EXAMINING CLIMATE ADAPTATION POLICIES AND STRATEGIES IN AGRICULTURAL LIVELIHOODS IN SARAWAK, MALAYSIAN BORNEO

A Project Paper

Presented to the Faculty of the Graduate School

of Cornell University

in Partial Fulfillment of the Requirements for the Degree of

Master of Professional Studies in Agriculture and Life Sciences

Field of

International Agriculture and Rural Development

by

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May 2020

ABSTRACT

This report analyzes responses from in-depth interviews and focus groups of 39 farmers and 44 state and local officials in 8 divisions of Sarawak. Data were analyzed according to standard qualitative practices, utilizing a process analysis technique based on grounded theory as described by Corbin & Strauss (2008). Key analysis followed both a narrative and phenomenological framework to explain complex ideas focused on respondents' experiences. The results revealed that even though there is no adaptation policy statewide, the majority of farmers have adopted an adaptation strategy in their production in response to a changing climatic environment. Although, the belief in climate change remains low especially, in terms of attributing changing climate conditions to anthropogenic causes, farmers noted significant change in their production due to the strategies they have adopted. The research findings also show that, in response to marked criticism of the government regarding its forest practices and the attendant threat to biodiversity on the Island of Borneo, the government unintentionally adopted sustainability and conservation approaches that are trade-offs to adaptation and mitigation strategies. This report concludes that in developing a comprehensive adaptation strategy it is critical that the views of all stakeholders are fully taken into account in the formulation of policy responses. Other necessary components of a comprehensive adaptation strategy include: a clear institutional framework, proactive provision of climate information to farmers and an analysis of the constraints to adaptation. Finally, in adapting Climate Smart Agriculture profiling for Sarawak as an entry point, several challenges that hinder adaptation strategies could also be addressed.

Keywords: Climate Adaptation, Sarawak, Agriculture, Climate Change, Mitigation

BIOGRAPHICAL SKETCH

Rex Ukaejiofo earned a bachelor's degree in Agriculture from the Federal University of Technology, Owerri, Nigeria (2005) a master's degree in Business Management from the European University, Lefke (2010), and earned a Doctoral degree in Rural Development & Management from the China Agricultural University, Beijing (2014). His interests are in agricultural policy analysis, smallholder agricultural development, research monitoring & evaluation, climate resilience and disaster risk financing.

Over the past ten years, Rex has worked in international development with a focus on agriculture, food security and international development. Much of his work has been based on the sub-Saharan Africa region. He's led several agriculture and rural development projects including those of the Consultative Group for International Agricultural Research institutions, namely: The International Institute of Tropical Agriculture in Nigeria and International Food Policy Research Institute in Washington D.C. Much of this work comprised providing technical and strategic lead in strengthening institutional linkages, integrating agriculture to enterprise development and in rural livelihood sustainability.

Prior to joining the MPS program at Cornell, Rex worked as an Agriculture Specialist Consultant in the Agriculture and Food Global Practice of the World Bank HQ in Washington, D.C., supporting and leading projects in Southern Africa since 2016. During this time, he led the development and management of technical inputs and policy analysis and liaised with private sector partners to develop innovative strategies to boost rural livelihoods access to market and higher incomes. He also facilitated high-level interactions between government agencies, partner stakeholders and led field and program implementation to shape a programmatic approach of the World Bank's engagement in Lesotho and South Africa. Such work was instrumental to maintaining client relationships and developing high-level-and-quality engagement with policymakers, academia and government stakeholders.

Rex loves volunteering and have contributed over 1000+ hours in the USAID Feed-the-Future Program working closely with smallholder farmers, cooperatives, women associations and farmer organizations in Angola, Ethiopia, Guyana, Myanmar and Mozambique.

To Isabel, Ezra & Francesca Ukaejiofo

ACKNOWLEDGMENTS

This capstone report was produced with funding from the International Programs - College of Agriculture and Life Sciences (IP-CALS) Cornell University, the Southeast Asia Program, Cornell University and from my advisor, Associate Professor Shorna Allred – who also provided general guidance to the entire research. I'm immensely grateful to Professor Allred for introducing me to Sarawak and becoming a lifelong mentor.

Special gratitude to Professors Lori Leonard, Chair of the MPS Program and Terry Tucker, Associate Director, IP-CALS who were instrumental to receiving funding and guided the overall project direction through the IARD 6970 Global Development, Master of Professional Studies, Seminars I &II. I wish to thank Assistant Professor Daniel Tang, Curtin University, Malaysia for collaborating with me throughout the entire research planning and travels in Sarawak.

Special thanks to Professor David Wolfe, Cornell University, who taught me fall semester course: PLHRT 3600 - Climate Change and the Future of Food; and also provided initial review of the research prospectus. I would also like to thank Francoise Vermeylen at the Cornell Statistical Consulting Unit for providing input to qualitative research analysis.

I would like to express sincere gratitude to the officials and staff at the State Planning unit of Sarawak, the Department of Agriculture, Sarawak especially, Mr. Chin Han Kiat and Mr.Stontan Morse who provided the research team with valuable support in facilitating research visits to divisions. Special thanks to Dr. Jason Hon, Head of Conservation at the World Wildlife Fund, Sarawak. State officials at the Forestry Department, the Meteorology Department especially Mr. Ambun Dindang, the Director-General who welcomed the research team and provided valuable insights on climate patterns, the Malaysian Palm Oil Board, staff at the Kubuloh Agricultural Research Station, Miri, Staff and farmers at the TKPM Station, Rampangi and Haji Hashim Haji Boket, the General Manager at the Sarawak Timber Development Corporation. I wish to extend sincere thanks to all Divisional Agriculture Officers and their staff in the following districts: Sri Aman, Bintulu, Mukah, Limbang and Sarikei.

The product of this research would not be possible without the express support and voluntary contributions of hardworking and enthusiastic farmers, who provided valuable context to adaptation strategies currently being employed in communities around Serian, Kuching, Sri Aman, Miri, Limbang, Bintulu, Mukah, Sibu – Bawang Assan and Sarikei. I also thank Professor Allred's research partners in Malaysia – Dr. Tariq Zaman and Mr. Gary, both of the University College of Technology Sarawak (UCTS), for providing valuable support to research coordination.

Finally, I'm grateful for those whom I met in the course of this journey, even though we all departed campus in a frenzy caused by COVID-19. I appreciate the collaboration, the engagement on the issues and being able to laugh despite it all.

To the MPS, Global Development class of 2020 – it's been the honor of a lifetime to be part of this experience with you.

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LIST OF ABBREVIATIONS

CCA—Climate Change Adaptation
DID—Department of Irrigation and Drainage
DOA—Department of Agriculture
DOE—Federal Department of Environment
EbA — Ecosystem Based Adaptation
EU—European Union
FD—Forest Department
GHG —Greenhouse Gas Emission
GoS – Government of Sarawak
IWRM—Integrated Water Resources Management
MANRED —Ministry of Modernization of Agriculture, Native Land and Regional Development
MCPD—3-monochloropropanediol
MD-2—Pineapple Hybrid Variety
MONRE—Ministry of Natural Resource and Environment (now MESTECC)
MESTECC—Ministry of Energy, Science, Technology, Environment and Climate Change
MA63—Malaysia Agreement of 1963
MPOB— the Malaysian Oil palm Board
MSPO—Malaysian Sustainable Palm Oil
MTCS—Malaysian Timber Certification Scheme
NAHIM—National Hydraulic Research Institute of Malaysia
NREB—Natural Resources and Environment Board
NRM— Natural Resource Management
PEFC—The Program for the Endorsement of Forest Certification
RISDA— Rubber Industry Smallholder Development Authority
SFM—Sustainable Forest Management
SPU—State Planning Unit
SRB—Sarawak Rivers Board
SRI—System of Rice Intensification
STIDC—Sarawak Timber Industry Development Corporation
SWA—State Water Authority
SWRC—Sarawak Water Resource Council
TKPM— (translated in English to: Food Production Permanent Garden Project)
UNFCCC—United Nations Framework Convention on Climate Change
WWF—World Wildlife Fund

CHAPTER 1

INTRODUCTION

Human activities in the form of land use change such as deforestation or forest fragmentation, agricultural expansion, and urbanization have been identified as anthropogenic causes of climate change (IPCC, 1992, 2020; Gottdenker et al. 2014). Sarawak's tropical deforestation has been a catalyst for unsustainable forest management practices. According to the International Timber organization, Sarawak is expected to reach a million hectare of industrial tree production by 2020 at its current rate of 90,000 ha forest conversion per year (around 10 per cent per year for oil palm) (Cramb and Sujang, 2013). One of the dominant reasons for this land use change is forest conversion for the establishment of commercial plantations, especially oil palm (Hansen, 2005; Wicke et al. 2011; Koh & Wilcove, 2008). It is important to note that farming perennial commercial crops as an adaptive measure to impacts of climate change as pathways out of poverty have been advocated, although the shortcomings in relation to externalities remain an issue. For example, "The belief that the adoption of commercial tree crops can lift whole rural populations out of poverty ignores diversity within communities and the unequal processes involved in such a transition" (Cramb and Sujang, 2012, pp. 3). Such approaches also fail to appreciate the resulting detrimental implications of largescale commercial mono-cropping on soil health structure. The removal of natural vegetative cover without natural protection for soils makes them more susceptible to flood risks, erosion and changes in the surrounding micro-climate. Although some commercial plantations are established in previously logged areas–and in some cases used for settlement purposes--the majority of oil palm plantations have been established on extensively logged areas, sometimes within 5 years conversion (Gaveau et al. 2016; Hansen, 2005; Mccarthy & Cramb, 2009). Some encroachment in the form of conversion of rainforests, both adjacent to and in native land holdings, still occurs on indigenous lands as there are no specific regulations regarding harvesting timber on indigenous reserves or areas where there are communal property rights (Hansen et al, 2008; Butler, 2013; NEPCON, 2017). Nearly 80 percent of the land surface of Sabah and Sarawak was impacted by high-impact logging or clearing operations from 1990 to

2009, which have become a major concern for biodiversity and the peoples in the region (Bryan et al. 2013).

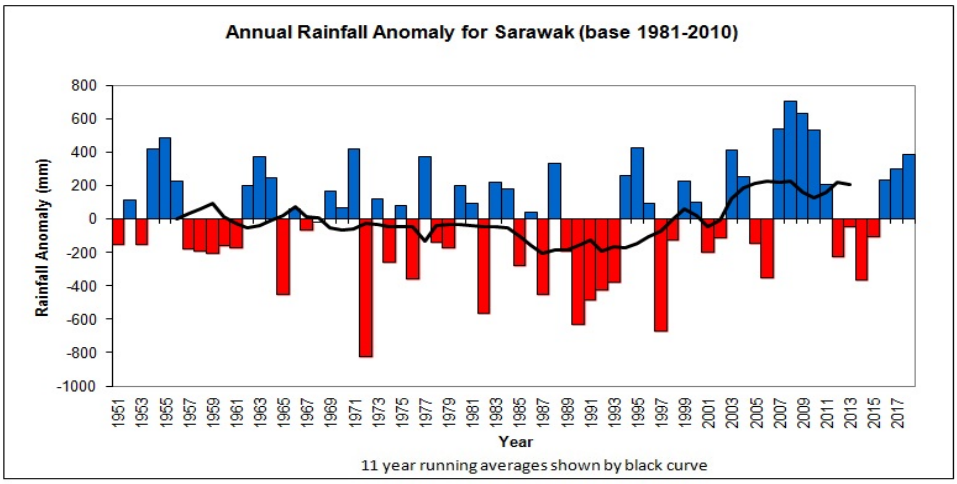
According to van Gevelt et al. (2019) this type of aggressive forest conversion threatens the indigenous Penan community – a traditionally nomadic indigenous people who live in the rainforests in the interior of Sarawak and others who continue to rely on the forest for their livelihoods (Selvadurai et al. 2013; Brosius, 1991; Brosius, 1997). Other impacts of logging and rainforest conversion include soil disturbances due to continued tillage, loss of organic soil matter, and soil erosion (Embrandiri et al. 2012).

Issues associated with the indiscriminate use of chemical fertilizers, made available through government input subsidies in these plantations and in small farms, portends risks. The chemical compounds in fertilizers and pesticides, as a result of sustained use in the landscape, can exacerbate issues with salinization and acidification of natural water bodies (Tanaka et al., 2009; Ahmad, 2001; Okpamen et al. 2013). Farming practices such as small-scale forest conversion and slash and burn, outlawed by the state, but still allowed in small holdings due to scale, is also a challenge. These factors, in the short run, could result in a higher volume of greenhouse gas emitted per year ha^{-1} from the soil (Russell et al, 2009) or lost through denitrification (McKeon et al. 2009). The accumulation of these practices has the tendency to increase the volume of biomass growth, soil and vegetation evapotranspiration and runoff – and in some cases, decrease rainfall (Tinker et al.1996; Shukla et al.1990; Coe et al. 2011; Lawrence & Vandecar, 2015). Both directly and indirectly, these factors such as increased inorganic fertilizers use, chemicals from herbicides and pesticides, including practices like localized slash and burn and forest conversion have strong implications for the sustainability of agricultural production and ultimately, sustainable livelihoods.

