TOWARDS A LOCAL CLIMATE CHANGE ACTION PLAN

Makakalikasang PULILAN

By Krystie Babalos, Christa Brown and Lavino (Wei-Chung) Chen

July 2013
Acknowledgements

The writing and development of The Municipality of Pulilan: Towards a Local Climate Change Action Plan involved many people from the Municipality of Pulilan and beyond. The University of British Columbia’s (UBC) School of Community and Regional Planning (SCARP) students were invited to research and write a preliminary assessment of local climate change impacts and potential strategies for moving forward. This partnership and report would not have been possible without the vision, leadership and ambition of Leonora Angeles, UBC Associate Professor. This report also depended upon the direction, knowledge, ideas and contributions of the Municipality of Pulilan, the Province of Bulacan, barangay councils, and broader members of the public.

Specifically, we would like to thank the Municipality of Pulilan’s Mayor Vicente B. Esguerra, Sr. and Vice Mayor Elpidio C. Castillo for envisioning a healthy, vibrant and climate adaptive future. Thank you to the Municipal Administrator Vicente A. Esguerra, Jr. for inspiring this project and Marcelo Enriquez, Municipal Consultant, for your guidance.

Special thanks are also expressed to Roberto Cruz, Municipal Environment and Natural Resource Officer, Harriet Cruz, Love Joy Mano and Gener Guzman, MENRO Clerks, for showing us your community, sharing stories and information about the past, present and envisioned future of Pulilan. Thank you also to Teresita Tetangco, Information Officer, for coordinating logistics and the partnership with UBC. Thank you to Cymbeline Mano, Municipal Disaster Risk Reduction and Management Coordinator, for your generosity and spirit in guiding us around Pulilan and for sharing information. To Laiza Valeo, Rhea Reyes, Donna Cortez, Information Clerks, and Rueben Rey Arenas, Photographer, thank you for coordinating and accompanying us to our interviews and on our field visits.

For sharing a wealth of information essential to this report, thank you to: Isidoro Santos, SB secretary; Leovigildo Garcia, Municipal Planning and Development Officer; Loreto De Jesus, Municipal Agriculturist; Leonor Acuna, Municipal Budget Officer; Anastacio Calderon, Municipal Accountant; Rosemarie Esguerra, Engineering Officer; Maria Adora Angeles, Municipal Social Welfare and Development Officer; Vicenta Santos, Nutrition Officer; Dr. Maria Conception Antonino, Municipal Health Officer; Elizabeth Mercado, Rural Health Unit Nurse; Amado Cruz Jr, Water Systems General Manager; Honorato Dalisay, Water Systems Clerk; Irene Isidro, PESO Clerk; Santos Santos, Tourism Officer; Loida Caleon, Sanitation Inspector; Fernando Clemente, Firemarshall; Daren Dy, Central Material Recovery Facility Supervisor; Restituto T. Esguerra, Tibag Barangay Captain; Danilo Calderon, Dampol 1st Barangay Councillor; Bert Ambo, Sto. Cristo Barangay Secretar; and Patricio Garcia, farmer from Inaon.
Preface

Plans, policies and programs do not come from wishful thinking. They are shaped by human actors who, for better or worse, often face external circumstances that are beyond their control. Such is the case with climate change impacts and climate-related disaster risks. While such impacts and risks are also partly the result of human activities, it is also our human activities, decisions and decisive action that will ensure our resilience and survival in the long run.

The three reports, intended to serve as background paper to the development of Local Climate Change Action Plans (LCCAP) in lower Angat River Basin Municipalities, are the result of a month-long, Studio-style and Community Service Learning graduate course offered by the School of Community and Regional Planning (SCARP) at the University of British Columbia (UBC). It is systematically designed as a mutual learning experience for SCARP Masters planning students, faculty members, municipal and provincial planning staff, and local residents, within the framework of UBC’s mandate to promote “global citizenship,” in order to examine the practices and challenges of formulating climate change adaptation plans and strategies in urbanizing watershed and river basin areas in a developing country in Southeast Asia.

This is now the fourth year that the Philippine Planning Studio Course is offered. The focus on LCCAP research this year ties well with the papers presented by the 2010 batch of students at the University of the Philippines’ (UP) National College of Public Administration and Governance (NCPAG) in an international conference sponsored by the School of Urban and Regional Planning (UP-SURP) on “Mainstreaming Climate Change Adaptation Strategies in Local Development Plans,” which also produced two SCARP Master’s Theses on collaborative watershed governance and irrigation management transfer, which offered analyses and recommendations for Bulacan province, particularly in its role in the governance of the Angat River Basin and the management of the ecosystem services and resources provided by the River.

The 2013 course’s main objective is to provide solid background planning research on climate change adaptation challenges and solutions that could be incorporated in the formulation of Local Climate Change Action Plans (LCCAP) of Bustos, Plaridel and Pulilan Municipalities located in the lower Angat River Basin.Region. For 2013, the Course has attracted nine (9) students who were distributed evenly among the three municipalities who were very generous in hosting the students and their course instructor, particularly providing them with the data and logistical support to carry out their research and planning tasks. As all Local Government Units are mandated by the Philippine national government to formulate and implement their own LCCAPs that will be integrated with other plans, it is hoped that the research and recommendations provided by SCARP students had complemented the human resource needs of the Municipalities in their preliminary work towards mainstreaming climate change adaptation planning and implementation.

The 2013 Studio course has been designed as a component of a broader three-year project (2012-2015), “Collaborative Governance of Urbanizing Watersheds: Integrated Research, Institution- and Capacity-Building for Sustainability and Climate Risks Adaptation in the Angat River Basin,” funded by the Social Science and Humanities Research Council of Canada (SSHRC).The key institutional partners in the project are the Provincial Government of Bulacan, the Bulacan State University-Malolos, De La Salle University-Manila, and the University of British Columbia. Two of the main objectives of the project are (1) the analysis of appropriate governance mechanisms
for Angat River Region and (2) the training of the next generation of academic and applied researchers in the Philippines and Canada.

The project’s focus on the 63,000 hectare Angat Watershed and River Basin is warranted in light of its provincial and national significance. It supplies 10% of electricity and 97% of water in Metro Manila (population: 12 million). It irrigates approximately 31,500 of vegetable farms and rice fields (total 94,000 hectares of farmlands) in the provinces of Pampanga and Bulacan (population: 4 million, density: 805 people/km). It also provides the water and land resources for Bulacan’s small fisherfolks and commercial fish farmers and those with interests in logging and other forest products, mining and quarrying. It has tremendous potentials for ecological tourism development. It is the life source of Metro Manila and Bulacan, whose aquifers and underground water sources are connected to and replenished by Angat Watershed and River.

Yet, at the same time, the current state of River Basin displays typical “tragedy of the commons” problem, when individuals and groups want to maximize their benefits from common pool resources and ecosystem services offered by Angat River. In such typical cases, environmental degradation and resource depletion are aggravated by unregulated mining, quarrying, logging, over-fishing, and water withdrawals. Poverty, in-migration, and poor enforcement of municipal by-laws lead to increased informal settlements with no secured water and sewage facilities. Poor land use planning efforts lead to the growth of industries along the River and industrial pollution that further degrade soil and water quality because of inadequate solid waste and wastewater management systems. These problems become more urgent to address in light of current plans to implement a Rapid Industrialization plan, as well as the impacts of climate change and climate-related disasters, particularly cyclical patterns of flooding and drought in Bulacan.

The challenge therefore is how go beyond this “tragedy of the commons” problem and address the governance issues that underpin this problem through democratic problem-solving, broad popular participation and institutional collaboration. The writing of the LCCAP reports, and the collaborative research that went into their writing, demonstrate the stock of human resource, social capital and civic capacity in the province, particularly the three Angat River Municipalities, that can make these solutions happen.

Universities and colleges in Bulacan and the Philippines in general have important roles to play on this scenario. They have roles not only in the training of the next generation of academic and applied researchers and capacity-building of local government people, but also in the strategic deployment of our civic capacity to problem-solve democratically, informed by the sciences, education, humanities, and the arts. This small example of Philippine-Canadian partnership in Community Service Learning and Action Research and Planning can hopefully to lead to similar efforts and richer networks of Universities, Governments and civil society organizations in Bulacan and beyond. To all our Institutional Partners, funders and the people of Bulacan, maraming salamat po.

Leonora C. Angeles
Associate Professor
Executive Summary

The effects of climate change are already being felt in the Municipality of Pulilan, Province of Bulacan, Philippines and will continue into the future. Current and projected climate changes include increased temperatures, altered seasonal patterns, changes in precipitation, such as more frequent and intense rainstorm events, and an increase in typhoons. These changes can impact a variety of areas within the community, from the local environment and ecological integrity to water supply, food system productivity, public health and security, infrastructure, and even local economic stability.

In 2013, the Municipality of Pulilan is poised to develop a Local Climate Change Action Plan (LCCAP), which will help them assess their vulnerability to current and projected climate changes, as well as identify and implement climate change mitigation and adaptation strategies. To begin this process, the Municipality has engaged planning support from the University of British Columbia’s (UBC) School of Community and Regional Planning (SCARP) Philippines Field Studio and Community Service Learning Program. This program provides three planning students, Krystie Babalos, Christa Brown and Lavino (Wei-Chung) Chen, with the opportunity to gain practical experience learning from and supporting Pulilan in taking a first look at current community conditions for the purpose of developing their LCCAP.

The Municipality of Pulilan: Towards a Local Climate Change Action Plan is thus a preliminary assessment of local climate change impacts and potential mitigation and adaptation strategies. The report, developed by the planning students, aims to introduce the challenge of and the basis for local climate change planning in the Municipality in six priority areas: the local environment, water systems, human health and security, food security, infrastructure and the local economy. The report also details next steps the Municipality can take for a more detailed local climate change vulnerability assessment and action strategy development. This report is the first step in the Municipality of Pulilan’s commitment to developing a formal LCCAP.
# Table of Contents

Acknowledgements .......................................................................................................................... 2  
Preface .............................................................................................................................................. 3  
Executive Summary ......................................................................................................................... 5  
List of Figures .................................................................................................................................. 7  
List of Tables .................................................................................................................................... 8  
List of Acronyms .............................................................................................................................. 9  
1. Introduction ................................................................................................................................ 10  
   1.1 Overview........................................................................................................................... 10  
   1.2 What Is Climate Action Planning and Why Do It? ........................................................... 11  
   1.3 Objectives ......................................................................................................................... 12  
   1.4 Report Structure................................................................................................................ 12  
2. Methodology .............................................................................................................................. 13  
   2.1 Methods ............................................................................................................................ 14  
   2.2 Limitations ........................................................................................................................ 14  
3. The Challenge: Climate Change Impacts and Vulnerabilities.................................................... 15  
4. Nature and Scope of a Municipal LCCAP ................................................................................. 21  
   4.1 Legislated Targets............................................................................................................. 21  
   4.2 Target Areas...................................................................................................................... 22  
   4.3 Recommended Priority Areas........................................................................................... 23  
   4.4 LCCAP Leaders, Allies and Partners ............................................................................... 23  
   4.5 General Revenue Sources ............................................................................................... 24  
5. Recommended Priority Areas and Strategies ............................................................................. 25  
   5.1 Environment: Ecosystem Services, Land Use Planning and Resource Management ....... 26  
   5.2 Water Resources: Water System Management and Governance ................................... 31  
   5.3 Human Health and Security: Climate-Change Adaptive Settlements and Services ......... 34  
   5.4 Food Security: Agriculture and Fishing ............................................................................ 37  
   5.5 Infrastructure: Transportation, Buildings and Public Infrastructure ................................ 40  
   5.6 Local Economy: Sustainable Livelihoods ........................................................................ 47  
6. Next Steps ................................................................................................................................... 49  
7. Conclusion .................................................................................................................................. 51  
8. Bibliography ............................................................................................................................... 52  
9. Appendices .................................................................................................................................. 54  
   I. The Municipality of Pulilan Demographic Profile in 2007................................................ 54  
   II. Land Uses Profile in the Municipality of Pulilan .............................................................. 55  
   III. Typhoon Profile of Bulacan ............................................................................................. 56  
   IV. The Municipality of Pulilan drainage system map.............................................................. 57  
   V. Pulilan Water System Revenue Collection from 2004 to 2013 ........................................ 58  
   VI. Housing in the Municipality of Pulilan in 2010. .................................................................. 59  
   VII. The criteria of adaptation actions .................................................................................... 60
List of Figures

