

THE IMPACT OF CLIMATE CHANGE AND AGRICULTURAL REGULATIONS ON SMALLHOLDER FARMERS PRACTISING 'NGAWU-AWU'

A CASE STUDY IN TEPUS VILLAGE, GUNUNGGKIDUL, YOGYAKARTA, INDONESIA



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September 2020**

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Van Hall Larenstein University of Applied Sciences in partial fulfilment of the requirements for
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Dedication

To my loving mother, Hj Siti Umami, the only one who knows my feelings, my desires, and advices me on what to do.

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Abstract

Smallholder farmers in Tepus, Gunungkidul, Yogyakarta, Indonesia, rely on rain fed farming that is based on indigenous knowledge. The indigenous knowledge farming practice is called *ngawu-awu* relying on weather predictions on the traditional Javanese calendar called *Pranata Mangsa*. The traditional Javanese calendar also functions as a practical guide for agricultural activities. This research is aim at providing knowledge and information on how climate change and governmental agricultural policies in Indonesia affected on the practices of *ngawu-awu* and its impacts on small holder farmers' livelihood in Tepus, Gunungkidul Regency.

This study employed qualitative approach. Desk study, key informants interview, and focus group discussion was used to gather information for the study. Furthermore, this research was using virtual observation method to get evidences to support the study. Using sustainable livelihood framework, this research was conducted to understand traditional agricultural practices that depend on limited natural resources and deal with the change in climate and government agriculture regulations in Indonesia.

The results of the study shows that smallholder farmers practising *ngawu-awu* must adapt to the climate and regulations change. This research reveals a triangle discussions between indigenous agricultural knowledge, governmental policies and natural environment beyond local knowledge practices.

Keywords: *Pranata Mangsa*, *Ngawu-awu*, indigenous knowledge, climate change

Abbreviation

BMKG	: <i>Badan Meteorology, Klimatology, dan Geofisika</i> (Bahasa); Geophysics, Climatology, and Meteorology Bureau of Indonesia
UGM	: Universitas Gadjah Mada
KATAM	: <i>Kalender Tanam Terpadu</i> (Bahasa); Official Integrated Farming Calendar
KWT	: <i>Kelompok Wanita Tani</i> (Bahasa); women farmers group programmes
MT	: <i>Masa Tanam</i> (Bahasa); planting time
NGO	: Non-Governmental Organisation
PSPK	: <i>Pusat Studi Pedesaan dan Kawasan Universitas Gadjah Mada</i> (Bahasa); Center for Rural and Regional Development Studies, Gadjah Mada University
UNESCO	: The United Nations Educational, Scientific and Cultural Organization
VHL	: Van Hall Larenstein University of Applied Science

Chapter 1 Background

Introduction

In 2013 the Gunungsewu area which stretches across two provinces and three regency, was designated by UNESCO as a World Geo-park Heritage. This geo-park is a landscape of karst tropics dominated by rock soil with limited water resources (Unesco, 2013). 65% of the karst area of Gunungsewu is administratively located in the Gunungkidul Regency and will be the focus location of this research. The local government of Gunungkidul Regency also established their karst area as an area used as a hydrology conservation area (Gunungkidul, 2011).

Figure 1 Gunungsewu Karst areas in Java



Source: researchgate.net

In Gunungkidul, most of the farmers are facing challenges and dependent on rain fed agricultural system. Karst areas dominate 53% of the total land area in Gunungkidul (Gunungkidul, 2011). Karsts areas are characterised by extreme dry lands during dry season. With limited financial capital resources and water unavailability, local farmers in Gunungkidul struggle to maintain a good harvest (Retnowati, 2014). Departing from this fact, that this region has several natural challenges that affect the agricultural practices of farmers this research studying this problems.

Smallholder farmers practising rain fed farming in Gunungkidul have a problem accessing reliable weather information from the Indonesian Body of Geophysics, Meteorology, and Climatology (BMKG) authority before the start their harvesting season. Otherwise, traditional farmers in Java use some natural indicators such as star constellation, plant and animal behaviour to forecast the conditions of weather.

An integrated crop calendar system officially created by BMKG is KATAM. This calendar however cannot give specific details about the weather forecast in Gunungkidul. Vogel and O'Brien argued that climate information is seen as a promising but underused tool for agricultural risk management, largely because of the lack of understanding about the local contexts in which agricultural decision are made (Vogel & K, 2006). Furthermore, Kawanishi (2016) explain that climate is only one factor that influences production decisions. Other factors, such as the ability to gain access to resources such as land, labour, fertilizer and credit are likely to confound a farmer's response to variations in climate.

Based on many challenges that mentioned before, smallholder farmers in the study areas this research will focus on the knowledge of indigenous dry land farming called 'Ngawu-awu', in Gunungkidul

Regency, Special Province of Yogyakarta, Indonesia. Local farmers in Javanese ethnic group have *Praata Mangsa*, a traditional Javanese calendar that functions as a practical guide for agricultural activities (Daldjoeni, 1984). The calendar shows to the farmers results and combination between of cosmographical (star constellation), bio-climatological (animal and plant behaviour), and sociological (human resource) aspects of agricultural activities in rural areas. The *Pranata Mangsa* are provided by every cultural leaders of small-scale peasant communities in scattered ways and are different from each other.

In addition, *Pranata Mangsa* calendar also considers sociological aspects as a part of its guidance. This sociological aspects could reflect one of the important resources that relates to harvest, production, land or a labour. This calendar measured together among community, and also reflect how they will start a season as a group. They consider labour availability for each farm thus there is no lack of labour resources in each farm of each group member.

One of the main focuses of this study is *Ngawu-awu* which literally means farming in the dust. When the dry season comes, farmers start planting paddy seeds in their dust-dry-land before the first rain drop comes. The process of *Ngawu-awu* illustrates the practice of *Pranata Mangsa*. Firstly, farmers look at the star constellation at the night. If the Orion constellation appears at the same spot every night at 12 a.m precisely, it means the rains will come soon so they can start to plant their seeds in the dusty dry land.

Secondly, *Ngawu-awu* has been practiced by the farmers from long ago because they have a limitation on soil quality, like in Gunungkidul Regency that they have to cultivating in the karst area. Traditional ancient farmers observed plants behaviour and made conclusions based on their observations. Paddy seeds are okay to be planted in dry soil as long as there is no exposure to rain. If a little water enters the ground and touches the seeds, the paddy seeds will rot without constant water supply both of from rain fed or irrigation.

Thirdly, *Ngawu-awu* system also shows us how farmers manage labour resource availability. If all the farmers start the harvest season while waiting for the rain come, there will be a lack of human resource during the farming season hence, small holder farmers develop their lands during the dry season which gives them the opportunity to work for other farmers when the rainy season arrives. This system helps the farmers to regulate the availability of agricultural workers. Agricultural system on Java Island is also focused on "*Gotong Royong*" meaning togetherness and kinship. As an important social element, the concept of *gotong royong* in Java animates the livelihood processes of the village community. The social relations from the *gotong royong* are able to patch the existing livelihood assets gaps.

Having considered these three elements, the star constellation is the most challenging fragment of *Pranotomongso* due to climate crisis. Star constellation have become ineffective in determining when the rains will come because predictions are now inaccurate because of the delays caused by climate change. The weakness of ethno-climatology is that it cannot provide predictions for sudden storms like *El Nino* storm (Kawanishi, Anggarendra, & Farid, 2016).

In this setting, *Pranotomongso* comes in as a basic guide that has been in existence hundreds of years ago. This traditional weather guideline system is more useful for local farmers due to lack of official forecast/seasonal information from the government's Meteorology, Climatology, and Geophysical Agency. Challenges are however multiplying in recent times because climate crisis has led to

unpredictable weather. Furthermore, this research will investigate how this ethno-climatology supports traditional rural farmers to dealing through climate crisis and its impact on their livelihood

In the other hand, nother factor that needs to be considered in this traditional agricultural practice is the change in governmental agricultural regulations and policies in Indonesia. This research will look at any policy changes that affect traditional agricultural practices such as *Ngawu-awu*. Changing laws and regulations, especially those related to agriculture, affect the practice of indigenous knowledge.

Research Problem

Smallholder farmers Tepus, Gunungkidul Regency, Special Region of Yogyakarta, Java Island, Indonesia, rely on rain fed agriculture doing *ngawu-awu* indigenous knowledge to face climate change and unpredictable weather condition. In addition, they also face agricultural governmental change in Indonesia. This research focused on how changes have been experienced by traditional farming practices in Gunungkidul during climate crisis and governmental regulations change and its relation to small holder farmer's livelihood.

The direct problem owner of this study is PSPK who has lack of information and knowledge about the practice of the indigenous knowledge adaptation in Gunungkidul Regency, Special Region of Yogyakarta, Indonesia. The commissioner is Dr. Suharko from PSPK Universitas Gadjah Mada, Indonesia. The indirect problem owners are small-scale farmers in Gunungkidul who are directly affected by unpredictable weather conditions due to climate change and also government agricultural change.

Research Objective

To provide knowledge and information on how climate change and governmental agricultural policies in Indonesia affected on the practices of *ngawu-awu* and its impacts on small holder farmers' livelihood in Tepus, Gunungkidul Regency and recommend inclusive solutions for communities practising indigenous knowledge and PSPK institutions to implement its scientific roles.

In addition, this study aims to determine the process of change experienced by small holders farmer related to climate and governmental regulations. After providing information related to the problems.

Research Question

1. What are the current Ngawu-awu traditional farming practices used by small holder farmers in Tepus to cope with climate change?

