STATE OF AGROCHEMICAL PESTICIDES USE IN UPLAND FARMING IN MOUNT MANTALINGAHAN PROTECTED LANDSCAPE

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Master of Environment and Natural Resources Management

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Faculty of Management and Development Studies

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20 January 2021

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20 January 2021

ACCEPTANCE PAGE

This special problem titled "State of Agrochemical Pesticides Use in Upland Farming in Mount Mantalingahan Protected Landscape" is hereby accepted by the Faculty of Management and Development Studies, U.P. Open University, in partial fulfillment of the requirements for the degree Master of Environment and Natural Resources Management.

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ABSTRACT

GARINGA, ROGER VELEZ. Master of Environment and Natural Resources Management. Faculty of Management and Development Studies. University of the Philippines Open University. January 2021. **State of Agrochemical Pesticides Use in Upland Farming in Mount Mantalingahan Protected Landscape.**

Special Problem Adviser: Dr. Ramiro F. Plopino

Agrochemical pesticides are inherently toxic that could harm humans, animals, and the natural ecosystem. Stories and unverified reports reveal the use of agrochemical pesticides in upland farming in Mount Mantalingahan Protected Landscape in Palawan. Hence, the study aimed to determine the status or current condition of agrochemical pesticide use in upland farming in the protected landscape. Through site visits and structured interview supplemented by review of literature, the use of agrochemical pesticides in upland farming in Mount Mantalingahan Protected Landscape is confirmed, spatially determined, risks enumerated and understood, and courses of action recommended. The use of agrochemical pesticides in agricultural systems in the uplands of Mount Mantalingahan Protected Landscape (MMPL) is an adaptive mechanism of the farmers in response to the changing circumstances of the people and of the place. While the use of herbicides like 2,4-D was found to have started much earlier, this phenomenon is gaining more ground today as more and more variants of agrochemical pesticides become available. Apparently, slowly but increasingly, the trend appears to indicate that more and more farmers are opting to use agrochemical pesticides to protect the economic objectives of the agricultural production system of the family, primarily ensuring that the potential harvest is not severely damaged by infestation of weeds and insect pests. Weeds, being the primary problem is a complex one, and is driven by factors such as land use regulation (Policy) resulting to shortened fallow in the swidden system as well as in the sedentary system (technical), exacerbated by the erosion of traditional free labor exchange (socio-cultural) which necessitates the search for alternatives in order to ensure the completion of the production cycle with the end result of a good harvest and hence, survival of the family (Economic) which pushed farmers to adopt agrochemical pesticides. Unfortunately, current practices exposed humans, animals, and ecosystem to risks of poisoning. It is therefore necessary for the stakeholders especially the management of the MMPL-PAMB to take cognizance of this concern and craft management options to address the risks associated with agrochemical pesticides use in MMPL.

Keywords: Agrochemical Pesticides, Weeds, Upland Farming, Protected Landscape, Swidden System, Adaptive Mechanism

DECLARATION

This is to certify that:

i the special problem comprises only my original work towards the MENRM except where indicated in the Preface,

ii due acknowledgement has been made in the text to all other materials used,

iii the special problem is fewer than 25 000 words in length, exclusive of tables, maps, bibliographies and appendices.

Roger V. Garinga

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TABLE OF CONTENTS

CONTENT	PAGE
Title Page	i
University Permission Page	ii
Acceptance Sheet	iii
Abstract	iv
Declaration	vi
Acknowledgment	vii
Table of Contents	ix
List of Tables and Figures	xi
CHAPTERS:	
I INTRODUCTION	1
1.1. Background of the Study	1
1.2. Objectives	2
1.3. Conceptual Framework	2
II Review of Literature	4
III. Methodology	9
3.1 Secondary data gathering	9
3.2 Spatial Distribution and site selection	9
3.3 Sampling	9
3.4 Analysis and Interpretation	10

3.5 Conclusion and Recommendation 10

IV RESULTS AND DISCUSSION 11

4.1 Study Area 11

4.2 Study Site 13

4.3 Respondents' General/Demographic Profile 16

4.4 Spatial Distribution of Agrochemical Adopters 20

4.5 Length of Agrochemical Pesticide Use 21

4.6 Source of Information 22

4.7 Common Agrochemical Pesticides used in MMPL 23

4.8 Description and Analysis of Risks of Agrochemical Pesticides 25

4.9 Deepening Understanding of the Drivers of Agrochemical Pesticides Use in MMPL 28

4.10 Alternatives to Agrochemical Pesticides 30

4.11 Summary Analysis of Adopters Behavioural Change and Pesticide Penetration in MMPL 30

V. Conclusion and Recommendations 33

5.1 Conclusion 33

5.2 Recommendations 34

VI References 36

List of Tables and Figures

Tables

Table 1	Demographic Profile of Respondents	16
Table 2	Religion of the Respondents	19
Table 3	Period (year) of Agrochemical use	22
Table 4	Common Pesticide Brands Used in the study Sites	23
Table 5	Pesticides Risk Factors and Management	26
Table 6.	Pesticides Environmental Risk Factors	26
Table 7.	Label signs and Reviews of Pesticides	28

Figures

Figure 1	Conceptual Model	2
Figure 2	Study Area Map	11
Figure 3	Agricultural Landscape Mosaic in MMPL	12
Figure 4	Study sites	14
Figure 5	Religious Affiliation	19
Figure 6	Spatial distribution of respondents' Farms, Bunog, Rizal	21
Figure 7	Spatial distribution of respondents' Farms, Mainit, Brookes Point	21

I. INTRODUCTION

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1.1 Background of the Study

In Mount Mantalingahan Protected Landscape (MMPL), there are already observations and unverified reports about the use of agrochemical pesticides around and inside the 120,457 hectares protected landscape, and studies are yet to be conducted on this issue to assess the extent and implication of the same on the landscape. Hence, the necessity to determine the status of its application in the uplands of MMPL is imperative to enable the formulation of appropriate measures to manage the risks associated with its use and become part of the management strategy of the MMPL.

The MMPL was established as a protected landscape by virtue of Presidential Proclamation Number 1815 signed by the president on Jun 23, 2009. Farming, as well as harvesting of non-timber forest products like almaciga resin, honey, wild fruits, and other food and non-food products naturally occurring in the landscape are among the key livelihood activities of the occupants either residing in or around the protected landscape. Agricultural activities revolve around shifting cultivation and cultivation of permanent crops like coconut, banana, and other fruit trees forming part of the sedentary system of farming.

