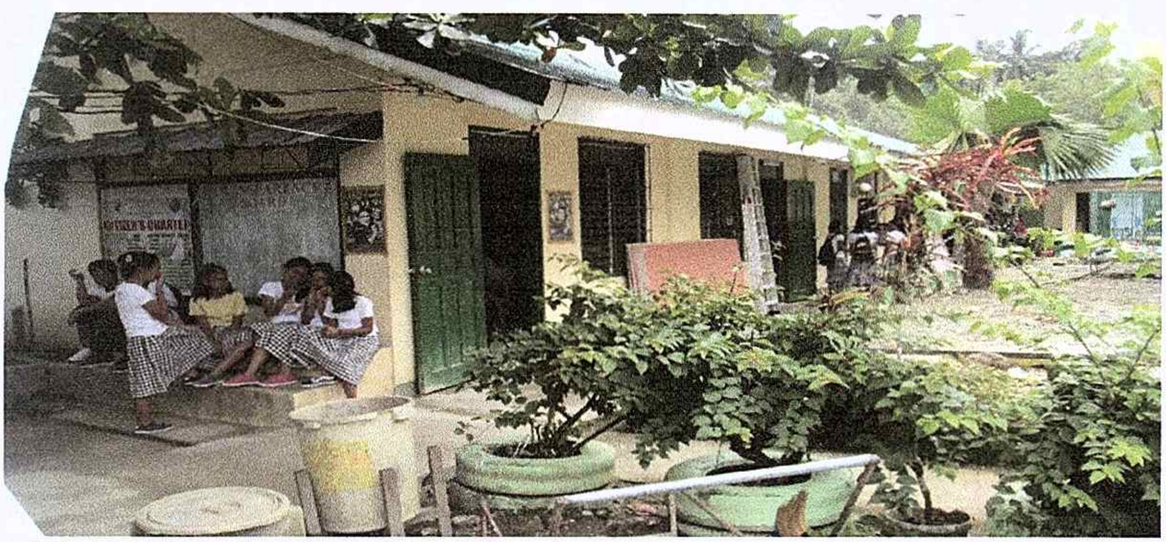
The terrain of INHS. Shown in photo is Building 10 on the upper portion of the hill.

JIABONG NATIONAL HIGH SCHOOL



Building 1. The SBM/Hub

Building 2. The school canteen



Building 3. Principal's Office and Computer Lab.

Building 4. Comfort Room

Building 5. Faculty Room

Building 6. Learning Resource Center

Building 7. SSG Office

Building 8. Classrooms

Building 9. Classrooms

Building 13. Classroom

Building 14. School stage

Building 15. Classroom

Building 16. School Clinic

Building 17. Classrooms

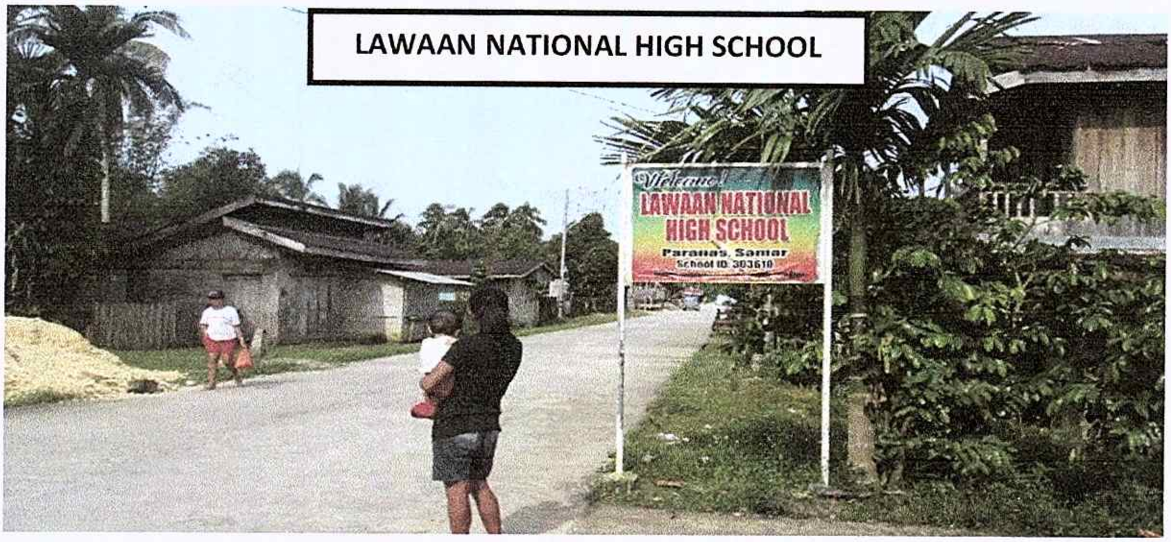
Building 18. Computer Lab

Building 19. Classrooms

Building 20. Classroom

Building 27. Classrooms

LAWAAN NATIONAL HIGH SCHOOL

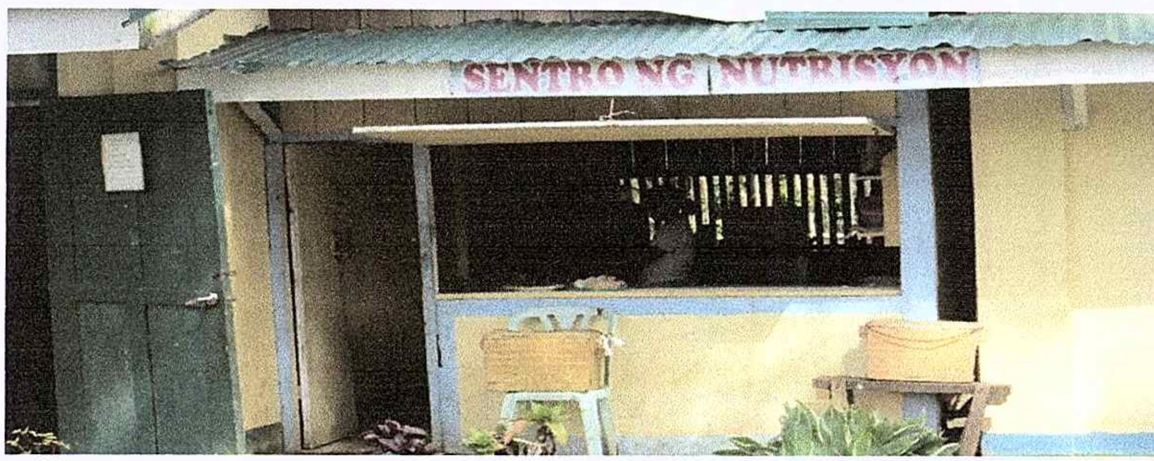


At the highway

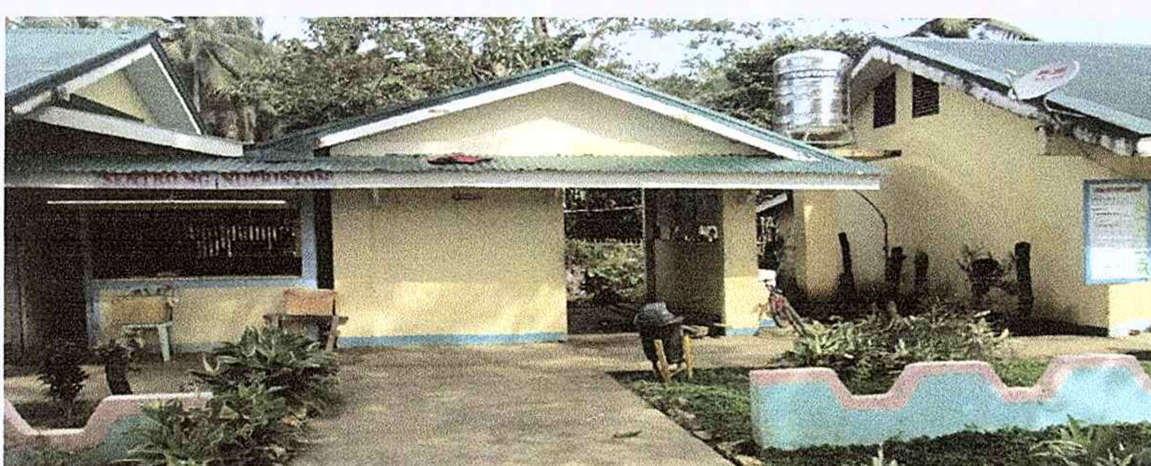
Lawaan National High School

Building 2. The school stage and the covered court

Building 3



Building 4



Building 5. Comfort Room

Building 6

Building 6

Building 7 at the left and Building 8 to the right of it.

Building 8

Building 8 at the left and Building 9 to the right of it.

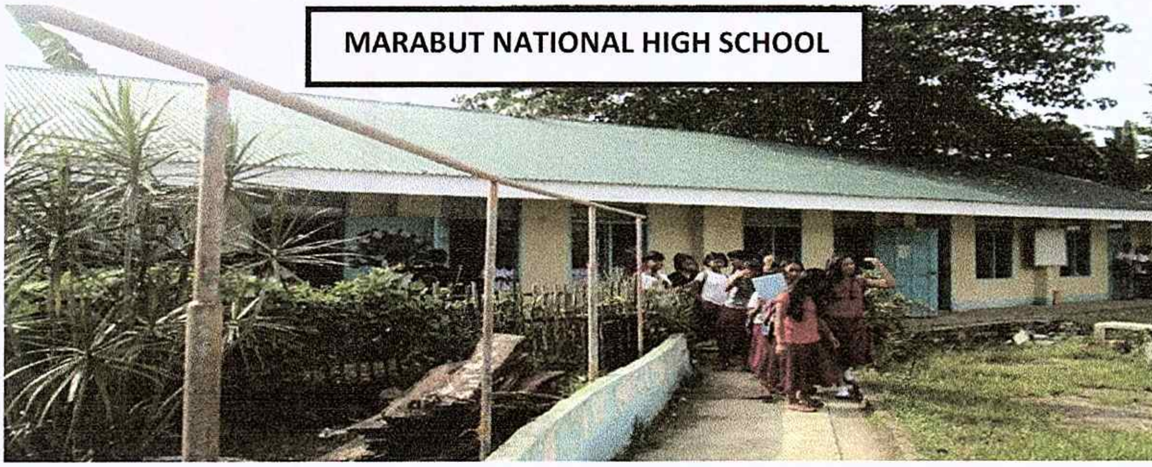
Building 10

The ground of LNHS

The LNHS ground

The LNHS ground

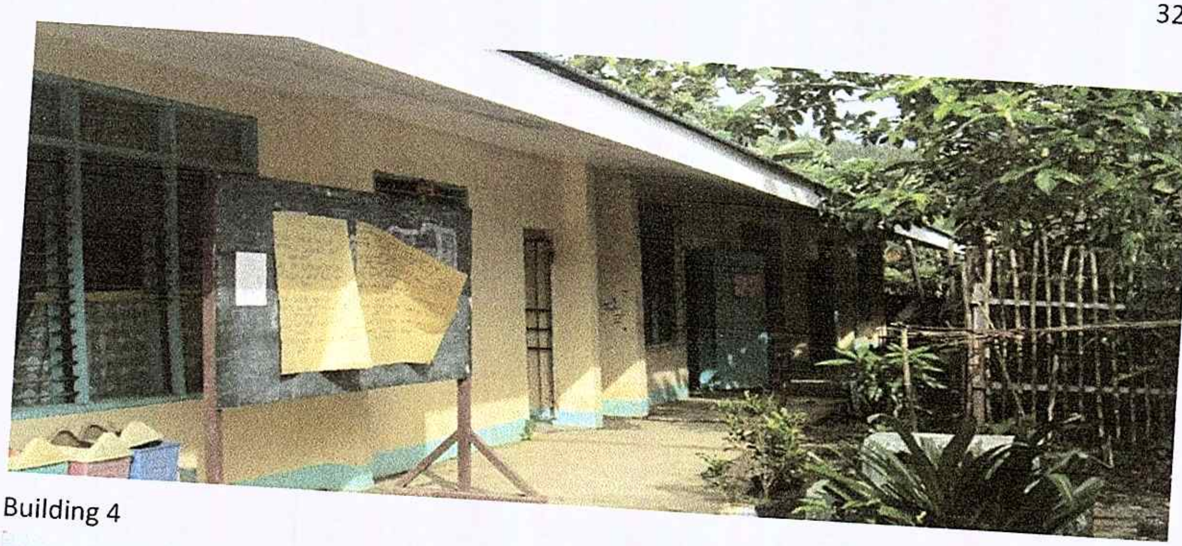
MARABUT NATIONAL HIGH SCHOOL



Building 1

Building 2

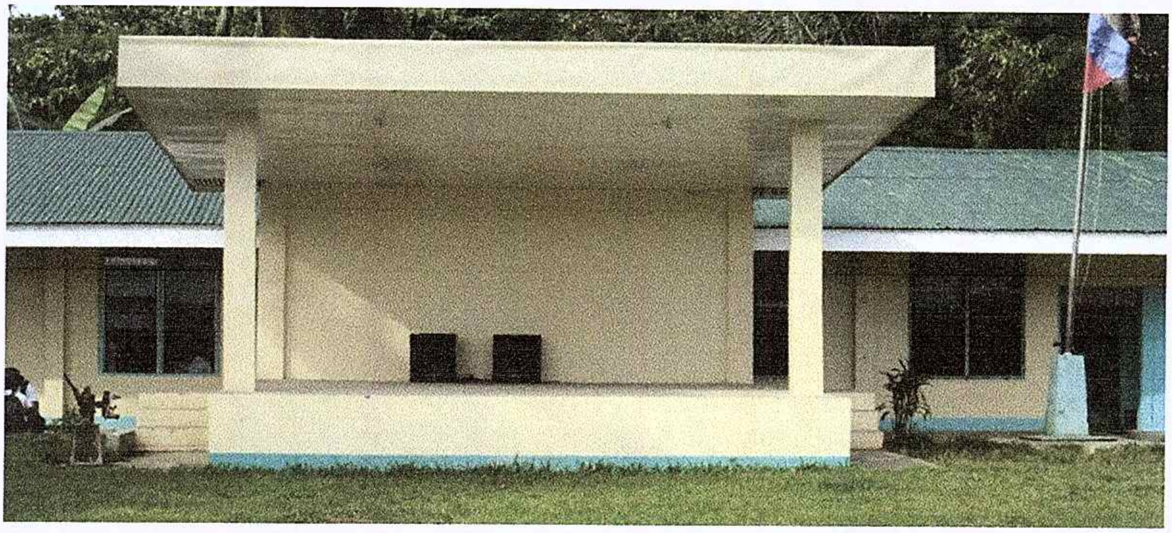
Building 3



Building 4

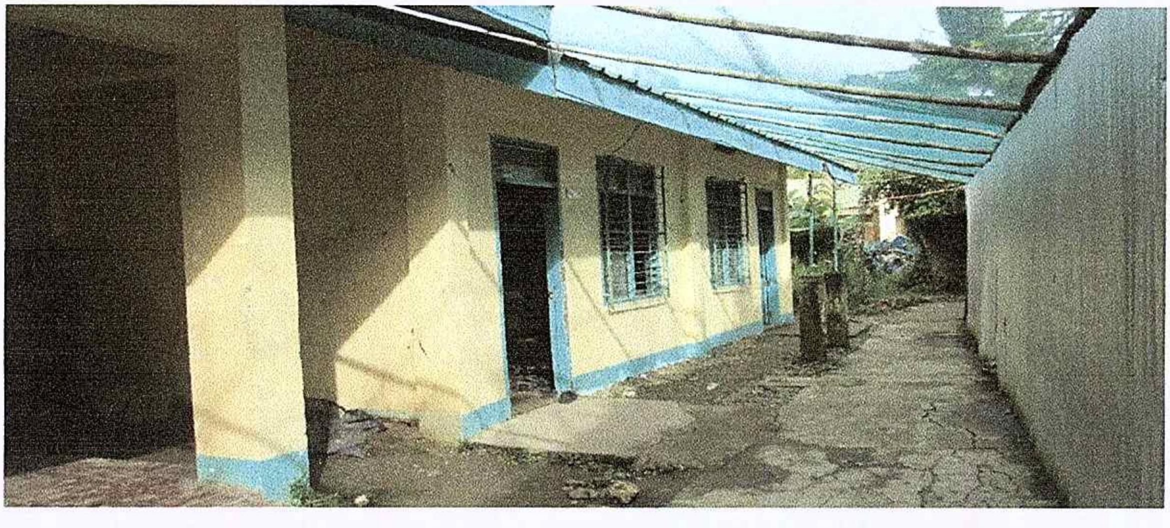
Building 5

Building 6

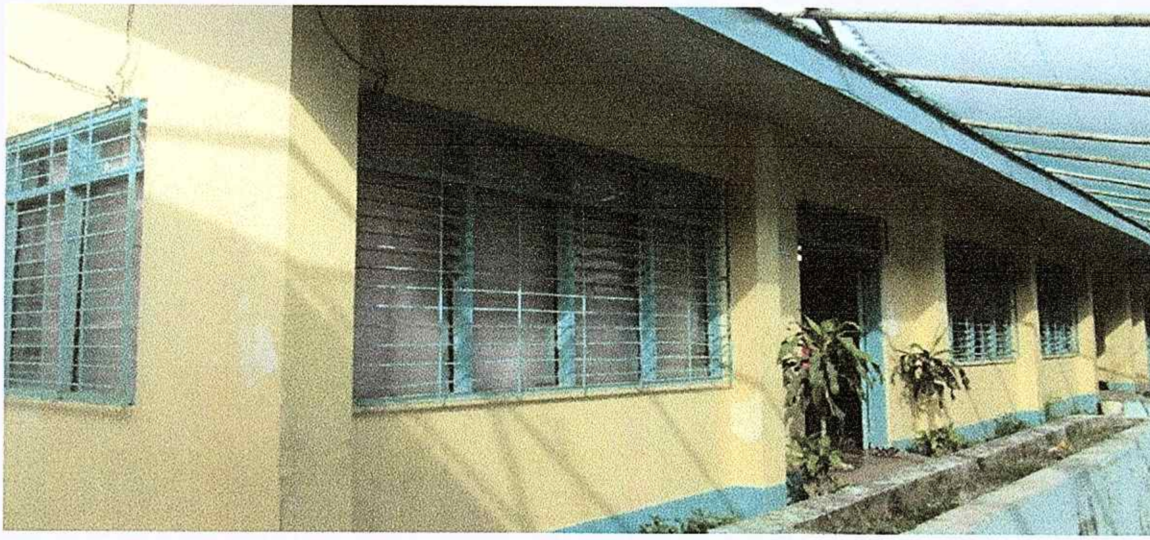


School stage

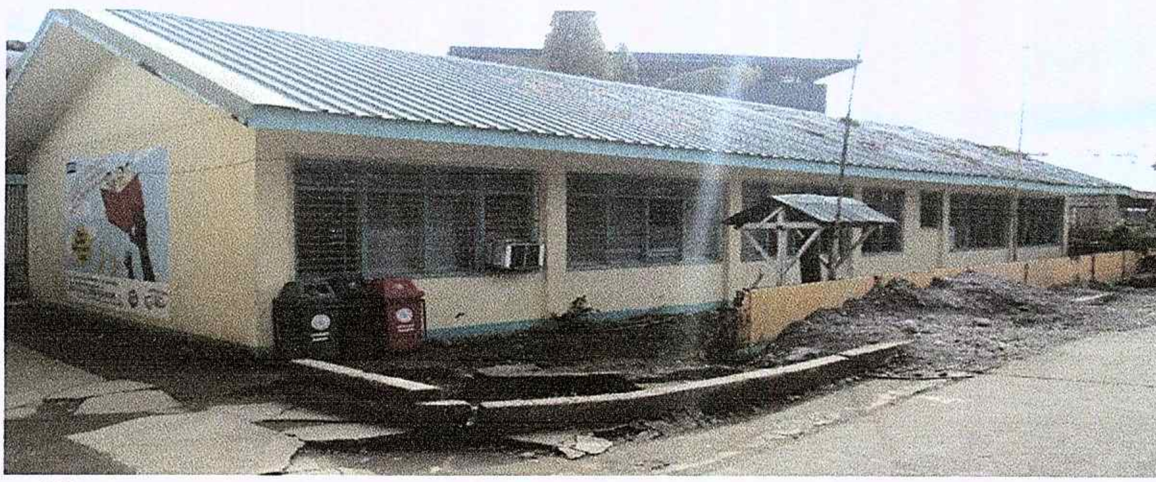
Building 10



Building 9



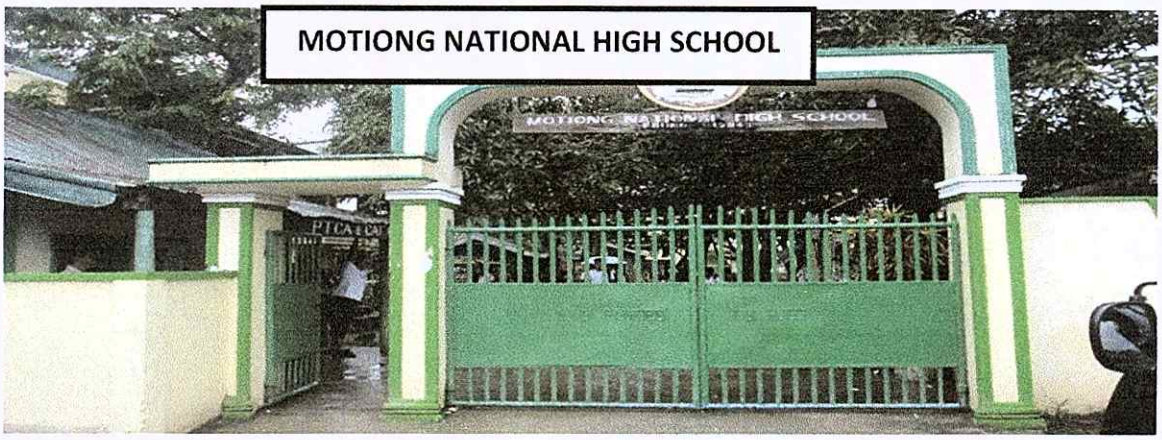
Building 8



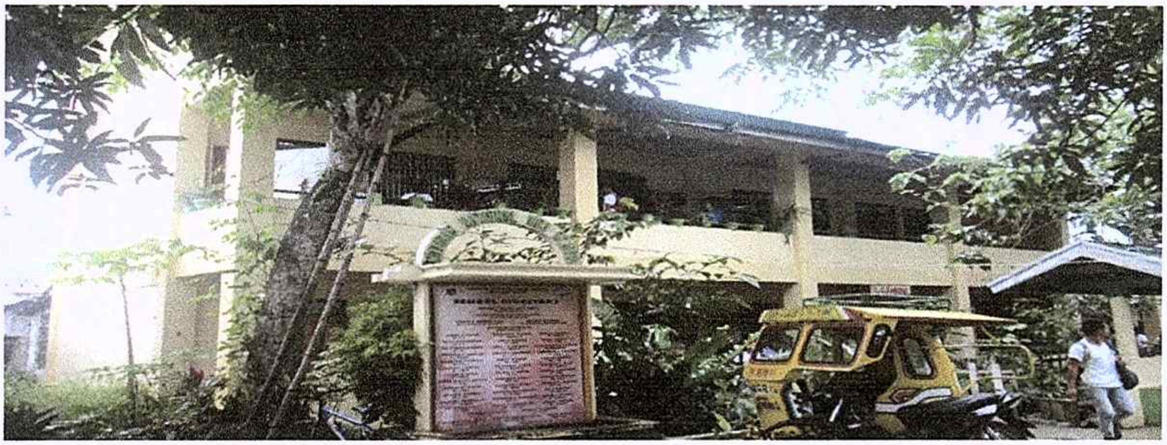
Building 7

Sr High Building

MOTIONG NATIONAL HIGH SCHOOL



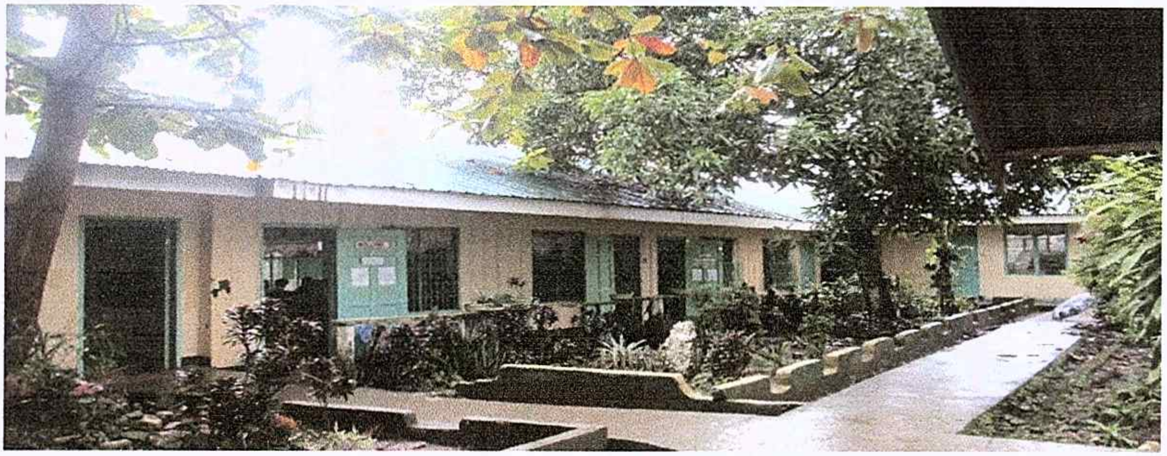
Main entrance at Motiong National High School.