The state of Sarawak has the most rainfall in Malaysia and both surface temperature and precipitation according to an analysis provided by the Sarawak meteorology department. Temperature has risen over a 30-year period fluctuating between 26 and 32^{o}C and rainfall between 3000-4000mm per year. Temperature is estimated to have increased between 2007-2017 from -0.1 to 0.2^{o}C in the coastal regions and 0.2-0.3^{o}C in the interior regions (Interview, January 2020) (see

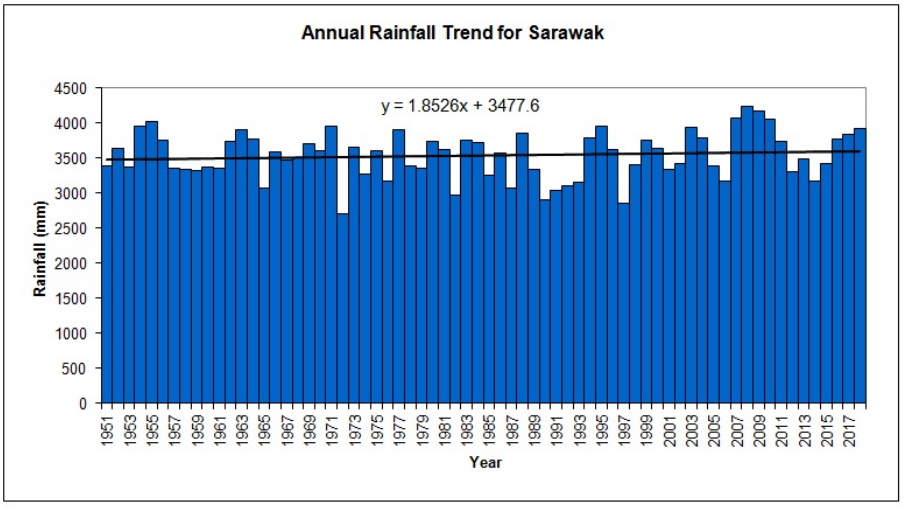
figures 1-3). The sea level around Sarawak's coastlines has a projected mean rise between 0.115 and 0.291m by 2040 (Sammathuria and Ling, 2009; Malaysian Meteorological Department, 2009; Kwan et al. 2013; Syafrina et al. 2017; Hussain et al, 2017; Hassan et al, 2014; Amin et al 2016; Ercan et al. 2013). Tidal inundation due to increased precipitation on the coastlines of Sarawak can have significant negative impacts as sea level rises (Ercan et al. 2013). Sea level rise could impede drainage resulting in flood risks and saltwater intrusion. Such intrusion has the potential to contaminate fresh water sources, destroy croplands and lead to large scale land loss.

Figure 1: Annual rainfall anomaly for Sarawak 1981-2010



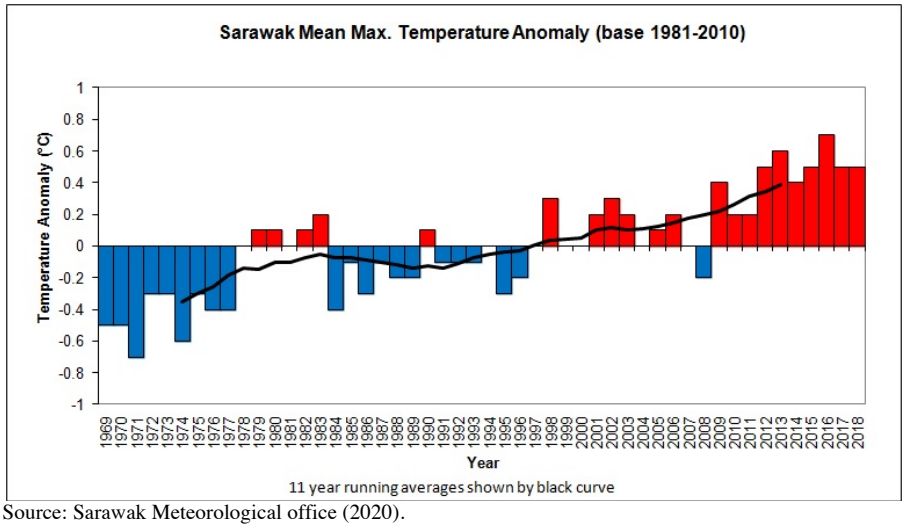
Source: Sarawak Meteorological office (2020).

Figure 2: Annual Rainfall for Sarawak 1951-2017



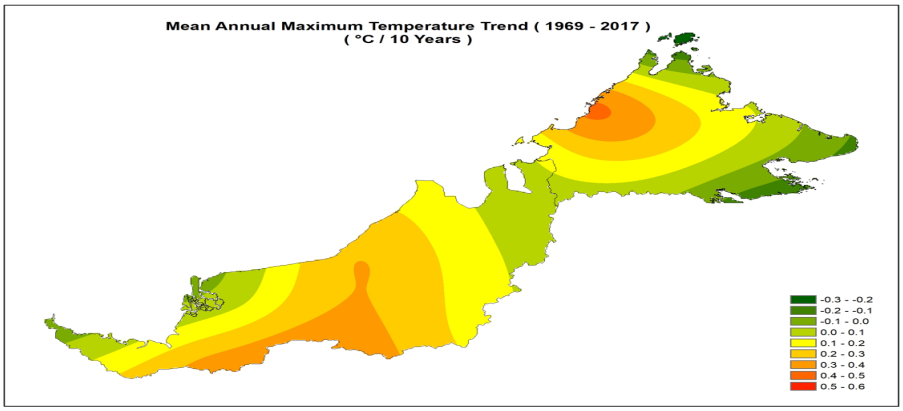
Source: Sarawak Meteorological office (2020).

Figure 3: Mean Maximum Temperature for Sarawak 1981-2010



Source: Sarawak Meteorological office (2020).

Figure 4: Mean Annual Maximum Temperature for Sarawak 1969-2017



Source: Sarawak Meteorological office (2020).

1.1.Agricultural livelihood activities:

Livelihood activities include the essential day-to-day activities to sustain oneself, their family and community for food, shelter, water, fodder or medicine (Rakodi & Lloyd-Jones, 2002; Salafsky & Wollenberg, 2000). Agricultural livelihood activities, for the purposes of this paper, include those activities that are mostly sourced through agriculture. In Malaysia, the majority of the population of the country lives in Peninsular Malaysia while Malaysian Borneo has some of the largest land area of the country. The population density of East Malaysia on the island of Borneo, where the dual Malaysian states of Sarawak and Sabah are situated, is considerably less than the rest of the

country. The 2019 total population of Malaysia is estimated at 32.6 million, while the population of Sarawak is estimated at 2.81 million and Sabah is 3.90 million[1]

In Sarawak, agriculture is the mainstay of the economy, concentrated with cash crop production. Cropland areas due to rubber and pepper, are becoming stagnated and declining slightly (Tanaka et al. 2009; Cramb, 2007; Hansen, 2005). Sago is largely dominated by small holdings confined to the coastal zones around Mukah (Mohamad Naim et al. 2016). Subsistence and shifting agriculture is a practice which involves the clearing and utilizing it for a season and then allowing it to become secondary forest for a fallow period of 5-15 years (Cramb, 1993). This practice is very prominent in rural communities and hinterlands in Sarawak. Farming systems are often mixed crops of wet and hill paddy, vegetables, and fishing and harvesting of wild ferns from the forest. There is also a focus on cash crops, particularly oil palms due to price and market opportunity derived from oil palm fruits[2] (see Table 1) (Thompson, 2004). Tang (2019) in his review of climate change in Malaysia, identified agriculture as one of its vulnerable sectors due to the impacts of climate change and determined that forestry, biodiversity, water resources, coastal and marine resources are also susceptible sectors. In Sarawak, agriculture, forestry and fisheries remain the most notable sectors that provide livelihoods to one-fourth of its population. Major agricultural crops in Malaysia include oil palm, horticulture (fruits, vegetables and spices), logging (timber production), natural rubber (produced mainly in Sarawak and a revitalized rice production over the last decade (See table 1 below)[3] [4].

[1] *The official portal of the Sarawak government. (n.d.). Retrieved March 26, 2020, from https://www.sarawak.gov.my/web/home/article_view/240/175/*

[2] *Malaysia | facts, geography, history, & points of interest. (n.d.). Encyclopedia Britannica. Retrieved March 26, 2020, from https://www.britannica.com/place/Malaysia*

[3] *Sarawak's agriculture, forestry and fisheries sector continues to thrive even as the sector diversifies*. (2015, April 23). Oxford Business Group. https://oxfordbusinessgroup.com/overview/sarawaks-agriculture-forestry-and-fisheries-sector-continues-thrive-even-sector-diversifies

[4] *Ibid* [2]

Table 1: Major Agricultural production in Sarawak

Crops	2014	2015	2016	2017	2018
Oil palm ('000 tons)	3439.3	3702.1	3585.2	4128	-
Cocoa (raw/roasted) ('000 tons)	479	616	349	273	-
Rubber (tons)	20	10.2	7.4	10.9	-
Pepper (White & Black) ('000 tons)	26.2	27.2	22.2	26.7	29.9
Paddy ('000)	235	242	246	250	264
Cocoa	4.9	6.9	6.7	6.8	-
Production of forest and forest products					
Saw logs ('000 m^3)	8534	9160	9079	8668	-
Sawn Timber ('000 m^3)	847	742	770	676	-
Plywood ('000 m^3)	2320	2653	2339	1818	-
Wood chips ('000 tons)	399	579	562	513	-
Veneer ('000 m^3)	569	520	485	339	-
Horticulture					
Fruit Trees ('000 m^3)	35	35	35	34	37
Leafy Vegetables ('000 m^3)	2.1	2.3	2.3	2.3	2.4
Fruit Vegetables ('000 m^3)	2.3	2.4	2.6	2.6	2.5

Source: Agricultural Statistics of Sarawak 2018. DOA[5]

1.2.Climate impacts on identified agricultural livelihood activities:

Several cases of climate-related impacts have been reported in oil palm cultivation (Paterson & Lima, 2018; Paterson et al., 2015), such as changes in fruit ripening, yield, and abnormal phenological traits, which have been detected in oil palm in east and west Malaysia. These climate impacts to oil palm correlated with higher precipitation caused by La Nina- flooding and severe drought (Shanmuganathan et al. 2014). Countries that cultivate oil palm are likely to face

[5] *Sarawak facts & figures portal*. (n.d.). Retrieved March 26, 2020, from http://sarawakfacts.sarawak.gov.my/modules/web/cls_list.php?clsid=42&catid=170&subcatid=&polid=198

increasing uncertainty in their production; yields are projected to decrease by 30 percent if temperatures rise 2°C above the required values for production and/or if rainfall drops by 10 percent in Malaysia (Paterson et al. 2015). With the continued aggressive conversion of forests to cultivate large scale oil palm and rubber estates and the inundation on the shores of Sarawak, flooding is likely to increase with climate impacts. "An overall small to moderate reduction of agricultural productivity and yields due to climate impacts has been reported" (Tang, 2019, pp. 1862). In inland fisheries, saline intrusion and diseases such as white spot disease has been detected in aquaculture in Penang and linked to impacts of climate change (Azril Mohamed Shaffril et al. 2013; Hambal et al.1994). Social impacts on the livelihoods of subsistence-oriented indigenous communities like the Penan who depend on the forests for their livelihood and cultural identity is becoming a real concern (Savo et al. 2016; van Gevelt et.al. 2019). New climate change related risks may manifest as a combination of new pests and diseases, shifts in temperature and rainfall, the inefficacy of pesticides as natural ecosystems respond to a changing environment, and the loss of biodiversity (Rosenzweig et al. 2011; Coakley et al. 1999; Rosenzweig & Hillel, 1995; Lamichhane et al. 2015). Communities in unprotected areas are increasingly at risk and subject to frequent coastal flooding in a majority of developing countries (Kulp and Strauss, 2019). These impacts make for a compelling case for proactive strategies towards adaptive capacities and preparedness to build resilience than have been previously considered.

1.3.Climate perception in South East Asia, Malaysia and Sarawak:

An empirical analysis of farmers climate perceptions in Southeast Asia revealed they understood that temperature is rising (96%) and a key component of that study showed that when farmers made changes to adapt, they shifted to other viable crops, new varieties, and changed planting times (Abidoye et al. 2017). In addition, climate adaptations of farmers in Cambodia and Myanmar included changes in area cultivated and adoption of new farm production principles such as a system of rice intensification (SRI), animal manure application, compost making and application, crop rotation and crop residues retention to minimize the risks to crops. Although, barriers to adaptation remained an issue among farmers (Shrestha et al. 2018). In eliciting responses from the public on perception of climate change in three developing cities in Southeast Asia, Mateo-Babiano et al. (2013) found that, while there was a clear understanding of climate adaptation, there was a lack of knowledge on what strategies will be most effective at addressing climate change. It

is, therefore, imperative for government to work closely with farmers and stakeholders in developing workable climate change adaptation plans adapted to each context (van der Keur et al. 2016; Begum et al., 2011; van Gevelt et al. 2019). Although, empirical evidence suggests that education and awareness, legislation and regulations, and the use of appropriate technological are important motivational factors (Begum & Pereira, 2015; Banna et al. 2016). Ninety-six percent of businesses surveyed in Malaysia believed climate change had no effect on Malaysia's economy. In Malaysia, there is a concern on how climate adaptation is communicated– a study found that 83-85% of farmers were concerned and understood that climate change could result in adverse impacts and wanted strategies to stay resilient. While a significant fraction worried about fiscal responsibility concerning adaptation (Banna et al. 2016). A study of six Penan villages in Sarawak revealed that climate perception is influenced by the magnitude and occurrence of severe cases of flooding and drought. The frequency and severity of such event can influence perception and likely determined by an individual's adaptive capacity at the time preceding shock. However, participatory approaches that link adaptive pathways to climate impacts at the community level are also effective in communicating climate coping strategies in indigenous communities (van Gevelt et al. 2019).