It is then important to analyze and understand in which part of the farming system in the uplands are the application of the agrochemical pesticides being adopted and the motivation for doing so. Understanding this context will enable the management of the MMPL to devise management strategies that will help address the potential risk(s) to human health and ecosystems associated with the application of the agrochemical pesticides in the uplands of MMPL.

1.2 Objectives

The study aims to determine the status or current condition of agrochemical pesticide use in upland farming in Mount Mantalingahan Protected Landscape (MMPL).

Specifically, the study will:

1. Determine spatial distribution of agrochemical pesticide application in farming MMPL uplands;
2. Identify the factors that drive farmers to use agrochemical pesticides in the uplands of MMPL;
3. Describe the risks associated with the use of agrochemical pesticides; and
4. Elicit options to manage the associated risks of agrochemical use in MMPL uplands.

1.3 Conceptual Framework

This study adopts the COM-B Model developed by Mitchie et al (2011).

This model is centered on **M**otivation as influenced by **C**apacity and **O**pportunity that, together drive a change in the **B**ehavior of a person. By using this model, this study then intends to unearth, understand, and explain how the circumstances of the agrochemical pesticides adopters in Mount Mantalingahan Protected Landscape drive them to change practice and subsequently adopt agrochemical pesticides in their current agricultural production system.

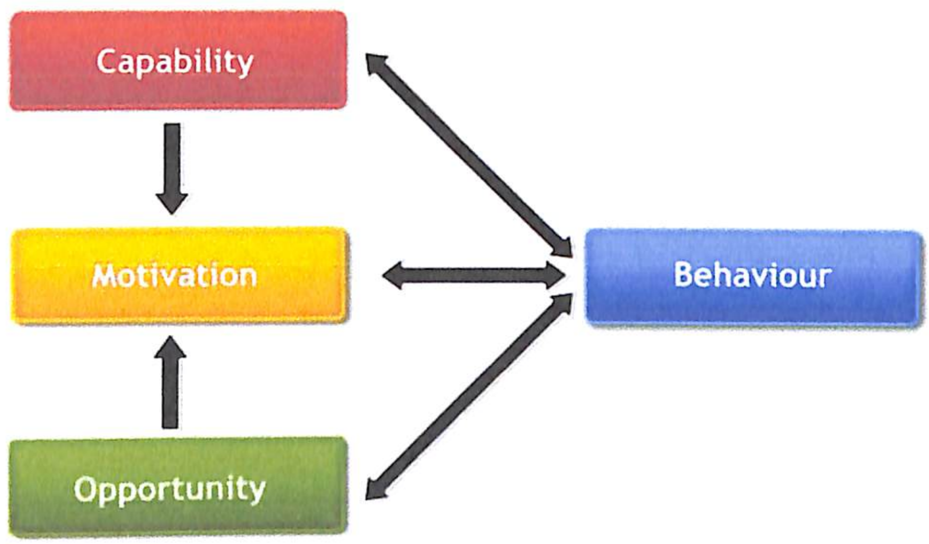

Figure 1. COM-B Model

II. REVIEW OF LITERATURE

As the name implies, agrochemical pesticides are inherently toxic. In fact, no less than the World Health Organization (WHO) classified pesticides into four namely: extremely dangerous, highly dangerous, moderately dangerous, and slightly dangerous (Yadav and Devi, 2017). But despite the dangers brought by pesticides on humans and ecosystems, it's use in agricultural production continues because it has a legitimate economic purpose and hence, made a necessity to safeguard the potential crop yield from damage due to various plant pests and diseases. Indeed, significant direct economic losses are prevented due to the application of the pesticides in agricultural production. The contribution of agrochemical pesticides in preventing losses, however, vary. Some estimates calculated losses prevented due to pesticides range from 37 to 79% in dryland farms for weeds control (Aktar et al, 2009) alone in India, but global estimate was made by Orke (2005) at 35% yield lost to pre-harvest pest worldwide as cited by Popp et al (2013). Unfortunately, the negative impacts on human health and environment have recently been put to the forefront of the discourse not only among scientists and policymakers, but among the public as well. As Aktar et. al. (2009) put it, the rampant use and misuse of these chemicals, under the adage, "if little is good, a lot more will be better" has played havoc with human and other life forms. Indeed, numerous cases of negative impacts on human health and the ecosystem cannot be ignored.

The history on the recorded use pesticide in agriculture dates back from as early as 4,500 years ago in Mesopotamia, now Iraq by the Sumerians who used Sulphur compounds to control insects (Unsworth, 2010). Proving the economic benefits of pesticides, its development and use evolved further along with the progress in plant breeding to develop new varieties that respond to the economic needs for more production outputs that the economy needs such as for food, feeds, and other materials or commodities resulting to more and more use of pesticides and spread all over the world. But as earlier pointed out, the negative consequences of the use of agrochemical pesticides have emerged but appeared to have been generally ignored or kept out of the public's eye until a book titled "Silent Spring" (Carson, 1962) was published, elaborating the negative impacts of pesticides use in agriculture particularly in the United states, bringing to the public consciousness the issues on negative impacts of pesticides. Hence the era of health, safety, and environmental awareness vis-a-vis pesticides use in agriculture began and continue even until today.

In the Philippines, the massive use of agrochemical pesticides was driven by the Green Revolution program of the government that was launched in the 1960's meant to increase mainly paddy rice production and food security in the country. Green revolution was accompanied by an expanded use of chemical inputs (Dolan, 1992), high yielding varieties, and irrigation.

While the green revolution program focused on lowland rice production where massive agrochemical pesticides were noted, the Philippine uplands are not spared from the use of pesticides because uplands in the Philippines including forested areas are inhabited by Filipinos, where their livelihoods are dependent upon. In addition, juridical persons like plantation and forest user companies are benefiting from the upland resources. With 18% slope and above considered uplands (GIZ, 2014) where both agriculture and forestry are practiced, it occupies about 55 percent of the land surface of the country and an estimated population of 17.8 million (Garrity et al, 1993) and is going to increase over time and hence, the pressure on the upland ecosystem as well.