Figure 1.1 Location of Pulilan. (Source: Municipality of Pulilan, 2011) ................................... 10
Figure 3.1 Mean Temperature Projections in the Philippines. (Source: CCC, 2011a) .......... 16
Figure 3.2 Pulilan Monthly Total Rainfall, 2011 and 2012. Note: July 2011 data not available
(Source: Province of Bulacan, 2013) .................................................................................. 16
Figure 3.3 Multi-model Projected Changes in Global Precipitation Patterns. (Source: IPCC,
2007) .................................................................................................................................. 17
Figure 4.1 Municipality of Pulilan, 19 Barangays. (Source:Municipality of Pulilan, 2010) .... 23
Figure 5 Recommended priority areas ...................................................................................... 25
Figure 5.1 Municipality of Pulilan current and proposed land use. (Source: Municipality of
Pulilan, 2011) ..................................................................................................................... 27
Figure 5.2 Pulilan water district system. (Source: Pulilan Water System, 2013) ............... 31
Figure 5.2.1 Municipality of Pulilan Water System: Annual average payment per household and
water consumption. (Source: Municipality of Pulilan, 2013) ............................................. 32
Figure 5.3 Municipality of Pulilan network of irrigation canals. (Source:Municipality of Pulilan,
2011) ................................................................................................................................... 38
Figure 5.5 Municipality of Pulilan road network. (Source: Municipality of Pulilan, 2011) ..... 42
Figure 5.5.1 Municipality of Pulilan location of schools and churches. (Source:Municipality of
Pulilan, 2011) ...................................................................................................................... 43
Figure 6 Municipality of Pulilan’s potential allies and partners in their LCCAP ................. 50
List of Tables

Table 3.1 Regional climate change trends, impacts (direct and indirect), and vulnerabilities in Pulilan ................................................................. 18
Table 3.2 Preliminary assessment of projected impacts and Pulilan’s sensitivity to climate change by impact sector ............................................... 18
Table 4.1 NCCAP Priorities and Outcomes. (Source: CCC, 2011) ........................................ 22
Table 5.6.1 Municipality of Pulilan family income by sector. (Source: Municipality of Pulilan, 2011) ............................................................. 47
List of Acronyms

APF – Adaptation Policy Framework
BULSU – Bulacan State University
CVR – Cagayan Valley Road
CCC – Climate Change Commission
CLUP – Comprehensive Land Use Plan
CCT – Conditional Cash Transfer
DENRO – Department of Environment and Natural Resources
DILG – Department of Interior and Local Government
DPWH – Department of Public Works and Highways
EI – Ecological infrastructure
GCMs – Global Climate Models
GHG – Greenhouse gas
ICE – Information, Communication, Education
IRA – Internal Revenue Allotment
LCCAP – Local Climate Change Action Plans
LGU – Local government units
MRF – Materials Recovery Facility
MWSS – Metropolitan Waterworks and Sewerage System
MO – Municipal output
NCCAP – National Climate Change Action Plan
NFSCC – National Framework Strategy on Climate Change
NIA – National Irrigation Administration
NPC – National Power Corporation
NPOs – Non-profit Organizations
NGOs – Non-governmental Organizations
PRBC – Pampanga River Basin Committee
PESO – Public Employment Services Office
RPT – Real Property Tax
RHU – Rural Health Units
SCARP – School of Community and Regional Planning
SDM – Structured Decision Making
MAM – Summer season
IPCC – The International Panel on Climate Change
UNDP-GEF – United Nations Development Programme Global Environment Facility
UBC – University of British Columbia
UPRIS – Upper Pampanga River Irrigation System
1. Introduction

1.1 Overview

The Philippines is an archipelago of islands in South East Asia and one of the most vulnerable countries to the impacts of climate-related changes. Current and projected climate changes include increased temperatures, sea level rise, altered precipitation patterns, and more frequent storm events (CCC, 2011). Over the long term, reducing greenhouse gas (GHG) emissions may make these changes less severe, but there are still unavoidable impacts expected as a result of climate change. These may cause detrimental consequences to local ecosystem integrity, human health and security, and economic stability. These potential consequences require immediate attention.

In 2011, the Philippine National Government took this call to heart. President Benigno Simeon C. Aquino III launched the Climate Change Commission (CCC) with a mandate to develop the National Framework Strategy on Climate Change (NFSCC) and a National Climate Change Action Plan (NCCAP). The NFSCC serves as the country’s roadmap to creating a climate risk-resilient Philippines (CCC, 2011b, p.2). The NCCAP aims to provide practical adaptation strategies the country can use to meet their adaptation needs.

While the CCC is leading the way at the national level, they also recognize many of the impacts of climate-related changes vary according to the local government units (LGU) unique physical, social, and economic characteristics. The CCC thus has a mandate to assist LGU’s to assess and address the implications of these localized changes by developing Local Climate Change Action Plans (LCCAP) (CCC, 2011b).

The Municipality of Pulilan, located within the Province of Bulacan, Central Luzon, Philippines is one such LGU experiencing...
unanticipated pressures from climate change. Pulilan is located in the western side of Bulacan Province (see Figure 1.1) with an area of ~3,975 hectares and a population of ~91,748 (Municipality of Pulilan, 2011; Lenora Acuña, Budget Officer, personal communication, July 11, 2013). Pulilan is part of the first congressional district of Bulacan, with 19 barangays. It is bound on the North by the Municipality of Apalit in the province of Pampanga; on the East by the Municipality of Baliuag; on the South by the Municipality of Plaridel; and on the West by the Municipality of Calumpit (Municipality of Pulilan, 2011).

The population of Pulilan is increasing at an annual average growth rate of 3.2% (Municipality of Pulilan, 2011; see Appendix I). A third of the population has grown in the past decade in the barangays of Poblacion, Inaon, and Sto Cristo, in particular along the Angat River and major roads (Municipality of Pulilan, 2011).

The Angat River cuts its way through the southern edge of Pulilan, emptying downstream into Manila Bay. The Angat River separates the Municipality from Plaridel for a length of ~13 km. The Municipality of Pulilan is also part of the Pampanga Delta, which is regularly flooded from the Upper Pampanga River watershed (Municipality of Pulilan, 2011).

The Municipality of Pulilan is poised to develop their Local Climate Change Action Plan (LCCAP), which assesses their vulnerability to current and projected climate changes, as well as identifies strategies to implement to reduce their vulnerability and increase their capacity to adapt. The development of Pulilan’s LCCAP will be led by a local team, consisting of government staff from various departments, such as the Mayor’s office, Municipal Environment and Natural Resource Office, Municipal Planning and Development Office, Municipal Engineers Office, Municipal Disaster Risk Reduction and Management Office, and Municipal Health Office.

The Municipality has also engaged planning support from the University of British Columbia’s (UBC) School of Community and Regional Planning (SCARP) Philippines Community Service Learning Program. This program provides three planning students, Krystie Babalos, Christa Brown and Lavino (Wei-Chung) Chen, with the opportunity to gain practical experience learning from and supporting Pulilan in developing their LCCAP. The development of Pulilan’s LCCAP will be a lengthy comprehensive process that will extend beyond the planning students’ stay, fostering greater citizen participation in the process and implementation. The planning students thus focused on working with the local LCCAP team to introduce the basis for climate change action planning, and to conduct a preliminary assessment of local climate change adaptation issues and possible solutions. The outcome, in the form of this report, can serve as a foundation for the Pulilan team to conduct a more detailed and formal LCCAP.

1.2 What Is Climate Action Planning and Why Do It?

Climate action planning is the process of reducing human contributions to climate change and managing unavoidable impacts by reducing local vulnerabilities and increasing the ability of people to adapt. There are many reasons to pursue climate action planning:

- As stated in the Philippine National Climate Change Action Plan (NCCAP), the National Government recommends that Local Government Units vulnerable to the effects of regional climate changes begin to create plans that assess these impacts; identify areas of vulnerability; and develop risk reduction strategies.
Many impacts of climate change are experienced locally and depend on the Municipality of Pulilan’s unique physical, social, and economic characteristics. The local level is best positioned to assess and address these impacts.

Citizens of Pulilan are already experiencing the impacts of climate change. If the Municipality plans now, they will have better options available at lower costs to mitigate and adapt to more significant impacts in the future.

Many mitigation and adaptive actions can provide multiple benefits to the Municipality of Pulilan, including improved public health and security, reduced pollution to land, air and watersheds, and greater economic stability.

1.3 Objectives

The Municipality of Pulilan: Towards a Local Climate Change Action Plan provides guidance to the Municipality of Pulilan in addressing some of the unavoidable consequences of climate change. This report introduces the basis for climate change action planning by conducting a preliminary, broad assessment of adaptation issues and possible strategies for action. As well, it is intended to form the foundation for a local team to conduct a more detailed, formal LCCAP process.

The objectives of this report are as follows:

- To conduct a preliminary vulnerability assessment of the municipality’s exposure, sensitivity and adaptive capacity to climate change effects.
- To identify the nature and scope of a formal LCCAP in the Municipality of Pulilan and potential adaptation and mitigation strategies that may be adopted.

1.4 Report Structure

The Municipality of Pulilan: Towards a Local Climate Change Action Plan is organized into the following sections:

1. Introduction: details the context of climate change adaptation planning in the Municipality of Pulilan.
2. Methods: details the process by which the local LCCAP team and planning students worked together to conduct a preliminary vulnerability assessment and identify potential mitigation and adaptation strategies.
3. The Challenge - Climate Change Impacts and Vulnerabilities: highlights general findings from field research on Pulilan’s vulnerability to climate change.
4. The Opportunity – Towards a Local Climate Change Action Plan (LCCAP): details the potential nature and scope of Pulilan’s future LCCAP, as well as the priority areas and strategies to consider in six impact sectors: the environment, water resources, human health and security, food systems, infrastructure, and local economy.
5. Next Steps: presents steps Pulilan can take to plan and implement a formal LCCAP.
2. Methodology

The creation of the Municipality of Pulilan: Towards a Local Climate Change Action Plan was carried out in the Municipality of Pulilan, Province of Bulacan, Philippines from July 1 to July 25, 2013, with guidance from the Mayor Esguerra, as well as help from municipal staff to design the nature and scope of this research. In particular, the Adaptation Policy Framework (APF) Methodology was selected to address the challenges of developing an LCCAP in the Municipality of Pulilan. The APF, developed by the United Nations Development Programme Global Environment Facility (UNDP-GEF), offers a step by step guide to developing research, planning and policies related to protecting and enhancing human well-being through the lens of climate change mitigation and adaptation (Lim et al, 2005). The APF is comprised of the following five steps:

1. **Design the nature and scope of the project.** A community can determine the nature and scope of their plan at the start and integrate its design and implementation with regional, provincial and national policies and plans. This report will provide some recommendations to the Municipality of Pulilan on the nature and scope of their LCCAP (see Section 4).

2. **Conduct vulnerability assessment.** A community can conduct a vulnerability assessment of their exposure to climate change impacts, their sensitivity to these exposures, and their capacity to adapt to projected impacts. This report will provide a preliminary vulnerability assessment for Pulilan.

3. **Conduct a future climate risk assessment.** A community can develop scenarios of projected climate change impacts. This report will only provide a broad assessment of future climate risks in relation to six sectors in Pulilan: (1) environment, (2) water resources, (3) human health and security, (4) food security, (5) infrastructure, and (6) local economy.

4. **Formulate a climate change action strategy.** A community can synthesize their assessment and generate strategies to address the challenges. This report will provide initial strategies Pulilan can consider within six sectors. In the Municipality’s future LCCAP, they will be able to set their own priorities for action, identify appropriate strategies, and evaluate these strategies accordingly.

5. **Continue to plan.** LCCAP planning is continuous and cyclical, changing with feedback and in response to climate changes. The Municipality of Pulilan can draw from this report to begin planning an LCCAP and to implement,
monitor, evaluate, improve, and sustain any initiatives generated.

The process of developing a LCCAP with the APF methodology varies from a short qualitative process to a more detailed and comprehensive approach. The APF does not require an abundance of quantitative data or expertise in computer-based models. Rather, it encourages the best vulnerability assessments a community can conduct and a participatory “bottom-up” process including different groups within society (Lim et al, 2005).

### 2.1 Methods

Three primary sources of information were drawn upon to develop this report:

1. A literature and data review of existing legislation, plans, programs, statistics, provincial and municipal staff presentations, and websites;
2. Interviews with key informants including community members (e.g., informal settlers), barangay Captains and council members, municipal staff, provincial staff and others (e.g., business and facility owners, and Rural Health officers); and,
3. Direct observations and visual documentation (pictures) during field visits to the six most vulnerable barangays, informal settlements, social housing and subdivisions, key infrastructure, agriculture and industrial sites, commercial sites, and municipal and provincial offices.

### 2.2 Limitations

The limitations of this report are as follows:

1. Due to significant time constraints, this report is a preliminary assessment of a variety of information and potential strategies. The team was not able to gather data on all relevant sectors and topics, and to conduct more in-depth interviews with key informants. No transcripts of interviews were made for validation and feedback.
2. The criteria, strategies and planning actions of this report were formed through an inter-cultural lens from western educated planning students. The limited familiarity with Filipino culture, politics and social customs thus influenced the development and interpretation of this project and results.
3. Because of the language barrier (e.g., Tagalog and English), there may be miscommunications or gaps in cross-cultural understanding from the research and data collected.
4. The Pulilan Comprehensive Land Use Plan 2011 – 2020 and Socio-Economic Profile provided a breadth of background information, but is limited by an unavailability of up to date data. This may limit the accuracy of the report.
5. This report was co-written by three students that have shared expertise in community, regional and ecological planning. They are limited in their knowledge of engineering, and Filipino community and economic development. Future LCCAP planning may require planners with a diversity of expertise to provide optimal recommendations.
3. The Challenge: Climate Change Impacts and Vulnerabilities

This section will profile the projected impacts of climate-related changes to the Municipality of Pulilan, as well as potential vulnerabilities. With this broad preliminary profile, the connection between projected impacts in six key sectors of Pulilan can be better understood and planned for accordingly.