- A. What are the effects of climate change on the smallholder farmers' in Tepus?
- B. What impacts does climate change have on the practice of Ngawu-awu?

2. What adaptations strategies are used in the current practice of Ngawu-awu in facing agricultural policy change in Indonesia that contribute to small holder farmer livelihood outcome?

- A. What are the changes of agricultural policies in Indonesia and their impacts on the practice of Ngawu-awu in Tepus?
- B. What strategies can be implemented to bridge the gap between governmental agricultural policy and Ngawu-awu practices to improve small scale holder farmers' livelihood?

Chapter 2 Theoretical Background and Conceptual Framework

The Indonesian National Disaster Management Agency, called BNPB, states that the five major disasters facing Indonesia are related to hydro-metrology related to water. The three biggest disasters that Indonesia has experienced in recent years are floods, landslides and drought (BNPB, 2020). As an archipelago (group of islands) country where 66% of its territory is oceans, Indonesia has a very high potential for disaster from the sea. In addition, being in the middle of the equator and having only two seasons, rainy and dry season, makes vulnerability to floods and drought also increased. Global climate change also contributes to the level of disaster vulnerability faced by agrarian communities in Indonesia, the majority of which depend on the agricultural sector (Binternagel, et al., 2010).

Indigenous Knowledge

Studies on the use of local knowledge to deal with the vulnerability context have been carried out. One of them is by Pandey et.al., that examined the role of indigenous knowledge in dealing with climate change in Latin America. Discussions about indigenous knowledge system also has gone through a long research's journey. When Chambers et.al. (1989), doing major agricultural research, conducting local farmer knowledge also being an important part in farmers' innovation. At the same time, the debate stuck out as researchers dichotomize between traditional knowledge and scientific knowledge. Arun Agrawal pursued that it is not easy to bring clear difference among them based on three main elements; substantive, methodological and contextual elements (Agrawal, 1995).

Research on ethno-climatological studies such as *Pranotomongso* calendar should start from local's specific context perspective. Agrawal (1993) states that traditional knowledge which is practiced is disorganized and alters from one another, these practises are undocumented, and marginalized by scientific knowledge, making them contradictory despite the positive impact on its implementers. Further research (Smith, 1997) has determine how the utilization of Indigenous knowledge could be disseminated and use to the advantage advantages of other communities with similar typical local perspective.

Similar to Orlove's (Orlove, Chiang, & Cane, 2002) research in Andes, farmers in Java had also seen Pleiades star constellation as one of the signs to start new planting season. This cosmographical measurement is not a fresh issues in ethno-climatology studies. Tania Li (2005) had an alternative approach to the question of indigenousness that is theoretically more adequate to the diversity of conditions and struggles in Indonesian countryside, and alert to the political risks and opportunities posed by particular framings (Li, 2005). The approach she offers is to give indigenous groups and their knowledge to have power when dealing with structures. In this study, researchers linked local knowledge with agricultural regulations in Indonesia as a 'structures' according to Li.

Traditional Knowledge and Scientific Knowledge

Pranotomongso is a tradition that makes farmers embody their natural environment. It helps famers to build their life, to arrange their economy, to save when dry season comes and to be happy when planting and harvest season comes (Handayani, K, & I, 2018). Adjusting to nature has made Javanese farmers smart at managing deficiencies and strong in welcoming expectations (Shindunata, 2011).

Their diverse forms of knowledge which are deeply rooted in their relationship with the environment and cultural cohesion has allowed many of these communities to maintain a sustainable use and management of natural resources, protect their environment and strengthen their resilience, whilst facing new and complex circumstances (Magni, 2017).

Climate Change and Rain Fed Farming

Drylands cover 41 percent of the Earth's land surface; and they are home to more than 2 billion people, making up 35 percent of the world's population (Safriel, Uriel, & Adeel, 2005). Impacts of climate change can be categorised into a range of direct components, consisting of changes in temperature, a shift in rainfall patterns and distribution. A variety of indirect affects connected to the regulations followed to address weather exchange together with renewable fuel objectives will generate a hard and fast of impacts on land values and returns to specific forms of crop production, among different things (Aderson, Morton, & Toulmin, 2010).

Smallholder farmer livelihood rests on their ability to interpret regular natural cycles and act in accordance with them. Though indigenous community certainly have contact with other society, are incorporated to some degree in the market economy, and have access to public health and education services, a large proportion of their livelihood depends on their knowledge, use, and management of forest and water resources (Kronk & Verner, 2010).

Adaptation to climate change is highly local, and its effectiveness depends on locals and local institutions through individual and collective actions. Differences in practices in local institutions affect their adaptation to climate hazard which results in their livelihoods (Agarwal, Perrin, & Chhatre, 2012). These differences include three main parts namely local institutions, community collective collegial action, and intervention from third parties. One of the important elements of *pranata mangsa* is the social and togetherness aspects or in Java it is called *gotong royong*.

Government Agricultural Regulations Related to Indigenous Knowledge Practices

References that specifically discuss the relationship between agricultural regulations and indigenous knowledge practices are still limited. However, in the case of Indonesia, quite a few studies on rural development have been carried out. Discussions about rural development practices in Indonesia are closely related to agricultural practices at the village level. At this point, this section will discuss about the study of rural development and its relationship with agricultural practices and rural livelihood of villages in Indonesia. As an agricultural country that centralize agricultural production in rural areas, rural development is closely related to agriculture in Indonesia.

Furthermore, in this research, the structure and process in sustainable livelihood framework will further examine the influence of two main things that affect agricultural practices in rural areas in Indonesia, the pattern of village governance in Indonesia and agricultural policy from national to local level. New Indonesian Law of Village UU 6/2014 accommodate local knowledge officially through law.

Ben White (White, 2017) states that the newest Indonesian village law called UU 6/2014 is the latest form of rural management in Indonesia which still contains a lot of rhetoric that is difficult to apply in the field (White, 2017). Furthermore, UU 6/2014 also states that customary heads are part of village management. Cultural leaders should also be able to raise the bargaining value of indigenous knowledge. A case studies in West Java, Law 6/2014 was able to legally recognize a *Baduy* tribe, but the problem that followed was the socio-political conflict in this area (Ramdhaniaty & Ratnasari, 2017). Ramdhaniaty and Ratnasari (2017) explained that formal legal recognition of customary groups is does not bring better rural development for local residents if not followed by in-depth need assessment and further study of local communities.

Framework

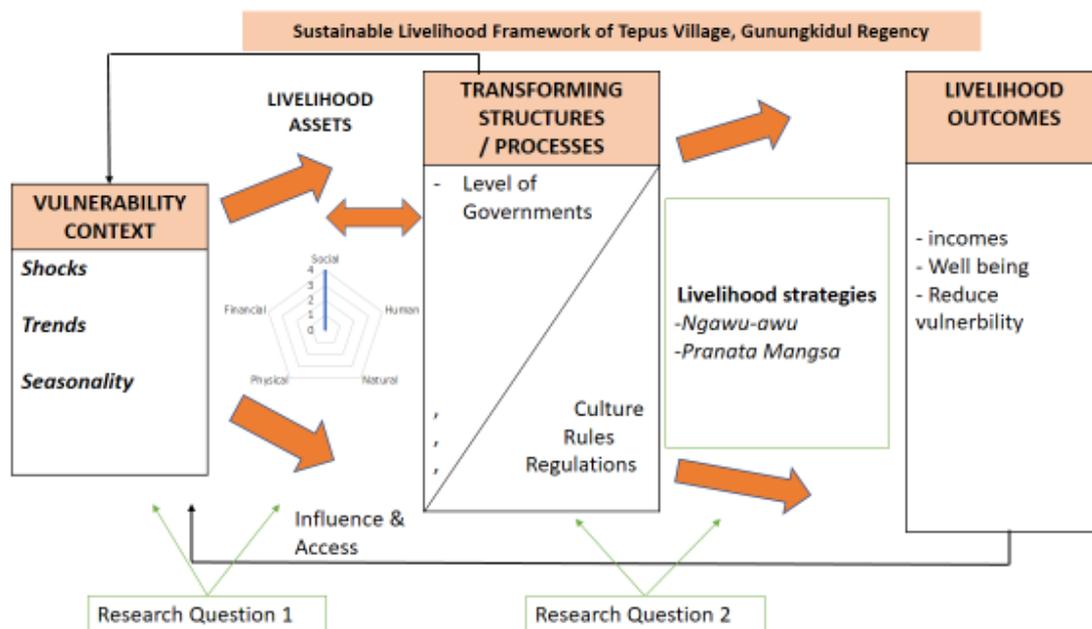
Sustainable Livelihood Framework (SLF)

The SLF approach helps to give a clear understanding of specific group's livelihood. This approach identifies the vulnerability context, measures livelihood assets, process of policies and institution, and its relation to livelihood strategies in order to achieve livelihood outcomes. The use of the framework in research on climate change, especially with regard to its impact on climate change has been done by many researchers.

Elasha et.al (2005), conducted a research based on a sustainable livelihood conceptual framework in Sudan to evaluate the performance of sustainable livelihood and environmental management. They measured recent climate-related shocks in relation to communities' potential for reducing vulnerability aspects to face climate crisis (Elasha, Elhassan, Ahmed, & Zakieldin, 2005). Pandey et.al. (2017) did the similar research in Himalaya to access the understanding of the social, economic, and environmental changes to rural livelihoods with specific vulnerabilities by addressing problems in education. If education can be accessed, then the need to overcome the vulnerability context will be overcome and can increase community livelihood (Pandey, Jha, Alatalo, Archie, & Gupta, 2017).