Building No. 2, the TLE building.

Building No. 3.

Building No. 4



Building No. 5

Building 6 showing one room damage due to the constrution of the adjacent building (Building No. 7)

A two-room Building No. 6. A clear view of the damage room adjacent to the three-storey building

Another clear view of the damage room showing the damage portion.

Building No. 7.

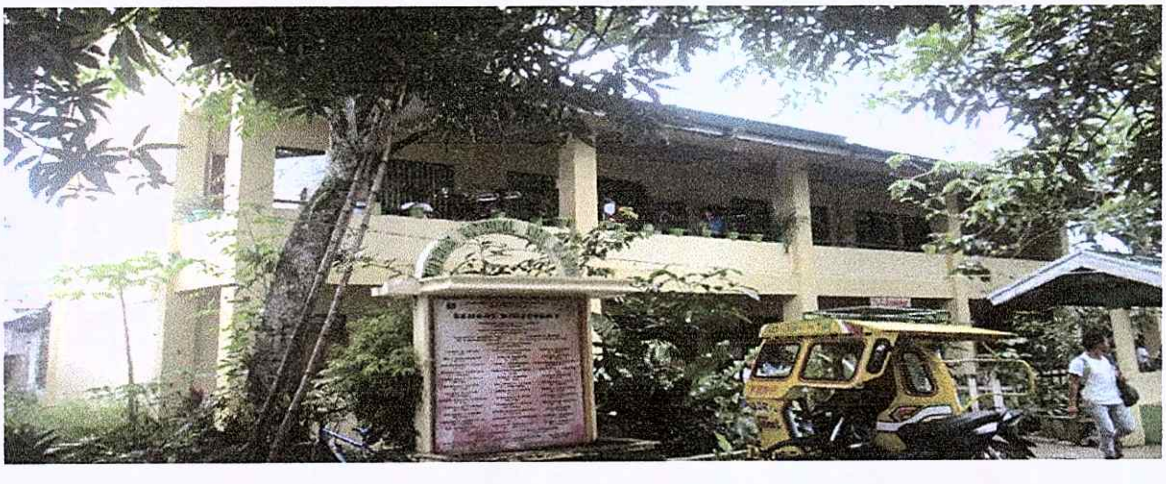
Building 8. Showing the damage portion due to the construction of the adjacent building.(Building No.

A clear view of the damage portion of Building No. 8

Building 9 (Comfort Room)

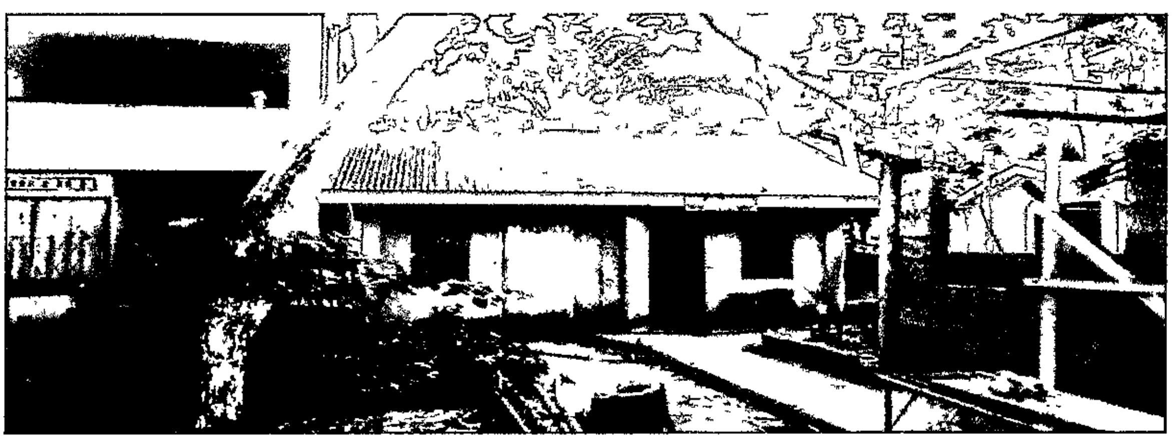
Inside Building No.9 (Comfort Room)

Building No. 10



Building No. 11

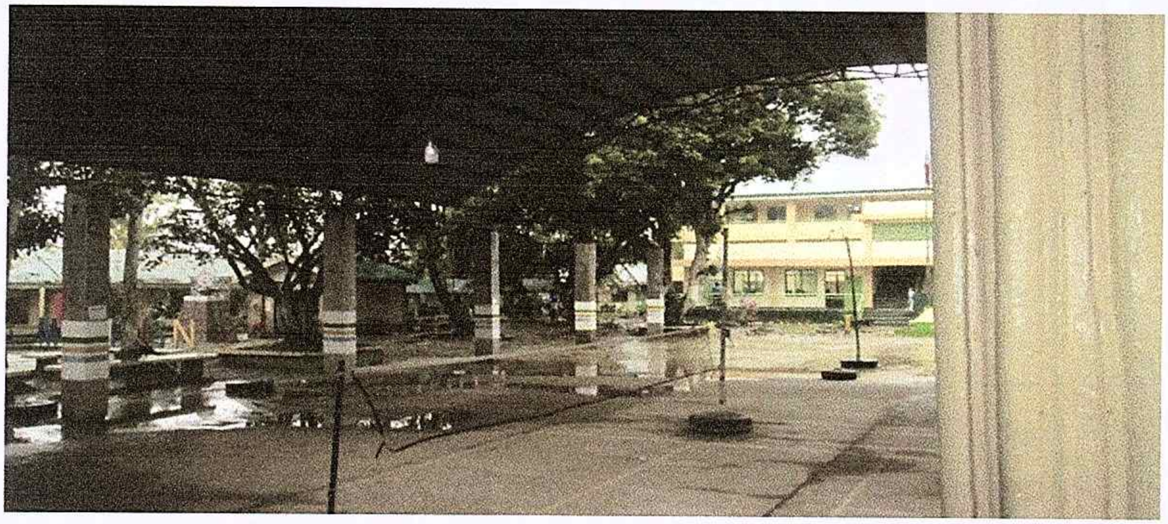
Building A. A resilient building.



Building No. 12

Building No. 13

Building 15. The Administration Building

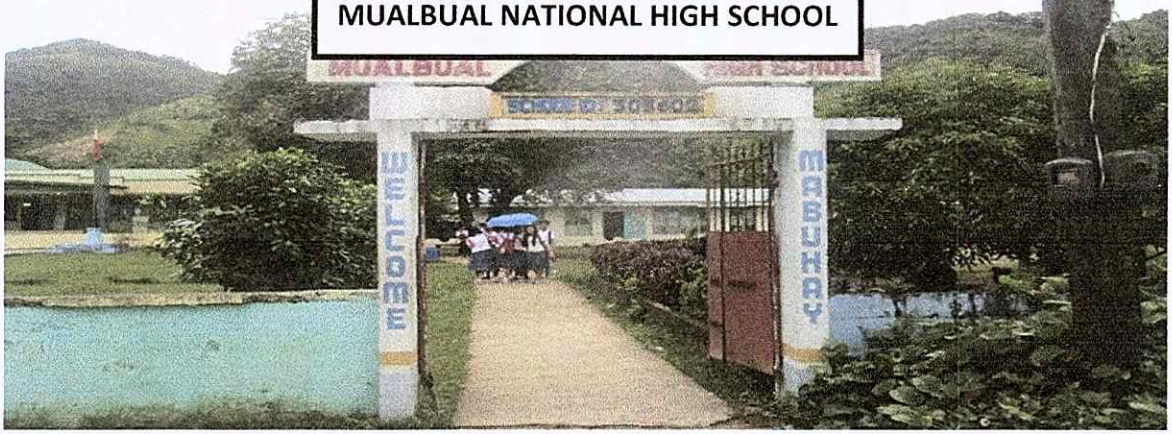


The covered court

Building 19. The school stage

Building B is on-going construction.

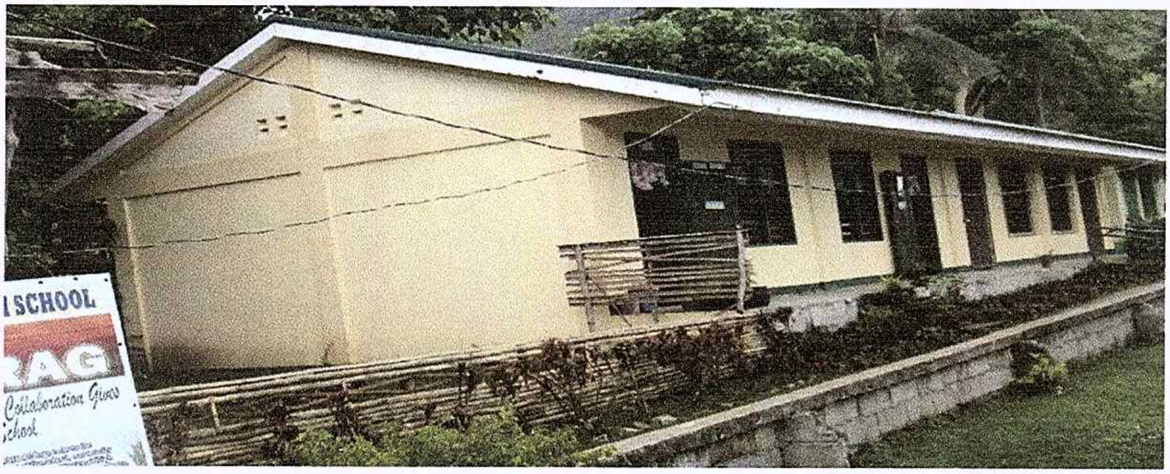
MUALBUAL NATIONAL HIGH SCHOOL



Main Entrance to Mualbual National High School

Building 1

Building 2



Building 3

Building 4

Building 5

Building 6

Building 7

Building 8

OLD SAN AGUSTIN NATIONAL HIGH SCHOOL

The main entrance to Old San Agustin National High School (OSANHS)

Building 1

Building 2. Sr. High Building

Building 3

Building 4. The comfort room

Building 5

Building 6. A makeshift classroom

From L-R: Building 7 painted and Building 8 not painted

Building 8

Building 9

Building 11

Building 12

Building 13

OSMEÑA NATIONAL HIGH SCHOOL

Building 1 and Building 2

Building 3

Building 4

Sr. High Building

Building 5

Building 6

Building 7

Building 8

Building 9

Building 10

Building 11

Building 12

Building 13

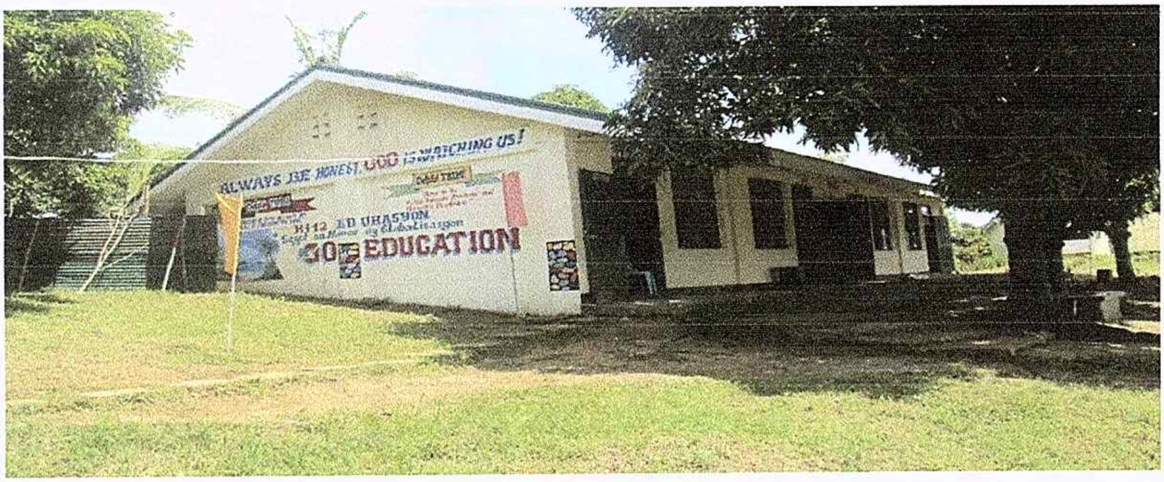
Building 14

Building 15

PANGDAN NATIONAL HIGH SCHOOL

Building 1

Building 2



Building 3

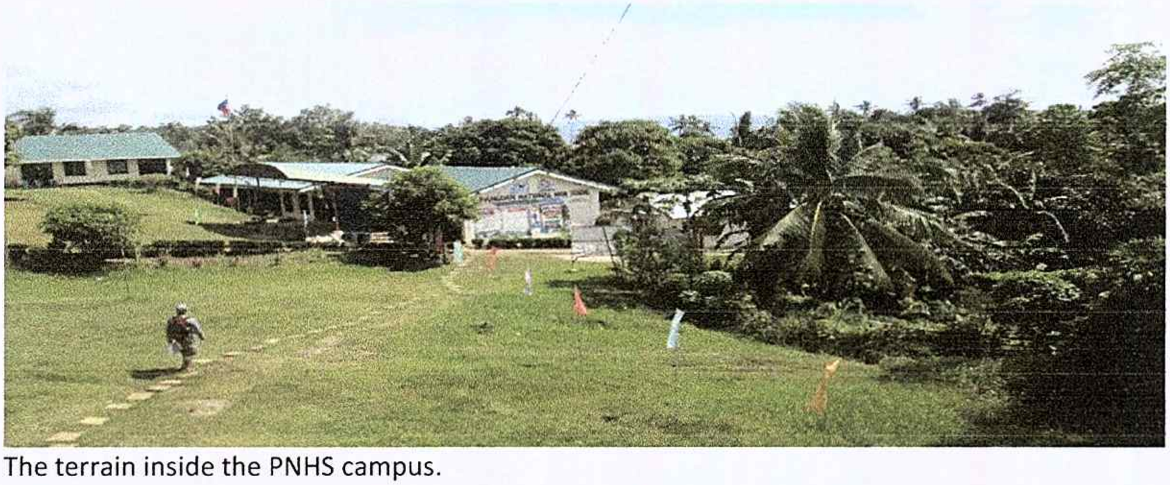
Building 4. School Library

Building 5

Building 6

Building 7

Building 8. School stage

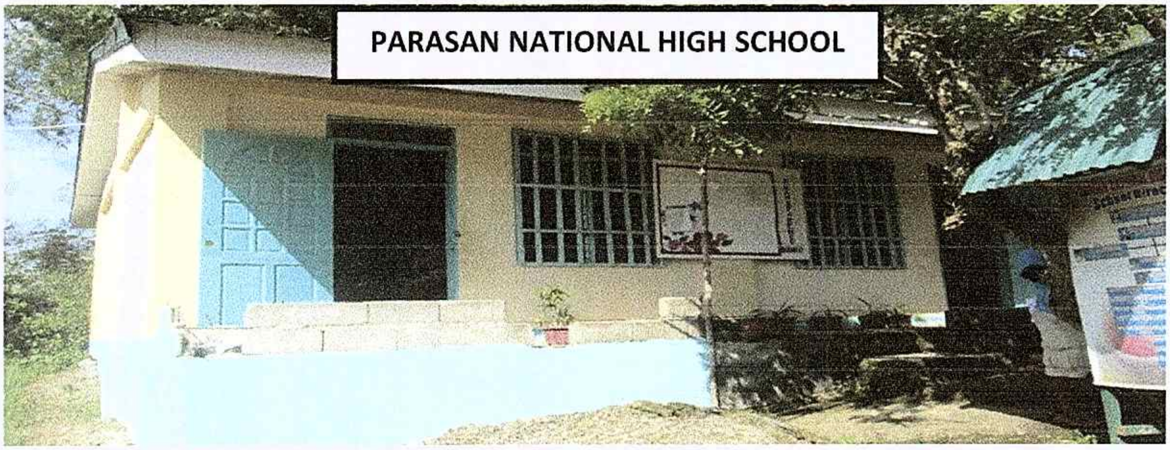


The terrain inside the PNHS campus.

The terrain of PNHS campus.

The terrain at PNHS campus.

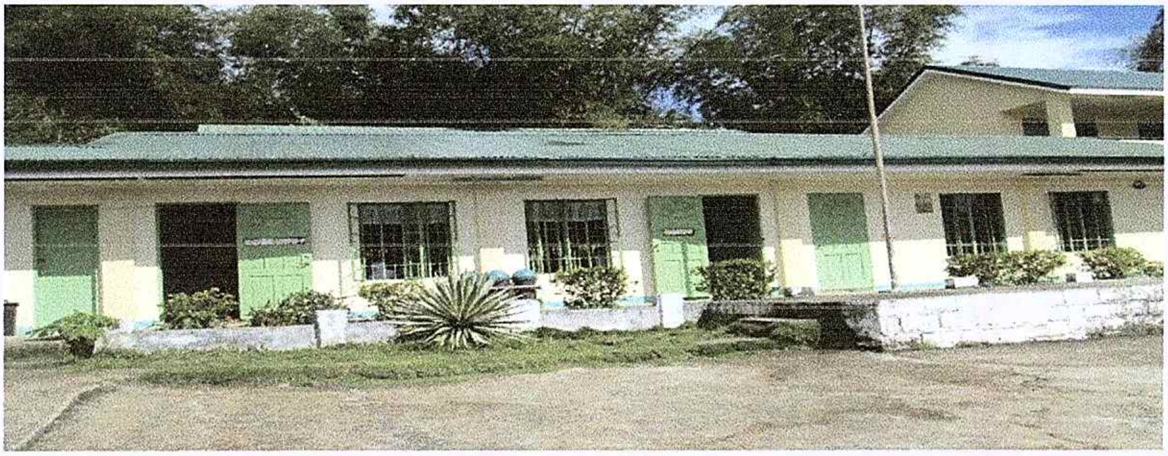
The terrain behind Building 6



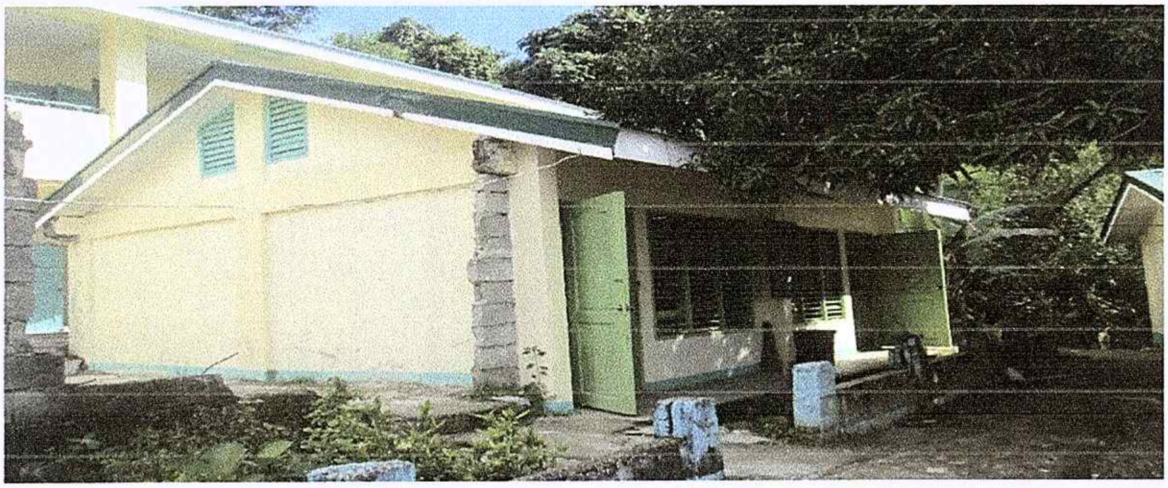
Building 1. Parasan National High Schoolp

Building 2

Building 3



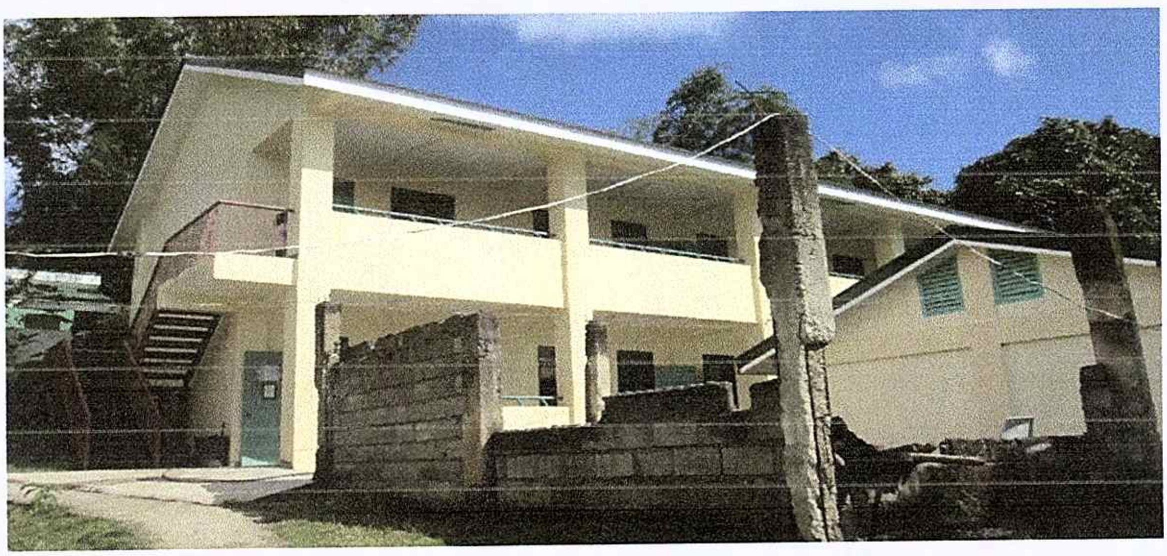
Building 4



Building 5

Building 6

Building 7



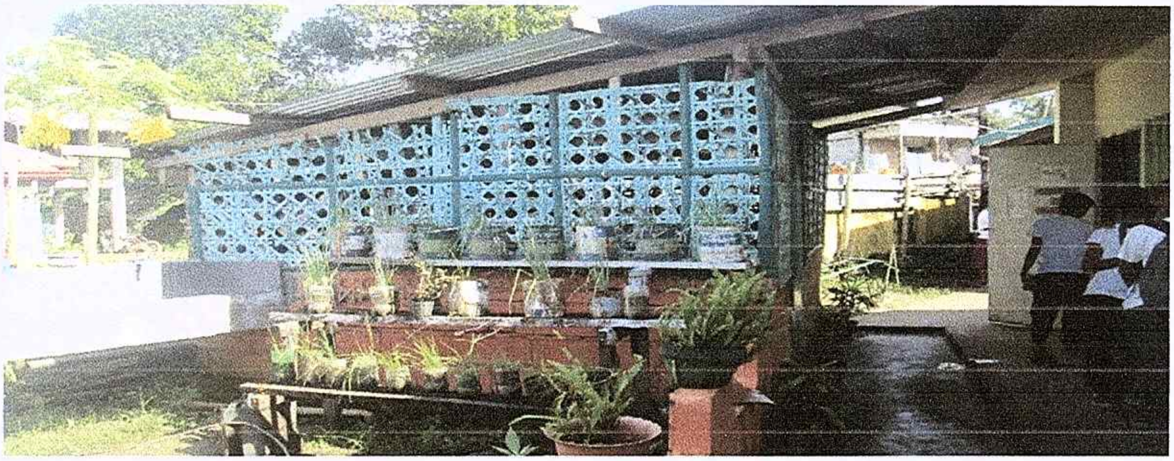
Building 8

PARASANON NATIONAL HIGH SCHOOL

The main entrance to Parasanon National High School.