Regional and local climate-related changes experienced by the Municipality of Pulilan are based on the information collected from primary and secondary data sources at the local, provincial, national and global level. Given limited access to local climate change observations and trend data, only rough climate change trends, without seasonal and regional trends, will be provided in this section.

Climate-related changes are often classified according to four characteristics: temperature change, precipitation pattern change, extreme weather events, and sea level rise.

1. **Temperature Change**: the Philippines NCCAP indicates that the mean temperature of the Philippines has increased by 0.64 °C from 1951-2010 (CCC, 2011a). In the last 60 years, maximum (daytime) and minimum (nighttime) temperatures have also increased by 0.36 °C and 0.1 °C, respectively. As far as future climate change projections, the Philippines is expected to get warmer, with major increases in temperature in the summer months, March, April and May (MAM). Mean temperatures are projected to rise by 0.9 °C to 1.1 °C by 2020 and by 1.8 °C to 2.2 °C by 2050 (Figure 3.1). In the Angat River watershed, changes in annual temperature from three different Global Climate Models (GCMs) anticipate an increase from 2 to 3.1 °C if CO2 doubles (Jose and Crus, 1999). This increase in temperature could result in an increase in the level of diseases affecting human health (National Nutrition Council, 2013). Moreover, it may deteriorate socio-ecosystem functions and services, and agricultural systems, fishing practices, settlement patterns, livelihood pursuits, food security and hydrological cycles of the Angat River basin (Allen, 2006).
2. **Precipitation Pattern Change**: In the Municipality of Pulilan, the rainy season (southwest monsoon season) is roughly from May to October, followed by a dry season (northeast monsoon season) from November to April. Based on the 2011 and 2012 monthly total precipitation record, Pulilan has limited rainfall from January to April (Figure 3.2; Province of Bulacan, 2013). According to the Philippines NCCAP, there is projected to be a reduction in future annual precipitation during the summer (MAM) season in Luzon, and an increase in rainfall during the southwest monsoon season (CCC, 2011a). The International Panel on Climate Change’s (IPCC) fourth assessment report shows there will be a reduction in precipitation during the dry season and an increase in rainfall during the raining season in the Philippines (Figure 3.3). Consecutive dry days may increase in the future. This indicates precipitation patterns may become more extreme, and pose a challenge to local, regional and national water resource management and agricultural activities (IPCC, 2007).

![Mean Temperature Projections in the Philippines](source: CCC, 2011a)

![Pulilan Monthly Total Rainfall, 2011 and 2012](source: Province of Bulacan, 2013)
3. **Extreme Weather Events**: the risk profile provided by PDRRMC reveals there has been no significant change in the number of typhoons hitting Bulacan between 2003-2012 (see Appendices III) (Province of Bulacan, 2008 and 2012). Nevertheless, recent studies have shown that by the end of the 21st century the frequency of occurrence and strength of tropical cyclones may increase by 10–45% (Emanuel, 2013). Furthermore, considerable increases in the total number of families and properties affected by typhoons can be observed, especially in the last three years (see Appendices III) (Province of Bulacan, 2008 and 2012). The impacts caused by typhoons Ondoy, Pepeng, and Pedring are more severe. This could be related to a change in the tracks of typhoons over time, as well as an increase in the unpredictability of typhoons. The location of the Philippines makes it vulnerable to the impacts of El Nino and La Nina. Prolonged droughts (with extreme high temperatures) often occur during the period of El Nino, whereas La Nina brings about prolonged precipitation days or even extremely heavy rainfall from an abnormal northwest monsoon season (NOAA, 2005). The El Nino-related drought of 1982-83 and 1997-1998, for instance, disrupted large areas of agriculture in the Philippines (Jose and Cruz, 1999). These climate events challenge local municipalities in their water resource and ecological management.

4. **Sea Level Rise**: Global average sea levels rose at an average rate of 1.8 mm per year from 1961 to 2003, and at an average rate of ~3.1 mm per year from 1993 to 2003. By the end of the 21st century, global average sea levels could rise up to 60 cm relative to 1980-1990 levels (IPCC, 2007).

Overall, climate change impacts vary depending on the specific sector and regional area of a community. To plan for climate-related changes, the Municipality of Pulilan can build flexibility into their LCCAP. Climate change projection data may be highly uncertain and unreliable at lower latitudes where air contains higher amounts of water vapor (e.g., monsoon regions), but it is still important to assess, identify and monitor local climate change impacts (IPCC, 2007).
Table 3.1 Regional climate change trends, impacts (direct and indirect), and vulnerabilities in Pulilan.

<table>
<thead>
<tr>
<th>Climate Variable</th>
<th>Summary of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>• Increase in average annual temperature, also in daytime and nighttime temperatures (CCC, 2011a)</td>
</tr>
<tr>
<td></td>
<td>• Annual increase of 0.9 °C to 1.1 °C by 2020s and of 1.8 °C to 2.2 °C by 2050s, especially during the period of the summer months (March, April, and May) (CCC, 2011a)</td>
</tr>
<tr>
<td>Precipitation Pattern</td>
<td>• Reduce future annual precipitation during the summer season (MAM) and increase rainfall during the southwest monsoon season (CCC, 2011a).</td>
</tr>
<tr>
<td></td>
<td>• Increase consecutive dry days and uneven rainfall patterns (CCC, 2011a).</td>
</tr>
<tr>
<td>Extreme Weather Events</td>
<td>• Increase strength and frequency of typhoons (IPCC, 2007).</td>
</tr>
<tr>
<td></td>
<td>• Changing tracks of typhoons and strength of El Nino and La Nina, making forecasting unpredictable (NOAA, 2005).</td>
</tr>
<tr>
<td>Sea Level Rises</td>
<td>• The mean global sea level might rise by 60 cm by 2100 (IPCC, 2007).</td>
</tr>
</tbody>
</table>

Table 3.2 Preliminary assessment of projected impacts and Pulilan’s sensitivity to climate change by impact sector.

<table>
<thead>
<tr>
<th>Priority Areas</th>
<th>Potential impact and sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment</td>
<td>• The Angat River wetlands are at risk of increased flooding. Farmers and informal settlements on the river banks are at risk of flooding (Municipality of Pulilan, n.d.).</td>
</tr>
<tr>
<td></td>
<td>• Surface water quality may be affected by changing hydrological cycles</td>
</tr>
<tr>
<td></td>
<td>• Underground aquifers may be affected by saltwater intrusion and depletion</td>
</tr>
<tr>
<td></td>
<td>• Barangays such as Dampol 1st are at risk of increased pollution because solid and liquid waste collects downstream in their irrigation canals, streams and Angat River banks (Danilo Calderone, barangay council, Dampol 1st, personal communication, July 11, 2013)</td>
</tr>
<tr>
<td>Human health and</td>
<td>• Marginalized groups are most vulnerable to climate changes, such as informal settlers, children (under 5 years old), women, large households with 4+ children, people with disabilities, and low-income households (NNC, 2013)</td>
</tr>
<tr>
<td>security</td>
<td>• Households in flood-prone areas are vulnerable to climate-related human health challenges, in particular in Sto. Cristo, Tibag, Dampol 1st, Inaon, Dulong Malabon, Dampol 2nd A, Dampol 2nd B and Longos (Roberto Cruz, MENRO, personal communication, July 22, 2013)</td>
</tr>
<tr>
<td></td>
<td>• Powerlines and buildings in flood-prone areas at risk of deterioration</td>
</tr>
<tr>
<td>Water Resources</td>
<td>• All residents may be vulnerable to inaccessible clean drinking water during extreme weather events.</td>
</tr>
<tr>
<td></td>
<td>• Low income households and informal settlers in flood-prone areas are most vulnerable (Municipality of Pulilan, 2011).</td>
</tr>
<tr>
<td></td>
<td>• Farmers, fisher folk and local industries are vulnerable to water shortages as they have higher water consumption demands.</td>
</tr>
<tr>
<td></td>
<td>• Children and the elderly with weak immune systems are susceptible to water-related diseases (NNC, 2013).</td>
</tr>
<tr>
<td>Food Security</td>
<td>• Farmers and fisher folk are vulnerable to floods, droughts and typhoons, especially in Dulong Malabon, Tabon and Inaon and on Angat river banks (Municipality of Pulilan, n.d.; Loreto De Jesus, Municipal Agriculturist, personal communication, July 11, 2013)</td>
</tr>
<tr>
<td></td>
<td>• Farmers that rely on high yield mono-crops may have reduced crop biodiversity and adaptability to changes in temperature and rainfall.</td>
</tr>
<tr>
<td></td>
<td>• Low-income informal settlements are vulnerable to food insecurity during</td>
</tr>
</tbody>
</table>
### The Challenges

#### Infrastructure

##### Housing
- Higher-density residential and commercial developments can make residents more vulnerable to extreme weather events as damage can result in higher death tolls, like in Poblacion and Lumbac (Municipality of Pulilan, n.d.)
- Buildings in flood-prone areas in Inaon and Dulong Malabon are vulnerable to damage and destruction from Pampanga Dam water releases (Municipality of Pulilan, n.d.)
- Informal settlements along the Angat River banks are vulnerable to flooding

##### Transportation
- 8 Bridges over irrigation canals may be most vulnerable to flooding (Rosemarie Esguerra, Engineering Officer, personal communication, July 15, 2013)
- 5 bridges over creeks may be medium vulnerable to flooding (Rosemarie Esguerra, Engineering Officer, personal communication, July 15, 2013)
- Angat waterways (river port, informal ferries and piers) are vulnerable to destruction during extreme weather events
- All mobility and transportation access along the ~10 flood prone roads are vulnerable to flooding (Municipality of Pulilan, n.d.)

##### Water System
- Water pumps in flood-prone areas (e.g. the water pump station in Dampol 2nd A) is vulnerable to degradation from flooding (Honarato Dalisay, Water System Clerk, personal communication, July 15, 2013).
- Groundwater and soils may be susceptible to saltwater intrusion, decreasing water quality for consumption and agricultural activities

##### Solid Waste
- Material Recovery Facility’s and industrial buildings are vulnerable to polluting hazardous materials, such as corrosives, flammable materials and toxins, during extreme weather events (MENRO, 2013)

##### Public Facilities and Religious Sites
- Essential facilities, like hospitals, medical facilities, police and fire stations, emergency operations centers, evacuation shelters and schools in flood-prone areas are vulnerable to flooding (Municipality of Pulilan, n.d.).
- Farming households in Dulong Malabon, Inaon and Balatong A and B are far from public facilities (Municipality of Pulilan, n.d.).
- Informal settlers living at edge of barangays and far from evacuation centers.

#### Local Economy
- Farmers, businessmen, agro-industries, livestock workers and families who rely on agricultural production, especially in Barangay Dulong, Malabon and Inaon are vulnerable to changing precipitation and temperature patterns (Municipality of Pulilan, 2011)
- If food production levels fall, food prices may increase and affect low-income, underemployed and unemployed access to food. Also, agricultural jobs may decrease rendering more people under- and unemployed (Restituto Cruz, personal communication, July 12, 2013)
<table>
<thead>
<tr>
<th>T. Esguerra S. Plamenco, Captain of barangay Tibag, personal communication, July 5, 2013.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• People whose economic activities are tied to the local economy (e.g., local business, jeepney and tricycle drivers, service workers, tourism, etc.)</td>
</tr>
<tr>
<td>• Low income families (or informal settlers) that cannot afford food that may increasingly rise in price to meet demand from outside tourists and visitors (Restituto T. Esguerra S. Plamenco, Captain of barangay Tibag, personal communication, July 5, 2013)</td>
</tr>
</tbody>
</table>

Photo credit: Christa Brown
4. Nature and Scope of a Municipal LCCAP

The purpose of this section is to outline the potential nature and scope of Pulilan’s LCCAP.

A local interdepartmental LCCAP team, in consultation with higher levels of government may develop a more comprehensive climate change vulnerability assessment and suite of strategies in six or more priority areas as part of their LCCAP. This section is not meant to prescribe the nature and scope of an LCCAP for the Municipality of Pulilan, but rather to provide some preliminary thoughts that can be explored alongside local knowledge in this emerging area of planning.

4.1 Legislated Targets

In 2009, the Philippines passed the Climate Change Act (Republic Act 9729) establishing:

- A Climate Change Commission (CCC) tasked with coordinating, monitoring, and evaluating the programs and action plans of government relating to climate change;
- That Local Government Units (LGUs) are responsible for the formulation, planning, and implementation of their Local Climate Change Action Plan (LCCAP), consistent with the Local Government Code, the National Framework Strategy on Climate Change (NFSCC), and the National Climate Change Action Plan (NCCAP); and,
- That collaboration between local governments shall be maximized in climate-related activities (CCC, 2011a).