The use of the sustainable livelihood framework will be linked to two main research questions. The first question related to climate change will take advantage of the first two parts of the SLF, livelihood assets and vulnerability context. Meanwhile, the second part of the question regarding changes to agricultural regulations in Indonesia will be related to the transforming structure and process in SLF and the practice of *Ngawu-awu* as livelihood strategies for small holder farmers in Tepus. Figures below describes the flow of the sustainable livelihood framework.

Figure 2 Sustainable Livelihood Framework



Source: Researcher's own construct, adapted from DFID Sustainable Livelihood Framework

Vulnerability Context

Vulnerability context includes shock trends and seasonality which has a profound impact on community livelihoods. This logic followed to its natural conclusion, means that adopting a vulnerability perspective demands a thorough investigation of biophysical, cognitive, and social dimensions of human–environment interactions (Polsky, Neff, & Yarnal, 2007). The ability of the community to survive shocks, trends, and seasonality as a vulnerability context shows the level of resilience of citizens in one particular place (Scoones, 1998).

Livelihood Assets

Human Assets

Human assets refers to the skills, knowledge, creativity, ability to labour and good health that enables people to pursue different livelihood strategies and achieve the livelihood objectives (DFID, 1999). Liat skill toward indigenous knowledge

In this research human assets in the form of indigenous knowledge will play an important role because this is where the practice of *Ngawu-awu* in the farming of small holder farmers in Gunungkidul proceeds.

Social Assets

With *Pranotomongso* practices that also pay attention to social aspects, the dimension of social assets will measure the extent to which the relationship ties within and between communities take place now. *Ngawu-awu* practices that involve many social aspects of Javanese society reflect traditional knowledge that is affected by the collective knowledge of the community (Badrudin, 2014). Social capital in the SLF will review co-operations, sanction, trust and rules in the implementation of *Ngawu-awu*.

Natural Assets

As researchers have pointed out in the introduction, natural factors in agricultural practices in Gunungkidul play a very fundamental role. The fact that they are karst areas will be further explored in reality on the ground today, and their impact on rural livelihood. The ability of farmers to predict the weather that naturally comes to them, will be the unit of analysis in this section. Furthermore, this will overlap with indigenous knowledge in human assets.

Physical Assets

The vital role of physical capital that will be reviewed from the SLF for this study starts from the typical Karst soil that runs along Gunungkidul. In Tepus Village, farmers rely on rock land areas that does not have an irrigation system. Furthermore, this research will focus on current physical assets, infrastructure and irrigation systems.

Financial Assets

Financial assets will measure the income of farmers who practice *Ngawu-awu*. The financial capital dimension also includes income, savings and farmers' yields (PSPK, 2019).

Transforming Structures & Processes

This section will explore the role of government both at central and regional levels, research institutions that implement studies and NGOs that have programs in Gunungkidul Regency. The Indonesian governmental agricultural policies will be analysed further here. The newest Indonesian Village Law which came into existence since 2014 and equipped with a village fund of 1 billion rupiah

per year or around 70.000 euro for each village has a big impact on agricultural practices. Furthermore, village funds target small holder farmers in rural areas as one of the main focuses of rural development.

Livelihood strategies

This research will place indigenous knowledge in *Ngawu-awu* agriculture as the main analysis in the livelihood strategy. However, it must be realized that the Gunungkidul region is also one of the local tourist destinations. Furthermore, the researches related to Indonesia with a related theme that also uses the sustainable livelihood framework has been carried out. In developing countries like Indonesia, climate change adaptation response must be done in conjunction with human development.

More specifically research with the theme of drought was carried out by Binternagel et al (2010) in Indonesia using the sustainable livelihood framework. The evaluation indicates that all interviewed families have been affected with severe climatic effects related droughts which lead to a decline in agricultural outputs. Our research identifies diverse varieties of model techniques on the micro stage. Most common techniques are reactive or ex-post variations which guide the household in coping with the outcomes of droughts (Binternagel, et al., 2010).

Chapter 3 Research Strategy and Methodology

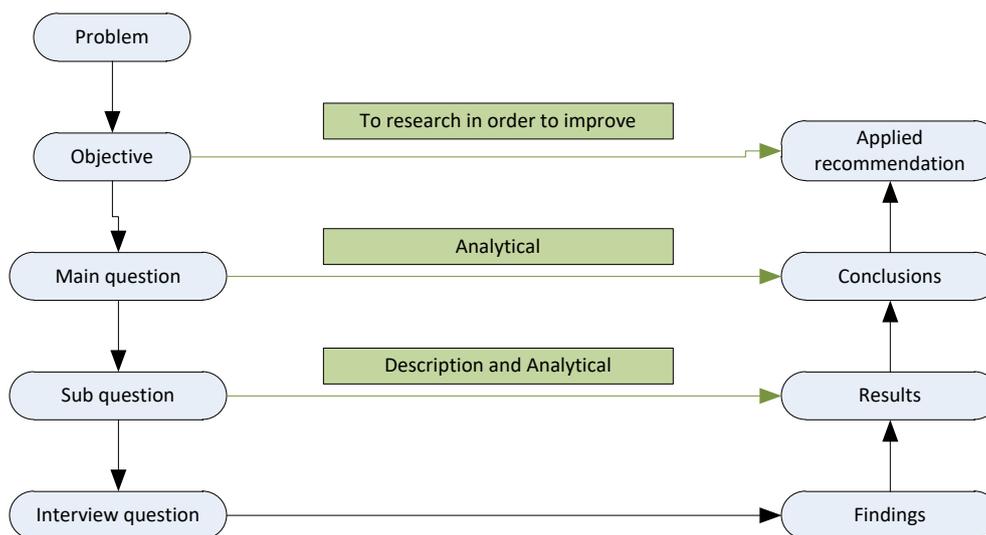
Research Design

This research was conducted and completely documents *Pranotomongso* from several research perspective approach and study how farmers apply their indigenous local knowledge in climate change. Online interviews, netnography and focus group discussions organised by a research assistant were used to obtain data while researcher documents *Pranotomongso*. This data collection method was chosen considering current COVID-19 regulations limiting free movement. Although the researcher was unable to make direct observations on the field, methods that have the maximum relevance to keep the quality of data accuracy were used.

The study used qualitative methods to conduct historical diagrams of climate change in Tepus, Gunungkidul Regency. Led by evidence from local key informants, in-depth online interviews and online focus group discussion were conducted. Historical diagrams formulated from the key informants were used to give a picture of past adaptation strategy of small scale farmers in Gunungkidul. Historical diagrams can give a snapshot of changes that have happened over the last 3 decades according to the needs of the research focus (Geilfus, 2008).

The findings were strengthened through online visual observation using photos and videos. To construct the understanding of livelihood assets and the vulnerability context, the researcher used online interviews and FGD's to get information and measure the impact of indigenous knowledge from the household level. The figure below represents the research framework adopted by me from Laws (2013).

Figure 3 Research framework



Source: Researcher's won construct, adapted from Laws et.al. (2013)

The researcher recruited a research assistant to assist with technical needs in the field. The assistant provided video and photo capture services. This role was conducted by a young researcher from Gadjah Mada University who already knows the situation in the field concerning Gunungkidul from his experience with previous research. The involvement of an assistant in conducting this research was not only to assist in technical issues mentioned above but also to obtain printed correspondence and

documented data from governmental institutions to enable the researcher access data that was used during the research. The research assistant was trained by the researcher on the processes to follow and was enlightened on the need to remain in the academic standards because they are not involved in the research content.

Study Area

Figure 4 Map of Tepus Village, Gunungkidul Regency, Indonesia



Source: google images, 2019

The research was conducted in Gunungkidul Regency, Special Region of Yogyakarta, Indonesia. This area is known for its dry karst lands with farmers relying on rain fed agricultural system. Due to its geomorphological setting, farmers in karst of Gunungkidul Regency, suffer water scarcity challenges during the dry season.

According to Regional Spatial Planning of Gunungkidul Regency, sub-districts that are geomorphologically classified as Karst area in Gunungkidul Regency are Ponjong, Semanu , Girisubo, Rongkop, Tepus, Tanjungsari, Saptosari, Paliyan, Panggang and Purwosari. The karst areas covers approximately 80,704 hectares (Gunungkidul, *Rencana Tata Ruang Wilayah Kabupaten Gunungkidul 2010 - 2030, 2011*).

The study focused on Tepus Village in Tepus sub-regency. This sub-district is also part of the UNESCO karst land world heritage site. This area was chosen because it has characteristics such as mountainous, flat land and coastal areas that can be used as a sample to represent the data requirements of several climatic features of the dry region. These three categorization gives complete understanding on practice of *Ngawu-awu* dry land farming system. Based on village statistic Tepus has a population of 8705 inhabitants and 2636 hectares of dry land (Statistik, 2019). Tepus is a village with a high population and large dry land areas where the soil type causes most small scale farmers to practice the *Ngawu-awu* system till this day.

Data Collection

Desk study

Desk study was used to gather information on the structure and process of making historic charts for climate change and agricultural policy. This was also used to strengthen my findings and triangulate data gotten from the field. The researcher made use of peer reviewed journals, law and regulation documents, videos, traditional calendars and books.

In-depth online interview

Semi structured interview was used in the data collection method. The long-distance interview, despite having some limitations, the interview was successful. The transition to online research requires the research world to also adjust to simplify the research process in certain situations while still paying attention to the ethical and precision side of the research (Bampton, Cowton, & Downs, 2013).