The common uses of pesticides in agriculture are related to production of fruits and vegetables mostly on a commercial scale as in the case of the highland vegetable growing in the cordilleras where pesticide application is already linked to human health problems (Lu, 2010). Among the various fruits, mango, and banana especially through the commercial plantation schemes are commonly using pesticides. Banana commercial plantations even apply aerial spraying methods (Mathews, 2009). However, pesticide use is not commonly observed in upland rice production such as those under the so-called traditional swidden system of farming, until recently when herbicide use began to be reported driven by the problems associated with weeds infestation. This issue is linked to intensified swidden practices and hence no longer considered a traditional swidden system (Ziegler, et. al.,2009). Swidden intensification or shortened fallow period, on the other hand is driven by complex factors, among which are: conservation policies or population increase (Hepp et al., 2018), the expansion of markets for commercial agriculture, and a complex of wider political, social and cultural trends (Cramb et al., 2009) citing as an example the case in Palawan where spontaneous migration of Cebuano and other groups from densely populated regions which, aside from competing with land resources also brings with them plough based farming technology that influenced land use change in the uplands.

Human and environmental risks associated with pesticide use in the uplands have been recorded and established. On health risks to humans, the exposure and mode of entry to the body and systems could be Dermal, Ocular, Inhalation, and Oral (Muntz et al., 2016). The most common forms of risks to ecosystems include contamination of surface water bodies via run-off and even of the aquifer through leaching (Aydinalp and Porca, 2004). This contamination may go a long way downstream and even to as far as the marine ecosystem. Numerous studies and evidence have proven the negative consequences of pesticides to ecosystems through different pathways. There are six (6) pathways which include leaching, diffusion, volatilization, erosion and run-off, assimilation by microorganisms, and plant uptake (Pérez-Lucas, 2019). Non target organisms like Ferns, amphibians, and fish are groups of nontarget organisms affected by many types of pesticides that end up in the environment (Soare et al., 2019).

But the extent of danger that pesticides pose on ecosystems, depends on many factors which can be traced to the specific characteristics of a particular pesticide such as the chemical composition and its reactive characteristics with other compounds and elements in the ecosystem that the pesticide reacts with (Özkara et al, 2016). In other words, the chemical properties and formulation of the pesticides define the potency of its effect. On the same note, the specific characteristics of the ecosystem elements such as the soil properties, rainfall pattern, among other physical and chemical aspects of the ecosystem define its vulnerability to contamination.

Hence, regardless of the economic imperatives, agrochemical pesticides use must be taken with utmost precaution.

III. METHODOLOGY

The study adopted the descriptive research method. The following key steps were implemented:

3.1 Secondary data gathering

Aside from relevant policy review, the study built upon the data gathered by the office of the Protected Area Management Board (PAMB) of the Mount Mantalingahan Protected Landscape (MMPL) in updating the inventory of protected area occupants through Socio Economic Assessment Monitoring System (SEAMS) as prescribed under Technical Bulletin No. 2017-18 issued by the Biodiversity Management Bureau (BMB) of the Department of Environment and Natural resources (DENR).

3.2 Spatial Distribution and site selection

One of the information collected which pertains to the use and disposal of pesticides in farming, were culled and mapped out using Geographic Information System (GIS) to show its spatial distribution in the protected landscape. Subsequently, the study sites were selected based on the degree of use of pesticides, meaning the greater number of adopters were considered as a priority site for the survey.

3.3 Sampling

A sample comprising 30% of the agrochemical pesticide adopters from each of the two (2) study sites was selected through a simple random sampling procedure and were interviewed using a structured interview questionnaire. Questions revolved around household demographics, tenure, crops grown, farming practices, problems, specific use of pesticides, reasons or factors for their adoption, safety measures, and alternatives.

3.4 Analysis and Interpretation

Descriptive statistics was used to describe and analyze collected data and were interpreted against the behavioral change model known as COM-B model adopted from Mitchie et. al. (2011). This model suggests that change in Behavior is driven by Capacity, Opportunity, and Motivation of the person which will essentially provide a framework for understanding the interplay of the drivers of behavioral change among agrochemical pesticide adopters in MMPL uplands.

3.5. Conclusion and Recommendations Formulation

The conclusion and recommendations were formulated based on the analysis as well as based on review of other options.

Chapter IV

RESULTS AND DISCUSSION

The results of the study are presented and discussed in the following sections or sub-topics, describing facts found and the corresponding analyses:

4.1 The Study Area

Mount Mantalingahan Protected Landscape (MMPL) is one of the priority sites for conservation popularly known as Key Biodiversity Areas (KBAs) in the Philippines. By virtue of Presidential Proclamation Number 1815 signed by the Philippine president on June 23, 2009, the 120,457-hectare KBA was established as a protected landscape. As shown in Fig 2, MMPL is located between 9° 9' 53.42" to 117° 59' 52.47" North latitude and 8° 40' 28.16" to 117° 26' 55.52" East longitude (PAMB, 2016) and is bounded by Mount Bulanjao Mountain Range in the Southwest, West Philippine Sea in the West, Malanut and Victoria Mountain Ranges in the Northeast, and the Sulu Sea in the Southeast.

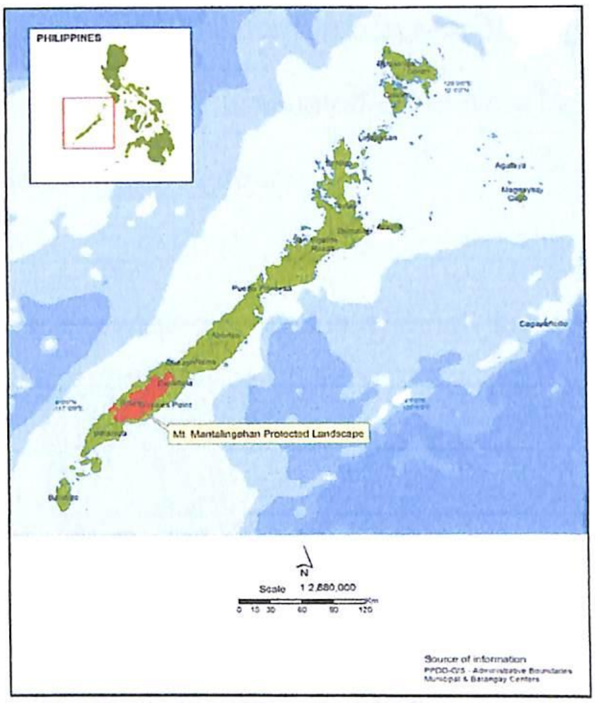

Figure 2. Study Area

MMPL is shared administratively by 5 municipal governments of Sofronio Espanola, Brooke's Point, Bataraza, in the east and of Dr. Jose P. Rizal, and Quezon in the west with a combined total of 36 number of barangays. The establishment of the MMPL as protected landscape followed the process prescribed under Republic Act 7586 otherwise known as National Integrated Protected Areas System (NIPAS) Act of 1992 and its implementing rules and regulation. Currently, the Protected Area Management Board is pushing for an Act of Congress as a final step to fully realize or achieve its status as a protected landscape individually because of the failure of the legislators to include MMPL along with the other protected areas in the province of Palawan when Republic Act 11038 was enacted expanding the National Integrated Protected Areas System or ENIPAS. During its recent PAMB *en banc* meeting held last September 24, 2020, the Board adopted the draft bill for the purpose, hoping that legislators representing the district where MMPL is situated will elevate the proposal to the legislature for appropriate legislative action

Within MMPL, farming activities is dominated by a system widely known as swidden, characterized by a cycle of forest clearing, short term cultivation, and fallow. The use of plough to cultivate seasonal crops as well as planting of perennial crops, however, have also been observed in MMPL introduced by farmers who migrated into the area.