CHAPTER 2

METHODOLOGY

2.1.Study site:

Sarawak is one of the two states of Malaysia on the Island of Borneo and is the largest of the country's 13 states, with an area almost equal to that of Peninsular Malaysia (see figure 1). The capital of Sarawak is Kuching, which is the largest city in Sarawak, the economic center of the state, and the seat of the Sarawak state government, which is comprised 11 divisions, 39 districts and 26 sub-districts. Economic activities in the Sarawak are dominated by energy, agriculture and forestry, with a significant increase since 2013 in investments in higher gas production in the energy sectors around Bintulu, boosting transportation and utility infrastructure[6]. This study focused on prominent areas for agricultural production (see figure 2 below), in major divisions of Sarawak, which include: Kuching, Sri Aman, Miri, Limbang, Bintulu, Sarikei, Mukah and Sibu. Agricultural livelihood activities were determined by land use area in agriculture (see Table 2 below) as follows: oil palm, rubber, paddy rice, horticulture (pepper and vegetables), coconut, and cocoa.

[6] Ibid [3]

Figure 5: Map showing Malaysia - Peninsular Malaysia on the left and Eastern Malaysia showing Sarawak on the right.

Source: Malaysia. Encyclopedia Britannica.

Table 2: Land Use Area in Agriculture in Sarawak, 2018

Activity	Rubber	Oil Palm	Pepper	Paddy	Coconut	Cocoa	Fruits	Vegetables	Sago
Area (ha)	166,636	1,555,828	16,798	135,426	13,260	6,862	38,225	2,579	40,641

Source: Author interview, Agricultural Statistics of Sarawak 2018. Department of Agriculture, Sarawak

2.2.Research questions:

Some of the issues identified from literature suggest that adaptation strategies in Malaysia are not based on local contexts or on future projections (Tang, 2019). In some cases, gaps still exist and may be directly linked to the lack of participatory approaches to current planning and implementation that address critical needs in these communities (Khailini & Perrera, 2013; Hamdan et al. 2017). The continual encroachment into indigenous forests as a result of expansion for development suggest a lack of inclusion of indigenous knowledge and local participation in adaptation policy planning (van Gevelt et.al. 2019; Savo et al. 2016). Farmer perceptions can influence the type of adaptation strategy adopted (Demski et al. 2017; Zanocco et al. 2018). Adaptation practices to cope with the agricultural vulnerability due to climatic change were found

to be inadequate and unsatisfactory as observed with paddy farmers in Northwest Selangor in Malaysia. (Alam et al. 2010). Azril Mohamed Shaffril et al. (2013) in their study on social adaptation among Malaysian fishermen noted that they showed highly adapted environmental awareness, attitudes and beliefs, and local environmental knowledge at individual level, even though their knowledge of climate change was limited. Tang (2019, p. 1869) stresses, that "adaptation strategies based on future projections of climate change which addresses current gaps by examining the adequacy of existing adaptation policy, planning and implementations would be beneficial." This research first examines and documents adaptation strategies currently being employed at the farm-level in Sarawak, the level of awareness and participation on scalable programs that are available, what strategies are in place to connect those that are being implemented, and what barriers in cultural beliefs, social attitudes, and indigenous knowledge exist. This study explored the following research questions:

1. Examine how national climate adaptation policies and strategies, in concert with the identified livelihood activities, align in design and implementation.
2. Review aspects of farm-level adaptation strategies employed in the identified livelihood activities and the limitations on accessibility, adoption and use of these strategies.
3. Examine the relationship between awareness of impacts of climate change and the attitudes towards the type of adaptation strategies adopted.

2.3.Methods and Data Analysis:

This paper applied a mix of qualitative methods to examine climate adaptation in Sarawak, including in-depth interviews with government agencies, focus groups and participant observation with farmers, and a synthesis of climate planning and land use documents. Sarawak state does not have an explicitly themed policy plan that focuses on climate adaptation and or mitigation. For the purpose of this study we consulted secondary data and documents within the nexus of agriculture, environment, natural resource management and forestry. This includes climate policy plans, data on land-use, prominent agricultural activities in the state, and adaptation and climate strategies including the academic literature on climate adaptation policies and strategies in Sarawak

including institutions that govern sub-sectors within the intersection of agriculture, environment, natural resources and forestry. This frame of reference is important in examining climate adaptation policies and strategies at a regional level because research on global environmental change is increasingly available and local perception in states such as Sarawak and how they deal with this change are largely overlooked (Pyhälä et al. 2016).

Questions for guided interviews (Appendix A) were developed for primary data collection and reviewed by the institutional review board at Cornell University for research ethics protocols; a total 83 participants took part in the study. Seven focus group interviews (with 5 participants each) and 4 interviews (with 9 people) were conducted with a total of 44 government officials in Sarawak as key informants from the following agencies: Sarawak State Department of Agriculture, Forestry Department, Headquarters in Kuching, Sarawak State Planning Unit, Meteorology Department, Serian District agricultural department, Divisional departments of agriculture in Sri Aman, Limbang, Bintulu, Mukah, Miri and Sarikei, Sarawak Timber Industry Development Corporation (STIDC), the Malaysian Oil palm board including experts at the World Wildlife Fund (Table 3).

Table 3. Mode of Interview

Mode of Interview	**Farmers**		**Government**	
	Type of Interview	Number of Participants	Type of Interview	Number of Participants
Focus Group	10	3-5	7	5
In-depth Interviews	4	6	4	9

Author

Focus group interviews were conducted with a total of 39 farmers across 8 out of 11 divisions in Sarawak state. For farmers, there were between 3 to 5 participants in each focus group and 6 participants in 4 in-depth interviews as some interviewed together (see table 3 above). The interview guide (Appendix A) explored farmers' perceptions and concerns on climate change, their adaptation practices, including farm level adaptation strategies currently employed and barriers to adaptation. Other aspects of the focus group included government response to climate impacts in agriculture, policy options and mitigation strategies. Interview questions were designed to elicit

narrative analysis on changes observed in local environment, identified impact of such changes, changes in farming practices to adapt and type of institutional support received.

Observational visits were sometimes conducted after interviews or on-site to gain greater insights on farmers production. The research team also conducted site visits of relevant government project sites such as the Tagang eco-tourism projects and TKPM demonstration sites to garner in-depth understanding of ideas generated during interviews.

Data were analyzed according to standard qualitative practices, based on grounded theory as described by Corbin & Strauss (2008). Utilizing a process analysis technique, based on grounded theory, field interview notes were transcribed and coded verbatim. The authors who conducted the interviews reviewed the transcripts for accuracy and completed an initial and final analysis by coding in excel by reviewing key themes. The key themes identified from the interview include institutional governance, enforcement and regulations, climate impacts and perception and adaptive measures. Key analysis focused on the respondents' experiences on how existing policies interact with users and how government can better tailor climate adaptation policies and strategies to target communities and respond effectively. The analysis of data including words, text or behaviors of experiences and the understanding of the subject to offer information on environmental change and how programs are implemented by government can help rural farmers deal with these changes. The analysis follows both a narrative and phenomenological framework to explore climate adaptation practices in the selected agricultural livelihoods and promote the exploration of possible future research topics.

CHAPTER 3

RESULTS & DISCUSSION

3.1. Government institutions and adaptation policies:

The only overriding policy on climate change in Malaysia –the National Policy on Climate Change– was developed nationally in 2009 and passed by the Parliament of Malaysia in 2010. The core objective of this national policy focused on strengthening institutional and implementation capacity to better harmonize opportunities to reduce negative impacts of climate change. The state of Sarawak has no particular policy on climate adaptation in place and officials argue they are not bound by the letters of policies developed by the Malaysian national government on climate change. The Sarawak officials, however, note that they will use polices developed by the national government as a guideline to adapt, monitor changes, and mitigate impacts due to climate change in the state. This, according to state officials, is due to the autonomous status Sarawak continues to enjoy – that allows it no obligations regarding such policies. State officials maintain, Sarawak will only adapt aspects of national policy regarding climate change that align with the state priorities and objectives. This is a result of the 20-point rule that formed part of the agreement that strengthened the MA63[7] agreements in 1963. One of the main items of the 20-point rule gave Sabah and Sarawak a high degree of autonomy over their financial affairs, development expenditure and tariff (Chin, 2019).

In 2018, Malaysia's new political leadership made bold declarations to set up a climate change center, a national climate change adaption and mitigation plan to be completed by the end of 2019, and a Climate Change Act to be sent to parliament in 24 to 30 months led by the federal Ministry of Energy, Science, Technology, Environment and Climate Change, (MESTECC) even though environmental issues in Malaysia are the shared responsibility of three ministries: MESTECC, the

[7] MA63: Known as the Malaysia Agreement, a legal instrument signed by Great Britain and the Federation of Malaya in 1963 which led to the formation of the Federation of Malaysia. The two Malaysian states of Sarawak and Sabah feel aggrieved the federal government pays lip service to the tenets of this agreement over more than half a century. Both states who rather preferred to be called regions, believes have lost their rights in the last 50 years and are openly calling for a review of federal–state relations.

Ministry of Water, Land and Natural Resources and the Ministry of Primary Industries[8]. The policy is still being developed and behind its scheduled release date of 2019. Officials at the Sarawak State planning unit acknowledged the plan was in the works and stated they participated in the planning process. State officials at the SPU noted they provided focus of state priorities and current policies in the intersection of environment, NRM and agriculture but declined to give a tentative date of release.

Conversely, any disconnect in policy and institutional governance can hamper efforts at achieving a well streamlined policy agenda and in its implementation. According to the National Hydraulic Research Institute of Malaysia (NAHIM) report, governance over rivers and water catchment in Sarawak spreads across several agencies such as Natural Resources and Environment Board (NREB), The Sarawak Rivers Board (SRB), the Forest Department (FD), the State Water Authority (SWA) and the Federal Department of Environment (DOE). The planning and management of catchments is the responsibility of the Sarawak Water Resource Council (SWRC), which suggest a need for collaborative governance. The NAHIM report noted a climate adaptation initiative consisting a multilateral partnership of six countries (Malaysia, Philippines, Indonesia, Timor-Leste, Papua New Guinea, and Solomon Islands) to coordinate work on the regional coastal and marine ecosystems that aims to capture and store more than 30% of its man-made emissions. The Ministry of Natural Resources and Environment (MONRE) now the Ministry of Natural Resource and Environment --a federal agency, leads oversight of this initiative. This initiative, a multi-lateral agenda does not specifically address agricultural vulnerabilities in its mandate (Pereira, et al. 2016).

Climate adaptation as a theme is listed as a policy under the Ministry of Urban Wellbeing, Housing and Local Government's National Physical Plan 2; and climate change adaptation, specifically determining measures to aid adaptation of water resources to threats and emerging threats is in the country's Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) (Table 4). The Department of Irrigation and Drainage (DID) in

[8] *Winds of change in Malaysia: The government and the climate | Heinrich Böll foundation | southeast Asia regional office*. (n.d.). Heinrich-Böll-Stiftung. Retrieved March 26, 2020, from https://th.boell.org/en/2019/02/27/winds-change-malaysia-government-and-climate

Sarawak coordinated both the Integrated Coastal Zone Management program and the Integrated Shoreline Management Plan (ISMP), both aimed at addressing the major issues and problems facing the country's shoreline.

Table 4: Leading Malaysia Institutions & Policies/Programs reviewed

Federal	State	Policies and Priorities	Climate Change Objectives
	Forest Department	Sarawak Forestry Corporation Ordinance, 1995 (Chapter 17)	Adaptation & Productivity
	Drainage Irrigation Department	National Coastal Resources Management Policy. (Environmental Impact Assessment) Order 1987 and the Natural Resources and Environment Ordinance (Sarawak) 1949 (As Amended 1994). Integrated Coastal Zone Management Program Integrated Shoreline Management Plan (ISMP)	Adaptation & Mitigation
	Department of Land and Survey	Sarawak Land Code 1958 (Chapter 81), Agricultural suitability maps	
	Natural Resources and Environment Board	Natural Resources and Environmental (Amendment) Ordinances, 2001 (Cap 84) and its relevant regulations.	Mitigation
Department of Environment		Environmental Quality Act 1974	Mitigation
Ministry of Natural Resources and Environment (MNRE)		The National policy on Climate Change 2010 Ministry has jurisdiction over communication with the UNFCCC. - Second National Communication (NC2) Project – greenhouse gas inventory, projections and mitigation options; vulnerability assessment and adaptation strategies	Mitigation Mitigation
Economic Planning Unit		11th Malaysian Development Plan, 2016-2020	Adaptation
Malaysian Meteorological Department		Climate change modelling and forest climate interaction studies. Climate pattern of Sarawak: rainfall, temperature, relative humidity and solar radiation.	Adaptation
	Department of Agriculture	Divisional Agricultural Department project documents - State fishery ordinances (2003) TAGANG – Ecotourism projects - TKPM Project documents - Sarawak Good Agricultural Practices (MyGAP) - Divisional Agricultural suitability maps - Agricultural statistic of Sarawak 2018 - External trade 2017 handbook	Adaptation, Mitigation & Productivity

Source: Author; Departments of Agriculture and Forestry project documents; the 11th Malaysian National Plan 2016-2020[9]; Pereira et al. 2016.