The researcher conducted 10 key informant interviews using online channels. These informants provided data that answered the research question and sub-questions. The key informants were selected from 4 sub-villages using the snowball method and consisted of village head, chief of sub-villages, cultural leader, extension worker, farmers' organisation, old farmers and young farmers. Below is a brief description of some of the Key informants who were interviewed.

- Head of village: In Indonesia, the head of village has information on everything that occurs in his village administratively because he functions as the lowest bureaucratic structure in the country making him closer to the local people. Number of respondent: 1.
- Chief of sub-village: After the village heads, the chief knows a lot about non-administrative socio-cultural aspects in the sub-village areas called *Dukuh*. Number of respondents: 4.
- Old farmers: Old farmers were needed to provide information on *Pranatomangsa* practices from ancient times to the present. Two respondents who are known to have a deep knowledge on pronotomongso practices were chosen for this interview. These two farmers were chosen to represent the old farmers in the region.
- Young farmers: Young farmers provide information on current practices in relation to climate change. Two respondents were chosen to represent the young farmers.
- Field extension workers: The field workers in Indonesia has an important role because they are a direct bridge between the local government and the farmers. Number of respondent: 1.

The implementation of the online key informant interviews were conducted using WhatsApp voice call and regular telephone calls. The advantage of this Tepus Sub-regency is that they are one of the leading tourist destinations in Java, so they have enough telephone signals to make whatsapp calls. During the interviews, when internet signal was not possible then regular phone calls serve as a backup.

Online Focus Group Discussion

Focus groups can be a great tool when you need to "explore perceptions, feelings, and thinking about issues, ideas, products, services, or opportunities" (Krueger & Casey, 2015). Focus groups are unique because of their focus on interpersonal interaction in analysis. The dynamics of this changes when utilizing an online, video-based venue.

The online focus group discussion was conducted using WhatsApp video call. The FGD was organized by the research assistant while the researcher attended using whatsapp video during which questions were asked virtually. The stakeholders gathered in the field with the research assistant who was responsible for interpreting questions asked by the researcher. The researcher made use of tools like the historical diagram to see the changes in agricultural practices over the last 30 years. This was done successfully with the assistance of the research assistant.

The FGD was carried out twice for two different purposes. One was to discover the change in climate crisis and the other was to discover the changes in agricultural regulations in Tepus. The same set of stakeholders were chosen because they have the knowledge and capabilities to represent the people. These are the same set of stakeholders who were respondents of the indepth interviews.

This first online FGD involved 1 cultural leader (village elder) who still have memories of ancient *pranotomongso* practices, 2 old farmers, 2 young farmer, 1 farmer organization representtive and 1 extension worker. The purpose of this was to collectively describe the climate change process in their region. The second FGD involved the same set of respondents as in the first FGD.

Netnography / Virtual Observation Methods

Visual observation data collection methods were carried out through several mediums including documentary films and video footage. *Ngawu-awu* is a culture that has been inherited along with Javanese culture. Documentation of this culture is available digitally on several platforms, although they are very few. The data gotten from the videos supported the process of taking field evidence on *Ngawu-awu* practices.

The fourth criterion is groundedness, defined as the extent to which: (1) the theoretical representation is supported by data, and (2) the links between data and theory are clear and convincing. Groundedness is not only a demonstration of the degree of empirical veracity; but a provision of sufficient and relevant evidence to back up the netnography's theoretical claims of contribution (Kozinets, 2015).

Video re-enactment captured the process of *Ngawu-awu* practice and how they measure the harvesting time with *Pranotomongso* calendar. This research coincided with the final phase of the drought that lasted from June to August based on the planting calendar. In the *pranotomongso* calendar, as shown in the diagram below, the dry season is called the "*Mangsa Terang*" as indicated in yellow and falls between the months of May to August.

The three main films are the source of this research for part of the Netnography visual observation method. The first two films, which were later called Film 1 and Film 2, were documentary films where the researcher had obtained permission from the film producer directly to be part of this research. The use of these two films as primary sources of research is justified by their participation in the Indonesian Documentary Film Festival. This participation in official film festival proves that the films documentation is based on true events. The last film, which is then called Film 3, is a documentation made by the researcher himself with the research assistant who is the image taker in the field. This research made use of screenshots from film to help the reader better understand to better understand the live situation in Tepus village. Images are found in the findings chapter.

Negeri di Bawah Kabut

Firstly, a semi-documentary film entitled “Negeri di Bawah Kabut”. This film was shot in the same area as the location of this study. This film tells the story of vegetable growers in mountainous areas in the central part of Java who experience a “musm owah” or changing seasons. From this situation they must begin to adapt to all vegetable cultivation practices which also have an impact on their livelihoods.

Pranata Mangsa: Signs of The Season

Secondly, a semi-documentary film entitled “Pranata Mangsa”. This film is documented in Yogyakarta Province and tells about the agricultural calendar system in Java which is also the focus of the study of this research, Pranata Mangsa. The film's problems explain and correlate with the long drought that occurred in 2018/2019. This film tells the details of the differences between what is written in the Pranata mangsa and the reality of what was in the field at that time.

Ngawu-awu in Tepus (2020)

The last film is a documentation of the author himself and his research assistant in the field. This documentation also serves as primary data for me as a researcher for the purposes of explaining the details of the Ngawu-awu process.

Data Source

Sample Selection

The sampling technique for online surveys for this study will use purposive sampling. This technique shows the level of importance of selecting respondents. In this study, respondents were chosen for reasons to provide arguments for the quality of their livelihoods and how the impact of indigenous knowledge on dry land farming systems is practiced. Although the total population of small holder farmers in the village of Tepus is known to be 3442 (desa.id, 2020), but the number is still heterogeneous. This study will only look at *Ngawu-awu* rice farmers, while the heterogeneity of types of agricultural products from the population of the number of Tepus farmers has not been seen in the available data. *Ngawu-awu* practices only require subsistence rice farmers as respondents. Meanwhile, the number of farmers in Gunungkidul who practice *Ngawu-awu* cannot be known with certainty as a sample frame.

Data Analysis and Processing

Qualitative analysis used three methods for data collection: online key informant interviews, netnography observations method and online focus group discussions to meet the necessities of primary data. The interviews and FGD were processed sequentially as follows:

Raw data → transcribe → coding data in themes → and final analysis (Laws, Harper, Jones, & Marcus, 2013). In addition, field data collection will help researcher to formulating historical diagram on impact of climate change on the practice of *Ngawu-awu*. The historical diagram is divided into two, explicitly, changes in indigenous knowledge as an adaptation strategy to see how far the impact of climate change has been on the traditional agricultural practices of *Ngawu-awu*. The second diagram will explain the structure and process of change in governmentality as part of the Sustainable Livelihood Framework that affects how agricultural schemes work at the local level. Secondly, quantitative analysis that will measure the extent to all aspects of sustainable livelihood small holder farmers. Microsoft excel will be employed to generating quantitative data.

Ethical Consideration

The researcher asked for consent from all of the participants with assurance that the identity of the smallholder farmers will be made confidential. The researcher used proper channels to gain entry and approval of carrying out the research in Gunungkidul Regency. The researcher ensured confidentiality and highlighted the purpose of the research being solely academic to guard against respondents' mind set of deeming it as a predecessor to government or NGO's and research institute assistance programmes. Furthermore, the issue of indigenous knowledge came into contact with ethical factors such as how those who are marginalized are positioned not to become marginal communities. This research maintained objectivity while still referring to the neutrality rules of science and academic purpose.

Limitation

The operational definition of climate change here is the change in weather and climate that is felt by Tepus small holder farmers in relation to *Ngawu-awu* practices at the local level. Researchers will not focus further on the causes of climate change or the global climate crisis. The same local contextualisation was also applied by researchers to the operationalization of applicable agricultural regulations in Indonesia. Although some points are drawn from the national level of agricultural regulations in Indonesia, their use in this study is only for the local level in Tepus. This study uses several references taken from 'doing research in pandemic' module. Taking video footage, virtual observation methods, and remote interviews are the main methods used. However, researcher still have to admit that the need for research to know exactly the *Ngawu-awu* process was carried out in Tepus is important. Thus, processions, signs of nature, and other evidence that becomes evidence of *ngawu-awu* activities are limited to remote/distance research methods used in this study.

Independency

I am recently affiliated with PSPK as a researcher and this research institution has conducted various researches in Gunungkidul. Nevertheless, I would like to point out that this research on the impact of *Ngawu-awu* dry land farming will be the first conducted by PSPK. I hope that this will contribute to climate change adaptation issues and support for my organisation. I also come from the same ethnic group who also practices the traditional pranotomongso calendar. Furthermore, I want to express my objectivity as a researcher so that in the field there will be no bias from my personal background.

Chapter 4 Findings

This chapter will present findings from the field. The structure of the findings follow the four sub-questions of the two main research questions as proposed in the methodology. Findings will also be presented using sustainable livelihood framework. The first part of the main research question will analyse the livelihood assets and climate change. Furthermore, the second main research question will analyse the changes in legislation affecting traditional agricultural practices in Tepus.

Climate change and farmers reaction in Tepus

Findings from this field research showed illustrations about major agricultural failures in Tepus, as well as Gunungkidul in general in 2019. Farmers in Gunungkidul in the past three years especially those who still depend on the *pranata mangsa* system experienced a longer dry season. The practitioners of *ngawu-awu* suffered losses after the rain fell only three times before the drought continued again. This caused the rice seeds that were sown to become rotten (interviewee, 2020).