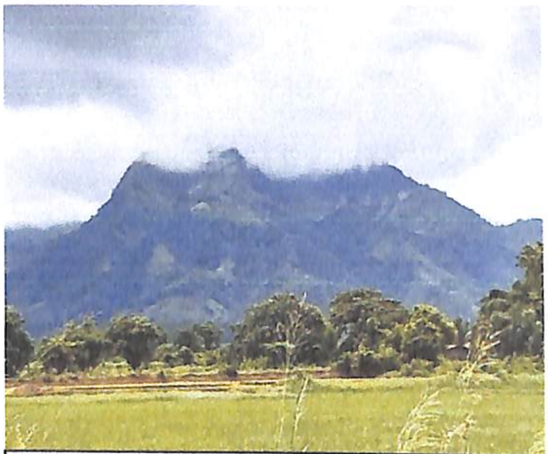

Figure 3. Agricultural Landscape Mosaic in MMPL, Mainit Brooke's

The farming system outside the perimeter of the protected landscape, on the other hand, is seen as a mosaic of swidden system, perennial crops production, plowed agriculture with seasonal crops, and lowland rice production systems. The use of agrochemical pesticides are commonly observed in lowland rice cultivation as well as in plowed fields with seasonal crops like corn and vegetables in both lowlands and uplands.

4.2 Study Sites

Within the study area, specific communities were purposely selected based on two parameters, as follows: a) representative of east and west of the landscape, and b) greatest number of identified agrochemical users. The two sites selected were Barangay Mainit, Brooke's Point and Barangay Bunog, Rizal, the location of which is shown in Figure 3 below showing also the distribution of the 36 agrochemical pesticide identified users from which the 30% respondents (11) were determined through simple random sampling procedure.

Courtesy visit and coordination with barangay (village) officials and subsequent survey interviews and field visits were conducted from September 25 to October 5, 2020, which started a day after the approval of the proposal by the Protected Area Management Board (PAMB) during its *en banc* meeting held last September 24, 2020 in Brooke's Point, Palawan.

The timely processing by the adviser of the proposed study made it possible to be included in the calendar of agenda tackled by the MMPL *enbanc* meeting which happens only twice a year. Otherwise securing permit for this study will take more time.

Figure 4. Study Sites

Barangay Mainit, as described in its profile (Mainit, 2020), is one of the eighteen (18) barangays that comprise the municipality of Brooke's Point located in the eastern side of Mt. Mantalingahan mountain range. Established in 1939, the barangay is bounded in the North by Barangay Imulnod, Barangay Pangobilian in the east, Barangay Aribungos in the south and finally the municipality of Quezon in the west which is part of the Mt Mantalingahan Protected Landscape. With a distance of 10 Kilometers from the town center and 194 kilometers from the City of Puerto Princesa, it is accessible via land transportation. The barangay has a total land area of11,242.16 hectares is generally classified as rural and is predominantly mountainous where farming is the key economic activity. It has a total population of 3,743 individuals or 859 households (2020 Census) and is dominated by Pala'wan tribe which comprise 69% while the remaining 31% is distributed among Bikolano, Tagalog, Ilokano, Ilonggo, Cebuano, and Waray ethnolinguistic groups who migrated into the area. Livelihood revolves around farming, small business, and employment. Farming is generally upland with swidden system, coconuts and other fruits, as well as small scale lowland rice production.

Barangay Bunog (Bunog, undated) on the other hand is one of the eleven (11) barangays that comprise the municipality of Dr. Jose P. Rizal or commonly called Rizal situated in the wester section of the Mt. Mantalingahan mountain range. Established in April 7, 1957 by virtue of Republic Act 2131, barangay Bunog is approximately 23 kilometers from the town center of Rizal and is bounded in the north by Barangay Quinlogan of the municipality of Quezon, in the west by the West Philippine Sea, in the south by Barangay Iraan, and in the East by the municipality of Brooke's Point which forms part of the Mt. Mantalingahan Protected Landscape (MMPL). The Barangay is accessible via land and sea-based transport facilities. With a total land area of 9,584.56 hectares, the area is generally hilly (30%) and mountainous (30%), coastal and flat areas are 20% respectively. With a total of 4,149 individuals and 852 households, the population still dominated by the Pala'wan tribe with a total number of 1,286 (31%) followed by Tagalog with a total number of 922 (22%), Ilonggo (20%), and the rest shared by Cebuano, Ilocano, and other migrant indigenous peoples from other tribes. The population is heavily dependent on farming (80%) and fishing and small-scale trading as secondary sources of income. Farming system in the uplands revolve around swidden and sedentary systems. Swidden system is practiced mainly by indigenous peoples while sedentary system involves production of coconut, banana, vegetables, corn, and other fruit trees. Rubber farming is also a growing industry in the Barangay.

4.3 Demographic Profile of Respondents.

The General profile of the Selected respondents are presented in the table below.