The NFSCC is based on the following Guiding Principles that can be integrated into the Municipality of Pulilan’s LCCAP:

- Improve risk-resilience
- Improve adaptive capacity
- Ensure equity of women, children, the poor, and other vulnerable citizens
- Develop participatory processes to include multiple stakeholders from within civil society, the private sector, local government, and indigenous and other marginalized groups vulnerable to climate change impacts (CCC, 2011a).
Towards a LCCAP

To ensure consistency with the NCCAP, Pulilan’s LCCAP can prioritize opportunities for adaptation that reduce the vulnerability and risk in communities that face impacts from climate change related hazards. Opportunities for mitigation and sustainable development can also be encouraged. The NCCAP seven priority areas with related outcomes (see Table 4.1) can also be addressed within Pulilan’s LCCAP.

### 4.2 Target Areas

The Municipality of Pulilan’s LCCAP can target the entire municipality, including all 19 barangays (Figure 4.2). In particular, the plan can focus on the Angat River to the south and lands in the northwest bordering the Candaba Swamp, as these areas are of ecological significance and prone to exposure to climate related hazards. Other areas identified as being at high risk to the impacts of climate change, such as urban areas prone to flooding, streams, and agricultural lands, can also be given attention in the plan. Additionally, populations that tend to be more vulnerable can be given explicit consideration in the plan. These populations include seniors, young children, women, persons with disabilities, and the poor, particularly those residing in informal settlements or inadequately serviced housing in formal settlements. The Pulilan LCCAP may not exist in isolation, but rather be integrated horizontally with other local level plans, such as the Pulilan Comprehensive Land Use Plan (CLUP) and plans from the neighbouring municipalities of Plaridel, Baliuag, Calumpit, and Apalit. The LCCAP may also be vertically integrated with other plans within the province, region, Angat watershed, and NCCAP.

---

### Table 4.1 NCCAP Priorities and Outcomes. (Source: CCC, 2011).

<table>
<thead>
<tr>
<th>PRIORITIES</th>
<th>OUTCOMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Food security</td>
<td>The objective of the national strategic priority on food security is to ensure availability, stability, accessibility, and affordability of safe and healthy food amidst climate change.</td>
</tr>
<tr>
<td>2. Water sufficiency</td>
<td>In light of climate change, however, a comprehensive review and subsequent restructuring of the entire water sector governance is required. It is important as well to assess the resilience of major water resources and infrastructures, manage supply and demand, manage water quality, and promote conservation.</td>
</tr>
<tr>
<td>3. Ecological and Environmental stability</td>
<td>Ecosystem resilience and environmental stability during the plan period is focused on achieving one immediate outcome: the protection and rehabilitation of critical ecosystems, and the restoration of ecological services.</td>
</tr>
<tr>
<td>4. Human security</td>
<td>The objective of the human security agenda is to reduce the risks of women and men to climate change and disasters.</td>
</tr>
<tr>
<td>5. Climate-friendly Industries and services</td>
<td>NCCAP prioritizes the creation of green and eco-jobs and sustainable consumption and production. It also focuses on the development of sustainable cities and municipalities.</td>
</tr>
<tr>
<td>6. Sustainable energy</td>
<td>NCCAP prioritizes the promotion and expansion of energy efficiency and conservation; the development of sustainable and renewable energy; environmentally sustainable transport; and climate-proofing and rehabilitation of energy systems infrastructures.</td>
</tr>
</tbody>
</table>
| 7. Knowledge and capacity development    | The priorities of the NCCAP on knowledge and capacity development are:  
  - Enhanced knowledge on the science of climate change;  
  - Enhanced capacity for climate change adaptation, mitigation and disaster risk reduction at the local and community level; and  
  - Established gendered climate change knowledge management accessible to all sectors at the national and local levels. |
4.3 Recommended Priority Areas

In consultation with municipal staff, and based broadly on the priorities outlined in the NCCAP, the following six priority areas are offered here as possible priorities for Pulilan’s LCCAP:

1. **Environment**: Ecosystem Services, Land Use Planning and Resource Management

2. **Water Resources**: Water System Management and Governance

3. **Human Health and Security**: Climate-Change Adaptive Settlements and Services

4. **Food Security**: Agriculture and Fishing

5. **Infrastructure**: Transportation, Buildings, and Public Infrastructure

6. **Local Economy**: Sustainable Livelihoods

Knowledge and capacity development may be incorporated into each of the priority areas because it is essential to the success of any actions developed and implemented to address climate change.

4.4 LCCAP Leaders, Allies and Partners

Within the Municipality of Pulilan, a dedicated staff team has been formed to develop and plan the LCCAP. It may also be useful to designate one LCCAP leader or champion who will be committed to its success. The Municipal Departments that may have a role in the formulation of the LCCAP include:

- Municipal Planning and Development Office
- Municipal Environment and Natural Resources Office
- Municipal Disaster Risk Reduction and Management Office
- Municipal Social Welfare and Development Office
- Municipal Engineers Office
- Municipal Health Office
- Pulilan Water System

Figure 4.1 Municipality of Pulilan, 19 Barangays. (Source: Municipality of Pulilan, 2010)
Potential allies and partners for Pulilan’s LCCAP are numerous, and include:

- Climate Change Commission (CCC)
- Department of Environment and Natural Resources (DENRO)
- Department of Interior and Local Government (DILG)
- Department of Public Works and Highways (DPWH)
- National Power Corporation (NPC)
- National Irrigation Administration (NIA)
- Metropolitan Waterworks and Sewerage System (MWSS)
- Pampanga River Basin Committee (PRBC)
- Provincial Government of Bulacan
- Neighbouring Municipalities of Plaridel, Baliuag, Calumpit, and Apalit
- 19 Barangay Councils within Pulilan
- Bulacan State University (BULSU)
- Non-governmental Organizations (NGOs) (e.g. Farmer and Fisherfolk’s Association)
- Industries and commercial businesses located within Pulilan
- Residents of Pulilan

4.5 General Revenue Sources

According to the Municipal Budget Officer (Leonor Acuna, personal communication, July 11, 2013), the Municipality of Pulilan receives funding from a number of sources.

- The National Department of Budget and Management provides funding to the municipality through the Internal Revenue Allotment (IRA) on the basis of population and land area.
- The Province of Bulacan may provide funding for specific projects.
- The Municipality generates income from the following: fees from the issuing of permits, such as building permits and business permits; Real Property Tax (RPT) from property owners; ‘pay-by-volume’ water meter system; and sales tax from the municipal-run market.

No specific budget has been allocated for the development and implementation of the LCCAP. Rather, funding for climate change adaptation related expenditures is integrated into the budgets of existing departments with relevant responsibilities.
5. Recommended Priority Areas and Strategies

This section outlines the six priority areas for the Municipality of Pulilan to consider when developing the LCCAP. The six priority areas include a preliminary profile detailing background information and the current status. This is then followed by a table of potential climate change impacts and strategies to consider. These priority areas are inter-connecting, as shown in Figure 5.

The LCCAP can be broadly based on the NCCAP’s Guiding Principles:

- Risk-resilience
- Adaptive capacity
- Equity for women, children, the poor, and other vulnerable citizens
- Participatory processes that include multiple stakeholders from civil society, the private sector, local government, indigenous and other marginalized groups (CCC, 2011a).
5.1 Environment: Ecosystem Services, Land Use Planning and Resource Management

Ecosystem Services

One of the seven strategic priorities in the NCCAP is Ecosystems and Environmental Stability, with the goal of “ecosystems protected, rehabilitated and ecological services restored” (CCC, 2011b, p.5). Ecosystem services can be defined as the provisioning services (e.g. food, water, timber), regulating services (e.g. affecting climate, floods, wastes, and water quality), cultural services (e.g. recreational, aesthetic), and supporting services (e.g. soil formation, photosynthesis, and nutrient cycling) that benefit people and are obtained from ecosystems. Changes in ecosystem services affect human well-being. Humans are also an integral part of the ecosystems on which they depend (Millennium Ecosystem Assessment, 2005).

Climate regulation is an ecosystem service. Human activities that release Greenhouse Gases, however, have contributed to changes in climatic patterns and ‘climate regulation’ services. The challenge for Pulilan is to adapt to these changing climatic conditions.

Within the Municipality of Pulilan, important ecosystem services include:

- Provisioning services, particularly food and water;
- Regulating services that help control flooding, disease, wastes, and water quality;
- Supporting services, such as soil formation, photosynthesis, and nutrient cycling; and,
- Cultural services, particularly recreational and aesthetic.

Many threats to these services exist, both from climate-related changes, and from urbanization, population growth, solid waste management practices, air and water pollution, and invasive species. Protecting ecosystem services through an ecosystem-based management approach to land use planning and resource management is one way of strengthening ecological resilience, and human health and security. An ecosystem-based management approach considers both human and ecological systems as interdependent (Berkes, 2010). Both the biophysical environment and the human elements are considered in land use planning and resource management.
**Land Use Planning**

The 2011/2012 Comprehensive Land Use Plan (CLUP) is the primary document governing land use planning within the municipality (Municipality of Pulilan, 2011). According to the CLUP, the topography of Pulilan is dominated by flat plains and relatively flat slopes. Flooding is the major climate hazard in the region, especially in the northwest in barangay Dulong Malabon during the rainy season when floodwaters come from the Candaba Swamp to the north (Municipality of Pulilan, 2011).

Human land use patterns have and can continue to worsen impacts from climate-related changes. For example, increases in the built up area tends to increase impervious surfaces and reduce lands that sequester carbon and infiltrate storm water. This can increase residents vulnerability to flood hazards.

Data from 2007 shows the dominant land use is agriculture at 3,163 hectares of land (~81% of total land area), followed by 449 hectares of urban land uses, including residential area (~11%). Other land cover areas include open areas, bush or scrub, tropical grass, swamp, and special uses (e.g., cemetery) which account for ~8% of total land area combined (Municipality of Pulilan, 2011).

Based on proposed land uses for 2020 (Figure 5.1), ‘agriculture’ land will decrease to ~76% of total land area while urban land uses will increase to ~23%, and ‘special uses’, including cemetery, parks, and tourism areas, will account for ~1% of total land area (Municipality of Pulilan, 2011). Other natural lands may also be converted to urban land uses according to the CLUP. This trend of converting agricultural land and ‘other’ uses to urban uses can lead to more impervious surfaces. This may pose a challenge to the municipality in terms of flood control and ensuring permeable surfaces for water infiltration into soils and underground aquifers. The community is dependent on the aquifers for its drinking water supply.

Pulilan has policies in place to guide development and reduce environmental impacts. New developments must align with the 2002 Municipal Environmental Code of Pulilan (Leovigildo Garcia, Municipal Planning and Development

**Figure 5.1 Municipality of Pulilan current and proposed land use. (Source: Municipality of Pulilan, 2011)**
Recommendations: Environment

Officer, personal communication, July 10, 2013). It is now in the process of being updated (Roberto Cruz, Municipal Environment and Natural Resources Officer, personal communication, July 10, 2013). The Environmental Code lays out the rules governing land use, water resource management, air quality, and solid waste management (Municipality of Pulilan, 2002).

Resource Management

As Pulilan does not have any extractive industries like mining or forestry, the main resources to be managed are its land base (discussed in the Land Use Planning section above), particularly agricultural lands and fishing areas (as discussed in the Food Security priority area), water resources (as discussed in the Water Sufficiency priority area), and solid waste. Rather than view solid waste as garbage, it can be viewed as a resource from which materials can be recovered, recycled, repurposed, or reused. Pulilan has as its solid waste management objective zero waste disposal, with initiatives assisting the community in this goal. For example, there is a comprehensive Solid Waste Management policy and program within the Municipal Environmental Code (Municipality of Pulilan, 2002), a Solid Waste Management Board, and a central Materials Recovery Facility (MRF) in barangay Longos in 2001 (Municipality of Pulilan, n.d.). Private initiatives also exist to collect, clean, and reuse recyclable materials. For example, some junkshops collect used glass alcohol bottles, clean them using acid, caustic soda, and water, and then repackage and sell them to manufacturers. The bottle caps are collected and sold to other junk shops and any broken glass is sold to a glass factory (Bert Ambo, Sto. Cristo barangay secretary, personal communication, July 11, 2013). There is no need for any waste from these bottles to end up in a landfill, but rather they can be utilized as a resource for other goods.

Similarly, organic waste is composted and distributed to farmers free of charge as fertilizers (Isidoro Santos, SB Secretary, personal communication, July 10, 2013). Waste to energy production is also being considered at the central MRF (Daren Dy, MRF Supervisor, personal communication, July 4, 2013).