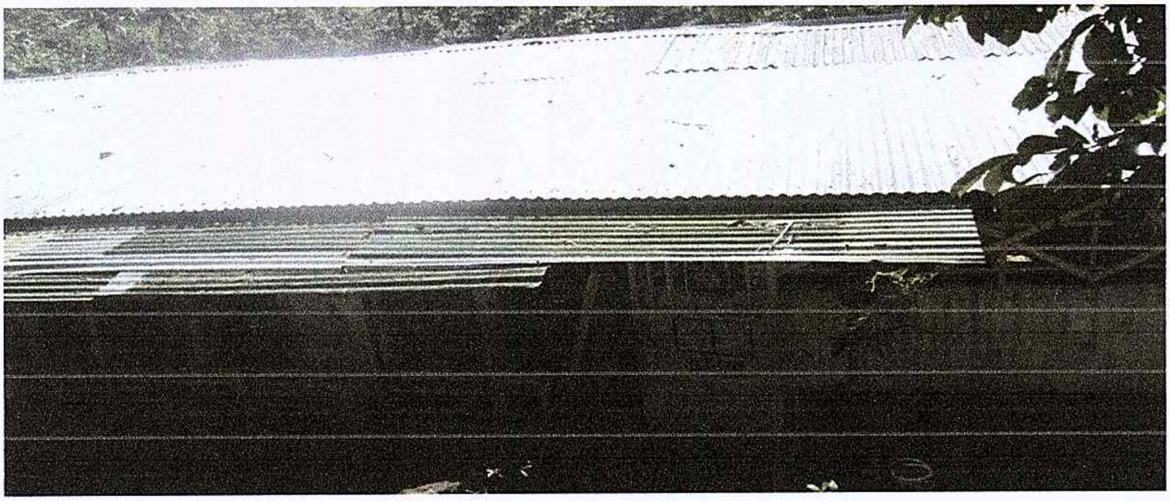
Building 1. The school stage

Building 2. A makeshift Reading Center.

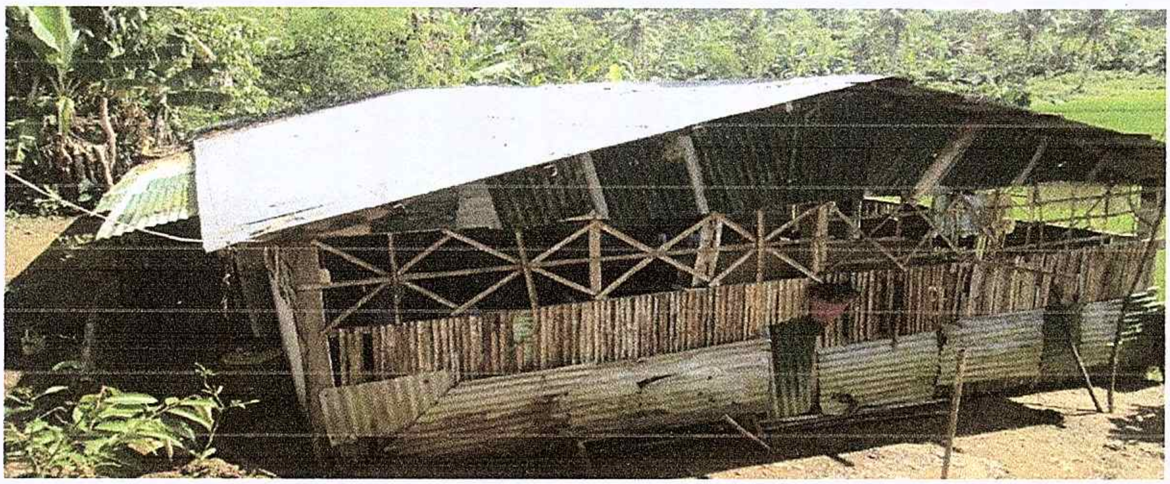


Building 3. A makeshift for washing facility.

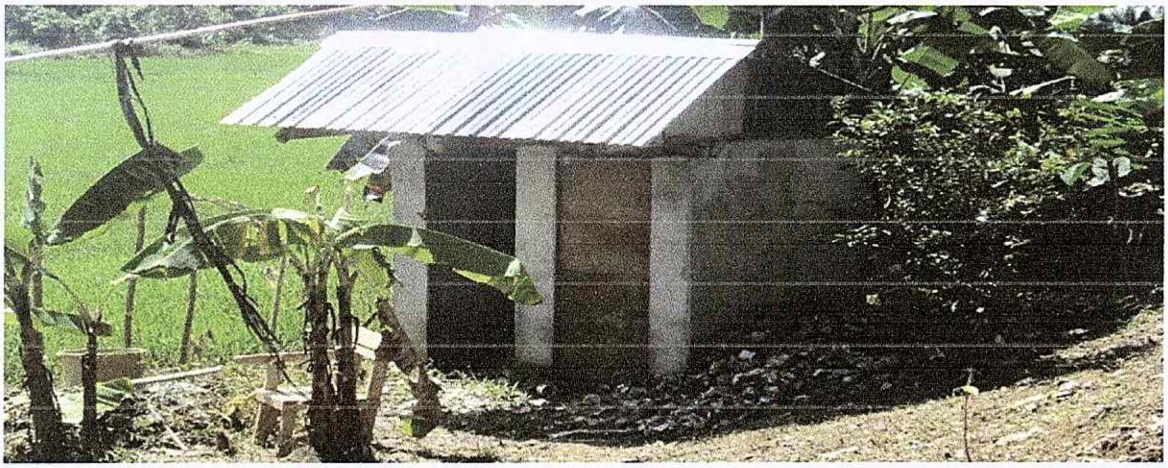
Building 4.



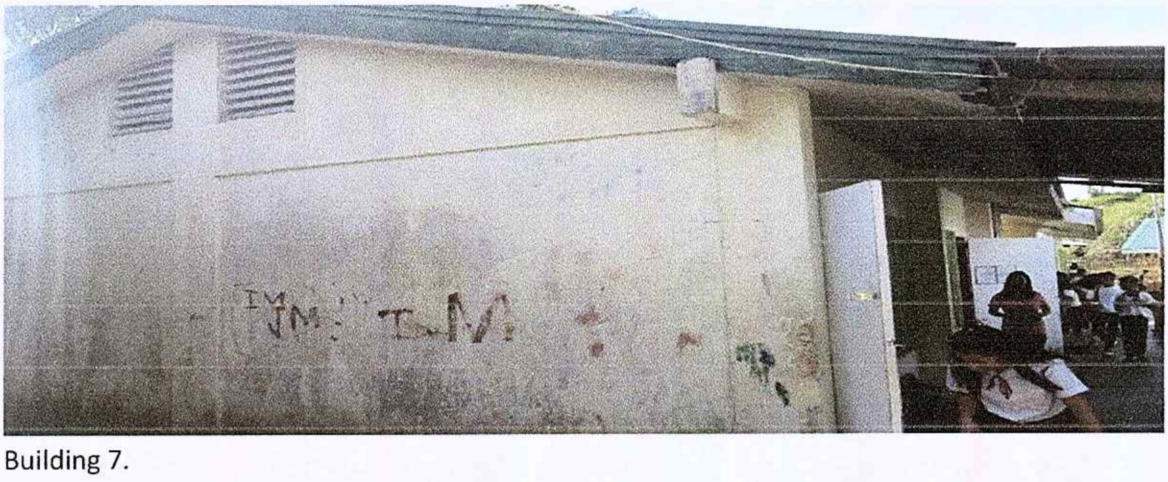
Building 5. A makeshift classroom.



Building 5



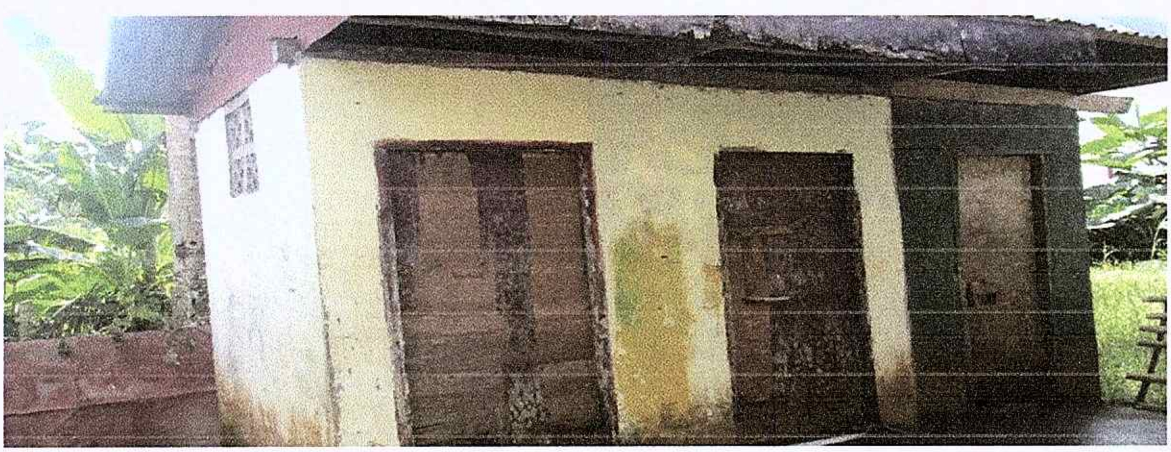
Building 6. Comfort Room



Building 7.

Building 8. School Guidance Office.

Building 9



Building 10. Comfort Room

Building 11

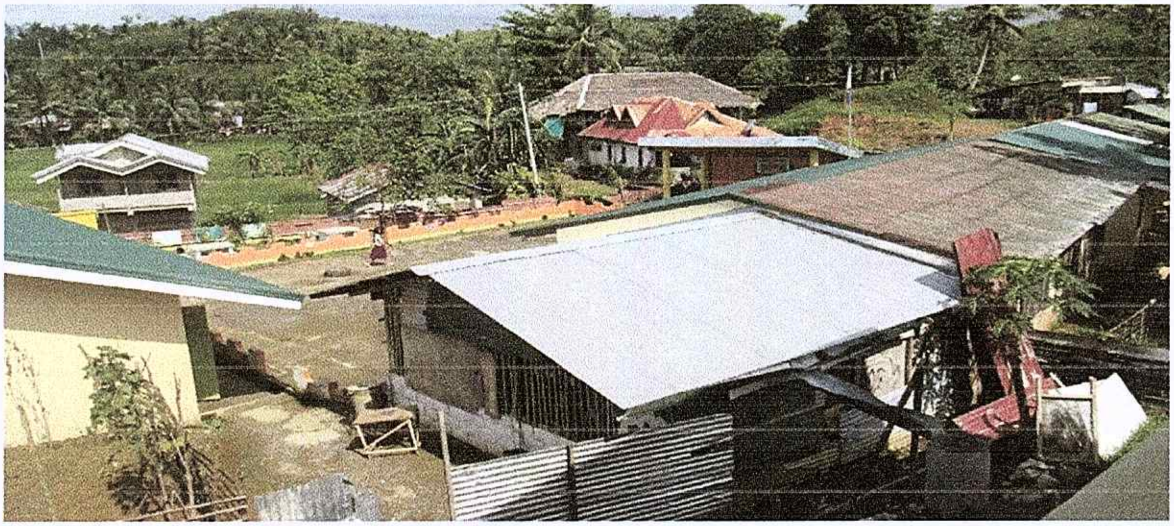
Building 12. A makeshift classroom

Building 13. On going construction of the building.

Building 14.

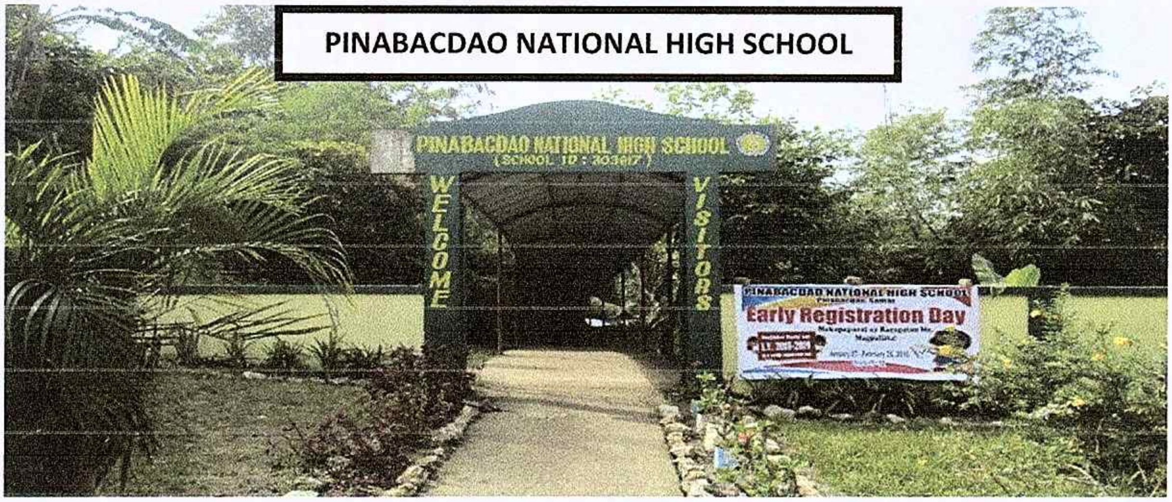
Building 15. The PTA and SSG Office.

A photo shot from Building 13, showing the PNHS campus.



A photo shot from Building 13 showing the PNHS campus.

PINABACDAO NATIONAL HIGH SCHOOL



The main entrance to Pinabacdao National High School (PNHS)

No. 1. The covered walk towards PNHS

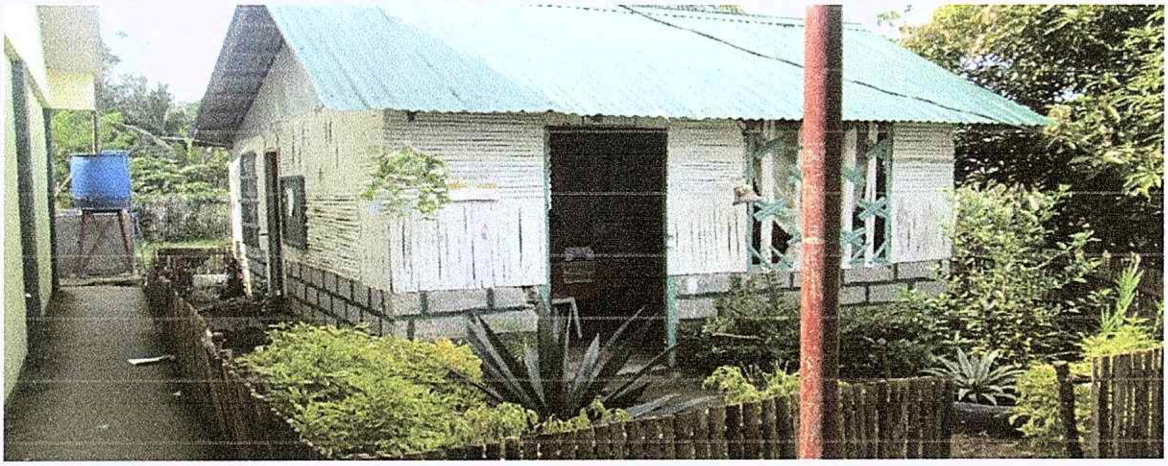
No. 2. Building 1

No. 3. Between Building 1 and building 2 is the kitchen.

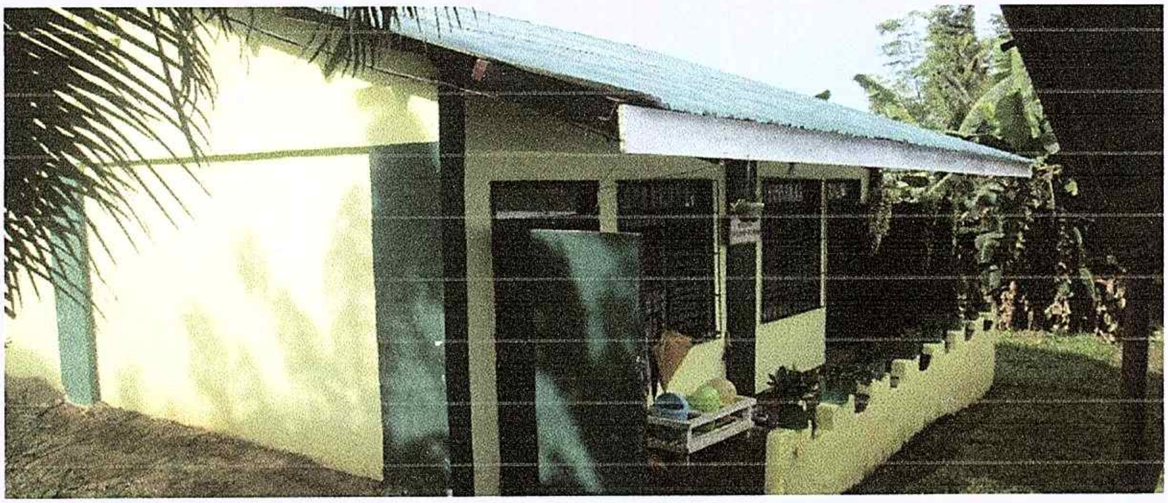
No. 4. Building 2

No. 5. Building 3 is the Principal's Office.

No 6. The school comfort room.



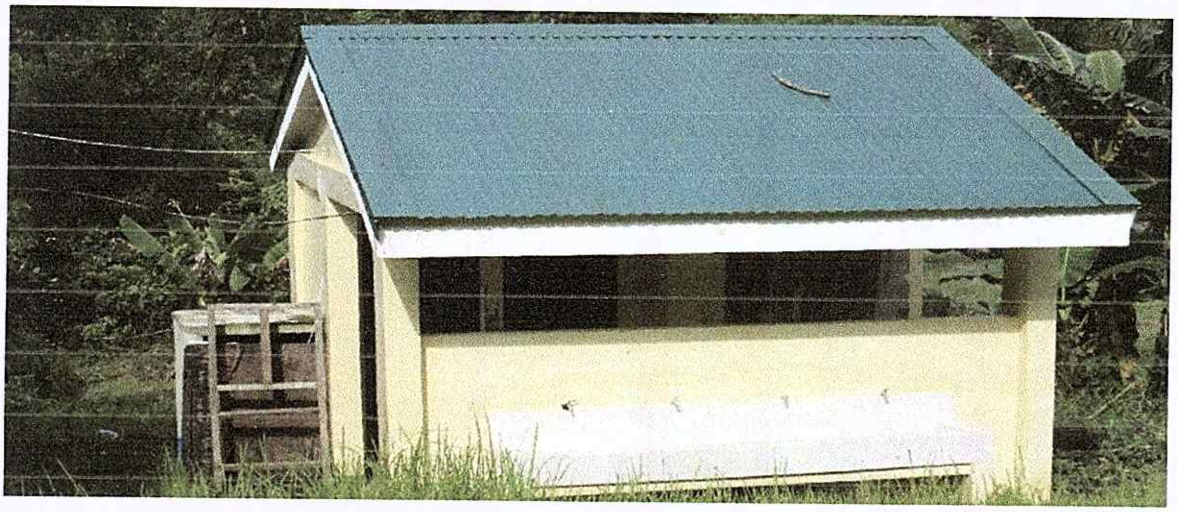
No. 7. The SSG/Reading Clinic



No. 8. Building 4

No. 9. Building 5

No. 10. Open Building

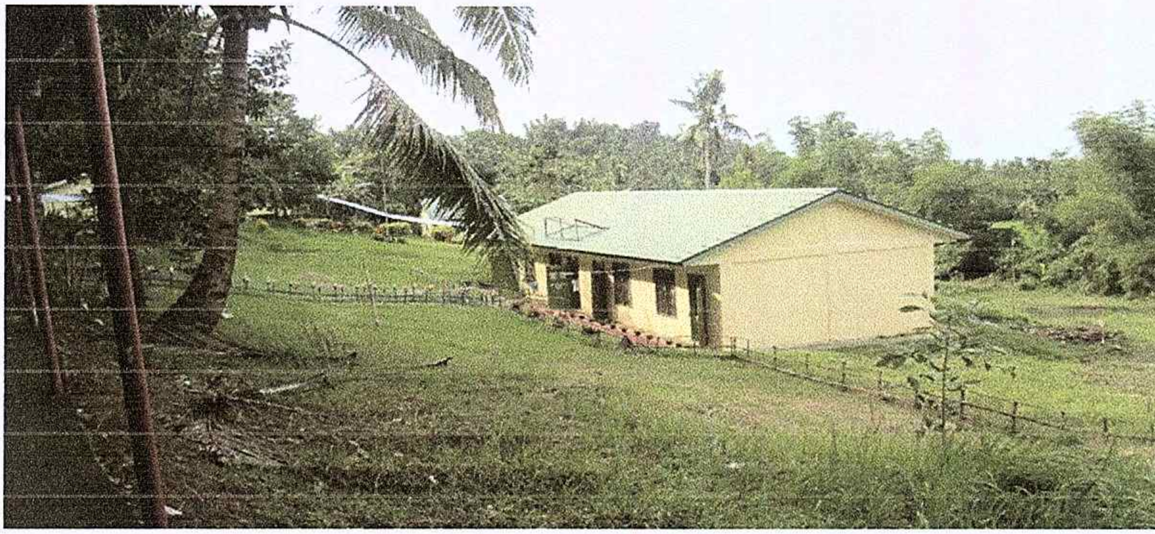


No. 11. The comfort room

No. 12. Building (SHS)

Photo shot from SHS building showing the terrain of PNHS and the hill after the covered walk.

The hilly terrain of PNHS.



A photo shot from the covered walk to PNHS campus.

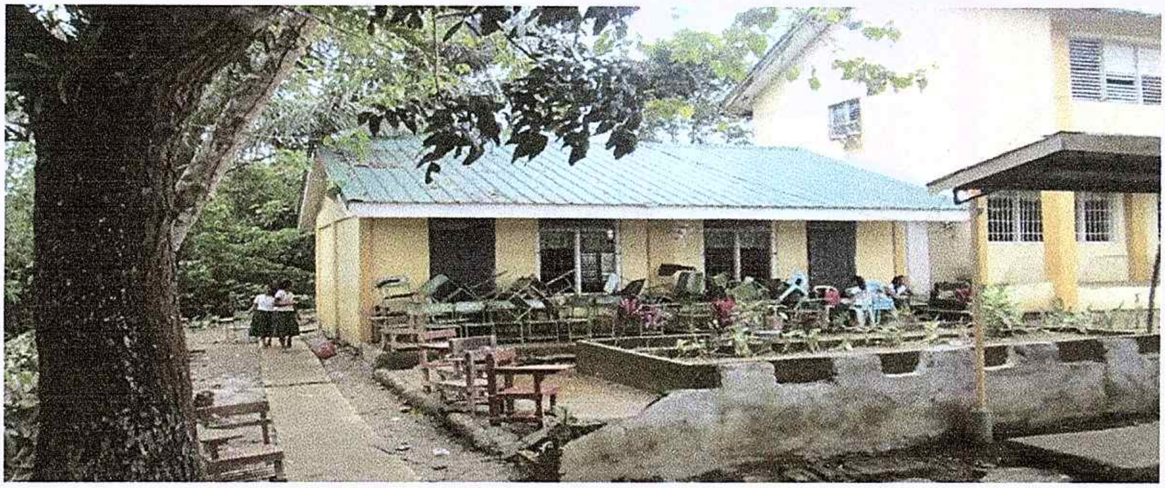
The terrain of the PNHS campus.