The Sarawak State Planning Unit, SPU led a plan in 2009 to formulate an integrated water resources management (IWRM) in Sarawak state to meet future water demand up to the year 2050 (Pereira, 2016). The SPU is also formulating an agriculture master plan which is currently in the draft stage. The report, according to officials at the SPU, began in 2019 and is undergoing peer review and final appraisals before release. Key objectives of the master plan include strengthening compliance in the agriculture sector, value chain prioritization – from table to marketing access, infrastructure (production to market), and certification. This effort is geared towards the state government vision 2030 to make Sarawak a net food exporter by 2030.

These policy plans (see table 4 above), featured prominently in the UNFCCC second communication underscoring major national development priorities, including improving awareness and preparedness towards building resilience that involves a robust stakeholder process (Alam et al. 2010). The separate jurisdictions across federal and state agencies results in duplication of roles for institutions at several levels. These will impact the effectiveness and ability to respond to challenges in a more targeted manner devoid of lingering bureaucratic protocols as Sarawak has its own laws and autonomy in adopting certain federal policies. The practice of having SPU formulate policies for a specialized sub-sector like agriculture can hamper efforts for agencies like Ministry of Agriculture MANRED and the Department of Agriculture, DOA whose role is in implementing those policies. Some of the institutional challenges that may arise due to bureaucracy, as government agencies are not clearly linked and largely mismatched with overlapping or vaguely defined roles. While some degree of redundancy can build resilience, it could also lead to ambiguity in execution of policy and agendas if operations are parallel and collaboration is limited. The DOA and MANRED need to lead its own efforts, as sectoral work ought to be in the purview of the particular ministry whose mandate ensures that. MANRED and DOA can also collaborate with SPU to get guidance on state priorities and communicate delivery and progress to overseeing structures like the SPU.

[9] *Government of Malaysia. 2015. The 11th Malaysian National Plan. Economic Planning Unit.* https://www.talentcorp.com.my/clients/TalentCorp_2016_7A6571AE-D9D0-4175-B35D-99EC514F2D24/contentms/img/publication/RMKe-11%20Book.pdf

Strong institutional governance and coordination and effective adaptation strategies are needed to ensure the sustainability of food systems in a changing climatic environment. Adapting to climate impact requires a multi-sectoral partnership that takes into account the various areas requiring technical know-how to implement. Specific areas requiring adaptation have been identified in Malaysia, namely drought, flood and erosion, which impact agriculture, health, forest and biodiversity sectors as well as coastal marine habitats (Solar, 2011). Key government representatives note that not much has been done as a country in the two years since Malaysia signed the Paris agreement in regard to plans on mitigation and adaptation. Additionally, Malaysians cannot link impacts such as rising sea level, temperatures, and frequent floods despite evidence and the climate debate is "somewhat muted" (Hamid, 2018, para 15). This is true in relation to climate change adaptation and mitigation. However, these strategies are being employed in several programs, projects and in policy directives, even though they are not explicitly themed as adaptation strategies. In many cases, they are occurring in unintended ways which will be discussed in detail in later sections of this paper.

3.2.Interviews with government officials:

3.2.1. Institutional Governance:

Agriculture in Sarawak is concentrated in the commercial and commodity sector and the Ministry of Industry and Plantation has lead oversight of the commodity sub-sector, whilst sectoral boards manage individual crop types, for example, the Malaysian Palm Oil Board, MPOB for oil palm, the Timber Board for timber, the Pepper Marketing Board for pepper and the Rubber Industry Smallholder Development Authority, RISDA for Rubber. Oil palm is the largest industry in Sarawak and falls under the purview of the MPOB —which is a federal agency and removed as a sub-sector under agriculture even though some small-scale farmers involved in its production interface directly with the DOA, which is the agency tasked to oversee small-scale farmers. The Ministry of Modernization of Agriculture, Native land and Regional development, MANRED & DOA however, have oversight on small scale agricultural production of the following: Rubber, oil palm (small scale) both, horticulture (pepper, vegetables), inland fisheries, fruit trees, sago and coconut. MANRED is the main agricultural agency in Sarawak with policy formulation and

general agricultural policy objectives purview while DOA implements programs as directed by MANRED according to staff of the agency (Interview, DOA January 6, 2020).

In 2016, the Natural Resources and Environment Board of Sarawak commissioned an environmental study to provide baseline database of vulnerability assessment due to climate change for the Sarawak River Basin. NREB, began operations in 1994 as the state environmental agency of Sarawak. The aim of the study was to strengthen the capacity of local governments and communities to plan, undertake, and implement adaptive management measures in the city of Kuching and contiguous areas in Sarawak. Another primary goal of NREB in the study, was to "emphasize requirements to adopt or to promote Ecosystem – based Adaptation (EbA) as the primary solution in coping with climate impacts" that result in inundation from rising seas levels with a focus on fishing villages with direct exposure to extreme sea fluctuations (Pereira, et al. 2016). EbA, according to the report, is a holistic response to climate change by protecting, maintaining, and restoring natural ecosystems to reduce climate impacts on communities and the ecosystem they thrive upon (Pereira, 2016). State governments in Peninsular Malaysia, Sarawak and Sabah have jurisdictions over land and soil conservation, rivers, water and forest resources (NEPCON, 2017).The state government structure in all 11 states on Peninsular Malaysia is similar to the government system of the federal government of Malaysia except for native judiciary powers in Sabah and Sarawak. This decentralized system, as opposed to being led by national actors, can be a catalyst to successfully piloting development programs, facilitating an effective policy process and providing effective feedback loops, given its proximity to the governed.

3.2.2. ***Strict enforcement and regulations:***

Land in Sarawak is administered by the Lands and Survey Department as are all land matters autonomous and state led. According to Forestry Department officials, logging concessions, which were granted by the state government to logging companies in the past, are now restricting logging concessions. However, since all land matters in Sarawak falls under the purview of the state government, although, 'certain criteria' (to suggest those with better power-social relations get a pass, notwithstanding the regulations) are often used to allocate land for conversion even though, the process is still extremely restrictive. The situation is the same for open burning; under the

NREB ordinance, prohibition of open burning can be lifted for open burning with same criteria as above.

Logging companies are now encouraged to pursue forest certification under the Malaysian Timber Certification Scheme to ensure sustainable management of Malaysia's natural forest and forest plantations, and the audits are conducted by an independent certification body under the MTCS. The forest management certification committee does not conduct the audit but facilitates the certification by engaging the local committees regarding social issues related to logging. A similar approach is also being adopted in the oil palm sub-sector, where the federal government has issued a strong endorsement of the Malaysian Sustainable Palm Oil (MSPO) certification plan, MSPO -- a national standard, which took effect in January 2020, committing the country to curtail damaging, destructive and unsustainable practices in oil palm production and ensure that producers adhere to the EU-prescribed level of 3-MCPD of 2.5 milligrams/kg for food products by 2021. Already, about 60% of the total oil palm planted area in Malaysia is MSPO-certified as of October 2019, with 328 palm oil mills or 72.6% of the total 448 mills in the country (MPOB, Interview, January 10, 2020; Kumaran, 2019 (n.d.); Shahida, 2019).

The state government now generally discourages slash-and-burn agriculture but limitations on enforcement persists in the production of certain crops such as hill paddy. Small holder farmers and subsistence households are still permitted to slash and burn and also convert nearby forests for agricultural purposes. State officials note that, since their production is limited, around 1-3ha each is impacted by small holders according to officials. Thus, the scale of slash-and-burn agriculture is considered too small to be disastrous and is often overlooked by government officials. However, such practices occurring in native customary lands all over Sarawak could have deleterious cumulative impacts which are largely ignored. For the purpose of optimizing forest resources, state officials explained that the government has earmarked its 12.4million ha of forest land in Sarawak state in the following ways:

Table 5: Forest classification for Sustainable Forest Management

Classification	Classification details	Area (M ha)	Percentage Cover
Total land area for SFM	Total forest area	12.4	100%
Protection Forest	5 million for Permanent forest estates 1 million ha for tree plantation development (provided licenses for planted forest (LPF)	6	48%
Conservation Area	Totally protected area (for national parks, wildlife sanctuaries and nature reserves)	1	8%
Limited Conversion Forest	Agriculture and Urban Development	2Mha each = 4	32%: Split 16% each
Conversion/Planted Forest	For permanent clearance and conversion, usually for 10-25 years and then clear-cut for agricultural/commercial purposes.	1.4	11%

Source: Author, SPU, Dept of Forestry, Dept. of Agriculture, Kuching.

In a bid to underscore Sarawak government's commitments in driving sustainable practices, one official note that:

> *"To achieve the 1 million ha planted species, we are looking at areas within the state with optimum production potentials – land, fertility, topography, drainage system, rainfall and temperature factors, we have to determine what species will be economically viable too – to derive the required yield in relation to climate vulnerabilities and adjusting planting requirements."*

However, a cursory look at table 5, shows that even though the motivations are assuring, the actions to achieve said commitment are not commensurate. Out of the total forest areas earmarked by state authorities, only 8% of is subject to conservation. State officials argue that, Sarawak like any other regions, is saddled with the task of providing opportunities for its people and they must do so with resources available to them, chief of which are its natural resources: wood, land and forests. To provide such economic opportunities, state officials interviewed agree, must be done in the confines of sustainable practices in the interest of their environment that is seen to be fair and equitable. Forest conversion for oil palm is increasingly in demand even though government officials argue there has been restrictions and several strict guidelines provided to those willing to invest in its production. One official put it this way:

> *"To provide income and opportunities for the citizenry of the state is the reason why government is utilizing resources available to them and chief of which include forestry. We have to do this with what we have and for good reason, we are doing so in a more sustainable way – which is why as I explained earlier, we are adopting such systemic plan. Plans like the forest distribution and uses are not as aggressive as most media and opinion papers have labelled our activities here."* (Interview, January 6, 2020).

Another official from one of the commodity boards explains thus:

"To improve the social conditions of our people is paramount and we have seen the impacts of the expansion of the oil palm in every sector of our economy and how much lives have been improved. We can all argue on how to get there, yes, I agree, but I think taking proactive steps like we are doing now to protect our environment is one of that". (Interview, January 10, 2020).

These officials bemoaned the criticism received by the state, that they pursue "an aggressive push for the conversion of forest trees and a global hotspot of forest loss and degradation," as unfair, *"without details on what exactly our government is doing."* Although, criticism has spurred some changes. Adopting sustainable forest management practices in the forest sector, in oil palm production, and in farming practices were, in part, a result of criticism the government received from the international community regarding the mismanagement of its forest resources, which threaten the region's biodiversity. While some officials reluctantly concede the point, they certainly view the longer-term benefits of adopting a more sustainable approach as ideal. These changes in approach are also viewed as an exchange for trade competitiveness in export markets – as both Sarawak and Malaysia plan to reposition its products and make them more attractive for trade, while also aiming to reduce its emissions, and protect its biodiversity.

3.2.3. Climate impacts and perception:

A key observation from all officials interviewed is the difference in perception held by divisional officers and those in the state capital. An assumption could be that those most close to the areas with less infrastructure tend to understand the underlying issues more clearly compared to those with increased government presence and structure. Divisional officials observed changes in their

microclimate – prolonged drying (droughts), an increase in temperature and an excessive rainfall pattern, an incidence of pest and disease that are alien to their regions and varying patterns in production yields, crop physiology and characteristics. Some of these observations, they believe are tied to the climate, even though they say their knowledge of these phenomenon is limited. In some cases, they suggest that oral histories passed unto them from their parents suggest a change in climatic requirements for crop production and determining production needs vis-à-vis the climate has been highly unpredictable.

- Common themes on climate impacts and perception from the interviews local and state officials include:
- In Sri-Aman, local officials have observed double fruiting phases in durian fruits (between April – July, and another between Oct-Dec.). They explained that durian plants cropped in the same period sometimes fruit differently, thereby producing two-period harvesting and a possibility of fruit availability all year round. These changes in the timing of phenology which is controlled by climate – could be a sensitive biological indicator of climate change. Farmers in the area see this as an opportunity, alluding it to be a positive impact of varying climatic conditions. The farmers hint on taking advantage of price increase at production downtime, during durian off-season – as the second batch of durian vines mature. According to local officials, this is increasingly common in durian production which they believe is a result of changes in their micro-climate. Phenological changes in crops can be triggered by the onset of rainfall, or temperature reaching or exceeding a certain threshold, or the number of hours of heat or perhaps, a combination of all (Hatfield & Prueger, 2015). This implies a possibility that the varying climate conditions now being experienced could be a factor. Local officials also blame the frequency of drought and its associated dryness to open forest burning due to on-going expansion for settlement in neighboring Kalimantan, Indonesia on the Island of Borneo. They further explain that with the severe climate impacts, especially flooding experienced in Indonesia, the Indonesian government is making plans to relocate to its own territory on the Borneo island. A move, local officials expect will lead to rigorous expansion that will increase current levels of deforestation to a much higher degree in the coming months. Thereby, influencing the changes in the microclimate around Sri-Aman.