Much progress has been made to manage solid waste within Pulilan. But not all solid waste is recycled, reused, or repurposed. Some areas continue to have issues with waste polluting waterways and irrigation canals (Danilo Calderon, Dampol 1st barangay councillor, personal communication, July 11, 2013). Ensuring clean water in streams, irrigation canals, and the Angat River will be an ongoing challenge, but one that is important for building resilience and adaptive capacity in the face of a changing climate. Water that is polluted by either solid or liquid waste is not fit for human use or irrigation as it can be a source of disease that affects human health. Polluted waterways also have their functions impaired and cannot provide ecosystem services that benefit residents. As many of the waterways in Pulilan cross political boundaries, inter-governmental collaboration will be essential in dealing with solid waste management problems affecting waterways.
### Potential Climate Change Impacts and Strategies

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> Increases in temperature and changing precipitation patterns can affect ecosystem structure and functioning and the services they are able to provide for humans</td>
<td><strong>Short Term</strong>&lt;br&gt;• Explore partnerships with researchers in physical and environmental sciences at local academic institutions to set up evaluation and monitoring of ecosystem health.&lt;br&gt;• MENRO to update the Municipal Environmental Code of Pulilan to ensure it includes an ecosystem-based management approach and climate change adaptation strategies.&lt;br&gt;<strong>Medium Term</strong>&lt;br&gt;• Explore developing elementary and high school curricula and other IEC programs in partnership with local public and private schools on how climate change affects ecosystem health and services.&lt;br&gt;<strong>Long Term</strong>&lt;br&gt;• Work towards conservation, restoration, and expansion of ecosystems within Pulilan, especially those adjacent to the Angat River and other bodies of water&lt;br&gt;  • Mobilize local residents to lead community-driven conservation and restoration activities.&lt;br&gt;  • Work with Pulilan Water System and province on an Angat watershed management plan</td>
</tr>
<tr>
<td><strong>2.</strong> Urban developments in current and projected hazard areas may be at increased risk to flooding due to heavier rainfall and more frequent and intense storms</td>
<td><strong>Short Term</strong>&lt;br&gt;• Consult with residents in areas exposed to flooding to jointly assess options to reduce their vulnerability&lt;br&gt;<strong>Medium Term</strong>&lt;br&gt;• Examine current land use plans and projections with aim of preventing further development in hazard prone areas, utilizing an ecosystem-based management approach.&lt;br&gt;• Incorporate zoning for protected areas in Comprehensive Land Use Plan.&lt;br&gt;<strong>Long Term</strong>&lt;br&gt;• Continuously monitor, evaluate, and update current plans (e.g. CLUP, DRRMP, etc.) to incorporate new knowledge and information.</td>
</tr>
<tr>
<td><strong>3.</strong> Expanding urban development and heat absorbing impervious surfaces (e.g. roads) will increase residents susceptibility to heat waves</td>
<td><strong>Short Term</strong>&lt;br&gt;• Explore options for reducing impervious and heat absorbing surfaces and expanding cooling areas in Pulilan (e.g. green space, tree canopy covers on side roads etc.)&lt;br&gt;<strong>Long Term</strong>&lt;br&gt;• Continuously monitor, evaluate, and update current plans (e.g. CLUP, DRRMP, etc.) to incorporate new knowledge and information.</td>
</tr>
</tbody>
</table>
4. Changes in precipitation and temperature, alongside inadequate waste management can worsen the degradation of land and water resources.

<table>
<thead>
<tr>
<th><strong>Short Term</strong></th>
<th><strong>Medium Term</strong></th>
<th><strong>Long Term</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Continue and expand existing solid waste management programs</td>
<td>• Build partnerships with neighboring municipalities and other levels of government to explore joint solutions for preventing solid waste disposal in waterways</td>
<td>• Encourage and advocate to expand zero waste policies and programs across the province, region and state.</td>
</tr>
</tbody>
</table>
5.2 Water Resources: Water System Management and Governance

In the Municipality, it can be easy to take the abundant sources of drinking water for granted. Water is all around the community in the Angat river basin, in the underground aquifers, as well as from significant annual rainfall. However, factors such as population growth and climate change impact Pulilan’s access to clean, safe and abundant water. Water resources, in this instance, is the right to clean and adequate water.

The Municipality of Pulilan provides more than 10,000 households with drinking water from the Pulilan Water System (Honarato Dalisay, Water System Clerk, personal communication, July 15, 2013). All local water uses, except for agriculture, rely on underground aquifers. Agricultural water uses is sourced from the Bustos’ Dam in the Angat River and the Upper Pampanga River Irrigation System (UPRIS) (Municipality of Pulilan, 2011; Loreto De Jesus, MAO, personal communication, July 11, 2013). The remainder of households, commercial, industrial and agricultural users rely on private water systems, drawing from deep wells. Most large enterprises have privately-owned pump equipment and are not controlled or monitored by the Pulilan Water System (Honarato Dalisay, Water System Clerk, personal communication, July 15, 2013).

There are 10 water pump stations, pulling water from the underground aquifers in the barangays of Cutcot, Dampol 1st, Dampol 2nd A, Poblacion, Sto. Cristo, and Tinejereo (see Figure 5.2) (Honarato Dalisay, Water System Clerk, personal communication, July 15, 2013). There are also 13 fire hydrants that rely on groundwater from the Pulilan Water System (Municipality of Pulilan, 2013).
The Municipality of Pulilan has built and continues to build a network of storm water drainage canals (see Appendices IV) (Municipality of Pulilan, 2011). The storm water canals are susceptible to being blocked by solid waste, soil and debris, therefore, overflowing during times of rainstorms and flooding.

The Pulilan Water system relies on water chlorination to sanitize all drinking water (Honarato Dalisay, Water System Clerk, personal communication, July 15, 2013). Water quality testing has been implemented since 2007 based on national standards. All businesses and factories in Pulilan are required to have a sanitary operation permit for waste-water treatment (e.g., lagune and tanks) (Loida Caleon, Sanitation Inspector, personal communication, July 12, 2013). However, some people prefer to purchase filtered drinking water at a higher price from private filtration stations. Further cost-benefit assessments of this issue could be studied.

In 2013, total monthly average water consumption was ~220,000 tons (cubic meters) and ~23 cubic meters per household (Honarato Dalisay, Water System Clerk, personal communication, July 15, 2013). Historical water consumption levels are from the Water System’s revenue collection records. From 2004 to 2012, there were no significant changes in water consumption in the summer months; but, there were a slight increase during the dry season (Figure 5.2.1) (Municipality of Pulilan, 2013). The number of customers 1 using the Pulilan Water System increased from ~4,200 to ~9,800 households from 2004 to 2012 (Appendices V); therefore, it is likely water consumption levels have increased, drawing more water from the aquifers without efforts to re-use and recycle water.

The Municipality of Pulilan can play a lead role in ensuring high water quality for all of its residents. Pulilan has a role to play in monitoring water quality and in working with residents and businesses to protect and to prevent water waste and overconsumption. Exploring low-impact water resources may be one option for the future, for example, rainwater and grey water capture, filtration and re-use.

---

1 Estimated number of customers does not take type of customers into consideration (e.g., residential, commercial, and industrial users).
### Potential Climate Change Impacts & Strategies

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Increased temperature and changes in precipitation can lead to more intense rainstorms and flooding, resulting in damage to water systems.</strong></td>
<td><strong>Short Term</strong>&lt;br&gt;• Work with Pulilan Water System to develop a water systems plan with safety and local hazard mitigation strategies&lt;br&gt;• Explore weather observation and forecasting tools for future climate change monitoring and preparedness&lt;br&gt;<strong>Medium Term</strong>&lt;br&gt;• Integrate water resource management into disaster risk reduction and management plan.&lt;br&gt;• Revise the CLUP to include water supply and demand management strategies for domestic and economic uses.&lt;br&gt;<strong>Long Term</strong>&lt;br&gt;• Explore feasibility of updating, retrofitting or replacing old or leaking water infrastructure (e.g. pipes, pumps etc.)</td>
</tr>
<tr>
<td><strong>2. Sea level rises and depletion of aquifers can lead to saltwater intrusion in groundwater</strong></td>
<td><strong>Short Term</strong>&lt;br&gt;• Consult with DENRO about plans to conduct groundwater surveys and mapping&lt;br&gt;• Measure, monitor and track water quality and quantity over time by source for the purpose of identifying trends or emerging issues.&lt;br&gt;<strong>Medium Term</strong>&lt;br&gt;• Explore partnerships to draw on local expertise to estimate underground aquifers&lt;br&gt;• Explore plans to protect aquifer recharge zones, mitigate against saltwater intrusion and reduce water system leakage</td>
</tr>
<tr>
<td><strong>3. Increased temperature and changing rainfall patterns can lead to higher demand for water, and less available surface and groundwater during drought conditions</strong></td>
<td><strong>Short Term</strong>&lt;br&gt;• Encourage reduction in water consumption in both private and public sectors&lt;br&gt;• Develop water conservation education&lt;br&gt;• Promote water-saving products and devices.&lt;br&gt;• Integrate planning for droughts in the disaster risk reduction and management plan.&lt;br&gt;• Support Pulilan Water System to monitor water consumption by user type: residential, commercial, industrial, agricultural and institutional&lt;br&gt;• Continue water quality testing at source and at point of use&lt;br&gt;<strong>Medium Term</strong>&lt;br&gt;• Explore possibilities for identifying, registering and monitoring water use from private wells drawing from common aquifers.&lt;br&gt;• Explore integrated rainwater management options and grey water recycling use.&lt;br&gt;• Engage all relevant stakeholders in developing a water plan. This may include water use audits, water conservation, and ICE.&lt;br&gt;• Ensure safe clean drinking water remains affordable to all (e.g. installing drinking water fountains/water bottle filling stations in public)&lt;br&gt;<strong>Long Term</strong>&lt;br&gt;• Explore green infrastructure options for storm water management to enhance aquifer recharge (e.g. bioswales, community gardens, green roofs, urban parks and forests)&lt;br&gt;• Review water pricing with lens of encouraging water conservation</td>
</tr>
</tbody>
</table>
Improving human health and security can be integral to building adaptive capacity to climate-related changes and impacts. One key determinant of good health is proper nutrition. Chronically hungry children and adults may be unable to fight common diseases and undernourished children may have impaired mental and physical development, leading to increased vulnerability in times of disaster, such as floods, droughts, and typhoons (National Nutrition Council, 2013). As will be discussed in the Food Security section, the productive capacity of the agricultural sector is influenced by climate-related changes. Lower crop yields can result in more residents without access to adequate quantities of nutritious food. The most vulnerable citizens are those whose livelihoods are dependent on agricultural production, as well as those who are poor and unable to afford adequate food.

Within Pulilan, vulnerable residents live in informal settlement areas with high exposure to climate-related hazards, in particular flooding. There are initiatives to resettle some residents. One informal settlement in barangay Dulong Malabon, located under the North Luzon Expressway (NLEX), an area highly-prone to flooding, has been surveyed in preparation for resettlement. Residents have been offered a new home of similar size to their current home in a new settlement within Pulilan. The only condition is that they voluntarily dismantle their existing home. The timeline for this relocation is for before December 2013 (Leovigildo Garcia, Municipal Planning and Development Officer, personal communication, July 10, 2013). Of the informal settlers on the banks of the Angat River in barangay Sto. Cristo, 19 families have been validated by Bulacan Province to relocate to a resettlement area within Pulilan. Their current settlement is susceptible to flooding during heavy rainfall. The challenge for resettlement is that there is often a lack of sufficient job opportunities and services in new communities (Burt Ambo, barangay Sto. Cristo secretary, personal communication, July 11, 2013).

Despite the challenges above, there are programs and services for improving the situation of Pulilan’s most impoverished and marginalized citizen, including:

- The MPDO requires residential developers to provide 20% socialized housing when constructing new
Recommendations: Human Health & Security

- Subdivisions (Leovigildo Garcia, Municipal Planning and Development Officer, personal communication, July 10, 2013).
- MAO provides farmers with capacity building and material/equipment support (Loreto De Jesus, Municipal Agriculturalist, personal communication, July 10, 2013).
- The Municipal Social Welfare and Development Office administers the Pantawid Pamilyang Pilipino Program, a Conditional Cash Transfer (CCT). This seeks to alleviate poverty and improve health among impoverished households with children. MSWDO also provides social pensions for seniors, daycare for children, and supplemental feeding for children aged 3 and 4 (Adora Angeles, Social Work Officer, personal communication, July 10, 2013).
- Public Employment Services Office (PESO) requires large companies to hire 70% of their employees from Pulilan (Irene Isidro, Public Employment Services Office Clerk, personal communication, July 10, 2013).
- Health care is provided to residents through four Rural Health Units (RHU) located in the barangays of Poblacion, Cut-Cot, Tibag, and Penabatan (Elizabeth Mercado, RHU Nurse, personal communication, July 11, 2013).
- Pulilan has developed a Municipal Disaster Risk Reduction and Management Plan to mitigate the effects of climate change, be prepared for disasters, prevent the loss of lives, protect property damage and needless suffering, and minimize damages during times of disasters, epidemics, and other emergencies (Municipality of Pulilan, n.d.).