QUINTIN QUIJANO Sr. AGRICULTURE SCHOOL

Building 1 (PSIP Building)

Building 2 (Stage with stock room and comfort rooms)

Building 3 (Covered court)

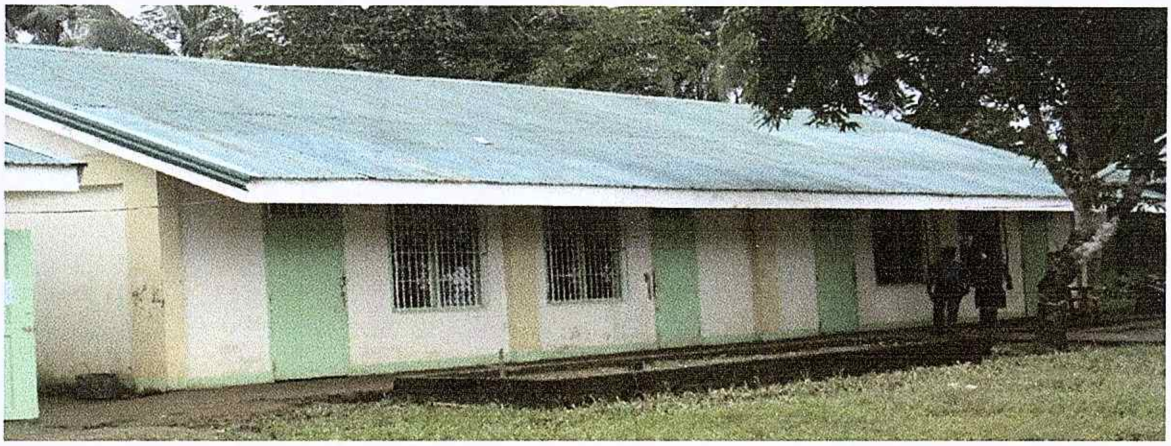


Building 4 (Academic Room)

Building 5 (Two-Storey SEDP building with Library, Computer Lab. And Classrooms)

Building 6 (Academic Building)

Building 7 (Academic Room)



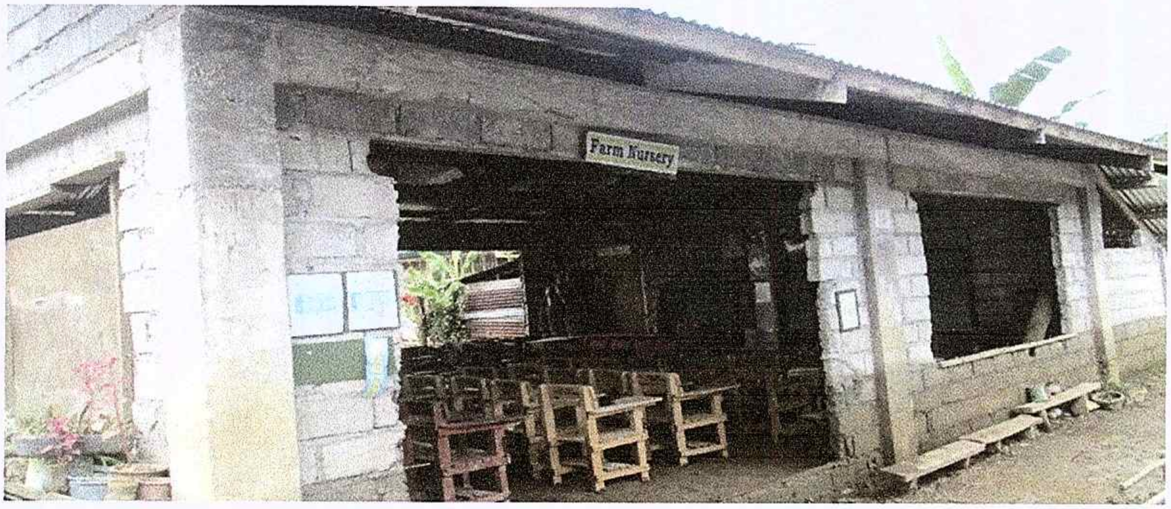
Building 8 (Academic Building

Building 9 (FVR Building)

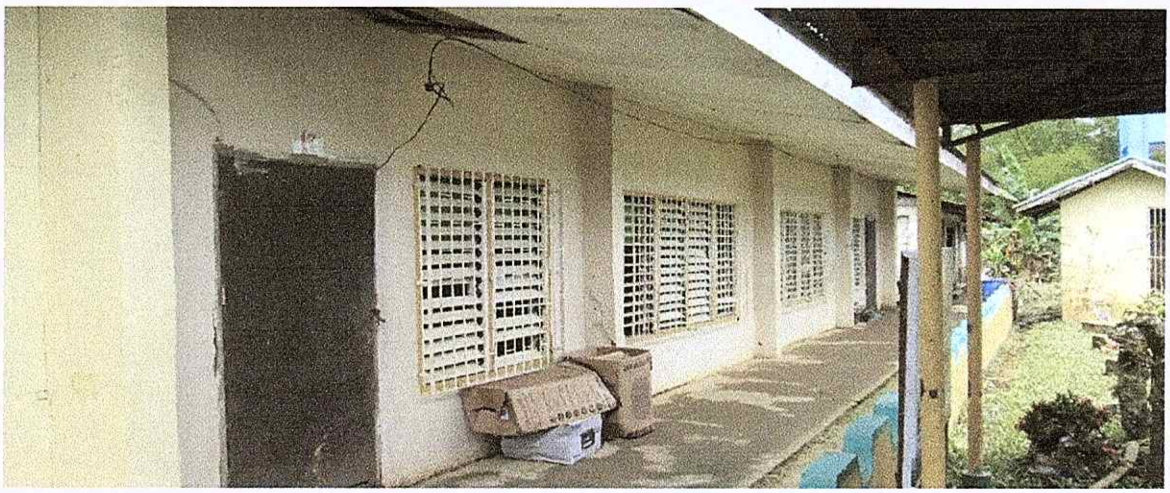
Building 10 (SHS Two-Storey Building)

Building 11 (Food Processing Laboratory)

Building 17



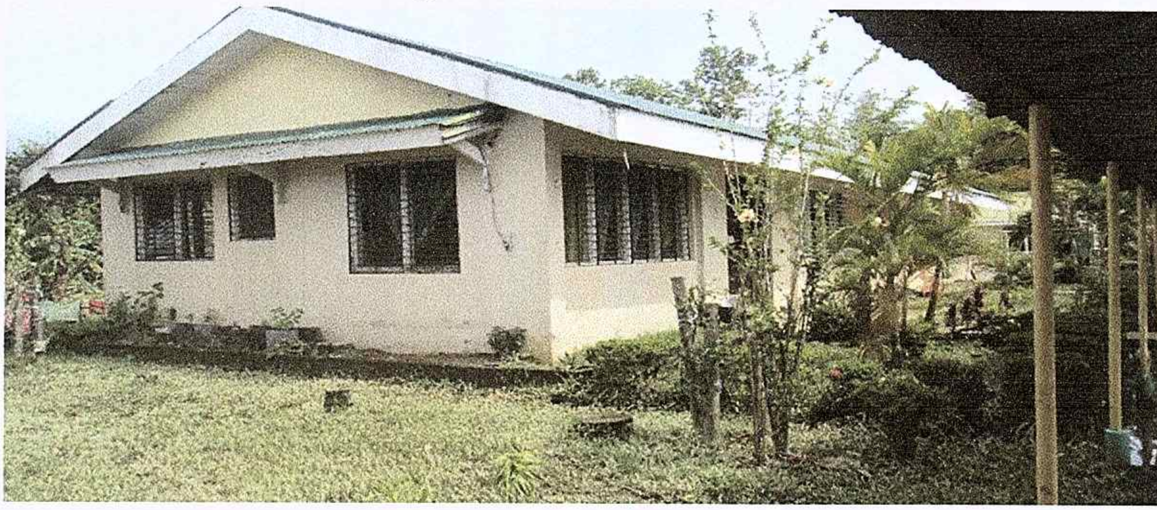
Building 12 (Horticulture Lecture and Nursery Room)



Building 13 (TechVoc Rooms)

Building 14 (Administration Building)

Building 15 (Water Tank and Pump)



Building 16 (Commercial Cookery Laboratory with Canteen)

Building 16 (Canteen)

Building 16 (Canteen)

The adjacent river which causes flood to QQSAS

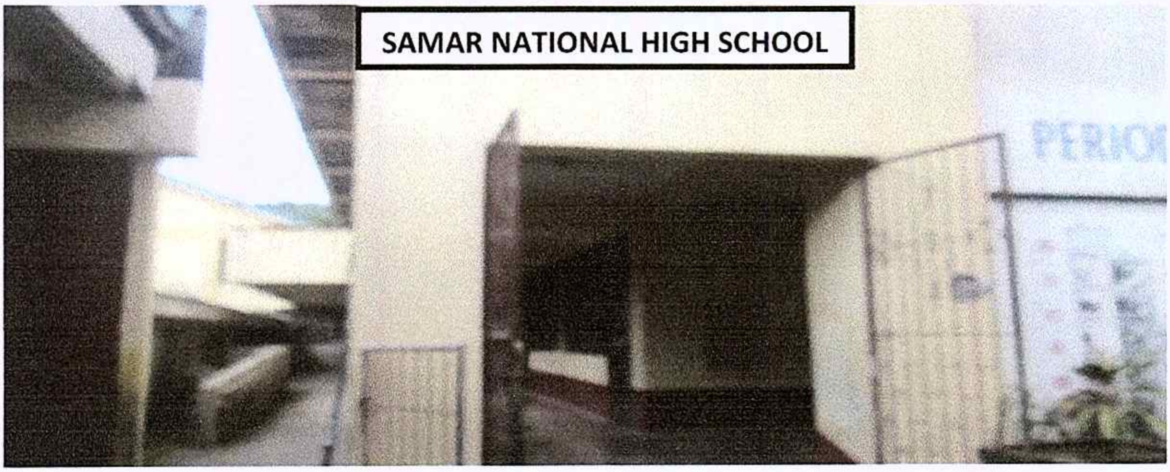
The adjacent river behind Building 1

The footbridge from the main road to QQSAS.

QQSAS is prone to flooding because of the adjacent river.

The main entrance at QQSAS.

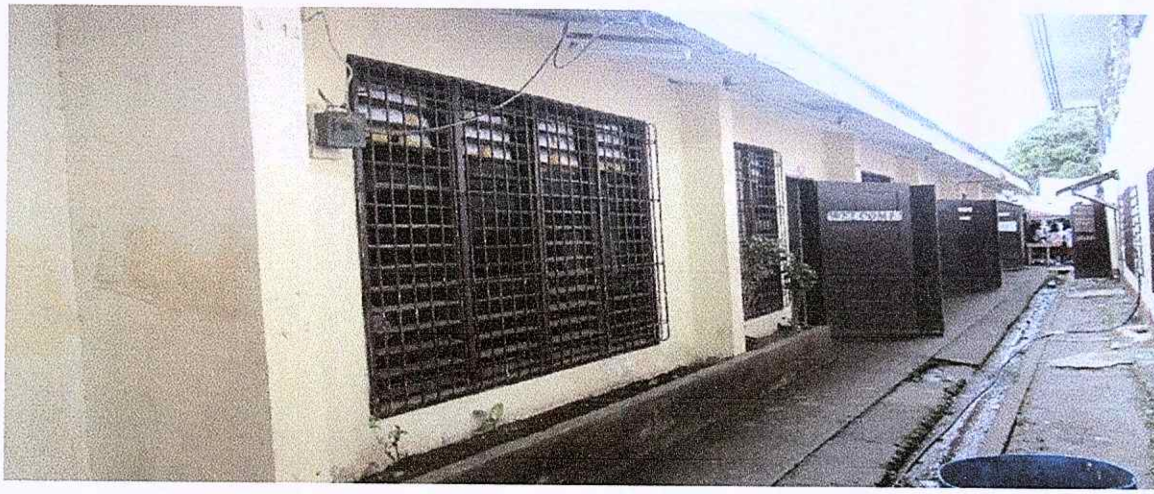
SAMAR NATIONAL HIGH SCHOOL



Building 25

Building 26

Building 27



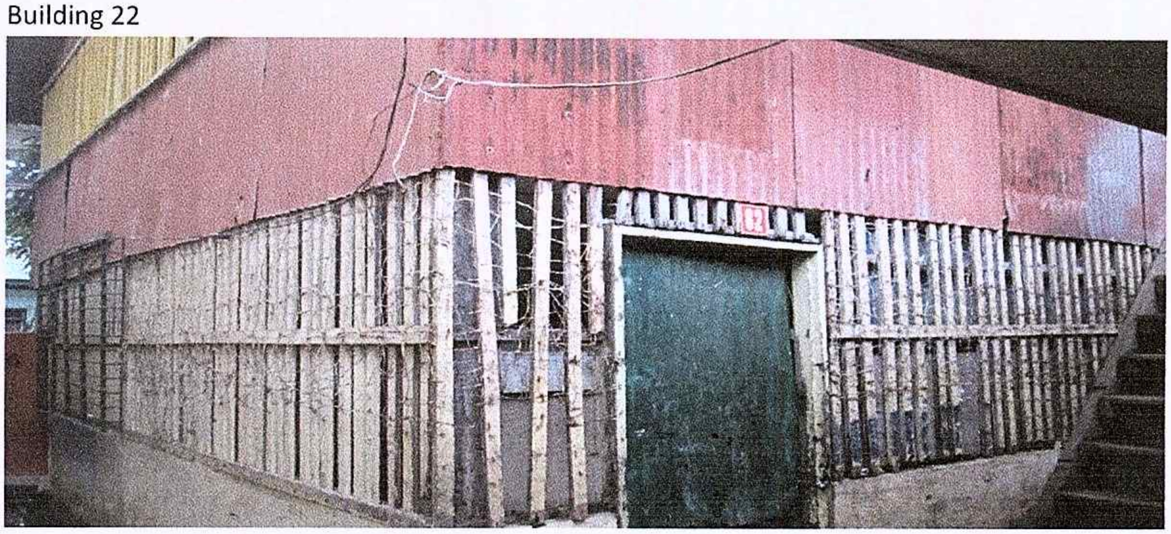
Building 28

Building 30

Building 47

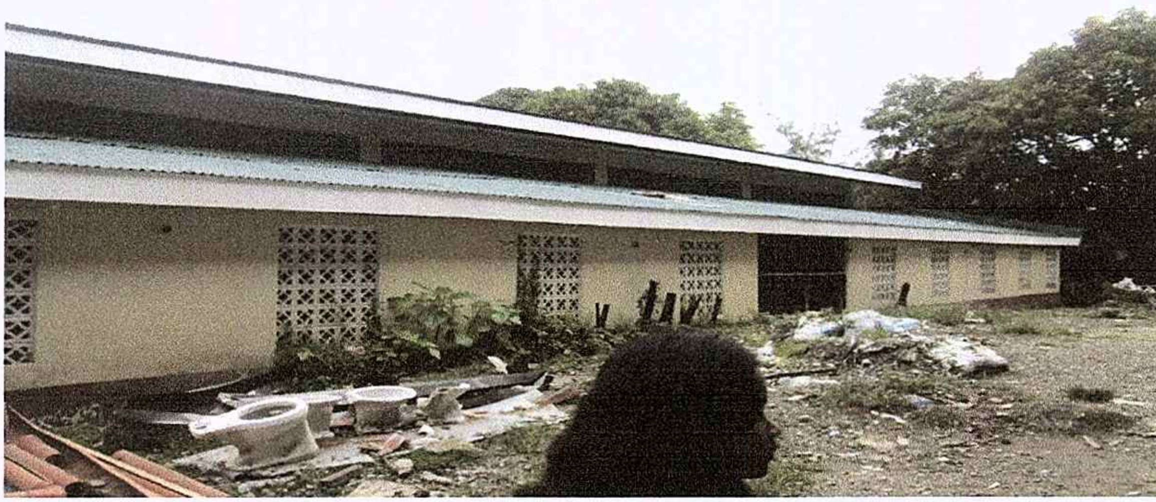
Building 24

Building 22



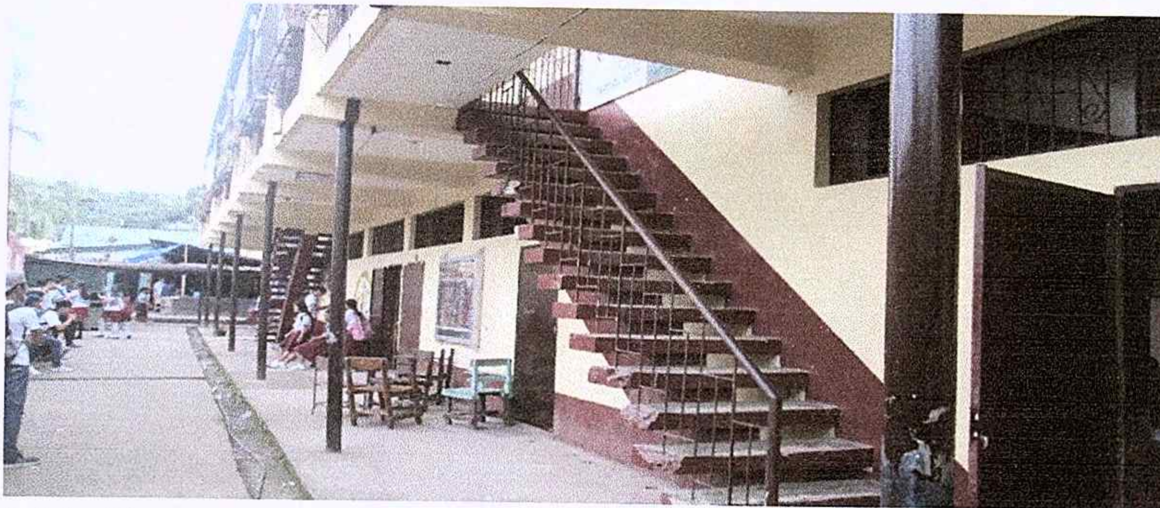
Building 20. A makeshift classroom.

Building 21. A makeshift classroom.



Building 45

Building 18.



Building 12

Building 14

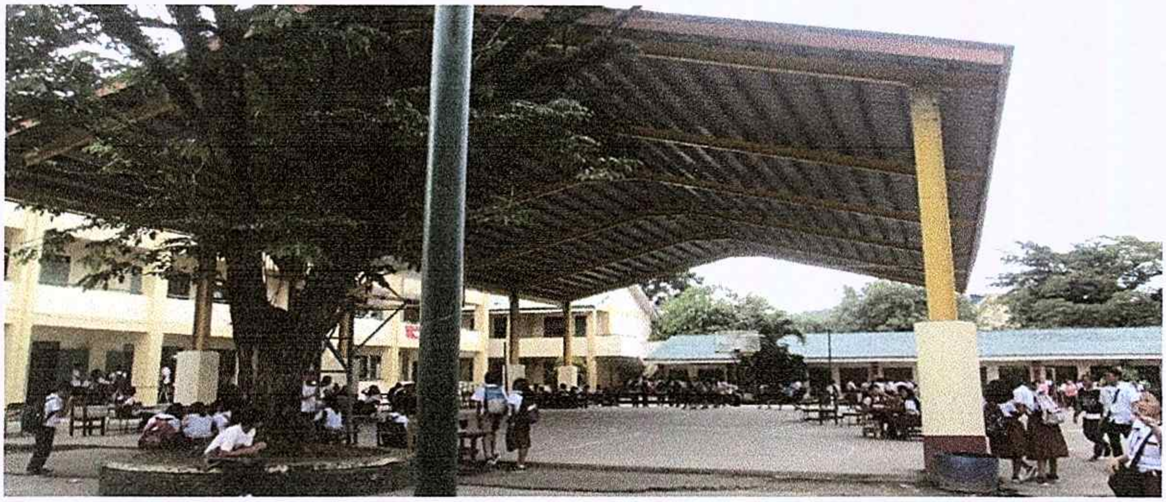
Building 39

Building 8

Building 9

Building 10

Building 38. Gabaldone Building



Building 34. The covered court

Building 2. The Sr. High Building

Building 4

Building 5

Building 52

Building 53

Building 55

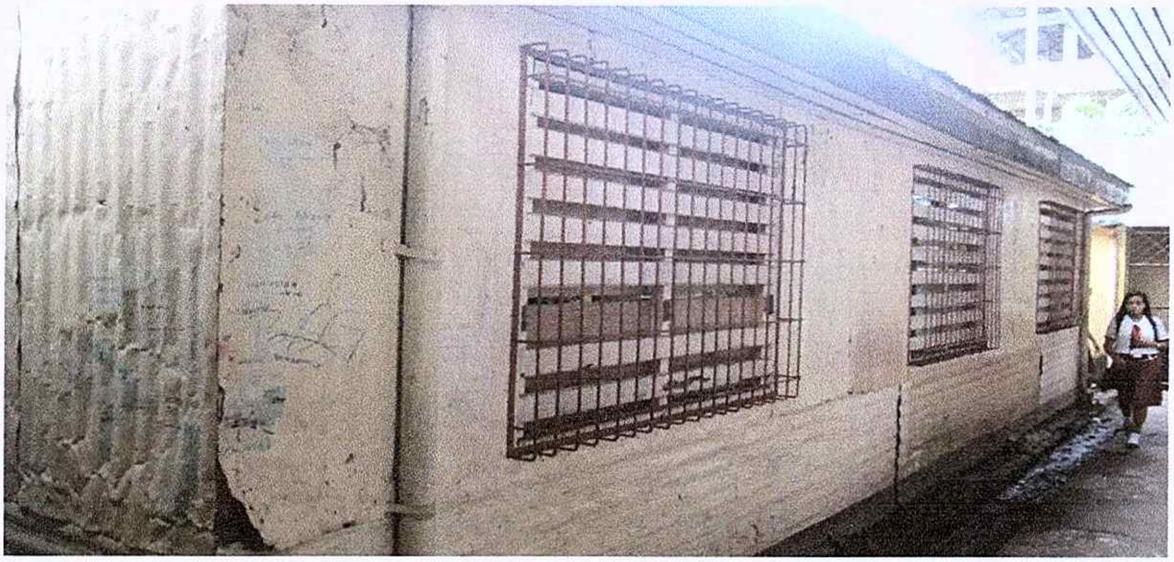
Building 50. The school canteen and classroom.