Figure 5 Rain still comes in 12th month in pranata mangsa calendar



Source: *Negeri di Bawah Kabut*

The picture above is from film 1 and the farmer stated: "It's already the 12th season in the Javanese *Pranata Mangsa* calendar, but how come it's still raining?" When the main planting period starts slowly because the average rain fed farmer has to wait for the rain a long time, in contrast, vegetable farmers are actually waiting for the rain to stop quickly. The dependence of farmers on the *Pranata Mangsa* calendar system can be a double-edged sword. Farmers know exactly what to plant, but climate change can be a backlash for farmers. The missed of *pranata mangsa* forecast can affect farmers crops. When the weather become more difficult to predict due to the climate change the problems faced by farmers will be even more complicated.

Figure 6 Dead vegetables plants rot because of the long rainy season



Source: Negeri di Bawah Kabut

Vegetables and fruit are the most susceptible crops to low or excessive rainfall. The image documentation from Film 1 above shows a tomato plantation withering before they are able to flower. The losses faced by vegetable farmers are most time greater than that of rice farmers due to the higher costs incurred by vegetable farmers when planting. Vegetables and fruits are supported by agricultural preparation and other support structures which require a lot of money.

Figure 7 Crops suffer and dying without water supply



Source: Negeri di Bawah Kabut

In the dry season, when farmers in the mountains should still be able to get access to water and have abundant harvests, they have difficulty accessing water due to prolonged drought. The image from Film 1 above shows dry cabbage because it has no water supply. The farmer in scene above said, "At times like this everyone is busy bringing their own hose for water."

Figure 8 Long line to get water supply in the Fifth month of Pranata Mangsa



Source: Pranata Mangsa; Signs of The Season

The picture from Film 2 above provides a deep narrative for this study. This picture was taken in 2018, in the fifth season of Pranata Mangsa calendar or 14 October - 9 November. At that time, the traditional Javanese agricultural calendar provides a weather forecast that the main rainy season will come, the tamarind trees are starting to leaf again, the emergence of caterpillars and insects, and tubers that are starting to bloom. In contrast, the background pictures speak differently. Peoples in Yogyakarta make a line yo get a water from government tank car.

Figure 9 Rain moslem pray in the seventh month of Pranata Mangsa



Source: Pranata Mangsa; Signs of The Season

The picture from Film 2 above provides a sadder fact when school children pray to ask for rain in the season which *Pranata Mangsa* should say is the peak of the rainy season. As a majority of the people in Tepus are Muslim, they have a special prayer to ask for water to come down from the sky. When this prayer is performed, the conditions are completely outside the normal limits of reasonableness and they have to ask God.

Livelihood Assets in Tepus

After finding evidence of the effect of climate change in previous sub-chapter above, the researcher continues the flow of writing the report by explaining about livelihood assets. Furthermore, it is aimed at building arguments about what Tepus residents have to face the challenges of climate change in their traditional farming systems. The results from field findings regarding livelihood assets in Tepus Village are summarized from the results of interviews with the village head, village secretary, Tepus Village profile documents and the results of the processing of two FGDs that have been carried out in the data collection process.

Human Assets

In terms of livelihoods, 3442 residents are farmers who own land, and 359 are agricultural laborers. Of all these farmers, both land owners and laborers, the majority of them still practising the *Ngawu-awu* farming system.

“99% of smallholder farmers who have rainfed land here still practice Ngawu-awu. Ngawu-awu's main reason was the division of labor to face the planting season. In general, small farmers have to work elsewhere when the rainy season comes.” – Head of Tepus Village.

In this research human assets in the form of indigenous knowledge play an important role because this is where the practice of *Ngawu-awu* in the farming of small holder farmers in Gunungkidul proceeds.

The profile document for Desa Tepus (Tepus, 2020) states that 4009 residents only received primary education, 1928 secondary education, 641 senior secondary education, and only 47 people studied bachelor's degrees. The fact that the low level of education in Tepus is in line with the opinion of Pandey et.al. (2017) relating to the impact on the development of local communities.

Social Assets

With *Pranotomongso* and *Ngawu-awu* indigenous knowledge as social assets researcher also pay attention to social aspects. The dimension of social assets explain the relationship ties within and between communities take place now. *Ngawu-awu* practices that involve many social aspects of Javanese society reflect traditional knowledge that is affected by the collective knowledge of the community (Badrudin, 2014). Social capital in the SLF review co-operations, sanction, trust and rules in the implementation of *Ngawu-awu*.

“Farmers in Tepus apply Ngawu-awu and social institutions that apply informally. We will help each other when Ngawu-awu because the process requires a lot of human labor. When something doesn't help, then he will be affected when he wants to plant himself, maybe no one will help.” – farmers 3

The prey organization calendar system also pays attention to social aspects as an indicator part. In addition, this social system comes together with sanctions and laws that apply informally in Java.

Natural Assets

As researchers have pointed out in the introduction, natural factors in agricultural practices in Gunungkidul play a very fundamental role. The fact that they are karst areas were further

explored in reality on the ground today, and their impact on rural livelihood. The ability of farmers to predict the weather that naturally comes to them, will be the unit of analysis in this section. Furthermore, this assets are in close proximity with indigenous knowledge in human assets.

Figure 10 Dry soil in Tepus where smal holders farmer do Ngawu-awu



Source: Co-researcher

Facts on the ground show that some of the land in Tepus is karst with very little groundwater supply. This is why some farmers apply rainfed agriculture.

Physical Assets

The vital role of physical capital that will be reviewed from the SLF for this study starts from the typical Karst soil that runs along Gunungkidul. In Tepus Village, farmers rely on rock land areas that does not have an irrigation system. Furthermore, this research will focus on current physical assets, infrastructure and irrigation systems.

Financial Assets

Financial assets will measure the income of farmers who practice *Ngawu-awu*. The financial capital dimension also includes income, savings and farmers' yields (PSPK, 2019).

Figure 11 Farmers talking about financial problems they face



Source: *Negeri di Bawah Kabut*

The documentation from Film 1 above explains that farmers have to buy carrot seeds now before planting because their money will be used for school fees. Small farmers have poor financial management because they do not have good financial reserves.

Some of the evidence above illustrates what challenges smallholder farmers in Tepus must face with regard to climate change. Over the last few years Tepus has experienced various losses, both material and crops losses that affect their livelihood. In relation to Ngawu-awu, climate change makes it difficult for smallholder farmers to predict when rain season and dry season comes.

*The use of **Pranata Mangsa** on practices of **Ngawu-awu**.*

The *Pranata Mangsa* calendar has 12 months but with a different number of days for each month. While the normal Gregorian calendar has a number of days between 28-31, the difference in *pranata mangsa* calendar is 17 – 40 days. The difference in the number of days occurs because this *pranata mangsa* calendar is based on the decreasing seasons. This calendar divides the year into four main seasons, namely the dry season, the wet season before the rain, the main rainy season, and the end of the rainy season. In addition, *pranata mangsa* have two additional intermediate seasons.

The six seasons mentioned above form the basis of the *pranata mangsa* calendar year after each season is further divided into two months. Thus, the *pranata mangsa* calendar still has 12 months in one year. The number of days in a year then follow the lunar calendar, as they make the moon and other celestial bodies as an annual signs.

Figure 12 Pranata Mangsa calendar wooden board guidance



Source: Anton Rimarang (2016)

The picture attached above is the original form of the *Pranata Mangsa* calendar from wood which used to be the standard for finding “good days”, one of its function is to determine the planting period. Each logo in the box represents a type of plant such as tubers, legumes, beans, or vegetables. The cultural leaders in Tepus, called ‘Mbah Kaum’, as one of the few people who understands how to read the ancient calendar explains to researcher how wooden blocks with various symbols are used. When it was first made in the past, it had accommodated the constellations that became markers for the changing seasons.

The following Table 1 is extracted from some of the *Pranata Mangsa* calendar documents and explained by Mbah Kaum, as a cultural leader. The signs for each month are written from the original poetical ancient Javanese language and translated literally by the researcher, but the explanation for each month is extracted from the cultural leaders' explanation. From the calendar, it can be seen if we return to the *Pranata Mangsa* calendar, interpreting it as guidance on the farmer's calendar is really detailed about what to plant and what signs are in nature.

Table 1 *Pranata Mangsa* calendar season sequence

No.	Mangsa/Month	Signs	Explanation
1.	Kasa/1 st 22 June – 1 August	<i>Sotya Murca Ing Embanan</i> Leaf fall from the trees	Leaf falls, grasshopper laying eggs, dry summer
2.	Karo/2 nd 2 August – 25 August	<i>Bantala Rengka</i> Cracked soil	Soil cracked, cotton and mango trees bloom,
3.	Katelu/3 rd 26 August – 12 September	<i>Suta manut ing bapa</i> the son of man must obey the mother earth	bamboo sprouts, tubers grow,
4.	Kapat/4 th 12 September – 13 October	<i>Waspa Kumembreng Ironing Kalbu</i> Tear drops are stored in the heart	sparrows lay eggs, weaver bird nest, cotton blooming
5.	Kalima/5 th 14 October – 9 November	<i>Pancuran Mas Sumawur Ing Jagad</i> molten gold drops from above	the caterpillar came out, the young leaves tamarind tree, the first rain fell
6.	Kanem/6 th	<i>Rasa Mulya Kasucen</i> feeling peaceful and purified	fruits everywhere, cockroaches in ditches, ducks in wet ponds

	10 November – 22 December		
7.	Kapitu/7 th 23 December – 3 February	<i>Wisa Kentar Ing Maruta</i> snake venom flew in the wind	Illness and disease occurs, flood,
8	Kawolu/8 th 4 February – 28 February	<i>Anjrah Ironing Kayun</i> happiness rose inside	mating cats, tall rice, earthworms
9	Kasanga/9 th 1 March – 25 March	<i>Wedaring Wacana Mulya</i> happiness is not just discourse	Rice blooming, crickets sounds loudly
10	Kasepuluh/10 th 26 March – 18 April	<i>Gedhong Minep Ironing Kalbu</i> greatness is stored in the heart	Yellowing rice, bird eggs hatch, mammals birth
11	Desta/11 th 19 April – 11 May	<i>Sotya Sinara Wedi</i> re-honed diamonds	Birds are feedings, harvesting time
12	Saddha/12 th 12 May – 21 June	<i>Tirta Sah Saking Sasana</i> water disappeared from its place	Dadap trees blooming, saving food in crop banks

Nowadays, practice of *pranata mangsa* calendar is combined with the daily Gregorian calendar as attached in Figure 13 below. In contrast, its use in the agricultural sector is another matter. Not necessarily all farmers in Java who have this combined calendar, apply it either for daily needs or farming. But the *Ngawu-awu* practitioner is clearly waiting for the fourth and third season to come.