Residents’ security is also intimately linked to access to clean and consistent energy for their homes, public infrastructure, the Water System and livelihoods. Electricity is generated from the Angat Dam, as operated by the Metropolitan Waterworks and Sewerage System (MWSS) and National Power Corporation, and distributed by MERALCO to Pulilan (Tabios and David, 2002). This is an important electricity source; necessary to power pumps to move water through the water supply system. In Pulilan, the hot summer months can lead to higher energy demands for cooling homes and businesses. Consuming energy in the heating and cooling of industrial processes is also done. Throughout the year, burning of fossil fuels is used to power vehicles.

With climate change projected to increase the magnitude and frequency of floods and temperature variations, the patterns of water supply for hydroelectricity will also be altered. Pulilan has an opportunity to explore technology and resources for energy conservation; for reuse and recycling of water; for reducing and recycling waste; and generating energy from alternative and localized sources. The Municipality of Pulilan can support its barangays to use less energy while contributing to cleaner air, green spaces, healthier people and new job opportunities.
### Potential Climate Change Impacts and Strategies

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Changes in climate can affect food production leading to food insecurity and increased water borne diseases in vulnerable populations</strong></td>
<td><strong>Short Term</strong></td>
</tr>
<tr>
<td></td>
<td>• Continue with social welfare and development office programs that support adequate access to nutritious food</td>
</tr>
<tr>
<td></td>
<td><strong>Medium Term</strong></td>
</tr>
<tr>
<td></td>
<td>• Consider feasibility of implementing secondary water treatment to chlorination to reduce risk of water-borne illnesses and diseases</td>
</tr>
<tr>
<td></td>
<td>• Refer to strategies under food security</td>
</tr>
<tr>
<td><strong>2. Increased frequency or severity of rainfall events can displace residents living in high risk areas</strong></td>
<td><strong>Short Term</strong></td>
</tr>
<tr>
<td></td>
<td>• Consult with residents in areas exposed to flooding, to jointly assess options to reduce their vulnerability</td>
</tr>
<tr>
<td></td>
<td><strong>Medium Term</strong></td>
</tr>
<tr>
<td></td>
<td>• Continue and expand early warning systems for flooding</td>
</tr>
<tr>
<td></td>
<td><strong>Long Term</strong></td>
</tr>
<tr>
<td></td>
<td>• Explore the development of a comprehensive and participatory ‘resettlement’ plan that provides sustainable resettlement options, including access to jobs, services and adequate access to food.</td>
</tr>
<tr>
<td></td>
<td><strong>Long Term</strong></td>
</tr>
<tr>
<td></td>
<td>• Revise land use plans to include restrictive zoning ordinances in high hazard areas for formal and informal settlements.</td>
</tr>
<tr>
<td><strong>3. Changes in precipitation patterns can affect the hydrology of the Angat River, limiting hydropower generation during droughts and potentially impacting livelihoods</strong></td>
<td><strong>Short Term</strong></td>
</tr>
<tr>
<td></td>
<td>• Encourage energy conservation</td>
</tr>
<tr>
<td></td>
<td><strong>Medium Term</strong></td>
</tr>
<tr>
<td></td>
<td>• Explore developing a local Energy Plan that aims to reduce energy consumption and local GHG emission. This may include feasibility of locally produced, low impact, renewable energy, as well as, funding options for research and development.</td>
</tr>
<tr>
<td></td>
<td><strong>Long Term</strong></td>
</tr>
<tr>
<td></td>
<td>• Explore programs to improve energy efficiency in new and old buildings (e.g. energy performance labeling, community-driven initiatives, and energy efficiency standards for appliances and equipment)</td>
</tr>
<tr>
<td></td>
<td>• Explore options to identify, monitor and project energy demand for future.</td>
</tr>
</tbody>
</table>
5.4 Food Security: Agriculture and Fishing

Food systems are the way Pulilan grows, processes, transports, consumes food and disposes of waste. Food security is the right to adequate food. This is where every citizen has physical and economic access to adequate, nutritious food all year long and are able to buy, grow, or get it through a safety net mechanism. The right to food protects the people of Pulilan from going hungry and being food insecure (National Nutrition Council, 2013).

The Municipality of Pulilan has a thriving agricultural industry; it is an important rice granary, as well as a major source of other products that range from vegetables and fruit to livestock. 25.4% of municipal output is from agriculture, fishing and forestry (Municipality of Pulilan, 2011). In 2012, the Municipal Planning and Development Office surveyed residents and found their top two sources of livelihood are farming and fishing (Municipality of Pulilan, 2012). The majority of land cover is also dedicated to agriculture (Municipality of Pulilan, 2012). Rice is the main crop in Pulilan. In the 2013 wet season, there are a total of 1,710 rice-producing farmers cultivating ~2,159.2 hectares of irrigated lands and all relying on irrigation canals rather than rainfall (MAO, 2013). This is particularly true in Dulong Malabon and Inaon, which account for more than 40% of the total rice-producing farmers and irrigated lands (MAO, 2013). The Municipal Agriculture Office (MAO) also estimates there are ~157 fisher folk that rely on fishing from the Angat River for their livelihood, predominantly on the riverbanks between Tibag and Longos because it is deeper there and fisher folk tend to live in these barangays. There are also an unidentified number of on-land fish pen aquaculture ventures in Pulilan covering ~10 ha of land, typically adjacent to agricultural plots (Roberto Cruz, MENR Officer, personal communication, July 15, 2013; Loreto De Jesus, Municipal Agriculturist, personal communication, July 17, 2013).
Recommendations: Food Security

The Municipality and MAO supports’ agriculture and aquaculture through a number of agriculture-related infrastructures. Agricultural production areas are served by a network of irrigation canals, drawing water from the Upper Pampanga River Irrigation System (UPRIS) (Figure 5.4.1) (Municipality of Pulilan, 2011). Many farm-to-market roads have been built to connect farmers and fisher folk with the three main local market sites: the Pulilan Public Market with ~61 stalls, the Massway Market with 6 stalls and Robinsons Market and Mall that offers ~48 stalls (MPDO, 2012). MAO also supports, regulates and monitors farmer activities by providing certified seeds for use and re-use in Pulilan, free carabao and free access to organic fertilizers, subsidized access to nutrients for nutrient-deprived soils (e.g. zinc sulphate) and connections to pesticide and insecticide agencies (Loreto De Jesus, Municipal Agriculturist, personal communication, July 11, 2013).

Climate change has a range of implications for Pulilan’s agriculture. Traditionally, Pulilan has two seasons: the wet season from May to October and the dry season from November to April. Climate-related changes have now altered seasonal patterns, reducing agricultural productivity during the wet season (Roberto Cruz, MENR Officer, personal communication, July 15, 2013).

This sector needs to anticipate and plan for any impacts of climate change on its productive capability. Currently, MAO provides farmers with crop insurance (600 Php/crop season). Farmers receive 6000 Php/crop season in the event of crop failure (Loreto De Jesus, Municipal Agriculturist, personal communication, July 11, 2013). This can be very costly for farmers and the municipality alike when food production is decreased and insurance payouts are high. Research and innovation into building a stronger local food system can reduce the size of Pulilan’s environmental impact by cutting down on the use of fossil fuels, protecting food-producing lands and related biodiversity. This can also contribute to greater human health and a greener more adaptive economy.

The agriculture industry can also respond to climate change by taking advantage of new
opportunities and reducing risks. Land use policies can be re-assessed and developed to provide appropriate incentives to ensure agricultural land retains its potential to sequester carbon, turn food waste into energy and balance food production with economic activity. Also, preserving, enhancing and expanding urban food systems can help to clean the air citizens breathe, absorb rainfall, filter toxins from storm water runoff, provide food, regulate temperature and more.

**Potential Climate Change Impacts & Strategies**

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Strategies</th>
</tr>
</thead>
</table>
| 1. Changing temperature and precipitation levels can lead to more extreme events and changed seasons can lead to reduced productivity in food, livestock, and fisheries, which may result in increased food prices, lack of adequate food and rising food insecurity | **Short Term**
- Explore ICE on the benefits of organic and sustainable food production
- Continue and expand volunteer cleaning of irrigation canals for crop security
- LCCAP can include a sensitivity analysis of local food poverty
- LCCAP can explore locally appropriate climate change food insecurity mitigation strategies (e.g. anaerobic digesters that capture methane from manure, improved fertilizer practices, and biogas digestion/electricity generation from food waste). |
| 2. Increasing temperature can lead to insect and disease damage to crop, livestock, and fishing | **Medium Term**
- Explore the development of a food systems plan that looks at local production, processing, storage, distribution and waste. This could include strategies to increase food self-sufficiency through land use plans that protect agricultural land, reduce vulnerability of crops to climate change, reduce the quantity of pesticides and insecticides, and expand local urban food systems (e.g. parks, gardens) and opportunities in sustainable food systems (e.g. permaculture, organic certification).
- Explore the use of ICE to educate on organic and sustainable food production and waste disposal options.
- Reassess the CLUP to ensure adequate protection of agriculture land from conversions to urban land uses.

**Long Term**
- Explore strategies to expand job opportunities in organic and sustainable food production, processing, storage, distribution and waste management.
- Explore strategies to increase “organically certified” farms.
5.5 Infrastructure: Transportation, Buildings and Public Infrastructure

Ecological Infrastructure

Ecological infrastructure (EI) is the structures and functions of an ecosystem that provide alternatives to traditional infrastructure systems (Danao, 2013). In the Municipality of Pulilan, EI includes all undeveloped sites that contribute towards a healthy and sustainable urban environment, including parks, the Angat River and riparian areas, greenways and urban green spaces. These can provide habitat for wildlife; recreational and cultural opportunities for citizens; and natural storm water channels, flood control and groundwater recharge areas (Danao, 2013).

Danao has put together a list of major EI in the Angat region and the ecosystems, services and benefits they provide.

1. Angat River: provides drinking water; hydropower; irrigation water for agriculture; water navigation; and access to food. Benefits also include water, sediment, and nutrients to floodplains, wetlands, aquifers, and estuaries, as well as habitat to humans and other animals.

2. Aquifers: provide water capture, storage, purification, and dilution underground; drinking water and water for industrial uses; soil moisture; and stream flow, wetlands in dry seasons

3. Angat River wetlands: provide water and waste storage, filtration and purification; flood control; sites for agriculture (e.g. water spinach) and informal settlements.

4. Clay-based soils: provide a medium for storage and supply of water and nutrients for plants and agricultural crops, as well as waste treatment and removal.

It is important for citizens of Pulilan to enjoy easy and equitable access to clean and green spaces that improve their health, and support more resilient ecosystems. Opportunities can be found in the form of community gardens, parks, and greenways along the streets, in barangay centers and along the Angat River.

Housing

The buildings citizens live and work in form a large part of their lives and their environmental impact and energy consumption. Currently, residential land and informal settlements are dispersed throughout Pulilan, with the highest
Recommendations: Infrastructure

concentration of residences in the barangay Poblacion and informal settlements in the barangays Sto. Cristo (26%), Longos (24.2%), Paltao (13.9%) (Municipality of Pulilan, 2010). An estimated 14,916 dwellings exist in Pulilan, 1,135 of which are informal settlements typically found on the Angat River bank (Municipality of Pulilan, 2010). There is a regional preference for low density, single family housing which can lead to urban sprawl over the long term. Development pressure is rising in and around the Poblacion area, with three to five major subdivision projects occurring in the coming years (Municipality of Pulilan, 2010).

The Municipality of Pulilan’s construction industry relies on a number of locally available construction materials: concrete, brick, wood, galvanized iron and aluminum, bamboo, sawali, cogon, nipa, makeshift salvaged materials, asbestos, and glass (Municipality of Pulilan, 2010).

Transportation: Vehicles, Roads and Bridges

Transportation is one of the largest sources of Greenhouse Gas (GHG) emissions and other pollutants that affect air, water and land quality in the Municipality of Pulilan. Transportation infrastructure can also contribute to climate change and exacerbate risks associated with local climate change impacts. Improving transportation options can help reduce pollution, and improve climate adaptation.

Vehicles: In 2013, the National Land Transportation Office revealed there are a total of 405 Jeepneys (privately-owned mass transportation vehicles) traversing Pulilan. Jeepneys offer the most affordable vehicular mode of transportation (8Php/trip). 65 registered drivers travel from Malolos to Pulilan, 272 from Calumpit to Pulilan, and 68 from Lumbac to Palengke Red (Gener Guzman, Municipal Environment and Natural Resource Office Clerk, personal communication, July 12, 2013). There are also 400 registered tricycles (Anastacio Calderon, Municipal Accountant, personal communication, July 12, 2013). Given the number of jeepneys and tricycles on the road, as well as unidentified personal vehicles and trucks, there is a high volume of traffic in Pulilan, in particular along CVR and Pulilan-Calumpit connection roads (Municipality of Pulilan, 2011). Recent commercial developments within a 100 meter radius of the intersection near Robinsons Mall has also increased traffic volume and the number of idling vehicles releasing pollutants into the air (Municipality of Pulilan, 2011).
Roads: The Municipality of Pulilan has an extensive land transportation network (Figure 5.5.1). National and local roads are denser to the south and connected to a network of irrigation canal service roads. Major roads traverse East-West and North-South. A U-shaped transportation network has shaped land use patterns in Pulilan. The Angat River also serves as a natural boundary to the south for built development, as well as for water navigation (Municipality of Pulilan, 2011). For example, Pulilan is implementing the Angat River Cruise Development Project - a network of river ports along the Angat River - that will serve as an alternative mode of transportation (Municipality of Pulilan, 2011).