Building 56. The principal's office

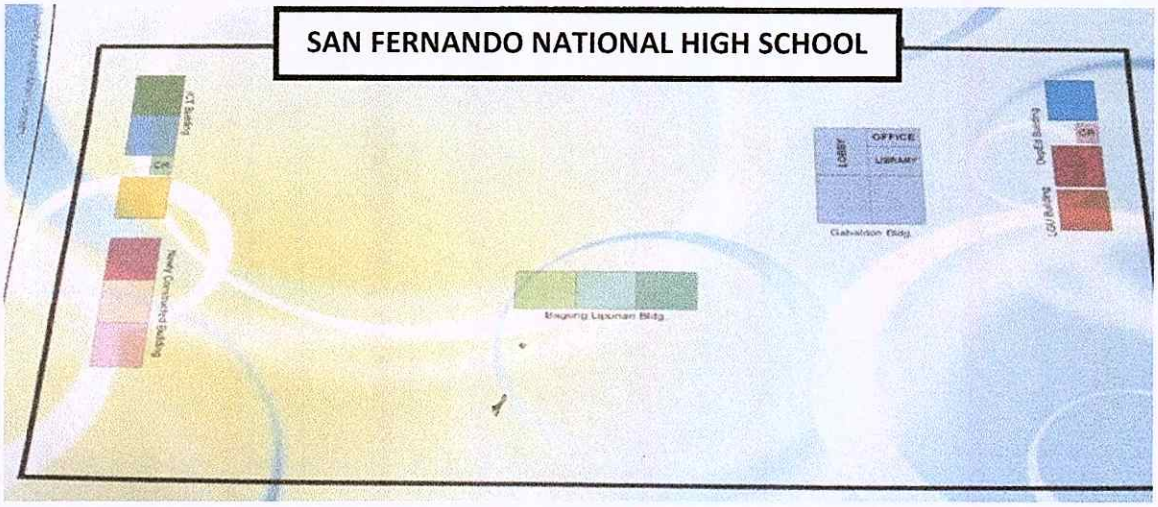
Building 31

Building 32. Makeshift office


Building 33



Building 51. Makeshift classroom



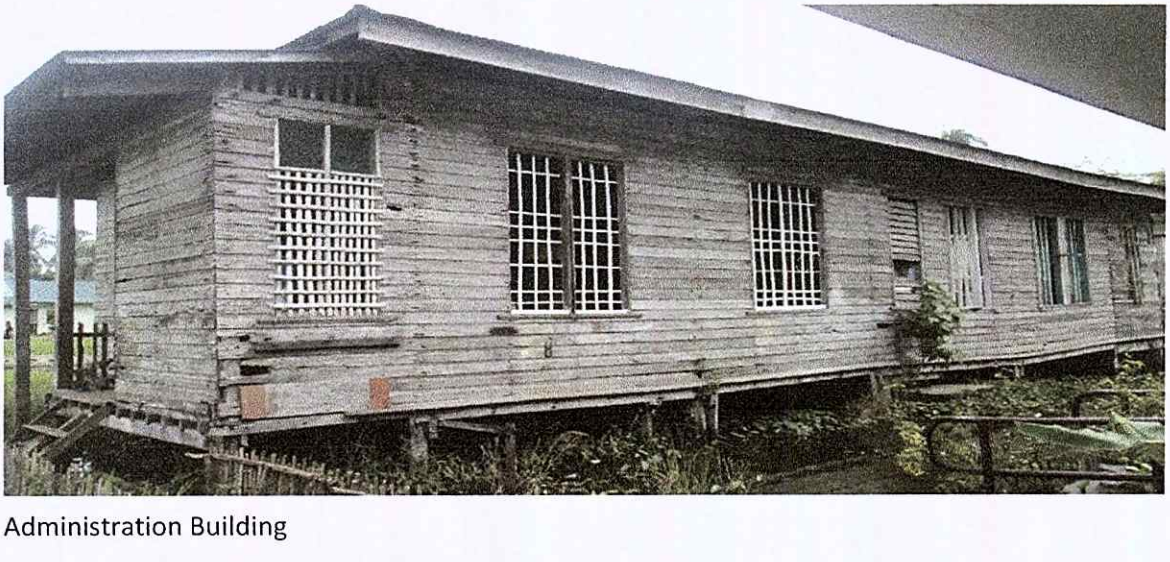
Site Development Plan of San Fernando National High School (SFNHS)

Building 1

Building 2. Comfort Room

Building 3

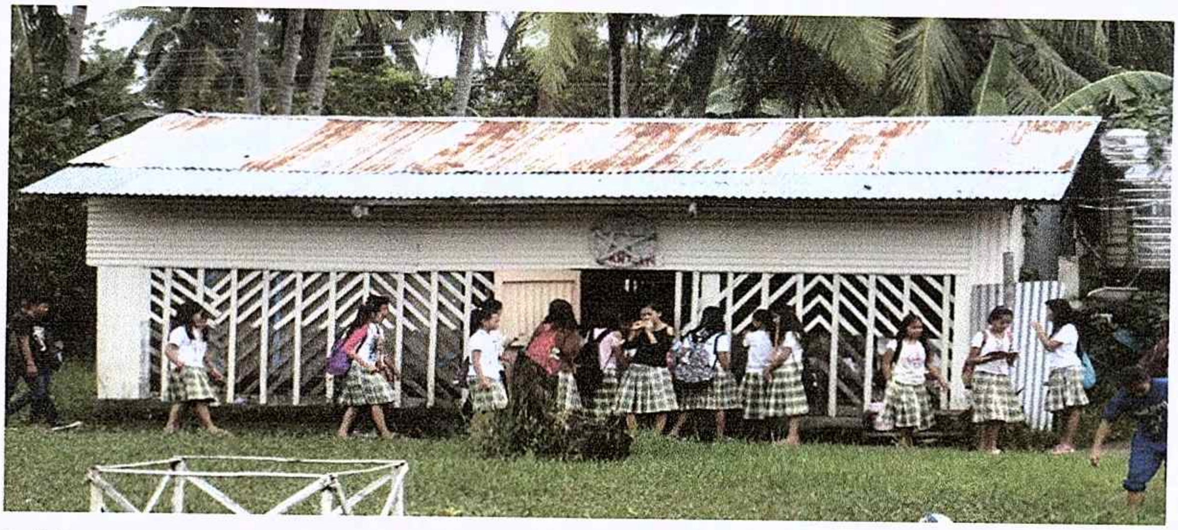
Building 4. Makeshift classroom



Administration Building

Building 5

Building 6



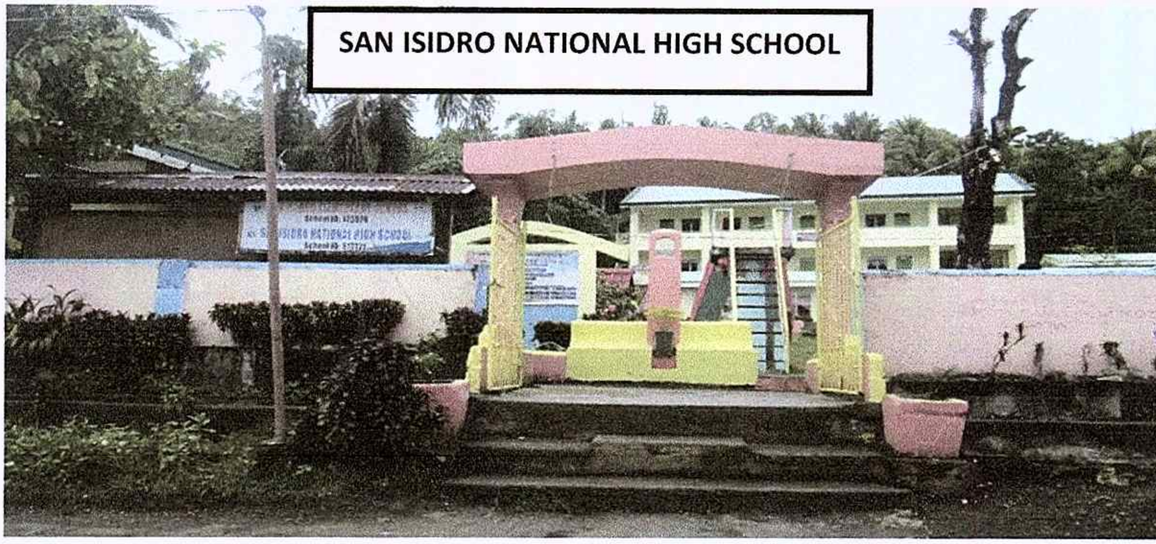
Building 7

Building 8

The flooded ground of San Fernando NHS, hence flood prone area.

SFNHS is flood prone area

SAN ISIDRO NATIONAL HIGH SCHOOL



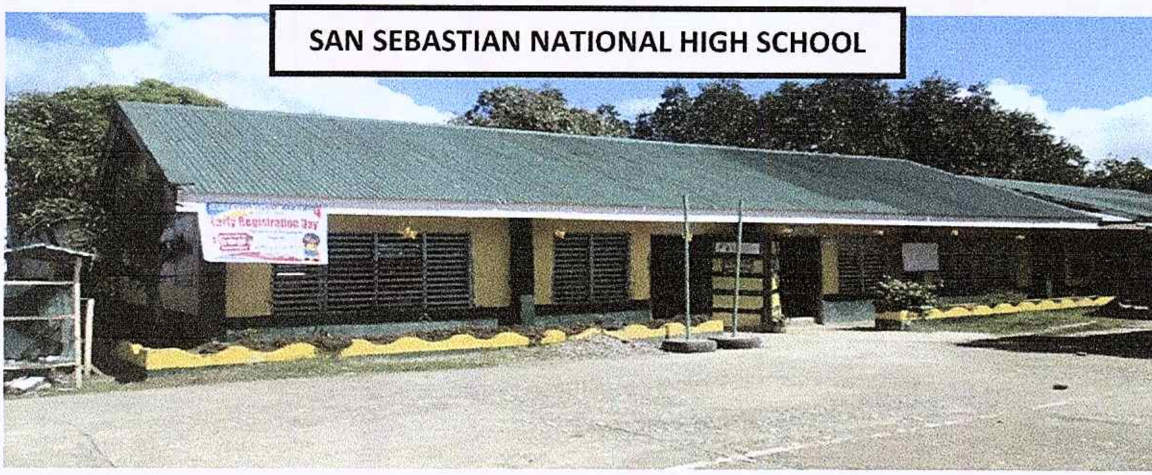
Main Entrance to San Isidro National High School

Building 1. SHB

Building 2. Classroom

Building 3

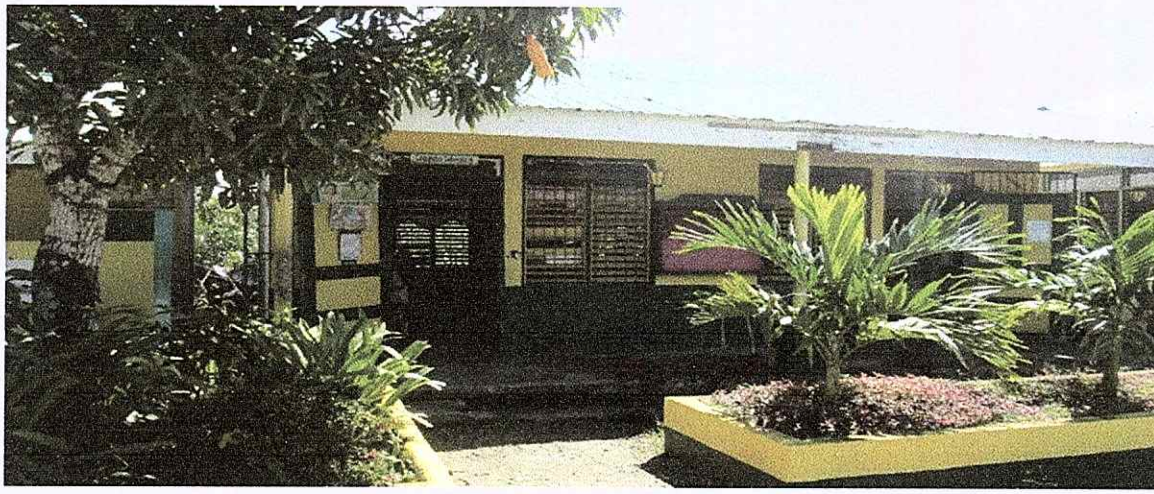
SAN SEBASTIAN NATIONAL HIGH SCHOOL



Building 1

Building 2. Beside it is the mangrove plantation. SSNHS is flood prone due to its location specially during high tide and typhoon.

Building 3

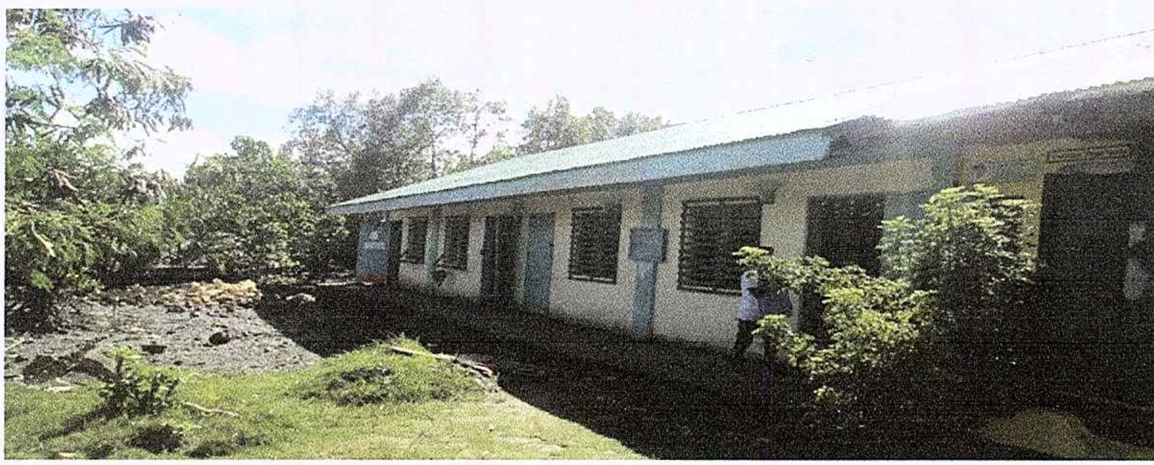


Building 4

Behind Building 4 is seen Building 6, mangrove plantation.

Behind Building 6.

Building 6

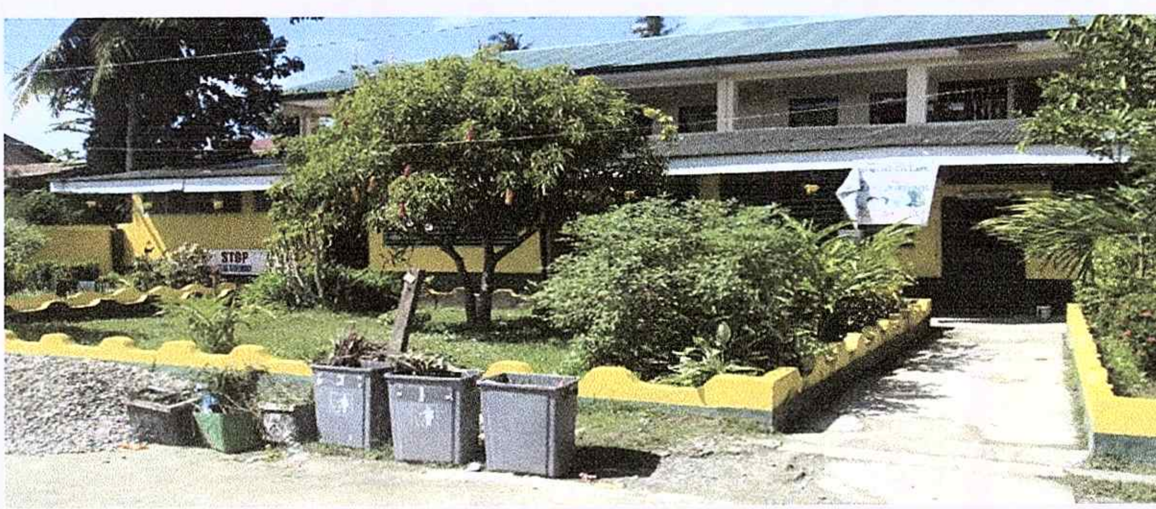


Building 7

From left to right: Building 7, Building 12 and Building 6

Building 8

Building 10



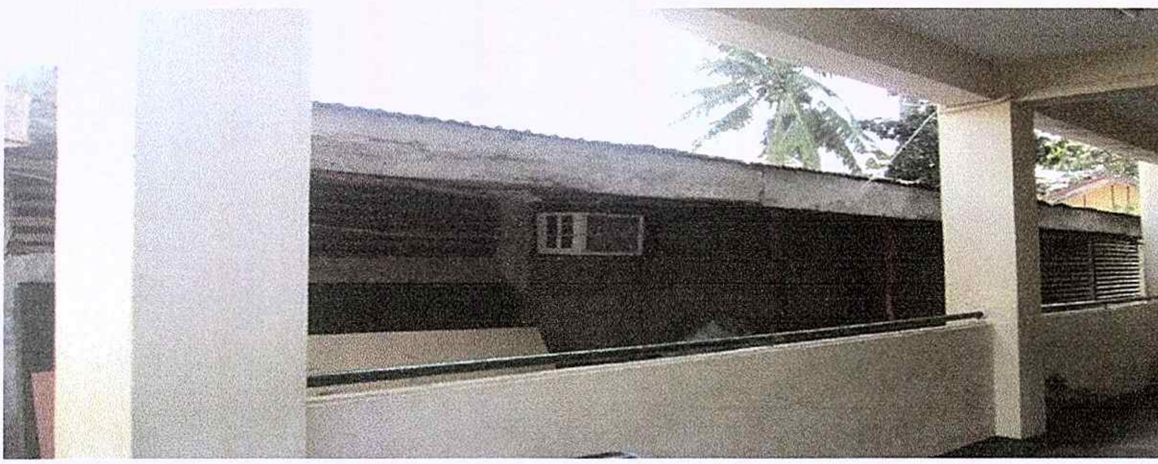
Building 11

Building 11. Shown in the picture is the wooden grills on windows and the deteriorating condition of the ceiling.

Building 12

Behind Building 7

Beside Building 7 are mangrove plantation. It shows that SSNHS is prone to flooding



Behind Building 11 is shown the damage windows and wall.

Picture shows the damage ceiling of Building 10.

Pictures shows the sorrounding of SSNHS.

Overlooking shot from Building 12 from left to right: Building 1, Building 2, Building 3, Building 4, flagpole Building 6, Building 7 & 8.

Overlooking shot from Building 12 is the roof of Building 11. From L-R: Building 1, Building 2, Building 3, Building 4, flagpole, and Building 6.

Overlooking shot from Building 12 from L-R: Building 4, flagpole, Building 6, Building 7 and Building 8.

Picture shows from L-R: Building 6 and Building 7. Between them is the mangrove plantation

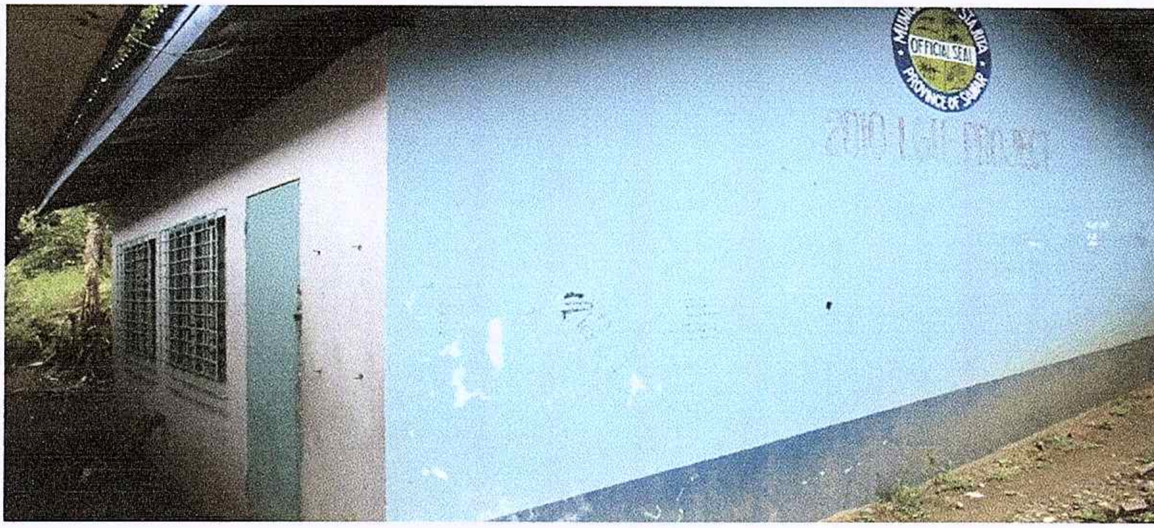
Beside Building 6.

STA.RITA NATIONAL HIGH SCHOOL

The entrance gate of Sta. Rita National High School.

Sta. Rita National High School Building 1.

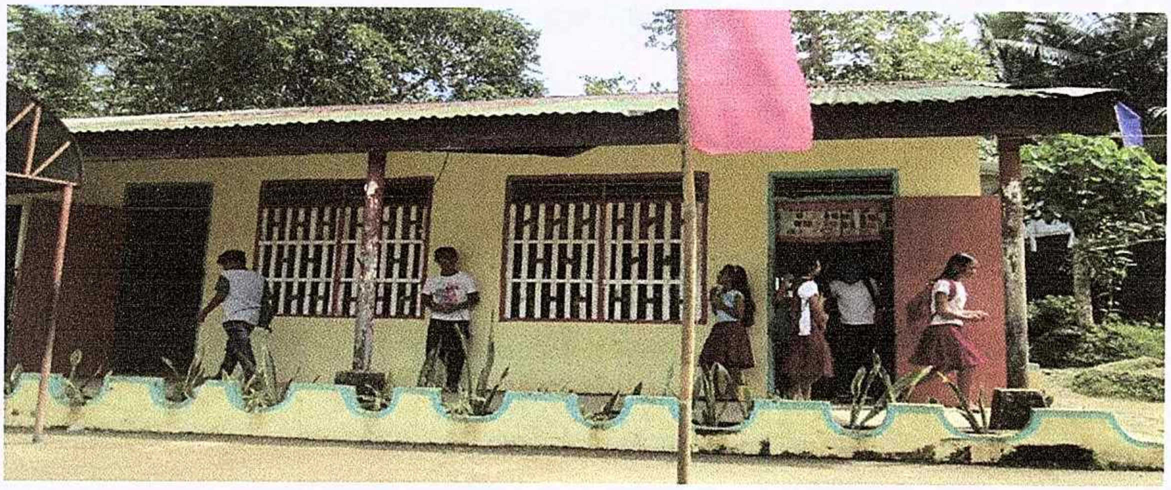
Building 2.



Building 3. The School Library

Building 4. Administration Building

Room 14 of Building 4. The MAPEH Center.



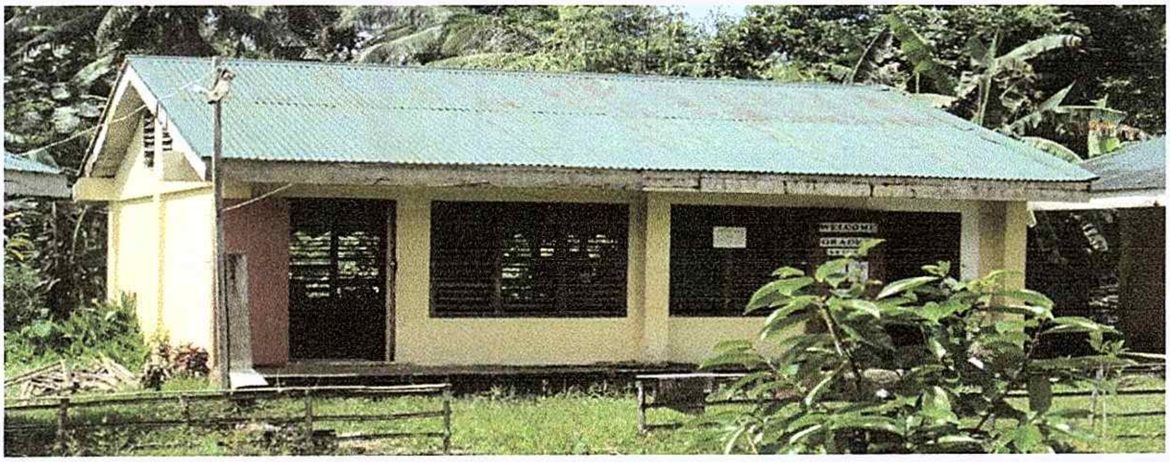
Room 15 of Building 4.

Building 5. The SEDP Building.

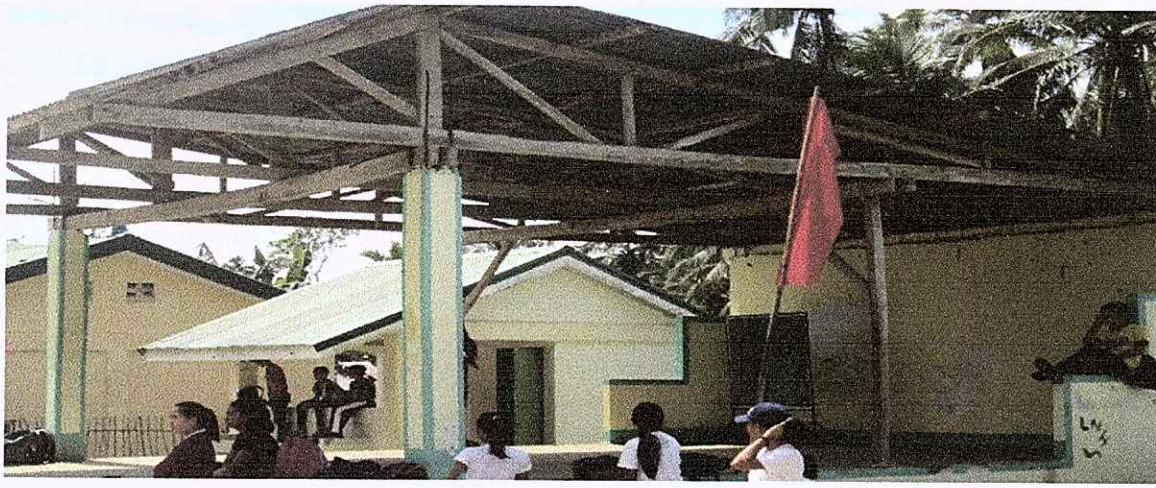
Building 6

]

Building 7. The SSG Office.