- Unpredictable rainfall, excessive rain – leading to crop damage- the wet monsoon normally starts around December-January but are currently being observed mid-year around May – June, affecting harvesting, flowering and paddy production which relies on a rainfed system.
- Yield drop in paddy and land competition with other crops like oil palm and rubber – paddy is increasingly been discarded for other profitable cash crops.
- Pest incidence in peppers is forcing a shift to small scale oil palm production.[10] Fruit rot disease have been observed in pineapples in Kabuloh, Miri which is soil borne and have been found to be spread by rain and through vectors like snails. The World Wildlife Fund found an incidence of the golden-apple snail pest ravaging wet paddy and the Tungro disease detected Bakalalan in Limbang – a lowland area, community-based program led by WWF and the DOA. Officials note that these pests are aliens to the regions where they are currently been detected.
- Rise in coastal erosion and or changes around the coastlines – receding coastlines was attributed to the excessive rainfall witnessed in Sarawak and corroborated by data from the meteorology department.
- Causal pessimism as one official noted "*Although we see these changes, linking them to climate change is still a challenge because we cannot say emphatically that they are linked, as we have our misgivings on what may be the actual cause."* Acknowledging their skepticism of what the actual cause could be. Another explains thus: *"flooding remains the same even when logging was minimal before the advent of development and we sought resources for expansion for settlements, income and the likes. Although temperature is observed to more intense these days. There's also delays in rains or monsoon - usually around October-February, we observed drying periods between October-February last year, however, its back to normal this year."* Another argument for deforestation – *"is why leave a green forest area with forest trees that are not productive instead of clear cutting*

[10] The general belief is that since oil palm can thrive in any type of soil providing there is a peak on fertilizer usage to boost yield. This signals a danger that points to incessant fertilizer use that could become a problem. If combined with small scale farmers behavior with bush burning (the cultural belief is that ash from the burnt area adds value to land – discounting the amount of carbon released in the atmosphere) and localized forest clearing, portends risks. At current levels, fertilizer application is around 200kg for 200 vines in 12 months.

the entire thing and replacing the land with more productive forest cover that can produce the needed returns for our state?"

At the state level, some officials have a more nuanced understanding of climatic change, a senior official at the DOA noted as follows in providing context to sea level rise: "*for a very long time and as we have seen from historical data, collected by the Japanese while conducting some work here [in Sarawak] regarding our sea level, the current level was far deeper than our current continental shelf – and from then till now our estimates suggests sea level rise from then has been around 5m."* In summation, state officials noted there's been change when comparing current coastline levels to those from past, they concede that it is obvious certain parts of the state have suffered coastline erosion. A senior official with some institutional memory, explained, that this change in coastline can be observed around the Miri region where rock embankments now stretch through the coastline to prevent more erosion. He explained that a detailed look will show that the coastline used to extend further out from where they are now --supporting the view on sea level rise. Nonetheless, looking further at different geological epochs he explained, the sea level rose and fell. In some epochs, the sea level rise was even more dramatic than it is currently – this view seems to attribute sea-level rise as part of the natural cycle as opposed to anthropogenic causes.

However, a lack of historical data remains a major challenge in measuring climate impacts in Sarawak; officials note that it is difficult to monitor how climate change has unfolded in Sarawak without comprehensive baseline or historical data. A sense of detachment noted within government circles during the course of the interview on the subject can be attributed to a lack of a general sense of knowledge regarding climate variations and its impacts. Sarawak has not witnessed a major shock or impacts that have threatened it, save for the usual flash flooding that is very common with the topography or exacerbated by human activities such as deforestation. For instance, the riverbank recession or inundation example buttresses this point. According to one WWF official, it took a community, close to a site where inundation have occurred continually, to be impacted for them to be propelled to call for action. There's also a sense of *"what is in it for us"* when there's an intervention planned in a certain location – quipped another official – "*People here are often very skeptical when they don't have a challenge threatening their way of life".* Another official put it this way: *– "look at our vegetation, it is lush green, does that mean we are*

impacted by the climate, we are confident it is not as bad as anybody thinks". – which invariably implies that an availability of lush vegetation is evidence climate impacts are not of significant consequence. Another official noted*: "why did you choose to study Sarawak, instead of other places with known impacts like Indonesia?* The above scenario shows that recent disaster experience as well as community wealth and population size are positive indicators to support planning in adaptation and resiliency (Berke et al. 2014). Most officials interviewed insist climate impacts are not significant in Sarawak. Others say it could be *"an act of God"* and some would rather not engage on the subject for fear of being misquoted or risk their career and believe the state is not in a dire situation in regard to climatic impacts. Overall, the sense is, climate related impacts are still relatively low and of no significance, notwithstanding the observed trends.

3.3. Farmer focus groups and interviews:

3.3.1. *Perception on climate impacts:*

Farmers interviewed across 8 divisions in Sarawak are unanimous in observed trends pertaining to their microclimate. Although their perception on climate change is low, they blamed their lack of access to media sources as a reason for this shortcoming. However, farmers indicated that they use the internet to find solutions to problems they seek concerning their production, which points to a lack of motivation to use the internet to increase their awareness on climate issues. A horticulture farmer in Sri Aman explained thus: "*you know our country is so different from what you have in the west. Although I know there is variations in weather, but our government is not saying anything about it and to that effect, we all think it's not a very serious issue".* While there seemed to be a lack of explicit interest in climate adaptation, common trends that emerged from the interviews related to climate include:

***Incidence of pest and disease exacerbated by higher temperatures*:** Farmers in Miri, Bintulu and Limbang noted they've begun to see inconsistencies in weather patterns, and it is no longer predictable. A farmer noted that, "*Excessive rain is a serious problem for us, pest and diseases too* – [points towards her field and signals us to follow along- she points at the damage to her ginger crops – rotting at the base of the roots]. In some areas, the incidence of pests has been made worse

by the use of pesticides in growing crops which invariably increases their cost of production and results in ground water pollution and GHG emissions.

Flooding: Excessive and unpredictable rains have been observed to lead to flooding and rising inland water level. Farmers bemoan the loss of crops and inputs such as fertilizers through flooding, leaching and run-off respectively – experienced after heavy downpour. Lack of adequate sometimes moribund infrastructure into inland waterways remains a problem. Floodgates in communities close to tributaries that link into inland waterways are particularly hit the hardest. According to farmers in these areas, the frequent flooding which dissipated sometime late 2019 destroyed farm access roads, damaged paddy rice, vegetables and some food crops. In some areas, this resulted in loss in yield and rotting in roots. In contrast, early rains from November, shed fruits immaturely – leading to low yields in citrus. This variation in rainfall have been noted to affect durian, *petai* and beans yields. In inland fish cultivation – flooding tends to overflow the area, causing aeration issues as oxygen drops. Some acknowledged impacts on yield in vegetable and in their observation started some 2 years ago impacting prices of vegetable as supply declined and demand on the rise. Wet paddy farmers suggest that the adverse impact of the flooding to their communities poses serious threat to their livelihoods. Some of the direct impact include dwindling yields, pest incidence, labor intensive, invasive species (like rodents), unpredictable weather and the lack of interest by their children and younger generation in continuing farming have resulted in a shift to more profitable cash crops.

Farmers believe human activities are also contributing to this problem. They blame deforestation upstream as the major cause of frequent flooding coupled with small scale farmers who are clearing forest lands for cultivation. In some areas in Mukah and Sarikei, as oil palm plantations sites are developed, flooding in the area becomes severe and leaving nearby farms waterlogged.

Skepticism on causal inference: Some farmers share the same skepticism as government officials on the causal inference of these changes to climate; one fish farmer in Mukah notes that he mistook poor management on his farm to be adverse impacts of climate variations. However, after undertaking principles of production management, he began to see better products. *"I believe I lacked good management practices in the production, I wouldn't say climate impacts affected me*

in that way, because, soon as I received training on fishery production, my production peaked." Another farmer with a fair knowledge on the climate says thus: "*I know it is too hard to predict, in the past weather was consistent, no extremes, but I'm not so sure what it is nowadays. But in following the trend, on what I hear socially, it's becoming very sunny and hot, excessive rainfall, I also hear about el-Niño and la-Nina – one brings more rain and the other more dryness. When there's a shift in climate around here, farmers tend to blame climate change – I'm not sure if that's the issue or if it's just because it is the new normal or fad to say these shifts are due to climate change that others tend to believe it."*. Others say, "*activities in the Indonesian Borneo is also cascading into our own territory", "Climate issues is from God, I believe he knows why all this are, so I believe solely is an act of God".* A paddy farmer in Sibu, believes climate impacts soil fertility but concedes his observations are merely assumptions and are yet to be corroborated by extension agents who serve them, although, he mentions families in the longhouse where he lives, who are farming paddy also have the same realities. Nevertheless, he sees change in paddy foliage and general plant morphology and attributes the change to the climate. Ultimately, some believe there's still a lot of land to be tilled – "*Due to our sparse settlements distribution, besides oil palm, you don't see an agricultural settlement – a lot of abundant useful lands are not been utilized."*

3.3.2. Adaptive measures

In the light of the various impacts necessitated by variations in climate, farmers have adopted several measures to boost their production. They explain that even though they lacked the requisite knowledge, they have simply adapted their production the best way they see fit until something better comes along. Some of this include changing planting dates and diversifying crop type especially for those whose greatest challenge is flooding caused by excessive rain. Several measures adopted across Sarawak are been summarized as follows:

Protected agriculture: One adaptation is the cultivation of high-value vegetables and other horticultural crops in greenhouses to grow cash crops on small plots in marginal, water-deficient/waterlogged areas where traditional cropping is not viable. In some cases, due to excessive rains, farmers have adopted the use of the left-over stalks to increase soil organic matter and keep moisture in place in the soil. The use of plastic sheets has become very popular amongst

farmers in Sarawak - to reduce water intake in soils to maintain soil moisture balance, increase yield, and create better quality in vegetables. According to another horticulture farmer, *"my farm gets water-logged when it rains excessively, so part of how we adapt our production is the use of shade nets to cover the entire plots – water from rain still get in but we have reduced it to amounts we can control effectively."* Plastic sheeting has also been effectively employed for weed and pest suppression, for example, to combat the fruit fly in vegetables and peppers. According to a farmer in the Kubuloh experimental station in Miri, he noted that *"the extension officers sold the idea that it was great, and it is also easy to use." I am also willing to adopt new technologies like the plastic sheets if it will be beneficial for me.*

New technologies for adaptation:

i. Hydroponics: is a growing form of gardening in Sarawak. It uses no soil, but instead grows plants in a solution of water and nutrients. *For example, I adopted the hydroponic system because of issues like long droughts, change in planting dates due to weather, long rainfall patterns and early last year droughts. I learnt it from another user and from my experience, it is easy to use, efficient and I don't worry about the weather."* According to farmers, new systems of production enhanced their productivity and assures the availability of crops all year round.

ii. Aquaponics: the combination of aquaculture (raising fish) and hydroponics (the soil-less growing of plants) that grows fish and plants together in one integrated system. This system allows the use of substrates from plants in the place of using soil. Farmers in Bintulu are taking advantage of an experimental private farm to learn the use of this system.

iii. New varieties of pineapple (MD-2) has been developed and are increasingly being cultivated in Sarikei and Mukah. Its major attributes include its ability to thrive in high elevations; it can also be planted in peatland (which makes undesirable marginal lands useful), has greater shelf life, and is sweet in taste.

iv. Open fertigation: Used in horticulture production for chili peppers and vegetables: this method was adopted as a measure against unfertile soils, areas that lacked land resources and is gradually gaining acceptance – substrates used include burnt oil-palm shrubs and coco peat – which reduces the incidence of pest and disease and

farmers are currently experimenting with its viability in the cultivation of tge Carolina ripper variety. The systems are easy to use, fertilizer usage is managed efficiently.

v. The use of System of Rice Intensification: WWF employed the use of System of Rice Intensification to aid farmers in Baklalan, Limbang to aid water-use efficiency in areas lacking water, manage fertilizer and chemical utilization to improve sustainable production. The system adds value to the ecosystem services such as the provision of clean water for irrigation, by minimizing upstream land use changes such as unsustainable logging or large-scale forest conversion to agriculture.

Diversifying to more profitable crops: Farmers concede that oil palm generates more revenue than most crops which they believe is the greatest attraction. They maintain that the crop of oil palm has an ability to generate as much harvest than any other crop and it can withstand of flooding and can grow on any soil. Oil palm according to these farmers can withstand a continual logged area for up to 3-4 months which makes it well suited for flooded areas. In some cases, paddy farmers are making the shift to be sure of a regular income and reduce disruptions caused by invasive species and low yields.

Flood resistant crops: There is an increased diversification to flood resistant varieties in flood prone areas. Crops such as *Kelatak* – which withstand flooding are increasingly cropped. Others include flood resistance vegetable varieties like *aubergine* (eggplant).

3.4.Unintentional adaptation strategies:

The government of Sarawak state does not have explicitly themed adaptation and mitigation policies or programs. However, the government has taken proactive steps in institutionalizing certain programs to address conservation, sustainability and vulnerability. State and local officials explain that state priorities are increasingly adapted to meet the United Nations sustainable

development goals[11], the Malaysian 11th and the soon-to-be-published 12th Malaysian National Plans are major determinants of government priorities. These priorities are focused on economic, social well-being and the environment–incorporating the sustainable forest management aspects of the Malaysian 11th National Plan. New questions then arise as to why state officials emphasize Sarawak's autonomous status in regard to the new climate policy, especially as they continue to provide inputs as part of its planning process. When engaged on the subject, state officials refer to the autonomous nature of Sarawak as the guiding principle on what plan is adopted. They also emphasize how state control on key sectors (such as land and soil conservation, rivers, water and forest resources) is paramount. There have been no concrete norms on how to fuse institutions like in this example, state and federal entities working on the subject together in such a way that reflect different thinking in disparate contexts (Birkmann and von Teichman, 2010). This may be the reason for the institutional behavior being witnessed in Sarawak as officials may be weighing the difficulties in effectively linking to national policy when it comes to climate adaptation. State officials may be inclined to believe that a full-scale resource allocation, planning and implementation as well as economy stabilization that a climate policy favors may put their own functions at risk (Forino et al. 2015).