Figure 13 Javanese Gregorian-Pranata Mangsa calendar



Source: Researcher

The *Ngawu-awu* farming system will focus on the third to fourth month of the *Pranata Mangsa* calendar (26 August - 13 October). Normally in Java, which still uses prey institutions, new rice is planted in the fifth month of the year which falls on 14 October - 9 November with the sign "*Pancuran Mas Sumawuring Jagad*" which means the first rain drop to the earth. In the *Ngawu-awu* farming system, the farmers in Tepus start sowing the seeds two months earlier.

From the results of the interviews and FGD 1, the researcher summarizes what signs are the indicators that the *ngawu-awu* are ready to be carried out. Firstly, plants behaviour indicator, ginger and turmeric, tubers, bamboo began to grow, and cotton tree are blooming. Secondly, animals' behaviour indicator, weaver birds nesting and sparrow nesting eggs. Thirdly, natural water resources indicators, the wells and groundwater sources began to dry up and the wind became dusty. As *ngawu-awu* comes from the Javanese word 'awu' which means dust, so *ngawu-awu* means farming in the dust.

The main reason they have to plant early is because in the rainy season, with all the land ready to be cultivated, the small farmers who practice this *ngawu-awu* will come to the rich peasants as farm labourers for cash. In addition, early planting in *ngawu-awu* helps farmers to avoid pests by planting together at the right time. In *Pranata Mangsa* they are sure pests will come and attack at the end of the harvest. From there they depart with the belief that pests coming at the end of the harvest will not be a problem, except for those who are harvesting late.

The factors that influence the practice of indigenous knowledge, to cope with climate change

Pranata Mangsa has three main indicators, namely star constellation, plants and animals behaviour, and social needs. Currently the constellations are only used as an indicator element, they are still obeyed, but only as a marker for when the ritual will be carried out. The rest of those practicing *Pranata Mangsa* will depend on the measurement of the season using the behaviour of animals and plants.

Adaptations used in the current practice of indigenous knowledge contribute positively on small holder farmer livelihood.

Vulnerability context

This section of the vulnerability context is part of answering the first research question on how traditional agricultural practices are affected by the climate crisis. Simultaneously, the analysis will use a sustainable livelihood framework which divides the vulnerability context into three parts, namely shocks, trends and seasonality.

Shocks

The sudden disaster experienced by farmers in Tepus is said to be a pest. Their local knowledge tells us that pests come in the final phase of the farmer's main crop. That is why farmers in Java believe that planting should not be intermittent for a long time. In one planting period, the same area should start planting together to avoid the victim of pests in the farmer who harvested the last crop.

"We plant in Ngawu-awu system, almost certainly the harvest is at the same time. This is because the seeds are sown in a one month time difference, the rice will grow together when the main rainy season comes. That is an advantage of the Ngawu-awu system because the harvest will also be almost the same. Ordinary farmers with sufficient irrigation systems experience this difference, the risk is that the last harvest will be attacked by pests." – head of farmers association

Seasonality

The main seasonal challenge faced by farmers is the fluctuations in harvest prices that often occur during the main harvest period. Nowadays farmers get around this with the existence of seed and

crop banks. Another seasonal challenge is the tourism sector, which is now a mainstay of the Tepus Sub-districts. This region has 5 beaches which are the main tourism destinations. Gunungkidul Regency is indeed famous for being a major tourist destination on the south coast of Java Island, by having dozens of beaches.

“Nowadays, fellow youths are more interested in working in the tourism sector. Especially if it's the high season, even a vehicle parking attendant can make a lot of cash. That is the reason why many are not interested in agriculture anymore. If they do not want to go to find a job in the city, another option is to work in the tourism sector to sell souvenirs, park guards, or ticket officers.” Young farmer 2.

Trends

The vulnerability context challenge faced by farmers on the trends side is youth who are reluctant to continue their career as a farmer. This finding is common in developing countries, but the reasons from the results of an interview with one of the young farmers who are also the village government officials are interesting to be investigated further.

“I am only in my 30s but most of my colleagues as farmers are old. Friends of the same age prefer to go to work to the city as anything with cash income. Gunungkidul Regency has also been one of the areas that has contributed to migrant workers in the capital (Jakarta, ed.) For a long time. If agriculture here is modern, they might want to survive. But because the natural resources are also not very good, and only rainfed agriculture, they choose to leave their homeland.” - Youth farmers 1

Current Practice of Ngawu-awu

Rice cultivation with the Ngawu-awu system is different from rice farming in general in Indonesia. If normally farmers sow the seeds, then after growing 15 cm they replant in watery soil, small farmers in Gunungkidul face another natural challenge, a limited water supply. The majority of Ngawu-awu practitioners are rain-fed farmers. They sow seeds in the third month of the Pranata Mangsa calendar, or two months before the prediction of the first big rain. The traditional agricultural calendar predicts rain for the fifth month.

The story of the failure in 2019 occurred in detail that it rained in early August, then the community was in a hurry to immediately sow the seeds. Furthermore, the rice seeds that have been sown on dry land rot because it only rains for three days, without further heavy rains came later. REFER

“But these day, even in the fourth period there is no nggaplek or season which is marked by the harvest of cassava.” – Old farmers 1

Videos as an evidences taken by research assistants in the field provide a complete picture of the Ngawu-awu procession. The pictures also inform the sequence of activities in ngawu-awu. Traditional agricultural principles in Java are closely related to rituals and prayers to nature. Since Hindu-Buddhism entered and continued with the entry of Islam, this immigrant religion was acculturated with previous rituals. Since now the majority of Tepus residents are Muslims, the prayers that are offered are a combination of prayers for nature and Islamic prayers.

The sequence of ritual ngawu-awu, among others, is to pray to nature and the land that provide livelihood. Second, pray for the seeds to be planted. Third, pray for cows that help farmers to plow on dry land. Fourth, plowing the land. Fifth, spread the seeds to dry land that has been plowed. Sixth, closing pray then eat together in the fields. These rituals accompany the whole Ngawu-awu process and are carried out throughout the fields that will sow the rice seeds. Figure below is a documentation of the process of sowing seeds on land that has been plowed in *Ngawu-awu*.

Figure 14 Process of Ngawu-awu



Source: Co-researcher

The government, through the agriculture department, has a planting calendar called KATAM which is socialized through agricultural extension agents. When this research was underway, I tried to access the calendar on the national website of the Indonesian Ministry of Agriculture but observed that the website still displays the 2015/2016 planting calendar, not the current year. The head of a farmer group in Tepus said that the agricultural extension provided predictions of rain to come in the field.

“The planting calendar of the agricultural service often misses in predicting the coming rain. we prefer to believe in natural signs that are around and have been practiced by our ancestors from generation to generation.” – old farmer 1

This fact disturbed my mind and made me ask about the perceptions of smallholder farmers towards KATAM in the FGD. One old farmer explained that it was better for them to watch for signs of the surrounding nature to wait for the rain to fall. The farmer association then replied that the existence of agricultural extension workers and how they adopted KATAM would be correlated with fertilizer rations and other matters relating to agriculture from the government.

Figure 15 Process of Ngawu-awu



Source: Co-researcher

"The existence of agricultural extension agents is also a medium for government policy. If we comply with them, that is also meant to streamline various programs including assistance from the government. So we have to follow their policies, even though the people in the field still adhere to the knowledge of Pranata Mangsa from their ancestors." – Head of farmers association of Tepus.

In certain cases one of the farmers expressed their frustration with the KATAM being applied through the agricultural extension agents from the government.

"We are often seen as farmers or small residents who do not obey the government. However, when we try to comply, the calendar from the agriculture agency also often misses." – farmer 4

Inclusiveness

Findings related to inclusiveness will bridge the section influence of climate change on indigenous farming practices with governmental agricultural regulations. Two kinds of inclusivity will be analysed, within the group of actors of indigenous knowledge practices and outside the group. After internal community inclusiveness, the structure of the report will directly goes to findings about the effect of governmental agricultural policies with traditional knowledge.

Within the community, farmers in Tepus are not fully aware of the use of indicators for prey structures. Reading the constellations and wooden planks of the traditional calendar is now known to only a few people. One woman farmer in Tepus illustrates this as in the quote below.

"We women don't really understand how to read the ancient Javanese agricultural calendar. The ones who know better are our husbands. So in the field we just have to follow what to do, but we still follow the agricultural traditions of our ancestors." Women farmer 1.