Building 8

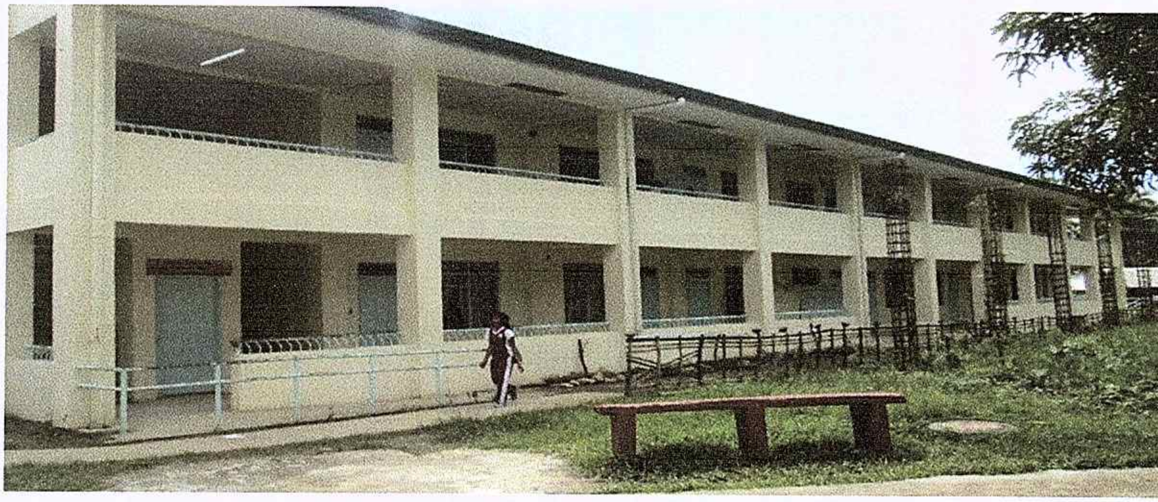

Building 9



Building 10. The school stage.

Building 11. The comfort rooms.

Building 12



Building 13. The Sr. High Building.

Adjacent Building 13 is a hill to right of it.

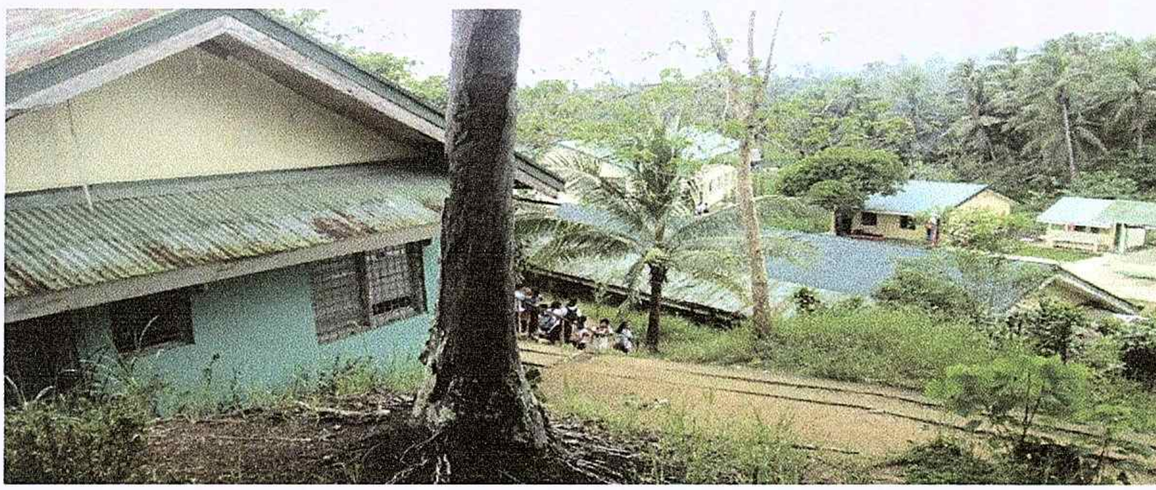
SRNHS is below the highway. Photo taken at the highway.

The way up to Building 1. Shown in photo is Building 1 which is built up the hill. SRNHS is prone to landslide.

Building 2 is located up the hill. Shown in the photo is the hill where Building 2 is located.

Building 2 as shown from where Building 1 is located.

SRNHS campus as shown from Building 1.



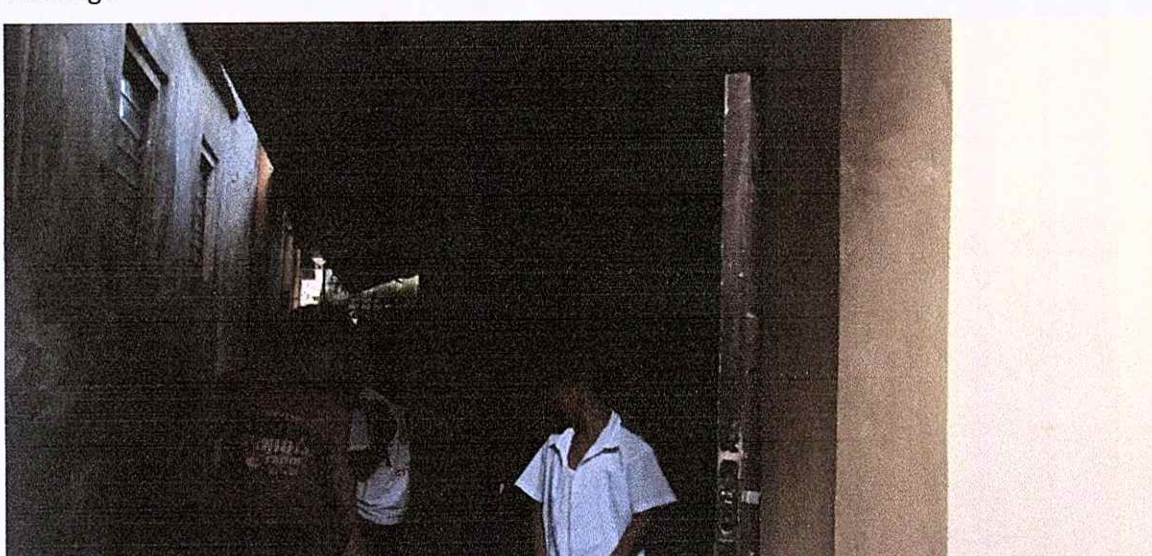
SRNHS campus as shown from Building 1. Shown in photo are the students going up the stairs to attend their classes.

The hill behind Building 3 and Building 4.

SILANGA NATIONAL HIGH SCHOOL

Building 1

Building 2



Building 3

Building 4. The comfort room

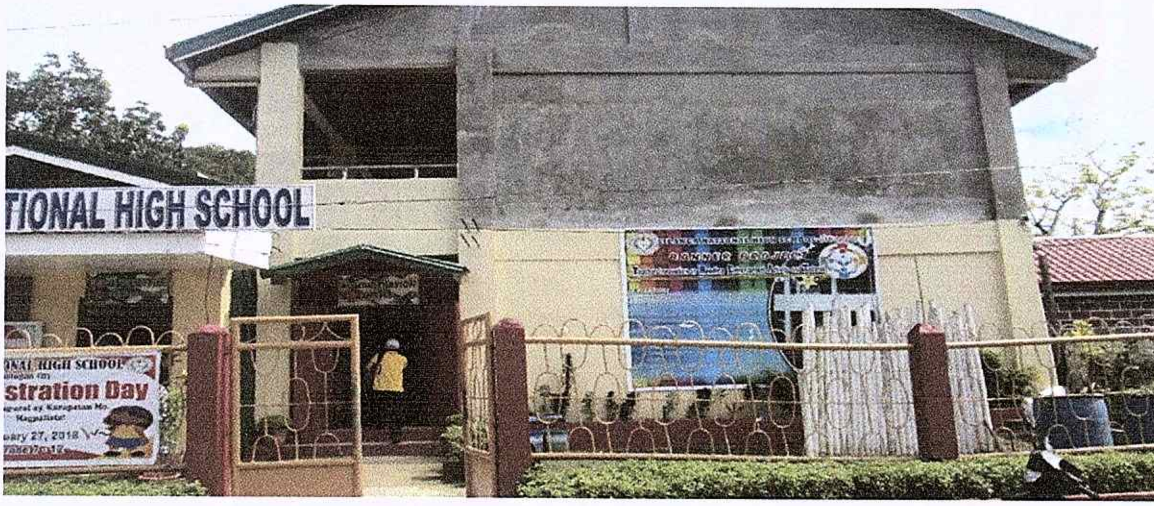
Building 5

Building 6. The Sr. High Building

Building 7

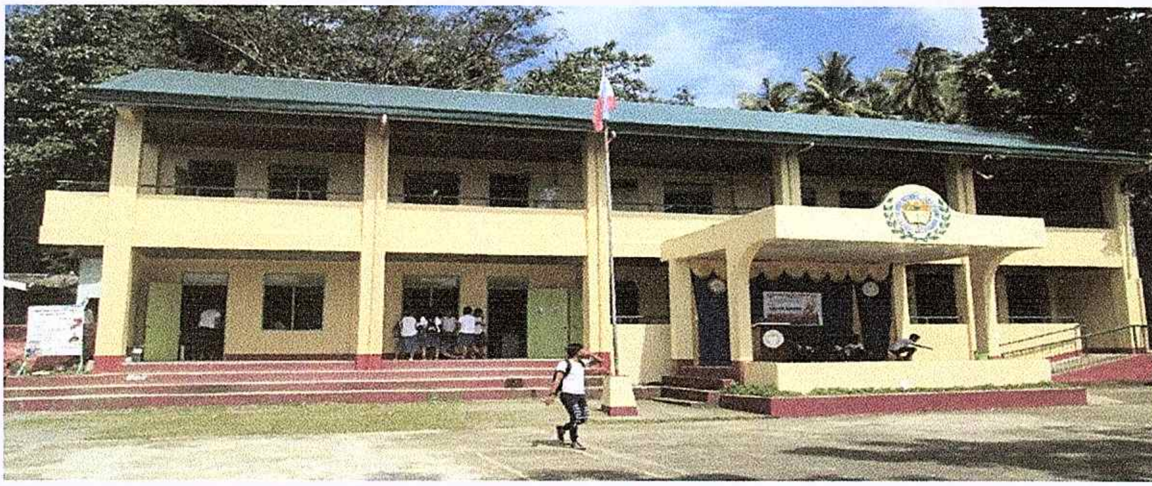
Building 8

Building 10



Building 12

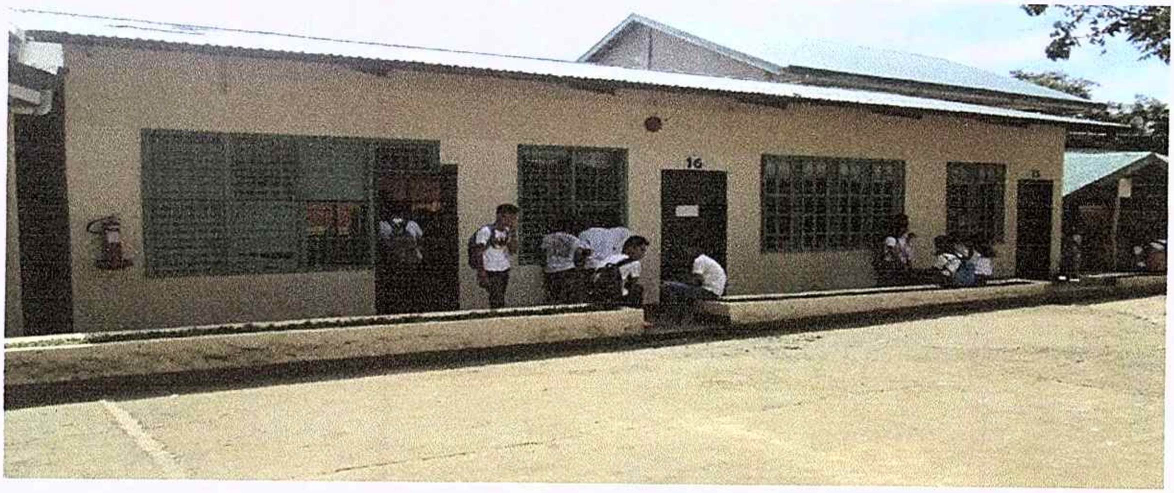
Building 13



Building 14. The Sr. High Building

Building 15

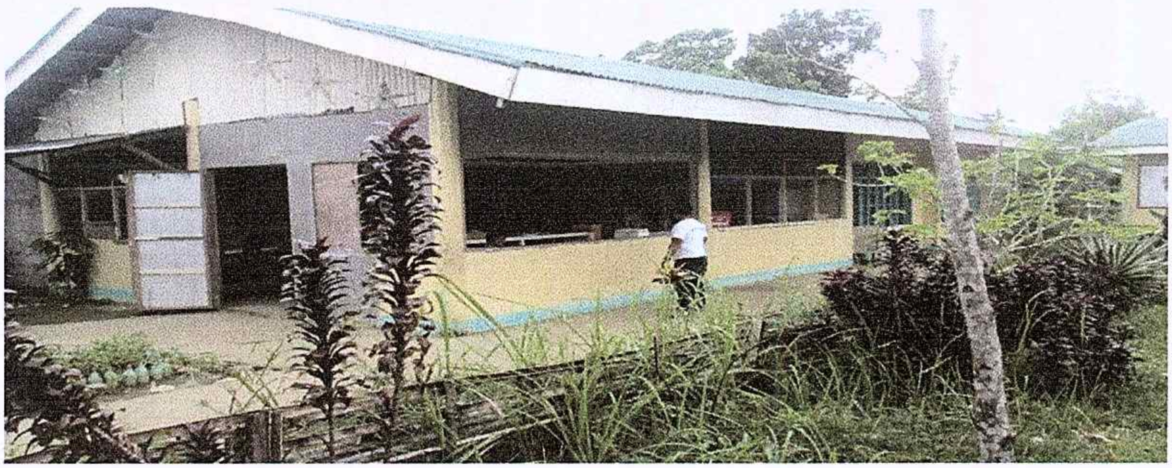
Building 16



Building 17

Building 21. The school stage

The main entrance to Simeon Ocdol National High School (SONHS)



Building 1

Building 2

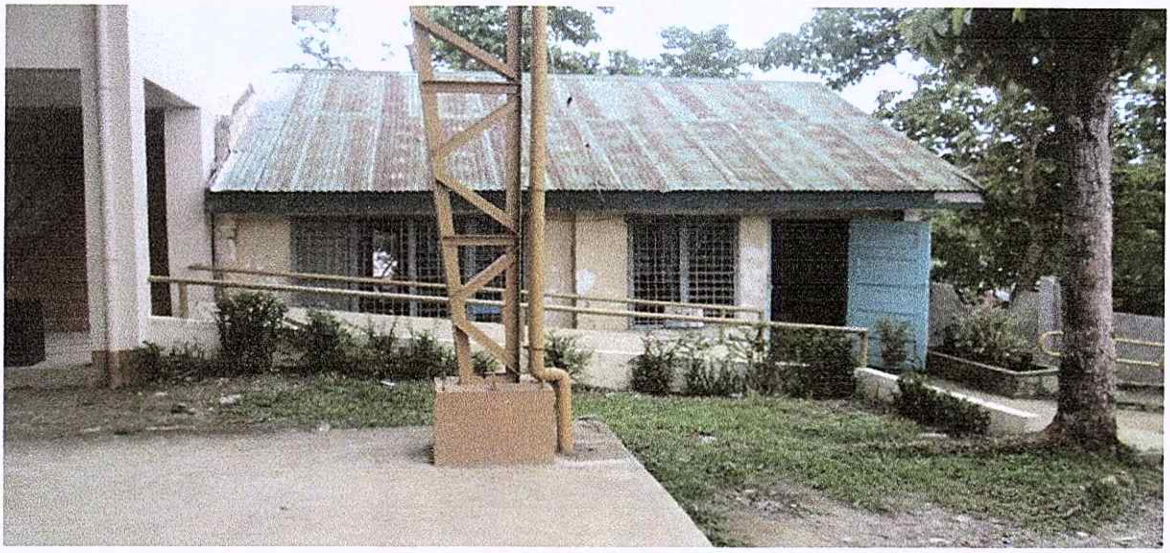
Building 3

Building 4

School Stage

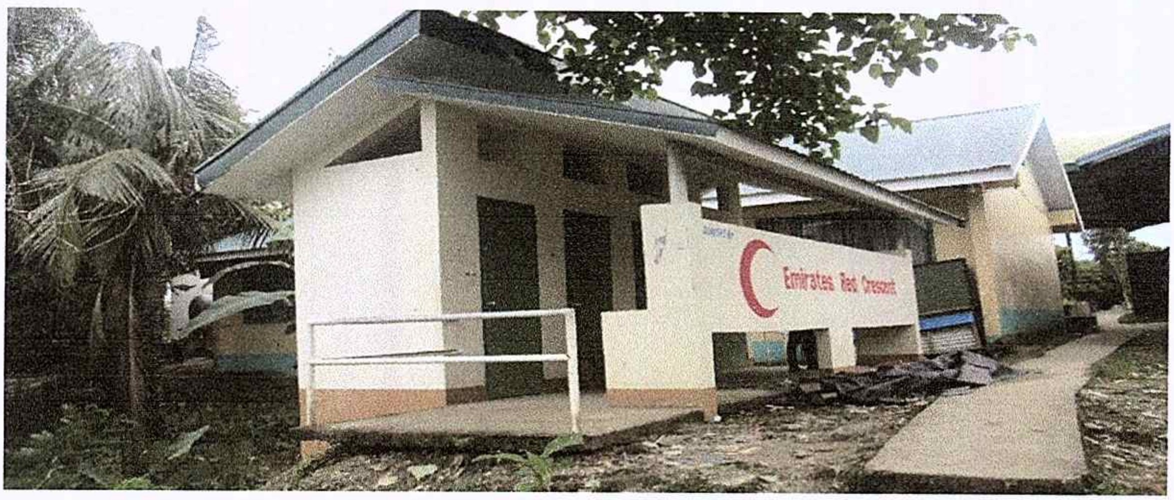
Building 5

Building 6



Building 7

Covered Court



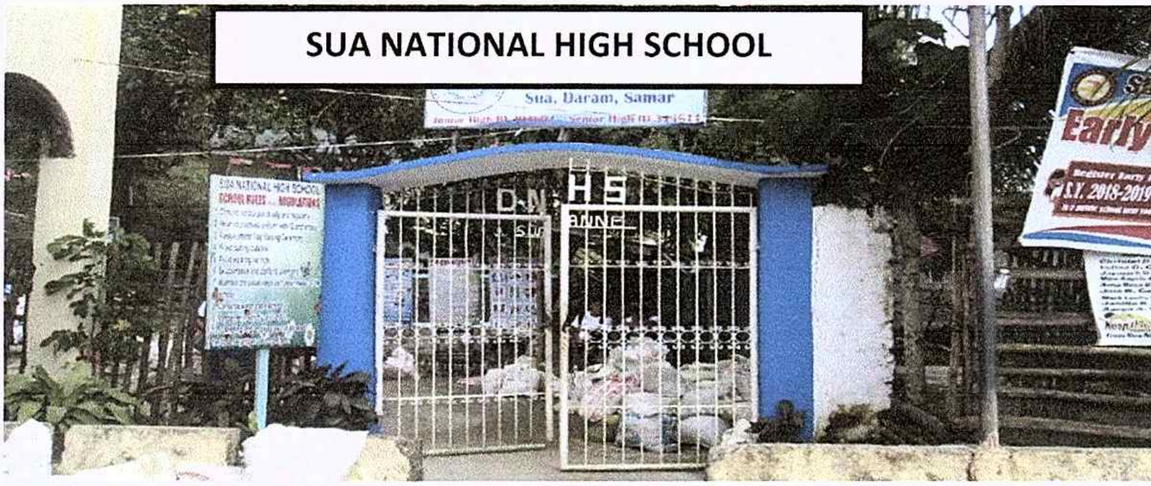
Comfort Room

Sr. High Building

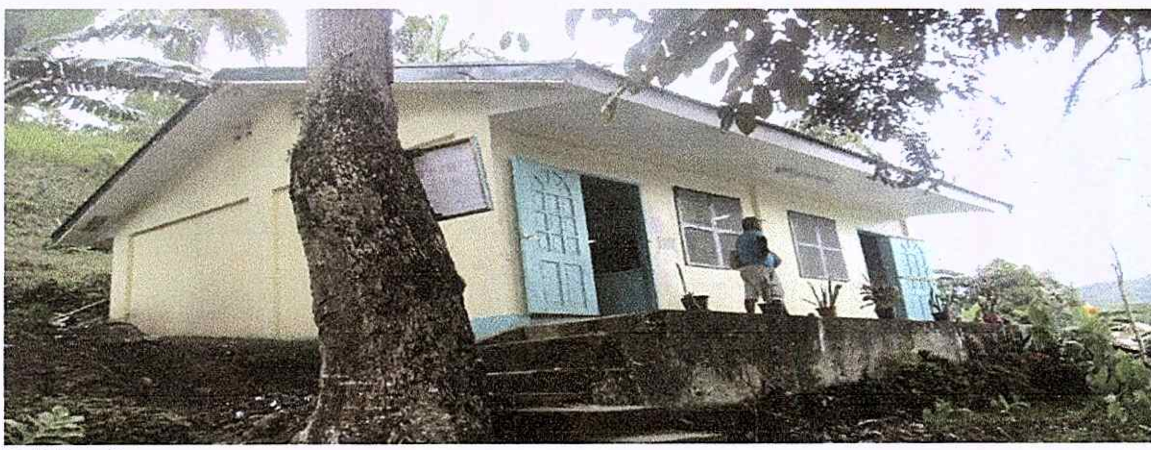
A photo shot from the SHB showing the SONHS campus.

Another shot from the SHB.