The programs currently mainstreamed in the forestry, environment and agriculture (see table 6, Appendix III) focus on rigorous certifications aimed at good agricultural practices, sustainability and biodiversity conservation and are likely to be more operational. These programs, which were born as a result of trade competitiveness in the oil palm, forestry and agriculture sectors have found an unintended use. In response to international criticism on ecosystem sustainability and biodiversity conservation (and to encourage productivity in the agricultural sector), the state has adopted a number of programs to address these issues. Issues ranging from indiscriminate use of chemical fertilizers and unsustainable ecosystem management in large scale oil palm plantations and in small holder production to disastrous farming practices like slash and burn, including forest clearance are still allowed in smallholder communes despite NREB regulations and exacerbate climate impacts. While not the intended objectives when they were instituted, the resultant

[11] United Nations. 2015. *Transforming our world; the 2030 Agenda for Sustainable Development*. Resolution adopted by the General Assembly on 25 September 2015.
https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

outcomes of forestry, environment and agriculture programs (Table 6, Appendix III) directly provide adaptive and mitigation outcomes. These outcomes include reducing GHG emissions, enhancing the resilience of natural systems to flood risk and drought damage, and combating the incidence of pest, disease and weeds. The programs also reduce yield losses and boost crop diversification and protect soil and water quality including social considerations for those who depend on forests for livelihoods (Lovejoy, 2005; Uphoff, 2003; Hauser and Norgrove, 2013; Agyeman, 2019).

3.5. Differences between government officials and farmers:

Proactively, the Department of Agriculture's divisional offices have delineated areas in partnership with the Lands & Survey Department that have been deemed suitable for farming and have less risk of flooding or water logging. Local officials say farmers who cultivate on their own lands without guidance from the department or local agricultural divisional offices do so at their own risk. It is designed so that crops are planted in areas suitable areas for growth, taking into consideration biophysical properties of soil. The areas of disagreement between farmers and local and state officials center around the quality of infrastructure and support available. Officials say, for example, that floodgates have been provided by Department of Irrigation and Drainage in coastal erosion-prone areas like Samarahan and Sri Aman divisions where there is known re-occurring inundation. However, farmers in inland coastal areas with derision dispute these positions. They cite decrepit floodgates and road infrastructure that have been heavily impacted and damaged by flooding over the course of 30 years and can no longer stop the flow of tidal waves to prevent flooding in farmlands and homes. Flooding infrastructure in communities experiencing flooding and waterlogged farmlands in Miri and Sibu (once with functional floodgates) are in need of repairs. These communities are forced to resort to waiting until the flood recedes before resuming production, most times after crops have been heavily devastated.

Interview results indicate that farmers and officials perceive climate impacts differently. This is probably because most farmers are located in places with little or no infrastructure and experience climate impacts in their operations. They see and understand the impacts of extended flooding and waterlogged farmlands and have more insights into the required infrastructure that could address their needs, such as floodgates and rural access roads infrastructure. Local officials, on the other

hand, believe that once requisitions are completed and delivered, the problem is solved. This suggests a significant disconnect between the communities and the agencies that serve them. Farmers generally claim that since they receive guidance from the DOA and there is no mention of climate impacts or adaptation in that guidance, farmers do not perceive it as a problem, unless otherwise stated by government officials.

State officials on the other hand adjudge the climate issue on the severity of previous disasters. They believe that although, the notion of climate change exists, the state is immune from adverse impacts. They cite lush vegetation in its domain as proof and dismiss credible criticism of unstainable practices in its forest management as erroneous exaggeration. An absence of a severe shock over the years, even though obvious signs of an impending situation abounds - keeps this confidence going. This attitude has allowed officials an avenue to skate the issues without consequence. The same argument goes for localized forest conversion and slash and burn, which remains a contentious issue. Even though government officials claim this activity has been banned (where people can only get permission to do so through NREB in some instances) open burning still thrives as a practice. It is allowed for farmsteads held by smallholders usually around 1-3 ha as stated in the NREB policy (see table 6, Appendix III) and farmers alike see no issues with this. A farmer noted: *"Government is retaining burning for small-scale producers and cutting down on commercial conversion of forest trees. But as you can see, enforcement can be difficult."*

3.6. Government's role and support to farmers:

In concert with other government agencies, such as DOF, DOE, the DOA is implementing the following programs and schemes TKPM, TAGANG (see table 6, appendix III), agricultural input subsidies in crop production, and fishery and post-harvest support. The DOA also leads on land preparation: infrastructure development – access road provision, electricity, water, and irrigation with the DID. According to state and local officials, the government provides support at collection centers, by providing quality control certification, contract farming, and support to producer boards and farmers marketing organizations. The DOA provides capacity building in post-harvest phases, and advisory services to farmers on testing new production systems, for example, interplanting in oil palm plantations using vegetables, pepper and watermelon. This is aimed to help small-scale farmers diversify their production and de-incentivize mono-cropping. The DOA agency also led

the research and development of the new pineapple (MD-2) varieties with significant benefits for Sarawak agroecology.

The DOA conducts disaster and flood monitoring and pays claims to farmers in that report damage in the aftermath of a disaster. For example, a local farmer, in Sarikei who also doubles as a key member of the local farmers group noted that top-up money is provided to them after disasters. *"Government gives farmers some money, after you report damage following a disaster, the damage must be reported to the district officials who then come to the farm and inspect the damage".* He also said that the turnaround time is lengthy, *"almost a year after a claim has been made and verified, sometimes, farmers make another report, while still in the process of receiving the penultimate one."*

The government through the DOA is implementing protective agriculture techniques to reduce impacts of excess rainfall, reduce the incidence of pest and disease and also manage horticulture production with the 'internet of things'[12]. However, some farmers argue the "*initial cost of adoption of these systems remains high – the direction was for crops produced under such conditions must be high value to meet the required return on investment"*–as noted by one of the pilot farmers in Bintulu. The stipulated guidance provided by the DOA is that a farmer must have farming experience, where some investments and costs to the farmer must be seen and evaluated before signing on. State and local officials argue that since these programs are output based, the criteria must to be able to screen out those that do not meet the necessary requirements. Local DOA officials maintain that farmers in the area are so poor that some cannot afford to establish the basic infrastructure for agriculture and the success rate of these farmers are often low. Additionally, available funding is limited only for those who are in a form of production already[13].

[12] IOT- internet of things – state actors refer to the use of automated systems in fertigation as IOT

[13] The program obviously excludes several poor farmers who don't have the requisite capital to make investment in a venture of choice. Although, another program the 1-AZAM program was jointly run by the welfare dept and DOA was cancelled at the outset of the new administration in Malaysia. The program linked promising beneficiaries with skills in agriculture to help them build skills and develop an agricultural production enterprise. Officials argue that such poverty alleviation schemes aren't what the current program intends to fulfill. In the absence of that, a social intervention program will be necessary to integrate these farmers who are displaced as a substitute until they can measure up with skills and capital to join govt. schemes and a farmer register becomes imperative to target beneficiaries for social programs such as an input subsidy.

The DOA leads all implementation and argues they remain in direct contact with farmers. Although there remains a divergence of needs regarding requirements in certain communities. For example, one local partner explained: *"While working with a community focused on developing alternative systems of production that uses no synthetic fertilizers, our farmers kept receiving fertilizer input from the government input program– it just littered their storage room and was a complete waste as they wanted none of that."* In this case, there was no data to distribute supply to only those who needed it, and, in some places, farmers received none at all because they were unaware of the registration process or the divisional units lacked logistics to reach certain groups of farmers. When asked, local officials suggested enthusiastic farmers will seek them out information on government programs and noted that logistics to some interior longhouses can be cumbersome.

3.7. Conservation, Adaptation and Mitigation:

The changes in biological and physical components of the environment as identified by farmers and local officials is consistent with the summation by Savo et al. (2016) and Wolfe (2013) who noted changes in temperature, rainfall and in managed ecosystems as observed climate impacts in the region. The most frequent observed impacts of a changing climate are decreases in crop production and or quality, crop and pest diseases, and declines in crop yields where agriculture is dependent on rain-fed systems (Savo et al. 2016). Multi-sectoral linkages observed in the several programs currently being implemented among agencies like the DOA, DOF, DID, NREB and the SPU collaborating on a national policy demonstrates a better integration already at the core of Sarawak state, even though the current strategy requires strengthening and more closely linked themes as well as more effective institutions. The current thinking as adapted in current programming lies at the core of integrating systems, institutions and sectoral units in defining details needed for streamlining CCA (Birkmann and von Teichman, 2010). The arrangement as exemplified in the programs being implemented in Sarawak (see table 6, appendix III) captures a conceptual governance framework for CCA integration as described by Forino et al. (2015). These include partnerships between state and social actors (WWF), multi-agency collaboration, strategies, polices and plans, and community-based initiatives (e.g. Tagang eco-tourism) with vulnerable groups e.g. Gahara Mayang Sanctuary project – a natural habitat eco-system-

mangroves conservation in collaboration with an Iban community that aims to foster community ecosystem management.

The trade-offs from the current programs being implemented in Sarawak demonstrate an adaptive strategy that is well suited as an entry point to developing state adaptation plans. The adaptive strategies that those programs promote include crop diversification, the use of flood and drought resistant varieties and improved pest and disease control. Consequently, the mitigating measures include reducing GHG emission by adopting SRI techniques, efficient use of inorganic fertilizers, reducing or minimizing slash and burn to increase crop residues, reducing soil tillage to slow organic matter decomposition and retain and incorporating crop residues that boost soil health and fertility (Wolfe, 2013; Wolfe, 2019; Primitiva, 2018). However, some of the constraints to adaptation highlighted by farmers corroborates Wolfe (2013 pp. 15). The Tagang system currently mainstreamed statewide, promotes community stakeholder engagement in communities that are at risk of climate impacts so that they are managing their own immediate environment (Chandrasekhar et al. 2014). Engaging such communities as is done in the Mayang Gahara Sanctuary project can help "fill gaps and broaden consistency in observations made by local subsistence-oriented communities and reinforces their value where instrumental data are unavailable". (Savo et al. 2016, pp 470). A community-based approach also enhances social cohesion and social capital among members in a community.

According to Wolfe (2013), conservation agriculture and sustainable development are closely linked. Conservation is an example of the synergy that can be derived from "agronomic solutions to climate change adaptation and mitigation, and environmental protection, sustainable development and human well-being" (Wolfe, 2013 pp 24). A new study which synthesized studies[14] on conservation in South Asia showed positive contributions of conservation practices to the Sustainable Development Goals of no poverty, zero hunger, good health and wellbeing and climate action (Jat et al. 2020). The authors found that conservation practices such as those as

[14] The study reviewed several agricultural, economic and environmental performance indicators—including crop yields, water use efficiency, economic return, greenhouse gas emissions and global warming potential—and compared how they correlated with conservation agriculture conditions in smallholder farms and field stations across South Asia.

instituted in Sarawak had significant benefits for the economy and environment. The study noted that the mean crop yield average of 6% using conservation practices, provided farmers with 25% more income and increased water use efficiency to about 13% compared to traditional practices and cut global warming by 33% (Jat et al. 2020). Ultimately, the strategy by Sarawak that is geared towards conservation and sustainability is well intended for climate adaptation and mitigation purposes and can be transformed in a more encompassing manner and scaled to benefit more people across the state.

CHAPTER 4

RECOMMENDATIONS AND CONCLUSIONS

4.0. Towards a Comprehensive Adaptation Strategy

4.1.1. How national climate adaptation policies and strategies, along with the above-identified livelihood activities, align in design and implementation:

In pursuing other goals for sustainability and conservation for their environment, the government of Sarawak is indirectly building climate adaptive capacity through its current projects. Thus, it is especially important to pursue a well-coordinated and balanced strategy that takes scale and depth into consideration. Such a strategy would require that the government build on it current programs especially for new projects within the nexus of agriculture, environment, NRM, forestry and biodiversity. In the preceding sections, the following factors identified as influencing elements may hinder the adoption of an articulated adaptation strategy and must be taken into consideration when designing a comprehensive adaptation strategy. As identified in this study, personal experience and the proximity to or frequency of climate impacts are essential to understanding actual and perceived variations of climate impacts and must all be properly assessed.

The UNFCCC guiding principle supports the needs for adaptation to be based on the best available science and appropriate traditional and indigenous knowledge (UNFCC, 2010. Para. 12). This pragmatic approach suffices especially when the government engages actors such as the UNFCCC and subjects itself to binding resolutions on actions, but it is also imperative to engage citizens in the underlying impacts through sound contextual policy and implementation. The observed climate change skepticism from the top has its own cascading effects on those they govern. When state officials view “erring on the side of caution” or adopting proactive measures as a threat to their positions or a disruption to resource allocation that impacts them, they inadvertently promote the understanding that climate impacts are not urgent concerns - a belief that is untethered to reality.

In designing these strategies, governments must pay particular attention to contextual acceptance and issues around cultural differences. With these realizations, although difficult, it means more work is needed in determining new programs that benefit different categories of individuals and households. Indigenous knowledge has its benefits in contextual framings of an intervention but must be scrutinized along with other forms of knowledge. Additionally, the role of science must not be misconstrued as taking the place of this knowledge base or dictating terms of an engagement. It must be viewed from a place of new knowledge that has an ability to improve outcomes if managed efficiently and used in concert with indigenous knowledge. Further, it is important to share in clear terms what practices may be a net negative or positive in boosting prosperity and shared outcomes. Consequently, aiding and abetting cultural practices that are detrimental to the environment, such as slash and burn in swidden agriculture or NREB codes in smallholder communes, must no longer be overlooked due to political exigencies.