Table 1. Basic Demographic Profile of the Respondents

Parameters	Bunog (No.)	Bunog %	Mainit (No.)	Mainit (%)	Total	%
Ethnicity:						
• Pala'wan	4	67	5	100	9	82
• Non-Palawan	2	33	0	0	2	18
TOTAL	*6*	*100*	*5*	*100*	*11*	*100*
Age Range:						
• 60 Above	0	0	2	40	2	18
• 40-59	2	33	2	40	4	36
• 21-39	4	67	1	20	5	46
• 20 & Below	0	0	0	0	0	0
TOTAL	*6*	*100*	*5*	*100*	*11*	*100*
Sex:						
• Male	6	100	4	80	10	91
• Female	0	0	1	20	1	09
TOTAL	*6*	*100*	*5*	*100*	*11*	*100*
Household Size:						
• 10 and above	0	0	0	0	0	0
• 7 - 9	0	0	1	20	1	09
• 4 - 6	4	67	3	60	7	64
• 3 and Below	2	33	1	20	3	27
TOTAL	*6*	*100*	*5*	100	11	100
Religion:						
• Catholic	1	33	1	20	2	18
• Born Again			1	20	1	09
• Muslim	1	33			1	09
• Adventist			1	20	1	09
• JIL	2	17			2	18
• None	2	17	2	40	4	37
TOTAL	*6*	*100*	*5*	*100*	*11*	*100*
Reason for Staying:						
• Birthplace	3	50	5	100	8	73
• Relatives	1	17	0	0	1	9
• Marriage	1	17	0	0	1	9
• Migrant parent	1	17	0	0	1	9
TOTAL	*6*	*100*	*5*	*100*	*11*	*100*

Ethnicity. Majority of the respondents (82%) belong to the tribe known as *Pala'wan*. This tribe is one of the three major tribes in the province of Palawan occupying the southern part of the province. The other two who are not part of this study are the *Tagbanua* and *Batak* occupying the south-central and northern section of the province. The other (18%) of the respondents are Ilonggo whose family migrated from the Visayas region and a *Pangutaran* (Muslim) who migrated from Mindanao regions. In-migration in Palawan has been a continuing phenomenon since the second world war and possibly even before. Apparently, in-migration continues until today which will be shown later

Age. Respondent agrochemical pesticide adopters are relatively young at age range between 21-39 years representing 46% of the pesticide users, indicative of a new generation of farmers adopting agrochemical pesticides in farming in the uplands. The other age groups between 40 to 59 follows representing 36% of the respondent agrochemical pesticide users. It is also interesting to note that farmers with age above 60 are found to be adopters of agrochemical pesticides in farming in the uplands.

Sex. One of the respondents (9%) which was among the listed agrochemical pesticide users drawn from the SEAMS raw data is a female farmer. During the interview, however, it was found that the husband is in fact the one who actually uses the pesticides in their farm. It is then safe to assume that the actual users of the pesticides in the family is done by the male. But the female is also involved in the pesticide entire adoption scheme either during the purchase and transport and disposal of the empty containers. During the interview, some of the respondents were the husband and wife themselves and both were responding to the questions jointly, affirming each other's responses.

Household Size. The size of the households of all the respondents is between 3 to 9, but the common household size ranges from 4 to 6 at the time of the interviews, representing 64% of the total number of the respondents. The size of the family is important among rural farming families as the family usually supplies the labor needs of the farming enterprise. Further, rural-based farming used to be mainly shared by neighbors who exchange labor without financial remuneration. Recently, however, labor to labor exchange has been replaced substantially by cash as a form compensating labor services for the most part in the study site. This pattern is also observed elsewhere in the Philippines. Hence, hired labor became another source of cash income in rural areas, but in turn added cash burden as well for those in need of labor for their farms.

Religion. Religious denominations have effectively been implanted in the indigenous peoples' community. Out of 9 respondents belonging to the Pala'wan tribe, 5 (56%) are members of various religious Christian denominations like Adventist, Roman Catholic, Jesus Is Lord, Born Again, and Adventist while the remaining 4 representing 44% of the respondents said they do not have religion but in fact retained their traditional (religious) belief system. Nevertheless, the remaining 44% of the respondents belonging to Pala'wan tribe maintained their traditional religious belief system explaining that they prefer the traditional system over introduced religious belief system because of the familiarity and simplicity of the traditional religious practices.

Table 2. Religion of the Respondents

Religion vs Ethnicity	Ilonggo	Panguta ran	Pala'wan	Total	%
Adventist			1	1	9
Born Again			1	1	9
Catholic	1		1	2	18
JIL			2	2	18
Islam		1		1	9
None/Traditional			4	4	36
Total	1	1	9	11	100%

Further, the graph below shows the distribution of religious affiliation in each of the two study sites. The religious divide is also evidently visible. For example, Adventist and Born Again are common in Barangay Mainit, while

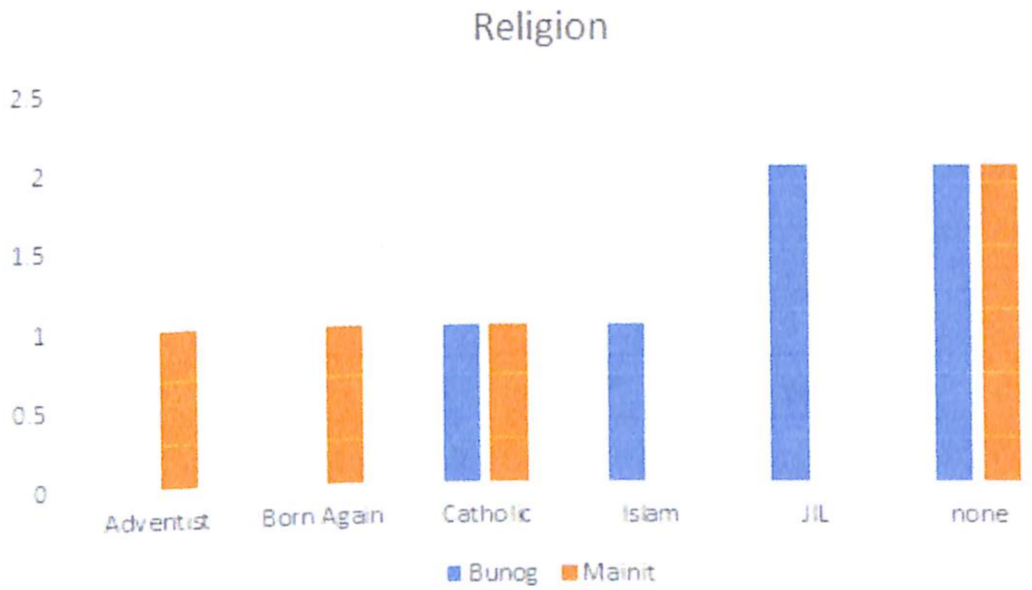

Figure 5. Religious Affiliation

Islam and JIL are common in Barangay Bunog. Interestingly, Roman Catholic is visible in both study sites, showing perhaps how widespread the catholic mission is, in these areas and possibly elsewhere in the province.