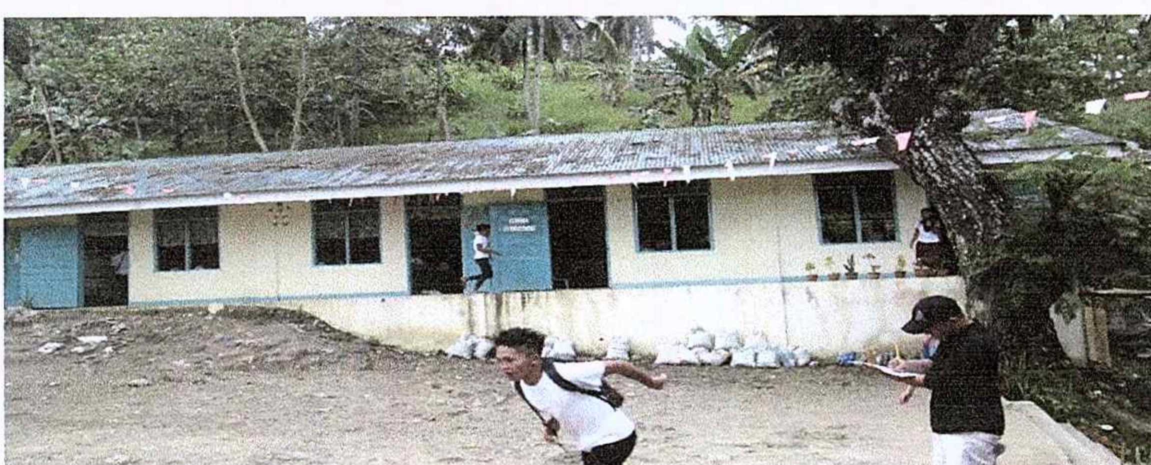
SUA NATIONAL HIGH SCHOOL



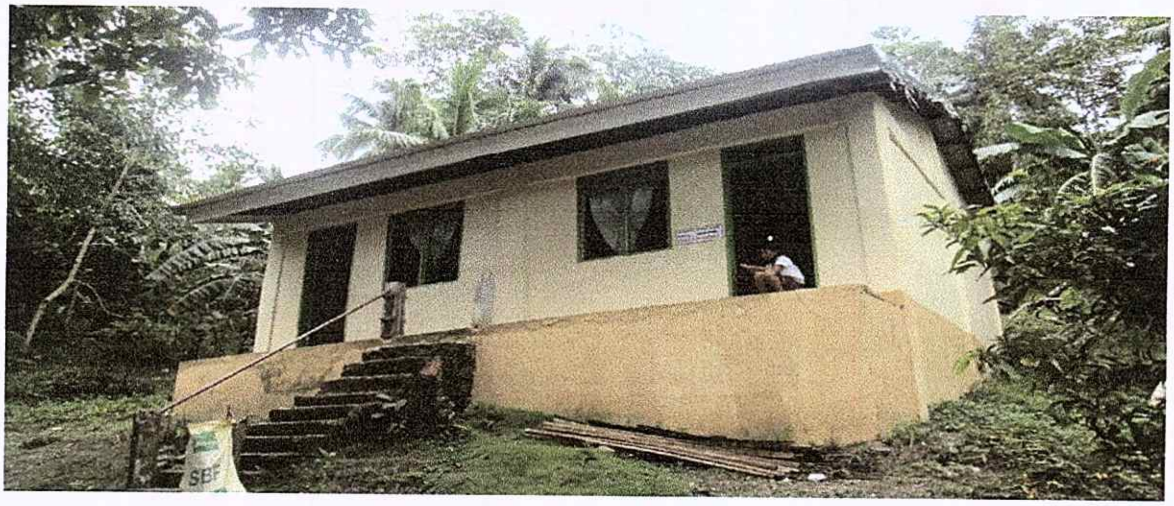
Main entrance gate to Sua National High School



Building 8



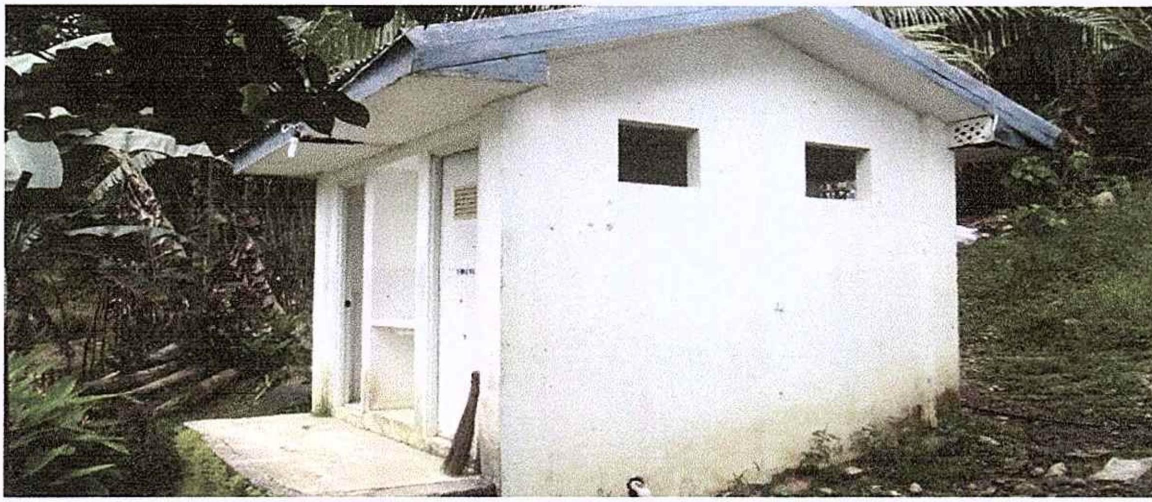
Building 7



Building 6

Building 5

Building 4



Comfort Room

Building 3

Building 2

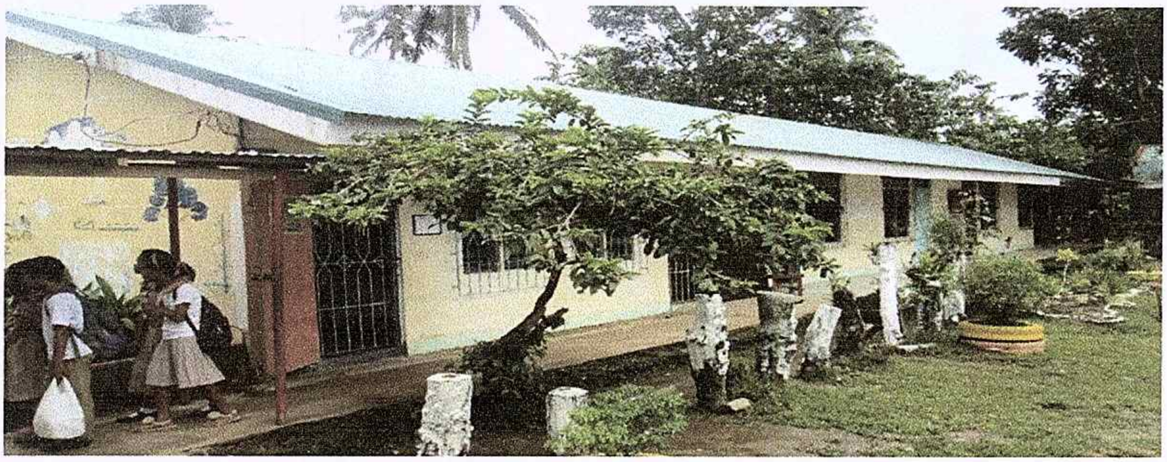
Senior High Building

Building 1

Tominamos Integrated School. Building 1

Building 2. A makeshift classroom.

Building 3



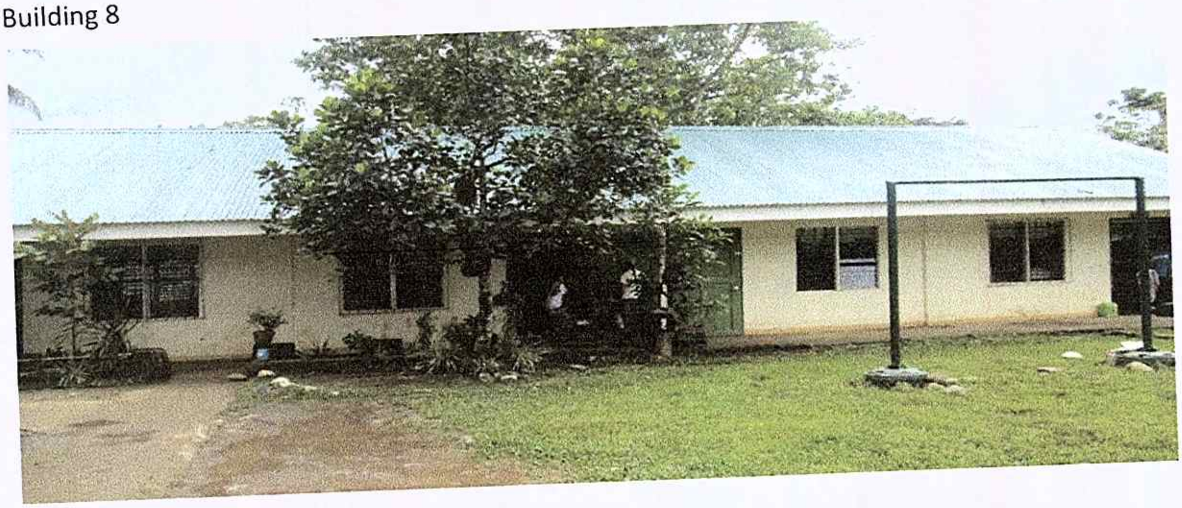
Building 4

Building 5 and Building 6 (Principal's Office). Building 5 is to the left of the Principal's Office.

The ceiling of Building 6.

Building 7.

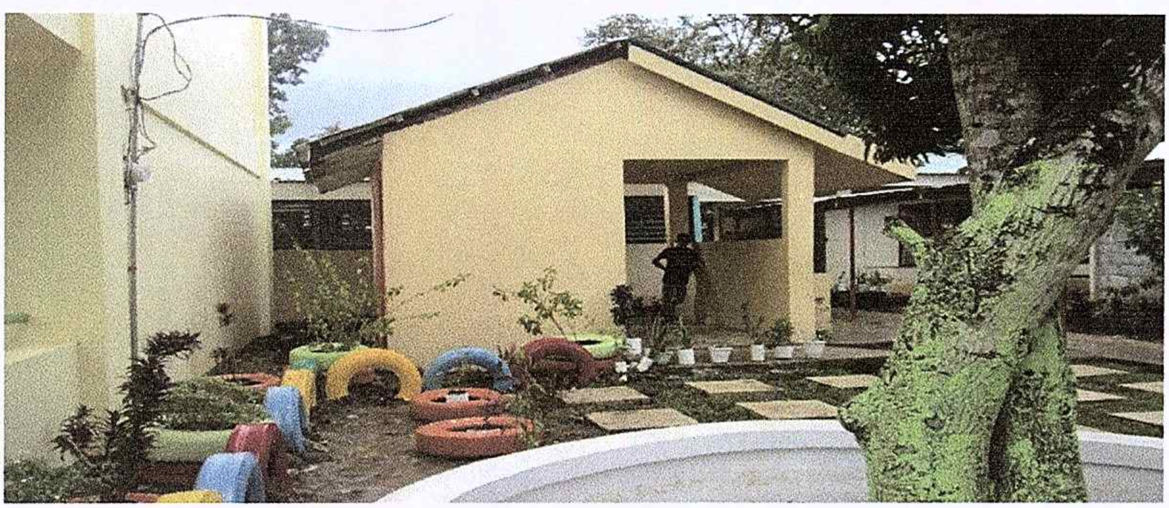
Building 8



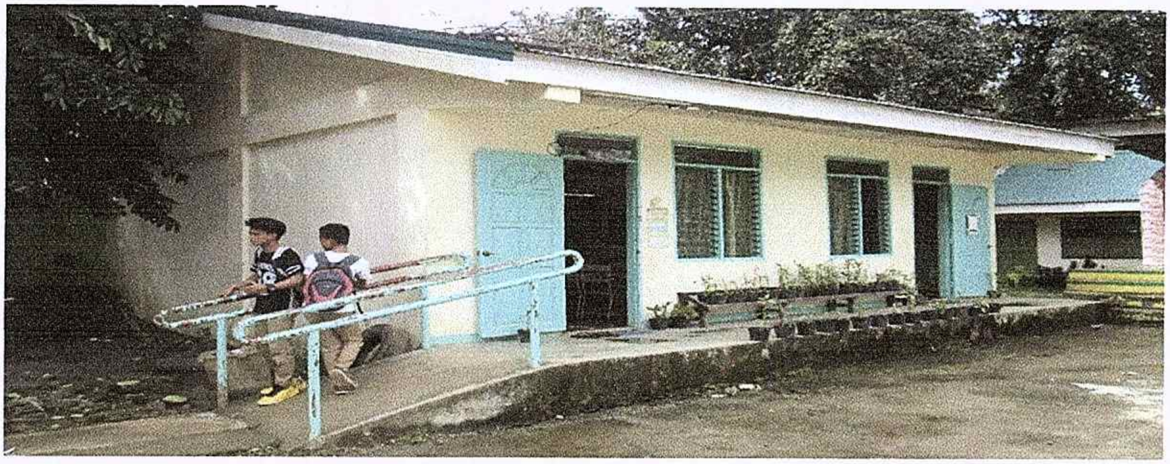
Building 9

Building 10. The DPWH CR

Building 11



Building 12. The school CR

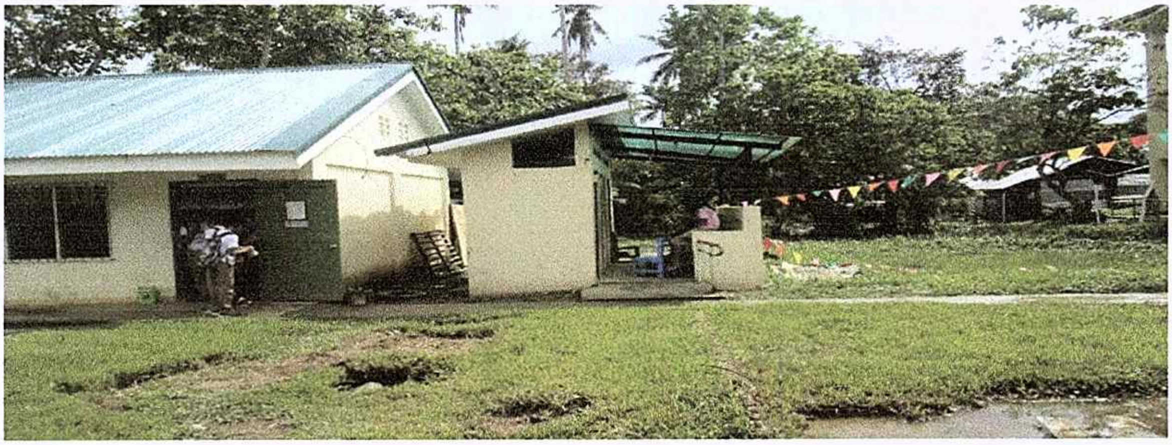


Building 13

Building 14

Building 15. The school canteen

The river behind Building 8. Tominamos Integrated School is prone to flood.



The TIS campus is prone to flood.

VALERIANO C. YANCHA MEMORIAL AGRICULTURAL SCHOOL

Entrance gate of Valeriano C. Yancha Memorial Agricultural School (VCYMAS)