Nations around the world, especially in developing countries, continue to grapple with the impacts of climate change. Challenges include constraints in reaching poor resource communities, especially those excluded in current programs unable able to meet the DOA set criteria. An “all hands-on deck” approach can be applied by assembling stakeholders with mutual objectives and goals as a workable alternative. These stakeholders, including non-governmental organizations, whose organizational priorities match those of state government development, can collaborate to find workable frameworks to pool resources and prioritize objectives. There are gaps to be filled in all strata of agricultural development in Sarawak, which means partnerships must be encouraged. The GoS must recognize the deep environmental knowledge of those communities, farmers and forest users who live in these areas. Over the years, farmers and small holders have managed their livelihood in the same ecosystem and can offer insights and guidance on the predictability and variability of their immediate climate and local environment.

In determining how the agricultural suitability maps were developed by DOA in collaboration with the Land Survey office, it is noteworthy that community inputs were not sought in the process. Although aided by technology and previous government records (devoid of evidence-based data on crop viability), the Land Survey Department conducted the delineation, according to local officials. State officials at the DOA merely passed any questions on the subject to the Land Survey,

even when directly linked to an area in which the DOA had purview. The lack of coordination between sectoral actors will make any climate policy implementation difficult. It was revealing to see that the SPU takes the lead on developing sectoral master plans, for example, in agriculture, and coordinates with the sector under review (in this case, DOA). The argument is that because the SPU guides state priorities, it should take lead on such specialized sectors such as agriculture. This approach discourages cross sector collaboration and leads to redundancy in ownership of plans by the executing sector.

It is important that sectoral actors lead their own policy development with the SPU providing state guidance at every level in such process planning. That way, the sectoral unit takes ownership of its own policy development and in its execution. In the event of failure, they can self-evaluate and identify mechanisms to make corrections. In the current approach, for instance, state officials at the DOA couldn't provide information on its sector adaptive plans and directed questions on future departmental programming to MANRED – who leads on policy and the SPU whom MANRED coordinates with. Questions on the agricultural suitability maps posed to local and state officials (which are needed by the DOA to direct resources or implement programs) are directed to the Land and Survey Dept. This department (land survey), although lacking technical expertise on agricultural development issues, can affect decisions in the agricultural sector. This suggests a disconnect in program management and a lack of collaboration between agencies working in cross-cutting areas in developing encompassing policy options. The same situation was observed in the provision of rural infrastructure to coastal communities where local DOA officials could not provide answers on the timeline regarding completion of rural roads or the maintenance of floodgates and merely directed questions to the DID. In analyzing CCA policy development in United States, Smith et al. (2009) identified an "adaptation architecture" fundamental to facilitating successful governance of adaptive action. This architecture, according to Smith et al. (2009) includes: providing clear governance structure, enabling coordination between agencies and departments, incorporating mainstream climate considerations into daily decision making, integrating new funding for adaptation into baseline support for climate-sensitive sectors, addressing institutional and policy barriers to adaptation efforts, and involving stakeholders in policy development and implementation (pp. 53-61).

4.1.2. Farm-level adaptation strategies employed in the identified livelihood activities and the limitations on accessibility, adoption and use of these strategies:

In Sarawak, farmers are adapting production according to their view of changing climatic conditions. Although the government, through the DOA, is mainstreaming the use of protected agriculture, the scale of adoption is still relatively low. Anecdotal evidence on adoption, according to state officials, seem to rely on small pockets of replication of the system across the state by farmers and private gardeners without much technical knowledge as success. Prominent strategies include protected agriculture systems and new technologies explored in 3.3.2 – adaptive measures above. Some of the constraints to adoption include the associated costs of materials used in the protected agriculture, which are not locally sourced and are expensive. Some farmers suggest that a government-operated technical forum, combined with experimental stations like the TKPM can become a helpful model to train farmers.

In the last decade, advancements in information and communication technologies (ICT) have translated to better agricultural production outcomes. Without a doubt, other challenges have also arisen, which are proving to be more impactful to agricultural production. These challenges, such as weather and climate variability, pose a serious threat to food security and livelihoods in many parts of the world. To address this challenge, scaling the use of ICT has now become imperative to keep food security levels optimal. ICT, as with every intervention, must seek to tailor needs contextually and can be achieved by categorizing tech-type by usage and sub-sector to employ such technology. The technology options must be easily accessible and practical. Large scale options like remote sensing and geographic information systems (GIS) can be adapted to improve farming decisions and planning for local communities and be delivered by government or the private sector depending on each context. GIS as a tool can take the form of policy used to delineate areas suitable for agricultural production as observed in Sarawak but must be organized in a manner that links communities to spatially based planning processes. Options must also be inclusive and participatory to help drive their uptake with the use of demonstration sites, financing, peer trainings and exercises.

The strategies discussed above and employed by farmers will require more support beyond the farm according to Wolfe (2019). The author notes such collaboration should focus on delivering climate change science and information to farmers, providing them with seasonal climatic forecasts and incentives for adaptation and the availability of climate resilient crop and livestock varieties. The economics of climate change and adaptation strategies must also consider the costs of adaptation in high value crop production. Financial issues were identified as a major constraint on climate adaptation by farmers in the study for example.

4.1.3. The relationship between awareness of impacts of climate change and the attitude towards the type of adaptation strategies adopted:

Farmers across Sarawak blame the lack of knowledge on climate change adaptation on the government, noting that the government has barely broached the subject. This attitude has largely informed farmer response and perception to climate impacts where they adapt their farm production needs based on changes in the amount of rainfall, incidence of pest and diseases and dwindling crop yields. Some farmers concede that excessive rainfall and soil moisture disrupting their production has made them seek alternative strategies that can ameliorate high soil moisture and crop destruction. Their general perception of the climate impacts was as a result of peer engagement, personal research, and social networks, which influenced the type of adaptation strategies they currently use.

Demski et al. (2017) found an increased concern about climate change following flooding experiences in the United Kingdom, which not only influenced their type of adaptive measures, but increased their need to take mitigating actions. The authors further suggest that in communicating the relationship between climate impacts and disasters, policy makers must face the hard choices of making the link between weather and climate where appropriate. The flood situation in Sarawak comes with the territory -its location on the coast. However, the increased frequency and severity points towards urgent action against climate impacts. Acknowledging potential vulnerabilities in their communities is an important first step and farmers are “trying out several methods to stay resilient” (Interview, January 11, 2020). The GoS can support farmer

adaptation efforts by using this as an opportunity to engage farmers more through the local agricultural divisional offices to gain valuable insight into how these farmers and their communities interact and share ideas. This engagement can be conducted in such a way that farmers are able to communicate their needs effectively. According to Nyong et al. (2007), it could serve as a platform to work collaboratively work with farmers in diverse communities - documenting what strategies can be improved, financed and scaled to other communities. This approach places value on indigenous knowledge and can complement evidence-based approaches to produce best approaches for mitigation and adaptation (pp 795). In determining the types of adaptation strategy that may be appropriate for communities around Sarawak, documenting the success of current programs (see figure 6, appendix III) provides an entry point. The inclusion of a monitoring, evaluation and learning mechanisms through a knowledge management process can help highlight each strategy on the merits of its suitability, accessibility and use. The relationship between adaptation strategy chosen by a farmer and what is readily available to ameliorate impacts of climate as suggested by farmers in this study, is a key component in assessing what method they choose. This decision lies ultimately with the producer (which in this case is the farmer) in the context of their prevailing economic conditions, institutional, regulatory arrangements, existing technology and social norms (Bryant et al. 2000). This implies that the type of programs currently mainstreamed by government, within a farmer's environment, can influence farm production practices (Hucq et al. 2000). This explains the anecdotal evidence observed by state officials regarding the replication of its protected agriculture model across the state. The success of the model will depend on the appropriate technical skill component deployed to help new users navigate this new practice through education and incentives (Hacq et al. 2000).

4.2. Recommendations for Developing an Adaptation Strategy

As stated above, in developing a comprehensive adaptation strategy, factors to consider include a clear institutional organization, identifying all stakeholders that are likely to use different adaptation options or strategies, proactive provision of climate information to farmers and an analysis of the constraints to adaptation. The actual strategies to be adopted are premised upon an appropriate technology development and diffusion and research that aids its use and sustainability.

To achieve all of this it this research suggests that the GoS to adopt the following recommendations:

1. ***Adopt a Climate Smart Agriculture (CSA) Program:*** The implementation of CSA practices, technologies and patterns have a significant effect on reducing climate impacts in agriculture. The adoption of CSA practice supports climate change adaptation planning by adopting options that can be localized in any context, taking into consideration climatic shocks and prioritization by farmers in that area (Khatri-Chhetri et al. 2017; Scherr et al. 2012; Lipper et al. 2014). These options can sustainably increase productivity, enhance resilience, reduce GHG emissions and explore the synergies between the three pillars of productivity, adaptation and mitigation (Ukaejiofo et al. 2018). CSA promotes collaboration between stakeholders who do not necessarily work together; fosters coherence between climate and agricultural policies; increases local institution effectiveness; and links climate and agricultural financing (Lipper et al. 2014, Ukaejiofo et al. 2018). CSA will help GoS conduct critical analysis of on-going and promising practices as identified in the state (Table 6, Appendix III) and the institutional and financial enablers for its adoption. It will provide the state with a baseline to initiate discussion and an entry point for climate adaptation strategies going forward. CSA practices are those field and farm practices that are increasingly adopted in a changing climatic environment and they differ across different agro-ecological areas. In developing a CSA program, the following actions should be prioritized:
    a. Pilot Farmer Registry Statewide: Only targeting agricultural subsidy inputs to those who need it will generate enormous benefits. The GoS cannot continue losing public resources by providing scare resources to those who do not need it. A careful evaluation of the data from such a registry will direct resources equitably and efficiently. Better targeting can have immediate impacts in terms of reducing extreme poverty and re-orienting investments in ways that directly benefits the poor and vulnerable.
    b. Review State Policies: In consultations to support CSA programming, state policies regarding climate and agriculture will be evaluated for coherence. In doing so, policies from the NREB, DID and Land Survey that connect to the agriculture sector will be evaluated to achieve institutional linkages to promote sectoral coordination.

c. Streamline Institutional/Policy Governance: Legislations need to be reviewed in the context of institutions, actors and sectoral work programs. The focus should be on evaluating roles and responsibilities and assigning them accordingly to remove the ambiguity of reporting lines while ensuring ownership by the individual ministries, department or agencies (MDAs) of government and cross-sector collaboration to realize synergies.

2. ***Provide farmers with climate information and deploy Early Warning Systems:*** Key investment and supporting infrastructure for climate and weather forecasting exist in Sarawak as well as the capacity of officials to manage operations and maintenance. It is important to deploy a platform that takes advantage of the existing environment to transform Early Warning Systems (EWS) into action so that it guides preparedness to floods, droughts and other weather-related risks. The MANRED and DOA should consider integrating EWS as part of an extension advisory program and ensures it positions itself to implement and mainstream preparedness for adaptation.
3. ***Use Knowledge Management to document regional specialization in agriculture:*** As stated earlier, the agricultural suitability maps suggest proactive thinking to ensure regional specialization and crop diversification as a key government priority. As this policy favors regional and rural livelihood transformation, it is important to include a Knowledge Management system that documents and curates' key results statewide. The analysis should cover critical components of key decisions and crop suitability (including climate and weather risks). It is useful for planning, as information about actual and potential climate-change impacts can be of considerable benefit to land and natural resource managers in informing and refining decisions in the sector.
4. ***Include biodiversity and wildlife to adaptation process:*** Sarawak boasts a diversified biodiversity that includes wildlife and forests and there are also indigenous communities that rely on those resources for their culture and livelihoods, so it is imperative that this aspect of the landscape is taken into consideration in any adaptation planning process. As the impact of climate intensifies, the needs of wildlife and humans continue to compete with one another. Mainstreaming the EbA strategy already in place in Sarawak can help account for the role of ecosystem services in human adaptation in equitable and

participatory ways. It reduces long-term pressures on natural systems on which humans depend, as the Gahara-Mayang project shows and provides a template to be explored.

4.3. Limitations of the study:

As with any type of qualitative research, the generalizability of these findings is limited, however the applicability of the findings to similar communities is something to consider. The author was able to achieve diversity in terms of geographic location and types of agricultural livelihood activity, making the study results relevant to communities grappling with similar issue and contexts. I believe that the results are relevant to farmers and government officials working in the agriculture sub-sector. I attempted to minimize any potential effects of my own bias by adhering to the interview guidelines as strictly as was reasonable in a qualitative study. In this qualitative study, state officials and farmers' perceptions of climate-related production risks and its characteristics were measured by self-report. This study might have been strengthened by obtaining feedback from a wider sample of interviewees consisting of indigenous communities, forest users and other government ministries as well. Finally, this study is limited by time constraints and logistics to reach other divisions. Because of this, I am unable to conclude that the characteristics that emerged are specifically associated with the lack of an adaptation strategy as depicted in theory. However, I report the characteristics that emerged strongly and consistently among a diverse sample of farmers in the identified agricultural livelihood activities and with local and state officials in nine divisions across Sarawak state. Furthermore, these characteristics are consistent with those observed in other studies on developing adaptation plans or constraints in adopting adaptation strategies more broadly.