Currently, 98% of all national, provincial, municipal, and barangay roads in Pulilan are concrete-paved, with some mixed with asphalt and/or gravel and others solely earth (Municipality of Pulilan, 2011). The breadth of impervious road surfaces poses a challenge to managing storm-water runoff, and recharging the underground aquifers.

Bridges: The Municipality of Pulilan is responsible for 13 bridges made of concrete (Municipality of Pulilan, 2010). Eight Bridges in Dulong Malabon, Olympia, Dampol 1st, Tenejero and Cut cot pass over irrigation canals and are highly vulnerable to damage from flooding. Five bridges in Longos-Cut cot, Longos, St. Penegrine and St. Cristo are less vulnerable to degradation and destruction during times of flooding. Three National bridges that traverse the Angat River from Plaridel to Pulilan and Pulilan to Calumpit are under the national government’s responsibility and are the largest, most stable and least vulnerable to damage from flooding (Rosemarie Esguerra, Municipal Engineer, personal communication, July 15, 2013).

How citizens move around makes a difference to their quality of life. Transportation options impact the air they breathe, the amount of land needed for roads, their physical health and wellbeing, the cost of travel and the ability of ecosystems to
Recommendations: Infrastructure

absorb the stresses of climate change. The challenge is for the Municipality of Pulilan to explore how it can make the community a safe and comfortable place, increase active transportation like cycling and walking, and improve air, water and land quality.

Solid Waste

Garbage has become so common in the urban landscape of Pulilan. In response to rising garbage levels, the Municipality of Pulilan is complying with the approved Ecological Solid Waste Management Act of 2000, entitled RA 9003. This provides the framework for an integrated and ecological solid waste management plan (Municipality of Pulilan, 2011). RA 9003 includes the administration of activities that characterize waste, segregate solid waste at its source, and collect, transfer, store, process, treat, recycle, compost and dispose of waste (MENRO, 2013).

The Municipality has a Central Municipal Materials Recovery Facility (MRF) in Barangay Longos to reduce the volume of solid waste in controlled dumpsites (Municipality of Pulilan, 2011). Three eco-parks have also been established to sort through, segregate and transfer waste to the central MRF (MENRO, 2013). Pulilan owns three dump trucks and rents one to haul solid waste from source to the MRF and deposits residual waste in a landfill outside Pulilan, commissioned by the Municipality (Municipality of Pulilan, 2010). Smaller garbage trucks owned and operated by the barangays also collect waste. The Municipal Government pays tipping fees to the barangay collectors on a ‘volume of waste’ basis (Municipality of Pulilan, 2010). Despite these efforts, some areas remain a challenge in terms of solid waste collection.

The municipality can find clean and green ways to dispose of its residual wastes and to eventually reach zero solid waste. Zero

Figure 5.5.1 Municipality of Pulilan location of schools and churches. (Source: Municipality of Pulilan, 2011)
waste can be critical to mitigating and adapting to climate change and other environmental challenges. Methane is a climate-altering GHG released when food scraps, grass and other vegetation are buried in landfills instead of being composted. The transportation of waste is also energy-intensive as more garbage requires more trucks for pick up and hauling. Recyclable materials that are not recycled also waste potentially valuable materials. By recycling and reducing the amount of materials Pulilan uses, there is less demand for natural resources to be extracted from the earth for other products.

**Public Facilities and Religious Sites**

Basic education services are provided through a network of public and private pre-elementary, elementary and secondary schools in the municipality (Figure 5.5.1) (Municipality of Pulilan, 2011). There are a total of 22 day care centers, 21 pre-schools, 24 elementary schools (with at least one in each barangay), 16 high schools, 2 technical schools, and 3 training centers (Municipal Planning and Development Office, 2012). The elementary schools are primary evacuation centers during times of emergency and flooding. The location of the elementary schools follows the development of the built-up areas. There is also a concentration of schools and churches along Angat River, revealing the historic role of the Angat River in shaping the development of the municipality.

As for health care and medical access, there are 4 Rural Health Units in the barangays of Poblacion, Cutcot, Penabatan and Tibag, 4 hospitals, 23 medical clinics. These also serve as evacuation centers during times of emergency (Municipal Planning and Development Office, 2012).

**Potential Climate Change Impacts and Strategies**

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Strategies:</th>
</tr>
</thead>
</table>
| 1. Changing climate has the potential to negatively impact existing ecological infrastructure and limiting its ability to provide services to humans. | **Short Term**
|                                                                                  | • Explore partnerships with local universities to begin tracking precipitations, temperatures and extreme weather events for the purposes of forecasting future trends.  
|                                                                                  | • LCCAP can include a sensitivity analysis of local ecological infrastructure  
|                                                                                  | **Medium Term**
|                                                                                  | • Explore strategies for protecting and enhancing ecological infrastructure, including habitat for plant and animal species  
|                                                                                  | **Long Term**
|                                                                                  | • Revise the CLUP to include EI. For example, creating zoning ordinances that protect and expand EI |
2. Climate changes can lead to flooding of buildings and rapid deterioration of building materials.

**Short Term**
- LCCAP can include an evaluation of resilience and climate adaptability of current housing stock
- Expand “Low Cost Housing and Resettlement Project” for families affected by flooding to integrate options for green infrastructure and climate resilient designs.
- Explore the establishment of a dedicated housing officer within the MPDO or Engineering Office

**Medium Term**
- Explore ways to calculate energy and material consumption of buildings
- Explore participatory IEC strategies for a climate adaptive building sector (e.g. home guides and toolkits, knowledge exchange)
- Explore regulation tools to reduce environmental impact of buildings and increase their resilience.
- Explore the feasibility of an Energy Efficient and Climate Resilient Building Strategy. This could include a locally-based building code that increases energy and water efficiency in buildings

**Long Term**
- Explore Climate Resilient Awards to recognize excellence in building designs and construction
- The CLUP could include green community building strategies that encourage compact communities outside hazard areas with reduced energy use, and increased green infrastructure and opportunities to walk and cycle.

3. Increased temperature and precipitation in wet season can lead to flooding of roads.

4. Jeepneys, tricycles, cars, and trucks release GHG emissions and other pollutants that contribute to climate change.

**Short Term**
- Develop and implement Anti-Smoking/Belching and Anti-Idling programs
- Reassess the Angat River Scenic Road Improvement and Construction project to consider limiting vehicular access to river and instead increasing public access through “river walkways”, bike paths, parks, rest areas and greenways.
- Explore ways to integrate climate change adaptation strategies in current and future projects. For example, bridge upgrades can consider flood impacts.

**Medium Term**
- Explore ways to measure and monitor Greenhouse Gas (GHG) emissions and pollution from vehicles
- Explore feasibility of traffic light or round-a-bout system to improve traffic.
- Explore strategies that channel storm-water run-off from roads into ecological infrastructure designed for groundwater recharge and flood control.
- Explore the development of an Active Transportation Plan that can improve pedestrian and cycling access, safety and shade (e.g. green infrastructure, sidewalks, bike paths etc.).

**Long Term**
### Recommendations: Infrastructure

- Consider inter-governmental cooperation to consider a public transit system. This is one way to reduce GHG emissions and pollution and the need for more road surfaces.
- Explore ways to encourage low- and zero-carbon-emission vehicles as an alternative to tricycles. For example, the municipality could give permit registration exemptions for zero-emission modes of transport.
- Explore partnerships with the province to develop strategies for transporting goods that protects key corridors and reduces emissions (e.g. low-carbon trucks, bicycle transportation, mandated times for truck deliveries during low-traffic hours).

| 5. Increased temperature and changed precipitation can lead to more intense rainstorms and flooding, which can transport improperly disposed waste into the river, polluting waterways and aquifers | **Short Term**
| | • Expand on RA 9003 by developing local services that dispose of e-waste, paints and thinners, batteries and acid.
| | • Continue and expand existing solid waste management strategies (e.g. barangay clean-ups, no plastic policy, MRF recycling and energy-production, irrigation canal protection etc.)
| | **Medium Term**
| | • Develop zero waste strategy
| | **Long Term**
| | • Explore ways to reduce solid waste going to the landfill
| | • Explore ways to reduce all plastic products (e.g. reusable grocery bag campaign)
| | • Explore ways to generate electricity from waste

| 6. Extreme weather events can lead to damage of facilities essential for emergency management functions from flooding and typhoons | **Short Term**
| | • Inventory all essential services
| | • Revise CLUP, possibly including zoning ordinances related to climate change impacts, building code revisions, protected green areas and integrated storm water management.
5.6 Local Economy: Sustainable Livelihoods

Developing sustainable and climate adaptive livelihoods in Pulilan requires an understanding of the local economy. Currently, Pulilan has three major sub-sectors: (1) agriculture, fishing and forestry, (2) industry, and (3) the service sector. The service sector contributes ~68% of municipal output (MO), followed by agriculture, fishing and forestry (25.4%), and industry (~4.8%) (Table 5.6.1) (Municipality of Pulilan, 2011). In 2005, crop farming and gardening (15.4% of the MO), and livestock production (8.8% of the MO) were major contributors to the local economy (Municipality of Pulilan, 2011).

Local agricultural infrastructure and convenient transportation routes attract many agro-industrial, industrial, and service companies. The industrial sector provides ~4,200 employment opportunities in Pulilan. Moreover, in 2013 there are 33 large scale enterprises (with more than 12 employees (Irene Isidro, PESO Clerk, personal communication, July 10, 2013). These enterprises are required to hire 70% of their total employees from the local labor force.

<table>
<thead>
<tr>
<th>Local Economy Subsectors</th>
<th>Municipal Sector (% Share)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture, Fishery and Forestry</td>
<td>25.4</td>
</tr>
<tr>
<td>Crop Farming and Gardening</td>
<td>15.4</td>
</tr>
<tr>
<td>Livestock Production</td>
<td>8.8</td>
</tr>
<tr>
<td>Aquaculture, Fishing, Forestry</td>
<td>1.1</td>
</tr>
<tr>
<td>Industry</td>
<td>4.8</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>3.2</td>
</tr>
<tr>
<td>Mining and Quarrying</td>
<td>0.2</td>
</tr>
<tr>
<td>Construction</td>
<td>1.4</td>
</tr>
<tr>
<td>Services</td>
<td>68.0</td>
</tr>
<tr>
<td>Wholesale/ Retail</td>
<td>33.4</td>
</tr>
<tr>
<td>Private Services</td>
<td>6.6</td>
</tr>
<tr>
<td>Transportation, Storage and Communication</td>
<td>28.0</td>
</tr>
<tr>
<td>Other</td>
<td>1.8</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>
Wholesale and retail services (33.4% of total MO), and transportation, storage and communication activities (28% of the total MO) are the main industries. These two industries are interrelated and dependent upon consistent and easy access to energy. Energy is supplied mainly by MERALCO from the Angat hydroelectric dam. Energy supply can be influenced by climate change. Further research is required to understand the full impacts of changing temperature, precipitation and extreme weather events for energy security.

Tourism also plays an important role in the local economy. Tourism is highly related to many sectors in Pulilan and can be affected by different climate change impacts. For example, extreme weather events may detract regional and international tourists from visiting Pulilan. Flooding and droughts may also affect food productivity and the quality and quantity of food for visitors.

Pulilan has 21 resorts – 5 private and 16 public, 5 hotels, 1 ecological park (butterfly heaven), 1 recreational farm (private) and ~43 heritage houses. The Feast of San Isidro Labrador or the Kneeling Carabao Festival and the Feast of the Biglang Awa are major attractions for hundreds of thousands of tourists every year (Santos Santos, Tourism Officer, personal communication, July 11, 2013). The Municipalities planned Angat River Cruise Development Project may also serve as a future tourist attraction (Municipality of Pulilan, 2011).