Reason for Staying. Being their birthplace is the major reason for the 73% of the respondents for staying in the study site. Obviously, the location is a *de facto* ancestral domain of the *Pala'wan* tribe in both areas. Other factors include migration, inter-marriage, and drawn by relatives. The need or the demand for land to cultivate brought the migrants to the area especially in Bunog either given by relatives, direct occupation of the "so-called" public land or purchase of lots from the occupants. All the last three enumerated factors are key pressure points to the diminishing ancestral domain areas of the tribe and to the forest ecosystem itself.

4.4 Spatial Distribution of Respondent Pesticide Adopters

Based on the raw data gathered from the Socio Economic Assessment Monitoring System (SEAMS) conducted by the Protected Area Management Office (PAMO), a total count of 59 agrochemical pesticides adopters located in five (5) out of 36 Barangays in the entire120,457-hectare MMPL were recorded out of the total of 2,191 counted landscape wide occupants. This number represents 3% of the population of protected landscape occupant households. Two (2) Barangays namely: Mainit (Brooke's Point) and Bunog (Rizal) where the survey was conducted is shown in Figure 5 and Figure 6. The map shows the relative representation of how the respondents are distributed spatially.

Such distribution indicates the extent at which the agrochemical pesticides have penetrated even the inner section of the protected landscape, further indicating

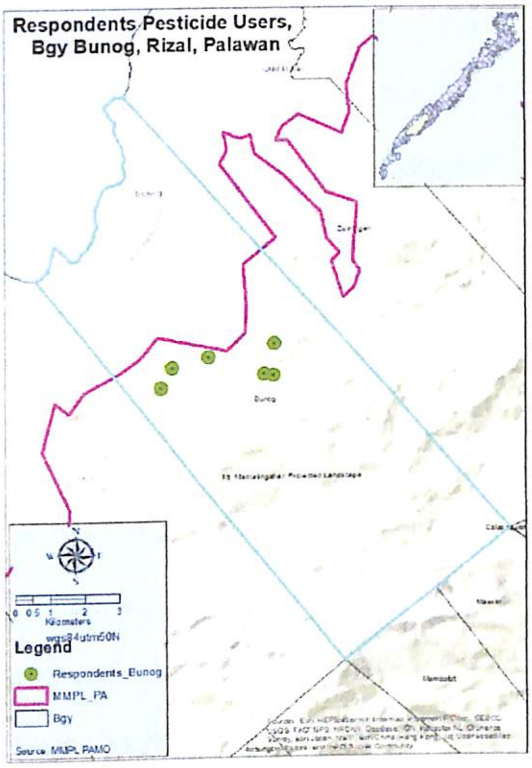

Figure 6. Spatial Distribution of Respondents' Farms, Bunog, Rizal

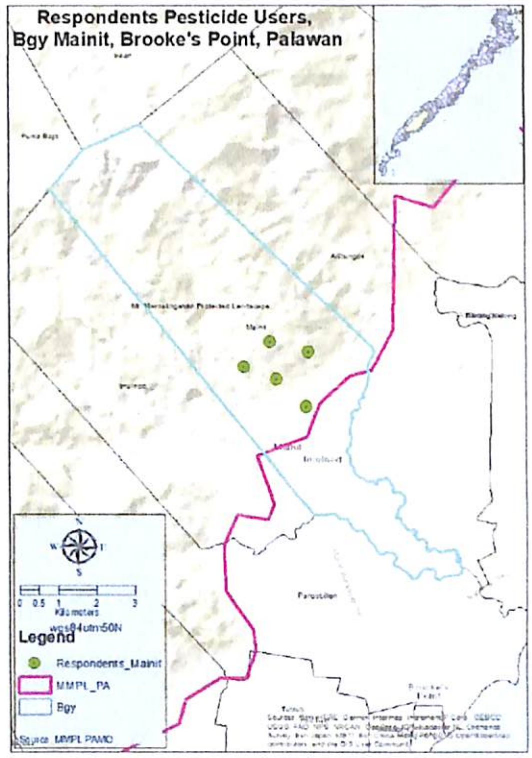

Figure 7. Spatial Distribution of Respondents' Farms, Mainit B. Pt.

the need for further study and the need to set up a monitoring system to track the possible pathways of the chemical pesticides that could have negative consequences on the values of the protected landscape for which it was proclaimed as such.

4.5 Length (Years) of Use and Common Reasons

The use of agrochemical pesticides in the study sites in MMPL has been confirmed by this study, the earliest adopter of agrochemical pesticides was noted in Barangay Mainit in which one farmer respondent started the use of agrochemical pesticides particularly 2,4-D in 1984 as against farmers in Bunog where the use of the agrochemical pesticide from among the respondents was recorded to have started in 2004. From then, slowly but more and more adopters grew as the years passed by. But the pattern appears to be in the increasing trend as 27% of the respondents have started using the agrochemical pesticides only in 2018 as shown in Table 3 below, an indication of the growing success of the penetration of chemical pesticides in the protected landscape.

Table 3. Period of Pesticide Use

Year Started	Bunog	Mainit	Total	Total
1984		1	1	9%
1997		1	1	9%
2004	1		1	9%
2006	1		1	9%
2008	1		1	9%
2013		1	1	9%
2014	1		1	9%
2017	1		1	9%
2018	1	2	3	27%
Total	6	5	11	100%

Weed problem is the most common reason why the respondents are using agrochemical pesticides. Another reason is the emergence of insect rice black bugs which is so voracious causing extremely serious damage to the Palay crops. All respondents use weedicides of different brands but only 1 use both insecticide and weedicide.

4.6 Sources of information.

Early adopters of agrochemical pesticides are the lowland farmers surrounding the MMPL who in turn learned from government and private enterprises. But as soon as the farmers in the uplands adopted its use, fellow upland farmers influenced other farmers as they heard and/or saw the effects on their crops. Today, the most common source of knowledge and skills are the neighbors with few learning from seminars and radio. Indeed, the word of mouth coupled with on field evidence seen by non-users are potent influencers as the farmers use to adopt the mindset of "to see is to believe". Hence, once an information circulates about something that the farmer relates with, they will find ways to investigate and learn the prospects of the new information.