APPENDIX I

Part I:

Initial Semi-Structured Interviews/Focus Groups with Farmers

Goals:

- Obtain preliminary farmer views on weather variations including intensity and duration including information (past and present) about weather as it relates to on-farm impacts.
- Document perceptions of patterns and trends in the weather and views on climate change
- Learn about types of adaptation options available to farmers and what adjustments have been made in farming decisions.
- Learn about the types of support that have been provided by external agents, what improvements to the current support they may require and any barriers to adaptation.

[interviews conducted in Malay, English]

Agricultural livelihood:

- Which type of agriculture activity do you practice?
- How long have you been farming?
- Could you describe where your farm is located?

Weather variations (Temperature, Rainfall patterns, intensity, and duration):
Have you noticed any weather variations that vary from normal? Is there a pronounced pattern in the last 5 years, 10 years or is there some historical trend you've witnessed, say your father (if family farm)/fellow farmer and colleagues talked about? What is happening now, that was like an anomaly few years ago? Please tell me about it.

- When did it happen?
- How long did it last?
- How did it affect your crops and farm or production?
- What was the economic impact? Positive and negative impacts?
- How will you capitalize on these opportunities or positive effects in future for better farm productivity?
- What was the impact on you and your family?
- Have you made any changes to your farming operation based on these changing patterns? If so, please explain.
- How do you plan for the next crop? What information do you use?
- What do you think causes these weather variabilities?

Drought and Weather Risks:

- Have you heard of the term "climate change"? If so, what do you think of climate change?
- Can you share your current farming practices?
- What adjustments have you made to your farming practice in response to these

variations? Why is that? For rainfall? For temperature?

- What are the biggest risks or concerns to your farming operation related to the weather, flood, drought, and natural disasters? How well prepared do you feel about these risks? What do you need to reduce the risk?
- How do you consider the vulnerability and risk level of your farm production to incidence of the following climatic related factors? Is it high or moderate?

Technology & Networks:

We are interested in learning how you currently make decisions about your farm and what information you take into account.

- What information sources are you currently using for the weather (as it relates to your farm)? What is the quality of the information? Is it telling you what you need? Why or why not?
- How are you notified when a heavy rain is coming or a change in temperature? How do you get emergency alerts? How do you keep in touch with updates on the flooding/drought status?
- How is the information transmitted?
- Are you in constant contact with peers and other Farmer organizations?

Adaptation:

- Do you receive any support from government, dept of agriculture? If yes, can you describe this support?
- Do you have regular interactions with extension agents from the department of agriculture concerning adaptation plans? Are other farmers also consulted? Do you think they can support/do more? If so, what would be helpful?
- What type of adaptation methods have been adopted or are currently being mainstreamed with farmers?
- What are the most important services, investments, or developments you would want the government/community/NGOs, or the private sector to provide in your efforts to adapt to changes in climatic conditions?
- Are there any other types of climate adaptation support from external sources? From where? What type of support do they provide? How do you receive this support? How long has this support been ongoing?
- What were/are the major constraints or difficulties in changing your farming practices?

Additional thoughts:

Is there anything else you would like to share with us?

Thank you for speaking with us. [Leave behind contact information]

APPENDIX II

Part II:

Initial Semi-Structured Interviews/Focus Groups with Government agencies/partners stakeholders

Goals:

- Obtain information on climate vulnerabilities and the process of policy planning including interactions for those whom policy is intended for.
- Document the main thrust of government policy if it is solely intended for productivity, mitigation or adaptation and the type of support provided to farmers in different livelihood activity.
- Learn about types of adaptation plans currently being developed and available to farmers and if there are certain barriers to adaptation.

[interviews conducted in Malay, English]

- Please tell me about your position and the work that you do.
- Can you share a list of current climate policies in place or being enacted?
- There's a new climate adaptation policy to be unveiled in 2019.
    - What is the status of that policy?
    - Which agency is taking a lead on it?
    - Who was consulted in the development of that policy?
    - Were farmers and external stakeholders' part of the process planning. Why or why not?
    - Are there specific issues these policies are intended to address?
    - Is the main policy thrust focused mainly on either productivity, mitigation or adaption? Is it on all three? If not, which is the focus?
- Have you witnessed any concrete outcomes on any policy? How do you measure outcomes of this policy? Do you have established feedback channels to measure impacts?
- What kind of information has your agency/organization been compiling with regard to (e.g., disaster impact assessments, vulnerability assessments)? Who is conducting these assessments?
- What have you identified as the major barrier to climate adaptation?
- What do you consider as gaps in adaptation policy planning process?
- Can you share the process of policy planning, who are involved? What are their contributions and target outcomes? Are there plans to get more participation? What are the challenges to getting more participation? Are indigenous communities' part of the process? Why or why not? If yes, which indigenous communities? Can you describe their participation?
- Are there challenges to policy monitoring and or compliance? What are the various challenges associated with this? If yes, what are these?
- Is there a feedback mechanism to manage concerns regarding adaptation policy plans?

Additional thoughts:
Is there anything else you would like to share with us?

Thank you for speaking with us. [Leave behind contact information]

Obtain informed consent orally:
I am Rex Ukaejiofo, a Master of Professional Studies in Global Development student, from Cornell University in the United States. I am conducting a study on farmer adaptation strategies, and I would like to ask you some questions about that. I would like to tape record our conversation, so that I can get your words accurately. If at any time during our talk you feel uncomfortable answering a question please let me know, and you don't have to answer it. Or, if you want to answer a question but do not want it tape recorded, please let me know and I will turn off the recorder. If at any time, you do not want to participate in this study please tell me and I will discard the recording of our conversation. The results of the conversations with farmers like you will be used in research. We occasionally share photos in presentations, on social media, or with funders of our fieldwork. If you prefer to not have your image used in research, in presentations, and on social media please let us know as you can consent to research, photos, or both. Now I would like to ask you if you agree to participate in this study, and to talk to me about climate adaptations in your work. Do you agree to participate, and to allow me to audio record our conversation? May we have your permission to take and use photos? If you have any questions, you can contact me (Rex Ukaejiofo) (I will leave behind contact information).

APPENDIX III

Table 6: Current programs focused on sustainability and conservation in Sarawak relevant to mitigation and adaptation

Programs & Policies	Description	Sector	Intended objectives	Relevance to Adaptation & Mitigation
Malaysian Sustainable Palm Oil (MSPO) Certification plan	A certification process that began January 1, 2020 that ensures full compliance by millers, estate and small-scale producers. A national standard committing Malaysia to fulfill sustainability requirements.	Oil palm	Ensures that producers adhere to the EU-prescribed level of 3-MCPD of 2.5 milligrams/kg for food products by 2021 Govt also encourages smallholder farmers to diversify production into mixed farming to diversify their income, particularly during low commodity prices.	Crop diversification to more profitable horticulture crops, mixed farming to de-risk the sector. Puts people at the center of the farming systems to increase resilience, income and security. Integrates trees into farming systems to increase carbon capture and biodiversity.
The Program for the Endorsement of Forest Certification (PEFC)	The Malaysian timber certification council MTCC, adopted a forest management certification in 2008	Forestry	the Malaysian timber certification council MTCC, adopted a forest management certification in 2008	Ensures sustainable harvest and regeneration, prevents indiscriminate deforestation, helps mitigate climate change by storing up carbon. Protects biodiversity, soils and water quality, social consideration for those who depend on forest resources for livelihoods.
Natural Resources and Environment Board (NREB)	The Natural Resources and Environment Ordinance 1993 established the Natural Resources and Environment Board in 1994. Has a target to enforce a total ban on all open burning by 2020 except for religious purposes and shifting cultivation in rural communities.	Environment	Monitor air quality, transboundary haze pollution, air pollution index (API) of particulate matter 10 and PM 2.5 with 15 stations throughout state. To detect illegal open burning by monitoring hotspots with satellite imaging through the Centre for Remote Environmental Monitoring. Proactive ground monitoring by enforcement teams	Reduces GHG emission. Increases field biomass that ensures higher transpiration rates and inhibits mineral losses from soils. Soil organic matter is retained, increases in soil C and N and soil and increases microbial biomass including mycorrhizae, rhizobia and other microorganisms.
Systems of Rice Intensification (SRI)	WWF in collaboration with the DOA, DOF in a quaint village, Long Langai in Ba' Kelalan highlands.	Agriculture	To increase yield and protects the environment and promote water-use efficiency in water scarce areas. Manage fertilizer and chemical utilization to improve sustainable production. Adds value to the ecosystem services such as the provision of clean water for irrigation, by	No chemical fertilizer, SRI fixes nitrogen 150-200kg nitrogen/hectare (Uphoff, 2003) Increase use of compost to boost soil fertility, compactness, Low/zero tillage and better water management.

			minimizing upstream land use changes such as unsustainable logging or large-scale forest conversion to agriculture.	Resistance to storm damage & drought, reduce GHG emission, reduce incidence of pest and disease.
The Gahara Mayang-Orangutan Sanctuary Project	In coordination with DOF, DOA, WWF, Sarawak Energy and a 40,000 Iban community in Batang Ai, Sri Aman - at the risk of deforestation by private interests for oil-palm production. The project provides a new conservation model in Sarawak by bridging local communities in rural areas to private capital with access to global markets	Forestry, Agriculture, Social Development	Natural habitat eco-system-mangroves conservation and for equitable wildlife distribution and ecological integrity of forests Promote sustainable land use and zero deforestation Model *Aquilaria* cultivation without pesticides and herbicides and promoting alternative livelihoods using Opportunity to engage community while serving as a new habitat for the orangutans.	Increases extent of protected areas, livelihood diversification and sustenance. Enhances the resilience of natural systems to climate change effects Provides orangutans the spatial flexibility to shift distributions as climatic conditions change. Focuses conservation resources on species that might become extinct as a result of cc.
Agricultural Suitability Maps	Led solely by the Department of Lands. Individual divisions are now promoting the production and commercialization of crops best suited to their divisions.	Agriculture	An example of Land-use planning To promote crops with comparative advantage (agro-ecological zoning) To increase sector productivity and boost trade competitiveness and mainstream the Sarawak Vision 2030 -which aims to become a net exporter of agricultural products.	Reduces flooding, drought, water scarcity and heat stress as well as avoid exposure to elements of production risks. Sustains wetlands, avoid bare soils during excessive precipitation, modified vegetation cover and helps introduce drought/flood tolerant crops that reduce flood and drought risks.
MyGAP, MyOrganic certifications	Implemented by the DOA. Compliance standards set by the national organic standard, MS 1529:2001. Producer uses the logo of *Organik Malaysia* on all products.	Agriculture	Key objectives to develop a modern farming practice. The DOA is increasingly promoting rain shelters (protective agriculture, move emerging farmers to more productive ways of producing food, by adopting fertigation, hydroponic systems.	Puts people at the center of the farming systems to increase resilience, income and security. Reduces GHG emissions through the combination of organic fertilizers, cover crops and less intensive tillage.
TAGANG eco-tourism projects	Partnership between DOA, DOF and host inland water-way communities. TAGANG means to control and preservation in Malay language. Project aims to raise awareness of the conservation and commitment of the local community towards. There are 23	Agriculture, Forestry	To promote the production of native fish species facing threat of extinction Promote ecotourism in far-flung communities and develop alternate livelihoods.	Establishes targeted monitoring of Climate Change on biodiversity and ecosystem such as assessing specie abundance, migration, changes in phenology and helps integrate

	functional TAGANG systems throughout the state and a total 116 at various stages of development.		Promotes inclusive community engagement that help prevents, control and reduce river pollution to protect the natural environment for future generations. Provides an avenue to conduct environmental research studies into flora and fauna found in each area and the prevailing socioeconomic status of the host community and impacts of climatic conditions.	results into planning to improve policies and reduce vulnerability. Increased resilience of fish species to climate impacts and aid genetic variability vital to enhancing specie adaptive capacity. Improve ecological protected areas to hinder threats due to human impacts. Stakeholder engagements increase the acceptance of adaptive measures on natural habitats e.g. fishing restrictions, changes in fishing times and delineated areas along water ways to fish periodically.
Food Production Permanent Garden Project (TKPM)	TKPM started in 2012, with 7 centers statewide and 2 in development. Only the Kuching center have the sheltered and automated systems, others are open centers: direct to soil cultivation, more conventional system.	Agriculture	Attracting youth participation in agriculture Provides alternative to land-use loss due agriculture depleting rapidly to commercial plantation for oil palm and rubber and development expansion Promotes less dependence on rain-fed production, optimal fertilizer usage. Easy to use and mainstreams technology uptake in agricultural production which - minimizes nutrient loss and promotes high value food production.	Promotes protected agriculture technologies with the use of shade house for cultivation, scaling the use of hydroponic for areas with scarce land and water. Promotes optimal fertilizer usage and reduce the incidence of pests & diseases occurring in traditional practices. Soil moisture conservation - protects crop production from devastating rainfall, flood, drought risks and predatory animals. Promotes the use of plastic sheeting to suppress weed and reduce soil run-off. Promotes the diversification to high producing horticulture crops with low.

Source: Authors interview, DOA, DOF project documents; Primitiva, (2018); Lovejoy, (2005); Uphoff, (2003); Hauser & Norgrove, (2013); IUCN, (2008); Edgar, (2018); Agyeman, (2019); Secretariat of the Convention on Biological Diversity (2019)

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