This study does not use gender analysis as the main part of the research, but this field data allows researchers to include this element. In Tepus, there is an agricultural program from the agriculture agency to empower a group of women farmers called 'Kelompok Wanita Tani' (KWT). Women tend to be excluded from decision-making in the agricultural system in Tepus.

The activities carried out by KWT are more about empowering women for processing agricultural production, not for being involved in the main agricultural system which is the focus of this research. Even so, the women's agricultural group in Tepus should be appreciated as a way for the agriculture agency in Indonesia to provide portions for women to be actively involved.

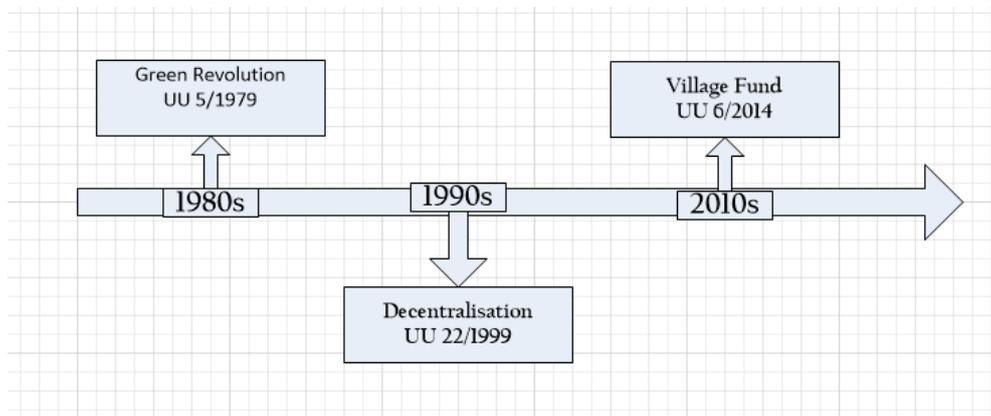
The problems of inclusivism need for indigenous knowledge practices are also found for youth generation. One youth respondent only knew part of the prey governance practices. The issue for youth was mentioned earlier in the vulnerability context section of going to the tourism sector as an income generating.

The consequence of changing Indonesian agricultural regulation to the practices of *Ngawu-awu* in Tepus

The findings for the second sub-question for the main question of this second research will be correlated with the key informants interviews and second FGD that was carried out in the data collection process. This FGD was dominated by head of the village and his secretaries. Commonly in villages in Indonesia these two people are the main actors in how policies are applied in their regions. Even so, in the FGD process, other participants such as traditional leaders, old farmers and farmer group leaders still provided eloquent input for this research.

This section will also be a combination of answers to the question of the impact of changes in agricultural policy in Indonesia with traditional agricultural practices, as well as the application of structures and processes in the sustainable livelihood framework. My main objective in this chapter is to trace the regulations and policies of the government related to agriculture which affect the practice of *Ngawu-awu* in Tepus. Before explaining it in the next sub-chapters, the image below provides a snapshot of the three main phases that become a reference for changes in governmental agricultural change that have had an impact on the practice of *Ngawu-awu* in Tepus.

Figure 16 Three major shift in agricultural regulations that affect *Ngawu-awu* in Tepus



Source: Researcher's own construct, 2020

Green revolution

Findings about the effect of agricultural policy changes in Indonesia on local knowledge practices such as *Ngawu-awu* in Tepus, bring us back to the 1970s. In the FGD, the village head of Tepus, who did not know exactly when the change occurred, became an explanation by asking one of the old farmers in the village.

"That happened in the late 1970s, when we farmers were introduced to the IR 32 paddy seeds. Previously, for Ngawu-awu, we had always used local "Gogo" seeds. This local rice has large stems, the rice is not too fluffier, and the yield is not much but it persists in all natural conditions from minimal water to resistant to several local pests as well." – Old farmer 1

The introduction of hybrid rice seeds together with the arrival of two systems of agricultural extensification and intensification in Indonesia then spearheaded the apparent success of the "Orde Baru" to achieve national rice self-sufficiency in 1980.

In 1979 the Indonesian government issued Law no. 5/1979 on Village Government. This regulation was the first to adjust all village government in 'one uniform' called 'Desa'. The smallest deepest units of government in Indonesia since law was issued to be called 'Desa'. Previously, villages throughout Indonesia varied both in name and in terms of bureaucratic structures, depending on each culture of the origin of region. Each major tribe or culture has its own rural system. However, Law no 5/1979 really uniformed everything to be the same throughout Indonesia, namely 'Desa'.

At the same time, the Indonesian government through agricultural intensification began to apply the concept of '*masa tanam*' or a more structured planting period. The explanation of the old farmer 2 below gives an idea of what planting period is.

"I forgot the exact year, but it was around the New Order. We are introduced to the term "MT" which is divided into MT 1, 2 and 3. On average, irrigated land should plant two main crops and one alternate crop every year. Ngawu-awu farmers only apply rice during the main planting period or MT 3." – Old farmers 2

Since the MT era, agriculture in Indonesia has also divided government practices related to agricultural business with three MTs. This application will relate to all existing systems in governmentality regarding agriculture, including the one whose effect is most felt is a matter of budgeting. Along with the equality of the village concept, came various agricultural regulations that coincided with the green revolution in the 1970s.

Decentralization

The second phase of changes to agricultural governmental regulations that affect the practice of Ngawu-awu in Tepus is the decentralization process in Indonesia. This phase coincided with the reform process that took place in Indonesia in 1998. This period marked the end of the "*orde baru*" era under President Soeharto's regime which previously lasted for 32 years.

The era of decentralization in Indonesia was marked by the shift in the centre of government which was spread to each regional government in stages, namely to the provinces and districts. Previously, the *orde baru* period was very centralized and repressed power with militarism. The mark of this period was when the Indonesian government issued Law no. 22/1999 on regional governance.

In relation to agriculture, this decentralization has begun to divide decision-making in the regions independently through local department of agriculture. Although still with structural oversight tiered to a level above it, the local agriculture agency began to have the freedom to determine their policy direction. The impact of this period on the Tepus is that the district of Gunungkidul has programs that only they have and is different from other districts in the vicinity.

“After the New Order era ended, the agriculture agency began to aggressively record local potentials. Since then, there have been many researches on how this karst area should be cultivated for agriculture. So far, many have researched natural groundwater sources. Because our main problem is lack of water resources.” Farmers 3

Indonesian Law of Village and Village Fund

Since 2014, issued the latest rural regulation namely Law no. 6/2014. This law is commonly called “UU Desa” or the Village Law and Indonesia has a Village Law supplemented with an annual village fund of 1 billion Rupiah or roughly the equivalent of 70,000 Euros for each village. This policy was implemented immediately and village funds were also channelled directly from the central government to villages without intervention from the district or province. Villages also have full freedom to manage the allocation of needs, planning and utilization of the annual village funds.

“Since there is a village fund, we have the right to determine what will be used for agricultural needs from that fund. However, one problem is that he has to follow three planting periods according to the regular calendar (gregorian, red). Because we use a traditional planting calendar, during the last planting period we definitely have to borrow funds before disbursing funds for the beginning of next year.” – head of village of Tepus

Village funds are generally used to build infrastructure and implement community empowerment such as training. The funds referred to by the village head of Tepus above are used for local farmers' needs, such as redeeming subsidized fertilizers and purchasing rice seeds.

So in practice, the difference in the use of the traditional planting calendar which is lunar-based is also problematic with the public administration in Indonesia which uses the Gregorian calendar.

Local Government Policies

Tepus Village, Gunungkidul Regency is located in the Yogyakarta Special Region Province. Since decentralization in Indonesia was declared in the late 1990s, each region has the freedom to determine its own policy direction. However, Yogyakarta as a special region has its uniqueness because it is the only province that still adopts the traditional royal system until now. The king who leads this province, also automatically becomes the governor of the administrative governmental zone.

This privilege should be able to become a fulcrum for the optimization of local knowledge such as *Pranata Mangsa* and *Ngawu-awu*. Yogyakarta Province medium-term development plan, also called “RPJMD 2017 - 2022” provide space for the implementation of local knowledge as cultural heritage. The mission of the RPJMD is to use the local Javanese language ‘*Among Tani Dagang Layar*’ and the meaning is taking care of farmers and opening sail boats. The space to adopt localities including indigenous knowledge in Yogyakarta province is wide open.

Chapter 5 Discussion

The previous chapter on findings will be refined in this section of the discussion. This chapter will bring back all the research question instruments to be analysed using a study framework and literature review. The first part of the research question that I brought up focused on climate change happening in Tepus. The framework used for this section is the livelihood assets of the residents and the vulnerability contexts they have to face.

The current Ngawu-awu traditional farming practices used by small holder farmers in Tepus to cope with climate change

The practice of the traditional Ngawu-awu farming system is proven to still be relevant and can be applied in recent times as a strategy to deal with climate change. Some of the advantages of this indigenous knowledge is that it has been applied for a very long time and has aided the people in the local community in dealing with challenges that developed as a result of the green revolution and decentralization.