**Potential Climate Change Impacts & Strategies**

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Potential Strategies</th>
</tr>
</thead>
</table>
| 1. Climate changes can alter ecosystem integrity, affecting eco-tourism areas, services and industry. | **Short Term**
  * Explore research on the impacts of climate change on the local economy and explore IEC programs to mitigate impacts*
  * Measure and monitor tourism activities to track trends over time and identify new opportunities.*
  **Medium Term**
  * Assess vulnerability of key tourism sites and activities to climate change*
  * Develop local economic development plan, with climate change lens*
  **Long Term**
  * Explore plans to improve ecological resilience using an ecosystem-based management approach.* |
| 2. It’s unclear whether climate change can lead to an increase in water lilies in the Angat River. | **Short Term**
  * Partner with local university researchers to determine causes and impacts of water lily proliferation and other invasive species.*
  **Medium Term**
  * Explore potential uses of water lilies for creating local products* |
| 3. Extreme weather events can damage infrastructure, affecting production and price of products and the broader local economy. | **Short Term**
  * Explore programs to assist vulnerable residents in accessing affordable basic necessities after extreme weather events.*
  **Medium Term**
  * Explore participatory strategies with industry to shift from high energy and resource production to greener and cleaner processes.* |
6. Next Steps

Climate change is the challenge of our generation, and meeting that challenge is a long-term commitment. In moving forward, the Municipality of Pulilan will develop a Local Climate Action Plan (LCCAP), building on the foundation laid during this initial phase of research. Key initiatives now in development will continue to take shape and, in the coming months, the Municipality may:

1. Create a local LCCAP team. It is important to get the right people involved in adaptation planning. This encompasses elected officials, civic leaders, Municipal staff, organizations and community leaders that can conduct a more in-depth vulnerability assessment and develop climate mitigation and adaptation strategies. It is also important to build political support and educate the public. Ideally, a formal “LCCAP team” can be assembled from municipal staff to gather and provide data, insights and strategies. This can be composed of representatives from government departments including planning, community development, health, environment and natural resource management, agriculture, information technology, engineering, emergency management and finance. Allies at the provincial and national government level are also important for providing data, guidance and funding. In addition, neighboring municipalities can be approached about collaborating on their LCCAPs (Figure 6).

2. Plan a participatory LCCAP process. Engaging the community is a crucial step in coming up with appropriate mitigation and adaptation strategies. Public understanding of climate change adaptation may be mixed. The “LCCAP team” can conduct public engagement sessions that are locally and culturally appropriate and educate and build commitment amongst local decision-makers and community members to take action.

3. Start planning. LCCAP planning often involves a sequence of steps as listed below:
   - Conduct a vulnerability assessment: Assess the community’s exposure to climate change impacts. Assess the areas, people and sectors most sensitive to these impacts. Evaluate the community’s capacity to adapt. Explore the level of risk and timeline of impacts;
Next Steps

- Set priorities for adaptation;
- Identify strategies within each priority area;
- Evaluate strategies and prioritize actions (some examples are provided in the Canadian Communities’ Guidebook for Adaptation to Climate Change);
- Implement actions;
- Monitor and evaluate;
- Structured Decision Making (SDM; Gregory et al., 2012) can be a useful tool to guide this process (UNFCCC, 2011);

4. Once climate change action strategies have been fully identified and explored, an implementation plan can be developed. This can include the cost of projects, co-benefits that may be realized if the strategy is implemented, and the timeline, duration and social acceptance for proposed projects.

5. Invest in new ideas and solutions: the Municipality can invest resources to assist local researchers and universities to undertake research and generate solutions to climate action challenges. Pulilan can bring together experts from different universities and the private sector to undertake research on and monitor the potential impacts of climate change and to assess and develop viable mitigation and adaptation options.

6. Explore dedicated and creative sources of funding for implementing the LCCAP, including international grants, including climate change action items in all programs and projects, or joint funding projects with other municipalities.

Figure 3 Municipality of Pulilan’s potential allies and partners in their LCCAP.
7. Conclusion

Developing the formal LCCAP represents an essential step for the Municipality of Pulilan in moving forward towards becoming one of the most climate change adaptive municipalities in the Province of Bulacan, Philippines. Increasing local understanding of how climate change will impact municipal systems, infrastructure, programs and services, and implementing adaptation measures will help the municipality meet its goals cost effectively. In summary, the overall objective of the Municipality of Pulilan: Towards a Local Climate Change Action Plan is to not only support the Municipality of Pulilan in coping with climate change, but also to find opportunities to thrive.
8. Bibliography


Municipality of Pulilan. n.d. *Municipal Disaster Risk Reduction and Management Plan*


9. Appendices


a. Basic Information.

<table>
<thead>
<tr>
<th>Pulilan Demographic Information, 2007</th>
<th>3,975</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographic Area (hectare)</td>
<td>3,975</td>
</tr>
<tr>
<td>Population</td>
<td>85,008 (~15,700 households)</td>
</tr>
<tr>
<td>Population Density (per/ha)</td>
<td>21.4</td>
</tr>
<tr>
<td>Population growth rate 2000 ~ 2007 (annual %)</td>
<td>3.2</td>
</tr>
<tr>
<td>No. of Barangays</td>
<td>19</td>
</tr>
</tbody>
</table>

b. Distribution of the population by Barangay in the Municipality of Pulilan.

II. Land Uses Profile in the Municipality of Pulilan. (Source: Municipality of Pulilan, 2011)


![Pulilan Land Uses, 2007 (ha)](image1)

- Urban Land Uses: 449 (11%)
- Agricultural Land Uses: 3,163 (81%)
- Others: 297 (8%)
- Special Uses: 6 (0.15%)


![Purposed Land Uses in Pulilan, 2020 (ha)](image2)

- Agriculture & Others: 894 (23%)
- Urban Land uses: 2,974 (76%)
- Special Uses: 36 (1%)

55
III. Typhoon Profile of Bulacan. (Source: Province of Bulacan, 2008 and 2012)


b. Statistics of total number of families affected by typhoons and flooding in Bulacan from 2003 to 2012.

c. Statistics of total damage to properties by typhoons from 2003 to 2012.
IV. The Municipality of Pulilan drainage system map. (Source: Municipality of Pulilan, 2011)

a. Revenue collection, estimated number of customers (households) and annual average payment per household from 2004 to 2012.

<table>
<thead>
<tr>
<th>Year</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month</td>
<td>Collection (Peso)</td>
<td>%</td>
<td>Collection (Peso)</td>
<td>%</td>
<td>Collection (Peso)</td>
</tr>
<tr>
<td>Jan.</td>
<td>525553.76</td>
<td>5.40</td>
<td>505167.73</td>
<td>5.18</td>
<td>1411247.75</td>
</tr>
<tr>
<td>Feb.</td>
<td>465400.88</td>
<td>4.80</td>
<td>89308.55</td>
<td>6.55</td>
<td>1211202.92</td>
</tr>
<tr>
<td>March</td>
<td>780261.53</td>
<td>7.68</td>
<td>92659.86</td>
<td>6.73</td>
<td>1320126.93</td>
</tr>
<tr>
<td>April</td>
<td>1006298.73</td>
<td>10.15</td>
<td>96559.87</td>
<td>7.40</td>
<td>1165276.35</td>
</tr>
<tr>
<td>May</td>
<td>945528.84</td>
<td>9.54</td>
<td>136874.69</td>
<td>9.63</td>
<td>1508261.5</td>
</tr>
<tr>
<td>June</td>
<td>864384.08</td>
<td>8.73</td>
<td>1150246.98</td>
<td>8.50</td>
<td>1474498.55</td>
</tr>
<tr>
<td>July</td>
<td>840511.95</td>
<td>8.51</td>
<td>1095950.63</td>
<td>8.32</td>
<td>1313406.29</td>
</tr>
<tr>
<td>Aug.</td>
<td>901543.7</td>
<td>9.09</td>
<td>1076076.55</td>
<td>8.38</td>
<td>1441045.55</td>
</tr>
<tr>
<td>Sept.</td>
<td>861958.81</td>
<td>8.69</td>
<td>1062791.35</td>
<td>8.37</td>
<td>1214273.43</td>
</tr>
<tr>
<td>Oct.</td>
<td>882711.57</td>
<td>8.80</td>
<td>1040841.8</td>
<td>8.36</td>
<td>1386963.15</td>
</tr>
<tr>
<td>Nov.</td>
<td>823119.75</td>
<td>8.40</td>
<td>1166474.95</td>
<td>8.60</td>
<td>1456146.6</td>
</tr>
<tr>
<td>Dec.</td>
<td>1046271.55</td>
<td>10.53</td>
<td>1170885.35</td>
<td>9.10</td>
<td>1291641.25</td>
</tr>
</tbody>
</table>

Estimated No. of Customers (household): 4200 4900 5600 6300 7000
Annual Average Payment per household: 2360.37 2634.18 2918.39 3307.13 3117.24

b. Statistics of estimated water consumption by season from 2004 to 2012.

<table>
<thead>
<tr>
<th>Year</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month</td>
<td>Collection (Peso)</td>
<td>%</td>
<td>Collection (Peso)</td>
<td>%</td>
<td>Collection (Peso)</td>
</tr>
<tr>
<td>Rainning Season Water Consumption percentage (May-Oct)</td>
<td>5284921.1</td>
<td>53.05</td>
<td>674514.9</td>
<td>52.29</td>
<td>847409.75</td>
</tr>
<tr>
<td>Dry Season Water Consumption percentage (Nov-Apr)</td>
<td>4655072.7</td>
<td>46.95</td>
<td>610954.09</td>
<td>47.71</td>
<td>786880.18</td>
</tr>
<tr>
<td>Summer Months Water Consumption Percentage (MAM)</td>
<td>2941089.1</td>
<td>27.65</td>
<td>319796.85</td>
<td>22.77</td>
<td>399664.65</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month</td>
<td>Collection (Peso)</td>
<td>%</td>
<td>Collection (Peso)</td>
<td>%</td>
</tr>
<tr>
<td>Rainning Season Water Consumption percentage (May-Oct)</td>
<td>1330633.23</td>
<td>49.34</td>
<td>1379514.85</td>
<td>47.21</td>
</tr>
<tr>
<td>Dry Season Water Consumption percentage (Nov-Apr)</td>
<td>1340633.32</td>
<td>50.42</td>
<td>1456070.19</td>
<td>50.89</td>
</tr>
<tr>
<td>Summer Months Water Consumption Percentage (MAM)</td>
<td>6352289.46</td>
<td>23.80</td>
<td>732050.29</td>
<td>24.72</td>
</tr>
</tbody>
</table>

Annual Average Payment per household: 3453.40 3381.90 4069.50 3629.40 > 10000

Year 2009 2010 2011 2012
| Estimated No. of Customers (household) | 7700 8400 9100 9800 > 10000 |
| Annual Average Payment per household | 3453.40 3381.90 4069.50 3629.40 > 10000 |
VI. Housing in the Municipality of Pulilan in 2010. (Source: Municipality of Pulilan, 2010)

Number of Dwellings by Type in the Municipality of Pulilan, 2010
### VII. The criteria of adaptation actions. (Source: Bizikova et al., 2008)

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sustainability</strong></td>
<td>Mitigation co-benefits</td>
<td>Result in increased GHG emissions</td>
<td>Would not affect GHG emissions</td>
<td>Would reduce GHG emissions</td>
</tr>
<tr>
<td><strong>Equity</strong></td>
<td>Benefits to few people</td>
<td>Benefits to many people</td>
<td>Significant benefits to many people, especially the minority</td>
<td></td>
</tr>
<tr>
<td><strong>Implementation cost</strong></td>
<td></td>
<td>Cost is high relative to cost of inaction</td>
<td>Cost is moderate relative to cost of inaction</td>
<td>Cost is low relative to cost of inaction</td>
</tr>
<tr>
<td><strong>Effectiveness</strong></td>
<td>Robustness</td>
<td>Effective for a narrow range of plausible future scenarios</td>
<td>Effective across many plausible future scenarios</td>
<td>Effective across a wide range of plausible future scenarios</td>
</tr>
<tr>
<td><strong>Risk and Uncertainty</strong></td>
<td>Urgency</td>
<td>Risks are likely to occur in the longer term</td>
<td>Impacts are likely in the near to mid term</td>
<td>Impacts are already occurring</td>
</tr>
<tr>
<td><strong>Opportunity</strong></td>
<td>Ancillary benefits</td>
<td>Will contribute little of not at all to other City goals and programs</td>
<td>Will contribute somewhat to other City goals and programs</td>
<td>Will contribute significantly to other City goals and programs</td>
</tr>
<tr>
<td><strong>No Regret</strong></td>
<td>Will have little or no benefit if climate change impacts do not occur</td>
<td>Will have some benefits regardless of actual climate change impacts</td>
<td>Will result in significant benefits regardless of actual climate change impacts</td>
<td></td>
</tr>
<tr>
<td><strong>Window of Opportunity</strong></td>
<td>There is no window currently</td>
<td>A window of opportunity could be created</td>
<td>A window of opportunity exists to implement</td>
<td></td>
</tr>
<tr>
<td><strong>Implementation</strong></td>
<td>Funding Sources</td>
<td>External funding sources are required but have not been identified</td>
<td>External funding sources are required and likely to be secured</td>
<td>Funding is available externally or internally</td>
</tr>
<tr>
<td><strong>Institutional</strong></td>
<td>Implementation requires coordination with, or action by other jurisdictions</td>
<td>Implementation requires external approval</td>
<td>Implementation is within local control</td>
<td></td>
</tr>
</tbody>
</table>

---

60