4.7 Common Agrochemical Pesticides Used

The most common agrochemical pesticides used as intended for weeds and insects as discussed earlier. In the following Table, the most common

Table 4. Common Pesticide Brands Used in the study Sites

Brand Name	Target Pest	Crops Applied	Frequency	Volume/ Year	Amount (Php)
Hedonal (2,4-D) Amine	Weeds	Palay kaingin, Banana	1-2x/crop	1-2 Quarts	450/qrt
Ester (2,4-D)	Weeds	palay kaingin	1-2x/crop	1-2 Quarts	440/qrt
Round Up (Glyphosate)	Weeds	Palay Kaingin	2x/yr	1 gal	2,500
Clear Max (Herbicide)	Weeds	Banana	3/yr	1 gal	1,800
Demolition (Glyphosate)	Weeds	Palay Kaingin, Banana	1/crop 2/yr	1-2 Qrts	400/qrt
Garav (Glyphosate)	Weeds	Palay Kaingin	1/crop	1-2 Qrts	440/qrt
Rice star (herbicide)	Weeds	Palay Kaingin	1/crop	2 qrts	450/qrt
Gold (neonicotinoid)	Insects (Rice Black Bug)	Palay Kaingin	4x/crop	2 qrts	510/qrt

brands of agrochemical pesticides used in the study sites are enumerated including basic information on their application.

Obviously, the most economically important problem associated with the use of agrochemical pesticides is brought by weeds in both swidden farming and sedentary systems of farming. In swidden farms both pre-emergence and post-emergence herbicides are used. However, farmers often choose whether to use glyphosate only or 2,4-D only. While the glyphosate has been the recent addition to the weed problem solutions, 2,4-D remains an actively used post emergence herbicide along with glyphosate.

Aside from the weed problem, insects are also of economic importance, especially the rice black bug that has been a serious problem among upland and lowland rice farmers. However, only one respondent reported to have used agrochemical pesticide (Gold brand) to combat Rice Black Bug. The respondent and his wife excitedly narrated how their rice harvest was protected from serious damage by using insecticide compared to their relative whose adjacent rice field was not applied with any chemical pesticide but was totally destroyed and not a single sack of rice was harvested.

The volume of pesticides used per farmer ranges from 1 quart of a liter to 2 gallons of assorted pesticides, depending on the farm area. As the area planted increases either kaingin fields or banana plantation, the volume of pesticides used will increase as well, as the weed problem persists.

4.8 Description and Analysis of risks of agrochemical pesticide

The use and Improper handling of pesticides could put both humans and the environment at risk regardless of the classification of the pesticides. The fact that these pesticides kill, the risk is always there.

Risk to Humans. The perception of the respondents on the risk of pesticides to humans is generally viewed as dangerous to health. The identified four (5) main risk points and the risky behaviors from the perspective of the respondents, include: 1) during transport (breakage and spillage), 2) storage (Children and other animals could accidentally touch and poison them), 3) application (safety gears), cleaning of equipment (wastewater), and waste disposal (empty containers). Table below enumerates the different behavioral risk factors associated with the handling and use of agrochemical pesticides in MMPL.

Respondents are aware of the need for safety measures in handling agrochemical pesticides. But there are still risky behaviors that need to be addressed as shown by 27% taking safety measures for granted in the application of the pesticides. Contamination of soil and plants, when disposing wastewater during cleaning can also pose health risks to humans when the contaminated soil and plants come in contact with unsuspecting persons. Burning done by 9% of respondents can be dangerous when fumes and smoke are inhaled.

Table 5. Pesticides Risk Factors and Management

Risk Points	Risk Factors	Risk Management	Risky Behavior Noted
Transport	Breakage and spillage	Packed well and use bags during transport	None identified
Storage	Children and animals may play with it	Warn Children Hang safely Dedicated place	None identified
Application	Inhalation Skin contact	Follow wind direction (18%); Use safety gears - mask and long sleeves (55%)	No safety gears (27%);
Cleaning	Skin contact Poison water bodies and ground	Wash hands Wash Clothes	None identified Cleaning in waterways (9%) Wastewater disposal on the ground (91%)
Waste Disposal	Poison animals Contaminate soil and air	Burying (64%) Segregate and Store (9%)	Burning (9%) Throw around (9%) Store with other plastic wastes (9%)

Hence, while there may be truth to the claim of the respondents about the less hazardous effect of herbicides when compared to the insecticides, the fact remains that these pesticides are threat to the health of humans.

Table 6. Pesticides Environmental Risk Factors (n=11)

Risks to Environment	Bunog	Mainit	Total	%
Animals Poisoning (including bees)	3	2	5	45
Non-Target plants affected (Weedicide)	1	0	1	9
Contamination of soil (e.g Enhanced soil erosion)	5	4	9	82
Water bodies contamination	4	4	8	73
None	1	1	2	18

Risk to Environment. Exposure of the environment to agrochemical pesticides in MMPL include soil, air, water, plants, animals, and other microorganisms. From the perspective of the respondents, the risk to the environment include 1) contamination of soil (e.g enhanced soil erosion); 2) contamination of water bodies and its biological components (e.g fish poisoning; 3) wild animals poisoning (e.g animals eating poisoned plants, bees poisoning). In addition to those identified in Table 5, the table 6 above describes the risks identified by respondents, showing consensus about the risks to the environment. It is noteworthy, however, to reiterate that there are still those who believe that agrochemical pesticides do not pose pose a threat to the environment especially when the risk of herbicides to the environment are asked.

An important observation of one of the respondents about bees is that bees avoid or stay away from rice fields even during flowering when insecticides are sprayed. The potency of the herbicide was also compared by one respondent saying that when he used Round up together with Hedonal 2,4-D Amine, the impact reaches as far as 6 meters from the point of first contact and he attributed this to the *Round-Up* herbicide. Hence, he decided to avoid using this type of glyphosate herbicide in his banana plantation and replaced it with another glyphosate brand to be mixed with Hedonal 2,4-D Amine.

It is therefore important for users to learn to read and understand the label of pesticide products and follow strictly the safety protocols when using them to reduce if not eliminate the risk associated with its use.