Entrance gate of VCYMAS

Building 1

Building 2

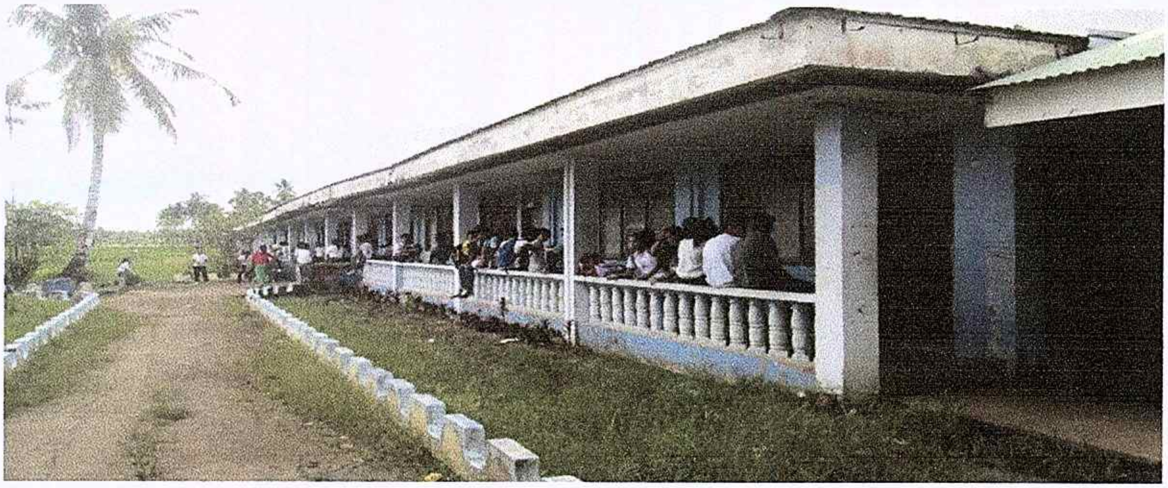
Building 4

Building 5

The school stage

Building 6

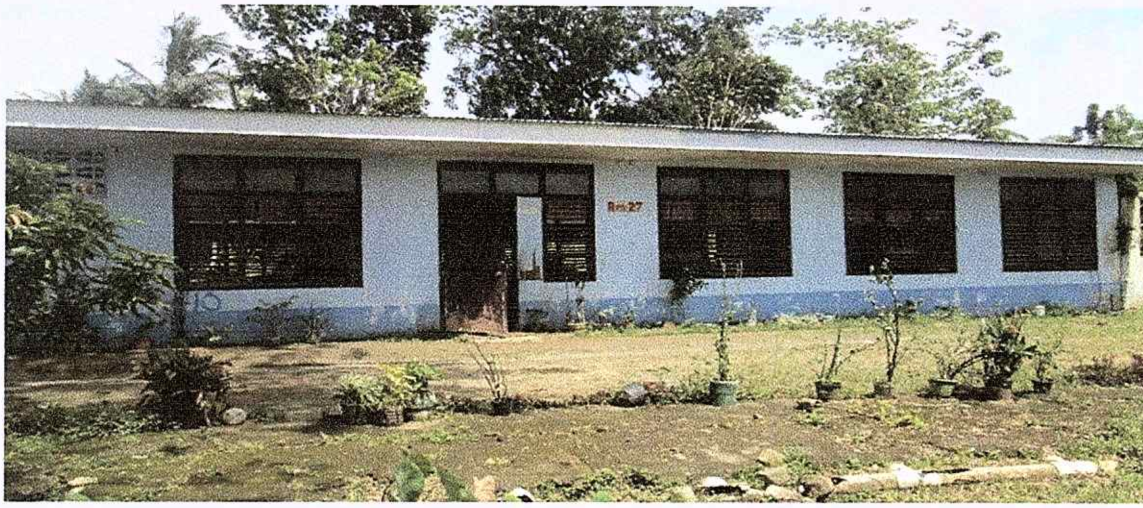
Building 7



Building 8

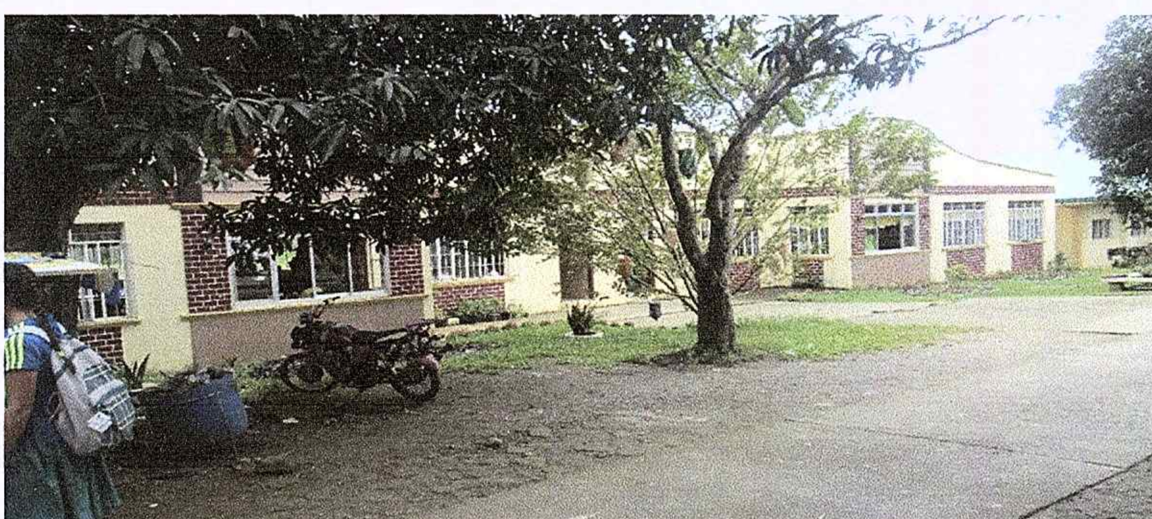
ELE Building

Building 10



Building 11

Building 12



Building 13

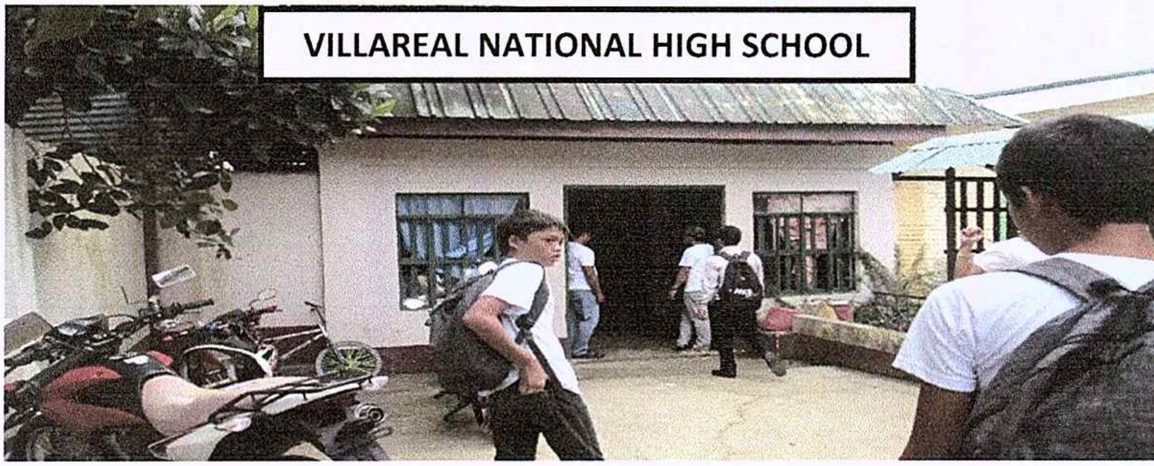
Building 14

Building 15

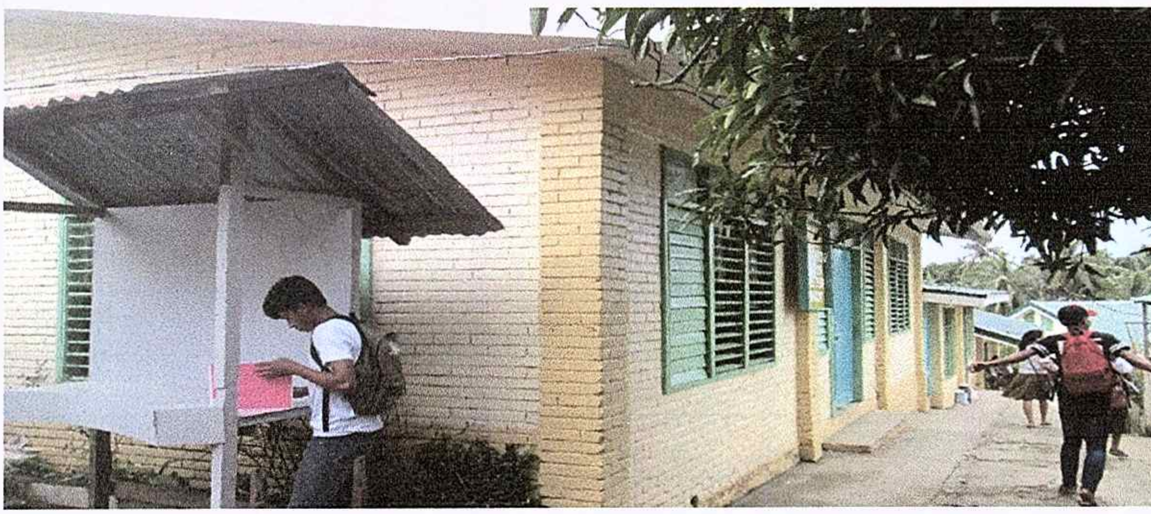
Building 16

Building 17

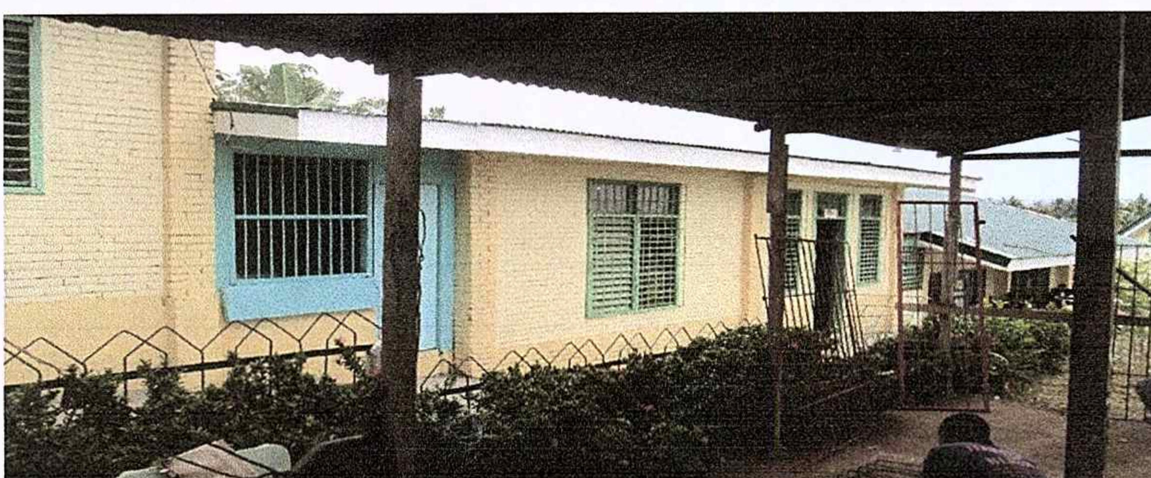
VILLAREAL NATIONAL HIGH SCHOOL



Building 1



Building 2



Colored Nile green is building 3

Next to Building 3 is building 4 in beige color

Between building 4 and 6 is building 5 in nile green color

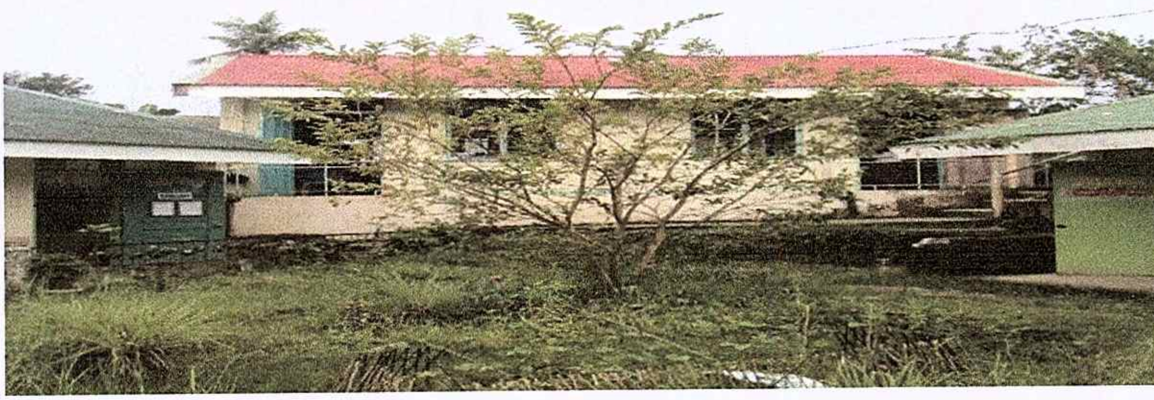
Building 6

Building 7

Building 8

Building 8

Building 9

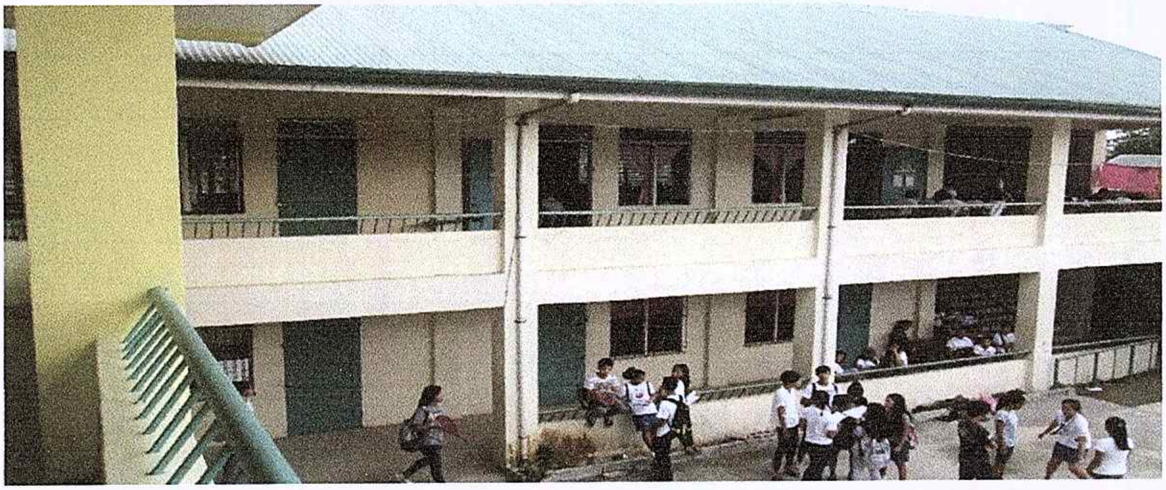


Building 10

Building 11

between 11 and 13 is Building 12

Building 13



Building 14

Builidng 15

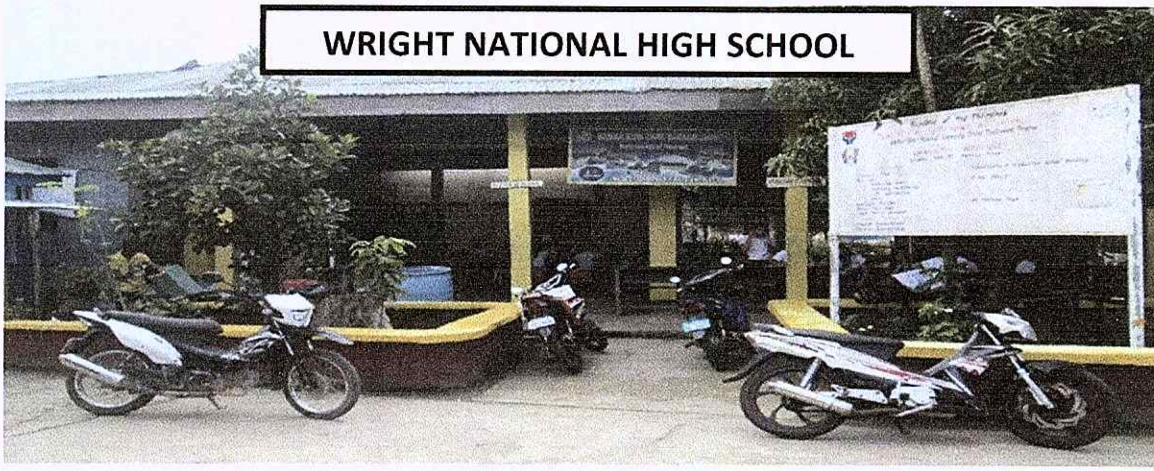
Building 19

Building 20

Building 22

Entrance Gate

WRIGHT NATIONAL HIGH SCHOOL



Building 1

Building 2 showing the casement type window at the left end of the building

Building 2 showing the glass jalousies at the right end of the building.

Building

Building 3

Building 4

Building 4

Building 5

Building 6

Building 7

Building 8

Building 9

Building 10 showing the casement type window at the left end of the building.

Building 10 showing the glass jalousies at the right end of the building.

Building 10

Building 11. The comfort room with 3 rooms.

Building 11. The Administration Building.

Building 12. The covered court.

Building 13. The school stage.

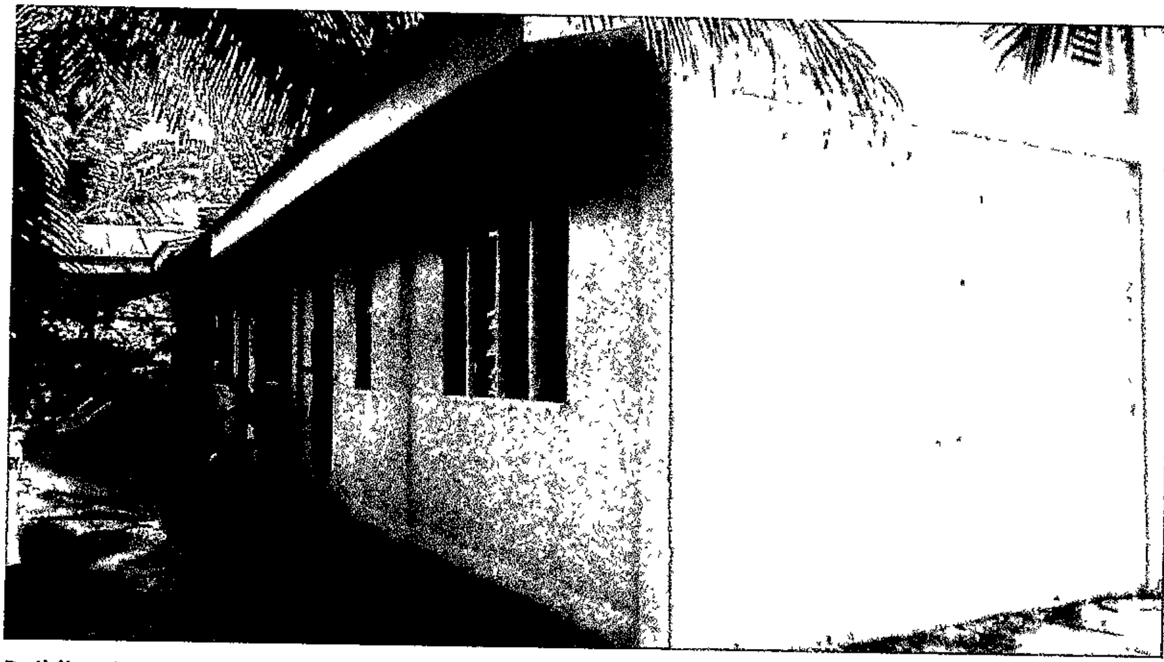
Building 14. The library and the guidance office.

Building 15. The Sr. High building.

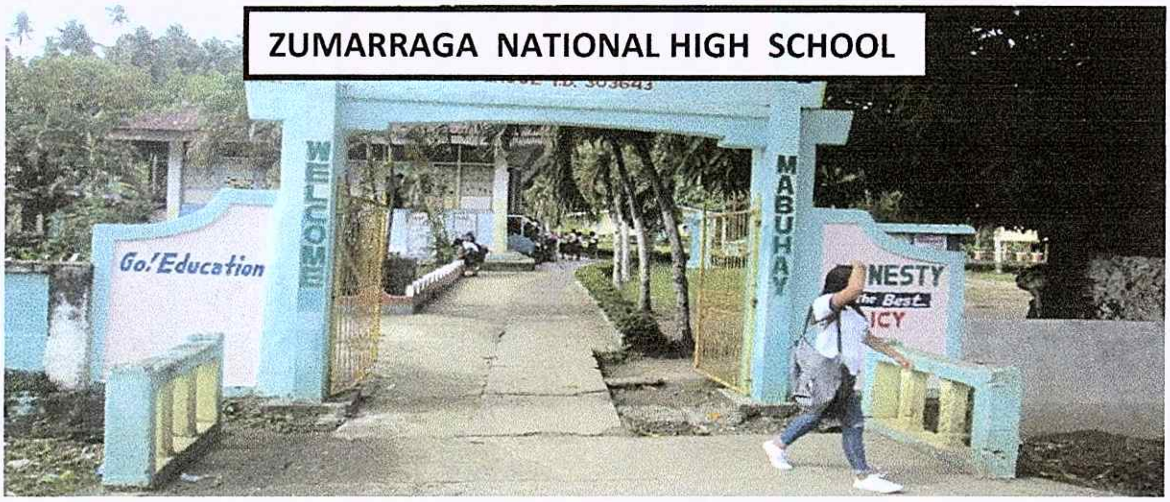
Building 16. The Sr. High building.

Building 17

Building 18

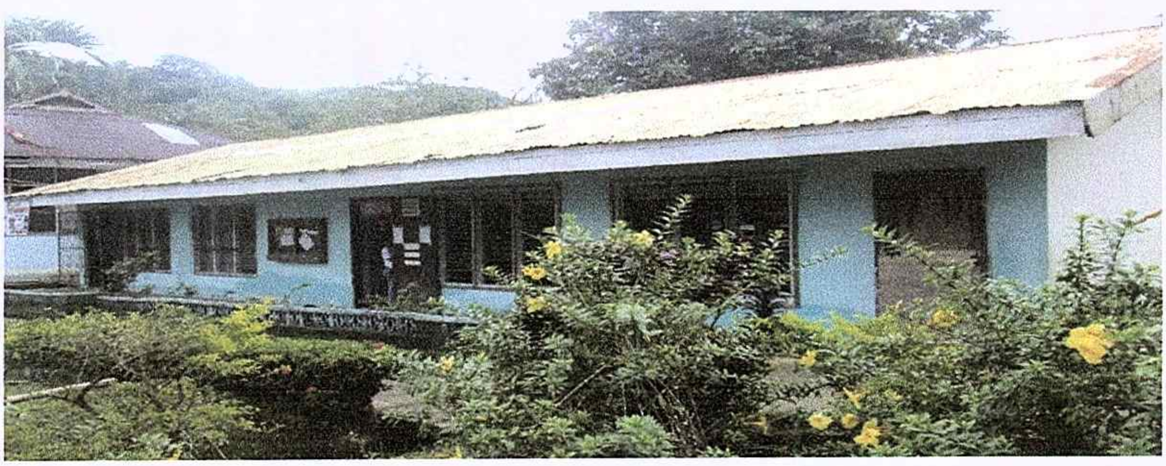


Building 19

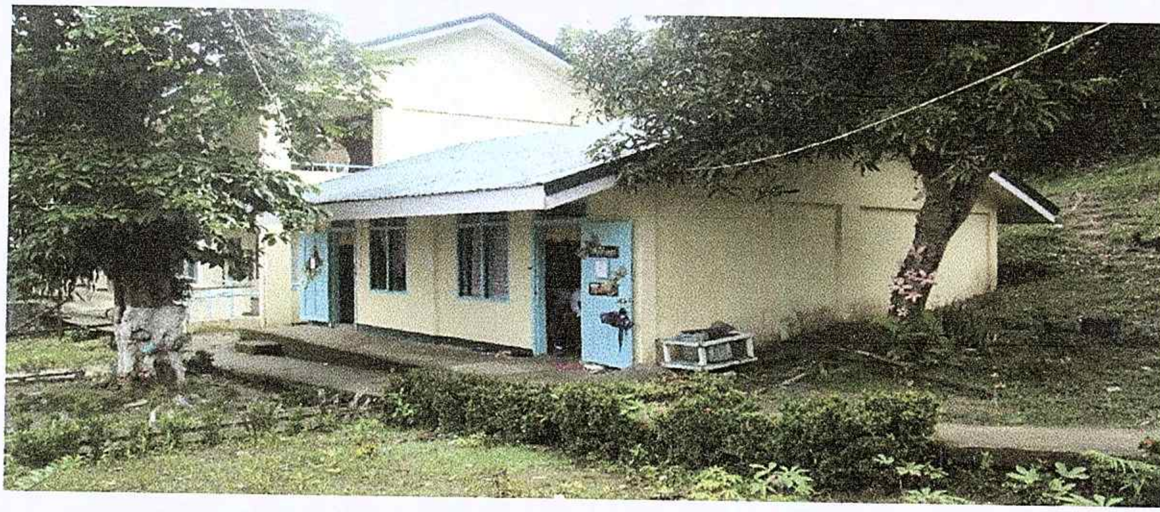


Main entrance to Zumarraga National High School

Building 1



Building 2



Building 6

Building 7

Building 8

CURRICULUM VITAE

PERSONAL INFORMATION

NOVILLA, RENE B.

Name	RENE BRAVO NOVILLA
Age	54
Birthday	March 2, 1964
Sex	Male
Birthplace	Alangalang, Leyte
Parents	
Father	Rogelio Cabalona Novilla
Mother	Gleceria Marcos Bravo
Spouse	Maxima Marco Novilla
Children	Reneville M. Novilla Renemarc Evon M. Novilla Renelle Roque M. Novilla Renesiy M. Novilla
Dauthers in-law	Dhel Gabiana- Novilla Jenny Rose Abegonia-Novilla
Grandchildren	Renedhel Leowil G. Novilla Renejevon A. Novilla Renemae Jen A. Novilla

EDUCATIONAL BACKGROUND

Elementary	San Vicente Elementary School San Vicente Alangalang, Leyte 1971 - 1977
Secondary	Alangalang Agro Industrial School Alangalang, Leyte 1977 - 1981
Tertiary	
Course	Bachelor of Science in Civil Engineering Leyte Institute of Technology Tacloban City 1981 - 1986
Graduate	M.A.T. Mathematics Samar State University Catbalogan, Samar 2005 - 2006
	Master in Fisheries Technology-CAR SRSF-ISCOF Consortium 1995 - 1998

ELIGIBILITIES

Passed – Civil Service Sub-Professional Examination
Tacloban City, October 14, 1984

Passed – Civil Service Professional Examination
Tacloban City, July 26, 1987

Passed – Professional Board Examination for Teachers (PBET)
Catbalogan, Samar, October 25, 1992

Passed – Civil Engineering Board Examination
Manila, November 26-27, 1988

TRAININGS/SEMINARS ATTENDED

1990 National Seminar Workshop and Convention: Teaching for Understanding the Concepts; Principles and Theories of Classical and Modern Physics PAPI, April 4-6, 1990.

Regional Technical Consultations, PICE, August 9-10, 1991.

Seminar-Workshop on English for Fisheries, Effective Approaches in Teaching Vocational Subjects, SRSF, August 1, 8, 15, 29, September 10, 12, 1991.

Echo-Seminar Workshop on Values Education Reading in Tertiary Level and Neurolinguistic Programming, SRSF, November 4-6, 1991.

1992 National Convention and Workshop on the Relevance of Physics Revisited, PAPI, April 6-8, 1990.

SEDP Mass Training of Teachers in Science, DECS, April 20 – May 4, 1992.

National Congress on Technical and Vocational Education: "Technical and Vocational Education: People Empowerment Towards Greater Productivity", DECS, November 8-11, 1992.

Innovative Approaches/Strategies/Techniques in Physics Teaching, SSPC-DOST-DECS, December 7-11, 1992.

Leave Administration Course for Effectiveness (LACE), CSC, September 20-22, 1995.

Trainer's Training on Coastal Resources Management, ATI-SRSF, May 13-19, 1996.

Entrepreneurship Training for Coops and Cooperative Classification System Workshop, CDA, August 20-22, 1997.

Training on Advances in Aquaculture, RFTC, October 15-17, 1997.

Seminar-Workshop on Financial Management for Cooperative, CDA, May 5-7, 1998.

Project Control (Project Management Series) Construction Manpower Development Foundation, September 23-25, 1998.

Study/Observation Tour and On-site Lecture, PICE, September 26, 1998.

Seminar or Road Engineering: Bridge Foundation, Retrofitting and Application of Finite Element Analysis, River Morphology and Road Hydrology, PERT Consult International, January 20-22, 1999.

Seminar Workshop on Research Methods and Management, SRSF, Mercedes, Catbalogan, Samar, February 24-26, 1999.

Seminar-Workshop on Alternative Strategies for Effective for Effective Teaching, SSPCMC, Catbalogan, Samar, September 27-29, 2000.

Strategic Planning Workshop for SSPCMC, SSPCMC, Mercedes, Catbalogan, Samar, December 13-14, 2000.

Regional Lecture Forum for Algebra, Leyte Institute of Technology, Tacloban City, March 2, 2001.

Seminar-Workshop on Testing and Evaluation, SSPCMC, Mercedes, Catbalogan, Samar, October 15-16, 2001.

Seminar on Improving Student Performance Assessment in the Classroom: A World Class Model, SSPC, Catbalogan, Samar, December 3-4, 2001.

Guidelines on Actual Practice of Engineering Profession, SSPC, Catbalogan, Samar, February 11, 2002.

Research and Development and Extension Strategic Planning and Proposal Hearing, SSPC, Catbalogan, Samar, September 4-6, 2002.

25th National Physics Convention/Seminar-Workshop; 16th National Physics Olympics; 11th National Physics Fair, PPS and SSPC-MC, April 2-5, 2003.

Training-Workshop on Strategic Planning, SSPC-College of Engineering, SSPC, Catbalogan, Samar, September 24-26, 2003.

In-Service Training on CSC Updates and New College Policies, SSPC, Catbalogan, Samar, December 17, 2003.

Training on Multimedia Development for Classroom Instruction, SSPC-College of Engineering, SSPC-Catbalogan, Samar, April 1-2, 2004.

Philippine Organization of Science and Technology Educators (POSTE) Region VIII 7th Convention Seminar-Workshop, SLSU, Sogod, Southern Leyte, September 23-26, 2006.

Seminar-Workshop on Module Writing, SSUMC, Catbalogan, Samar, November 4-5, 2004.

Training for Research Proposal Making, SSUMC-RFTC, Catbalogan City, July 8, 2005.

2nd In-Service Training on the Use and Operation of Multimedia Equipment and Learning System Units, Audio Visual Production Center, SSU, Catbalogan City, June 28, 2007.

Seminar-Workshop on Verbalizing and Conceptualizing Research Project, SSU-Research Office, Catbalogan City, February 4-5, 2008.

First Samar Research and Development and Extension Conference, SSU-Research Office, Catbalogan City, September 24, 2008.

Agency Research Development and Extension in-House Review as Paper Presenter of the Project "Development of Pneumatic Plastering Machine", SSU-Research Office, Catbalogan City, December 17, 2008.

Seminar-Workshop on Business Planning, SSU-Research Office, Catbalogan City, February 26-27, 2009.

RDE Project Management for SSU and Catbalogan Academic Institutions Researchers and Extension Workers, SSU-Research Office, Catbalogan City, July 1-2, 2010.

Updates of SUC Budgeting: Normative Financing Scheme, SSU-Research Office, Catbalogan City, September 27, 2010.

First Level Research and Development In-House Review, SSU-Research Office, Catbalogan City, April 16-17, 2012.

Capacity Enhancement Program on Hazard, Risk Assessment and Exposure Database Development through the Use of the Rapid Earthquake Damage Assessment System Software, REDAS, Philippine Institute of Volcanology and Seismology, March 8-13, 2015.

In-House Seminar Workshop "Towards Excellence in Teaching Through Outcome Based Education", SSU, May 4-8, 2015.

Seminar-Workshop on Modelling and Simulation: Part 2, SSU, September 18, 2015.

In-House Seminar-Workshop on Academic and Administrative Processes Towards Increasing Productivity and Excellence, SSU, May 25-27, 2016.

In-House Seminar-Workshop on Academic Processes Towards SSU Quality and Excellence, SSU, May 29, 2017-June 1, 2017.

Republic of the Philippines
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PRESIDENTIAL RESEARCH AWARD
BRONZE Medal

is presented to

Engr. RENE B. NOVILLA

researcher of the project entitled

"Disaster Risk Management for Resilient Public School Buildings in Samar"

which was recognized as the **BEST DOCTORATE DISSERTATION** in the **DOCTORATE DISSERTATION CATEGORY** during the **2018 GRADUATE STUDENTS' RESEARCH PROJECTS COMPETITION**.

Given during the 83rd Samar State University Recognition Day ceremonies this 19th day of March 2018.

MARILYN D. CARDOSO, Ph.D.
University President

Arteche Blvd., Guindapunan Catbalogan City, 6700 Samar Philippines
Telephone No. (055) 251 – 2139 | Fax: (055) 543 - 8394 | Website: www.ssu.edu.ph

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SAMAR STATE UNIVERSITY
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Certificate No.: PRE-CO-17-18-CP-011

awards this

CERTIFICATE OF RECOGNITION

is presented to

Engr. RENE B. NOVILLA

researcher of the paper entitled

"Disaster Risk Management for Resilient Public School Buildings in Samar"

as **BEST DOCTORATE DISSERTATION** in the **DOCTORATE DISSERTATION CATEGORY** during the **2018 GRADUATE STUDENTS' RESEARCH PROJECTS COMPETITION** on March 17th, 2018.

Given this 17th day of March 2018 at the Audio-Visual Center, Samar State University, Catbalogan City.

RONALD L. ORALE, Ph.D.
Vice-President, Planning, Research and Extension Services

MARILYN D. CARDOSO, Ph.D.
University President

FELISA E. GOMBA, Ph.D.
Vice-President, Academic Affairs/Dean, College of Graduate Studies

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LIST OF TABLES

LIST OF FIGURES