4.9 Deepening Understanding of the Drivers of Agrochemical Pesticides Use

Weeds followed by insects are the most common problems faced by farmers in the study sites and hence are the key drivers of agrochemical pesticides use. Table 7 below adds more information about the risks

Table 7. Label signs and Reviews of Pesticides

CLASS	BRAND NAME & Signal Word	RISK TO HUMAN	RISK TO ENVIRONMENT
Glyphosate (Herbicide)	RoundUp Demolition Garav (CAUTION)	Subject to continuing debates e.g carcinogenicity	Potential risk to terrestrial and aquatic plants and birds; Low: Honey Bees; Surface and Groundwater contamination*
Fenoxaprop-p-ethyl (Herbicide)	Rice Star (WARNING)	Causes substantial but temporary eye injury; Harmful if swallowed**	Toxic to fish, shrimp and oysters** Contamination of Water bodies***
2,4-D Amine (Herbicide)	Hedonal (DANGER)	Low: Cause eye irritation Carcinogenicity still under debate	Moderate: birds and mammals Light: Fish and aquatic invertebrates
Clothianidin (Insecticide)	Gold (DANGER)	Highly toxic	Toxic chronic exposure to honey bees, as well as other non-target pollinators; moderately toxic to small mammals; Detected in groundwater

Notes: * EPA (2017 ** Product Label *** Jing et al., (2016)

associated with the use of pesticides used in the study sites based on literature. Respondents describe the weed problem especially in swidden farms either as "too much" or the area cultivated is large enough like one (1) hectare or larger swidden farm which makes family manual labor difficult to handle unless they hire additional labor, which is quite prohibitive. Weed problem is also linked by some of the respondents to the current short fallow swidden system (2 to 5 years) which is not a problem in a long fallow (15 years or more) swidden system as practiced, long time ago. Hence, a combination of pressure factors such as shortened fallow, large area cultivated, growing population pressure due to birth and migration against limited forest area, resulting in increasing weed problems in farming, drive farmers to opt for practical and least cost agrochemical pesticide solutions.

While forest and protected landscape policy such as the declaration of no-go zone for agriculture in the protected landscape may have contributed to the current pressure to reduce fallow in swidden farming along with the other factors enumerated above, it is safe to argue that due to more dominant factors - population pressure due to birth and seemingly, the more aggressive occupation by migrant population, it will be just a matter of time before the same situation of shortened fallow will be reached. Hence, shortened fallow and large area cultivated are dominant underlying causes of weed problems in the uplands particularly in swidden farming.

Aside from the swidden system, another agroecosystem practiced in the MMPL is generally termed as intensification or sedentary system of farming characterized by continued cultivation with seasonal or perennial crops. In the study site, semi and perennial crops like cacao and banana farms are the crops grown to which the agrochemical pesticides are applied to control weed problems. Vegetables and other seasonal crop cultivation under the land use intensification system is also suspected of using insecticides but this is not the case among the respondents in the study. However, this can be another area for further investigation.

4.10 Alternatives to Agrochemical Pesticides use

The state of knowledge of the respondents on possible alternatives to the use of the agrochemical pesticides appear to be not encouraging. When asked about the non-chemical option to combat weed problem, straightforward "no" is the common answer, or simply return to manual means of controlling weeds.

For insect control however, there is only one option mentioned by one respondent but requires further development. The plant identified is called *Begna*.

Indeed, the local knowledge about pest management is diminishing, and hence, must be a subject of further research and development.

4.11 Summary Analysis of Adopters Behavioral Change and Pesticide Penetration in MMPL

The key findings of the study are enumerated below, as follows:

First, agrochemical pesticides use in MMPL is not recent and have been practiced decades ago, but the recent trends suggest a growing number of adopters is evident and must be a cause for concern to ecological stability of the landscape;

Second, if in the past, the common source of information about the use of synthetic pesticides are lowland farmers, now, the influencers are the actual users in the upland areas which makes the chance of a faster spread adoption by other farmers;

Third, the spatial distribution of agrochemical users even to the inner section of the MMPL is influenced by the weeds problem in swidden farming system driven by the diminishing area for cultivation due to increasing population, and other factors resulting to intensification of swidden system, hence shortened fallow prevails;

Fourth, while the practice of safety measures in handling toxic pesticides has been found, risky behaviors put the health and safety of the users at risk;

Fifth, some of the risks to the environment are within the consciousness of the adopters, the evidence needs to be tracked by way of implementing a strategic monitoring and evaluation system.

Sixth, the almost absent knowledge of possible alternatives to chemical pesticides to manage weed problems is an indication of more and more farmers going to adopt the use of chemical herbicides and maybe just a matter of time before this becomes a common practice in MMPL.

Chapter V

CONCLUSION AND RECOMMENDATIONS

Based on the facts gathered and analyses, the following conclusion and recommendations are put forward for consideration of farmers, extension workers, researchers, managers, and policymakers:

5.1 Conclusion

The interplay of **C**apacity (knowledge and skills of pesticide use, purchasing power), **O**pportunity (Availability and accessibility of pesticides), and **M**otivation (convinced of pesticide as better option) has driven the farmers to change **B**ehavior (adopt agrochemical pesticide use) that fits well with the COM-B conceptual model for behavioral change in this context. While the actual number of adopters of agrochemical pesticides in farming at this point is relatively small (at 3%) against the total number of PA occupants, the fact remains that the recent pattern of a growing number of adopters, suggests an effective influence and that it could be just a matter of time before others will follow suit. Further, the safety measures performed by the adopters appear to be insufficient to ensure the human safety especially of the user and putting at risk the ecosystem as well as the synthetic agrochemical pesticides are known to affect not only the fauna and flora but also the surface and ground water resources. This should therefore be a cause of concern of the stakeholders in general and MMPL Management, in particular.

5.2 Recommendations

After thorough assessment of the facts and the circumstances surrounding the adoption of agrochemical pesticides in MMPL, the following recommendations are hereby put forward:

- Pesticide monitoring and residue tracking - the MMPL management should establish monitoring system at the point of entry to the points of possible contamination o impact. Soil, ground water and surface water bodies at different locations upstream and downstream including coastal zones are important areas for monitoring. This recommendation also include study on the Possible effect on wildlife and biodiversity in general. This can be done by Palawan Council for Sustainable Development (PCSD) and in collaboration with the Department of Environment and Natural Resources Environment Management Bureau (DENR-EMB);

- Promote safety measures to reduce human and ecosystem exposure to pesticide risks e.g proper handling and responsible use of pesticides from acquisition to waste disposal. Specifically focus on a) application, b) cleaning, and d) waste disposal. The MMPL-PAMB could include this in the management plan of the protected landscape. The Department of Agriculture and local government units are in good position to provide technical support in this aspect;

+ Explore improved pest management practices and/or alternatives to synthetic agrochemical pesticides in agricultural production pest management such as improving natural or non-synthetic chemical-based pest control technologies applicability and effectivity especially relating to weeds management and control. The Department of Agriculture could very well offer the technical expertise on this aspect which can be done along with the program of the local government units and Agricultural schools; and

+ Further study to investigate the motivation and belief system about agrochemical pesticides, of those who opt not to use synthetic pesticides despite experiencing similar pest problems in their agricultural production situations. The PAMB may also consider further investigation to determine if there could be possibly more users of agrochemical pesticides than what has been recorded.

Chapter VI

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