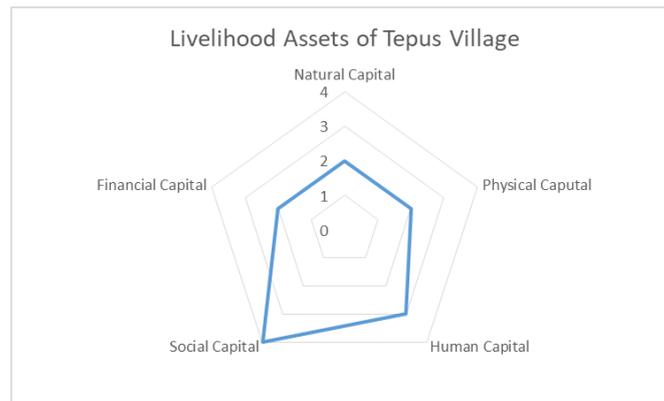
The position of the star constellation changes over a thousand years but the weather changes faster due to climate change hence, one of the star constellation has become irrelevant in weather monitoring however, local communities still use it in performing rituals to nature. Farmers however use Pranata Magsa indicators such as plant and animal behaviour as natural signs. Climate change has an impact on the lives of farming communities in Java. Animals and plants are able to provide and indicators when the new season will come (Shindunata, 2011).

The finding showed a correlation between co-planting among farmers and the avoidance of pests and disease. Avoiding pest with co-planting among farmers is indigenous knowledge worthy of preservation. However, the rainy seasons have become more difficult to predict due to climate change. This is one area that requires special attention and which can be solved by combining local knowledge with modern knowledge. The combination of indigenous and scientific knowledge can potentially be used to face a very specific vulnerability context (Mercer, Dominey-Howes, Kelman, & Lloyd, 2007). A study on the effect of joint planting and prann on pest control efforts was conducted by Wisnubroto. His research focuses on rice stem borer pests which decrease in intensity when rice in a community is planted at the same time (Wisnubroto, 1998). To conclude, the practice of *ngawu-awu* which depends on the rainy season, and causes paddy plants to grow together can reduce the risk of pests and plant diseases.

The effects of climate change on the smallholder farmers' livelihood in Tepus

The analysis of livelihood assets in this study shows that the Tepus community has limited natural assets, physical assets, and financial assets. These three capitals are the main challenges that the Tepus community must face. With natural limitations such as karst soils and the lack of natural springs, the farming system in Tepus is difficult to optimize. Eventually they just become rainfed farmers. Meanwhile, in the other two assets, namely human assets and social assets, Tepus actually have strength on this side. The image below reflects the livelihood assets in Tepus which has been processed from the FGD and key informant interviews.

Figure 17 Livelihood Assets of Tepus Village



Source: Researcher's own construct, 2020

In facing climate change, the availability of livelihood assets is an important factor. Maintaining the stability of assets in order to be ready to face climate challenges is the main thing that must be done to maintain livelihood (Verner, 2010).

As discussed earlier, human capital is the most important starting point why *ngawu-awu* is practiced. This agricultural system maintains the stability of the availability of human resources in a community. They work together by managing work time as a groups. Because on average small holders farmer work elsewhere for cash during the main planting period, they work alternately in the neighbouring fields for free.

This kind of mutual cooperation above in Indonesia is commonly referred to as *gotong royong*. In Java today, *gotong royong* has metamorphosed in a more flexible way in terms of social construction (Irfan, 2017). The principle of mutual help without compensation, although informal, also has social sanctions for those who do not implement it. For those who don't help planting in their neighbours, in the future, it will be difficult for them to find people who want to help if they need help (field interview, 2020).

The impacts of climate change on the practice of *Ngawu-awu*.

In 2019, crop failure at Tepus left small holder farmers in debt as many of them had to buy seeds from the seed bank on credit. This was as a result of their seeds refusing to germinate, probably because they had rot in the soil. This created awareness of the risks involved in *Ngawu-awu* practice among small holder farmers. In the face of climate change with unpredictable weather conditions, *Ngawu-awu* could pose a threat on local farmers however, these farmers have no other choice.

Small holders farmer who own rain fed plantations have to work in other fields or even other sources of livelihood when the main rainy season comes. This is what causes farmers to depend on the traditional *Ngawu-awu* farming system. Given this fact, the government needs a solution to adjust their policies to accommodate the needs of small holder farmer who still practicing *Ngawu-awu*.

Adaptations strategies are used in the current practice of *Ngawu-awu* in facing agricultural policy change in Indonesia

The most obvious adaptation in Tepus about the *Ngawu-awu* agricultural system practitioners is how they negotiate two main things in this research, climate change and governmental agricultural rules and regulations in Indonesia. This section focuses on the influence of regulations, legislation, and rules on indigenous farming knowledge practices in Tepus.

The changes of agricultural policies in Indonesia and their impacts on the practice of Ngawu-awu in Tepus

Budgeting problems are still one of the biggest scourges in the development process in Indonesia. One of the spirits of UU 6/2014 is to streamline the bureaucratic process of development in villages that are too complex and lengthy. Law No.6 / 2014 gives each village to directly take care of its village budget directly from the centre, without going through the province or district.

The law on villages in Indonesia, since Law 5/1979 which came with the green revolution, Law 22/1999 along with decentralization and Law 6/2014, have influenced the development of the entire development process in villages in Indonesia (Mahanani & Ghofur, 2020). National standard seed policies, district agriculture service programs and now village funds, the whole process affects adaptation to *ngawu-awu* practices. However, the peasants of *ngawu-awu* remain just as they are with 90% of the smallholder farmers in Tepus still practicing it (interviewee, 2020).

In the other hand, the application of traditional agriculture also hopes that the government will implement several things in the field, such as inputs, subsidized fertilizers and seeds. The problem with the government budgeting application in Indonesia so far is that they use a Gregorian calendar while farmers are *ngawu-awu* when it will rain. The *ngawu-awu* planting period is a period where on average comes at the end of the year, when the village government can no longer access funds in village funds or funds from other government agricultural programs such as the ministry of agriculture programs.

Implemented strategies to bridge the gap between governmental agricultural policy and Ngawu-awu practice

The effects between changes in agricultural regulations in Indonesia and traditional agricultural practices are correlated with each other. This study finds three major changes in agricultural regulations in Indonesia that make *Ngawu-awu* practice adaptable. First, the green revolution which brings new seeds for *Ngawu-awu* agriculture which previously used local "gogo" rice seeds. The arrival of the green revolution in Indonesia resulted in the extinction of hundreds of indigenous local rice seeds in Indonesia (Iskandar & B.S., 2018). The exact number of extinctions is difficult to trace but the number is in the thousands, however, Indonesia currently only has 3000 local rice seeds left (MAS/RYO, 2008).

Secondly, decentralization that brings development is more based on the context of local potential and resources. Thirdly, the 2014 Village Law, which provides an annual fresh fund which affects the development policy in rural areas in Indonesia. Since then, village funds have become a development cake that has made all sectors including agriculture have to adjust. *Ngawu-awu* practitioners must follow the legislation of the 2014 Village Law which uses the annual timeline of the Gregorian calendar. These funds will correlate with the time the funds are disbursed when farmers receive assistance or development programs from the government.

The gap that exists between government regulations and *Ngawu-awu* can be bridged with the Jogja Privileges Law Law 13/2013 which can accommodate the potential of local knowledge. In his speech to commemorate the 8th anniversary of the implementation of Law 13/2013 this year, *Sri Sultan Hamengkubuwono X* the king as well as the governor of the special province of Yogyakarta, mentioned the preservation of cultural wealth, one of which is *ilmu titen* (Hamengku-Buwono-X, 2020).

The *ilmu titen* referred above is a Javanese local knowledge to read signs from nature. One of the applications of this title is the *Pranata Mangsa* calendar which is used in *ngawu-awu*. This support from the king is a good sign for the application of indigenous knowledge in Tepus. Even though it still requires some approaches, perhaps local government could support *ngawu-awu*.

Reflection as a researcher

I have had the desire to choose *Ngawu-awu* as the theme of my thesis since the first period of the study at VHL however, the research has become a burden in itself because from the start, I set a high expectation for this research. The research became too tasking and difficult to achieve nonetheless, this is one topic I am already in love with.

I work at PSPK which is concerned with rural development. Being a part of this institution led me to investigate the agricultural problems faced by locals in rural areas of Java. It is in the course of my investigation that I discovered and became interested in Indigenous knowledge of *pranata mangsa* planting calendar and its practice for rain fed *ngawu-awu* agriculture.

The fact that we could not return to our home country for field data collection really hit me. Since then, I became skeptical about meeting the expectations I had for this study. My most prominent challenge was relaying my research questions to my research assistant in the field.

The time difference between the Netherlands and Indonesia was also a big challenge for me. With a 5 hour difference, it gets to noon in Indonesia when it is still dawn at Netherlands. On the other hand, when it is afternoon in the Netherlands, Indonesians are already sleeping. This affected my working hours and sleep time to enable me make appointments for interviews with residents or respondents in Indonesia.

The experience of doing research during this pandemic also taught me quite a lesson. Remote study is possible. The online interview and online group discussion methods were able to provide relevant data even though it is not exactly the same as when we go to the field. The feeling obtained will be more perfect with the interactions that occur between the researcher and the object being studied. Interaction with sources will also provide opportunities to explore a problem more deeply.

In addition, my study is concerned with the natural signs used by smallholders in determining harvest time. These natural signs will certainly be felt more when I have the opportunity to see with my own eyes. The constellations, animals and plants behaviour, the colours of natural water resources, I imagine I could have the opportunity to research more deeply.

One new thing for me is the visual method. From there I found a new network of acquaintances with documentary filmmakers in Yogyakarta. Some of them were kind enough to talk about local knowledge, especially about *Pranata Mangsa* and *Ngawu-awu*. The film that I referenced in this research is a documentary film which explains these practices to the audience in very simple language.

If I have another chance to do this research I certainly hope to do better. This kind of qualitative research requires full involvement and intimacy between the researcher and the object of study, just like ethnography. The experience of working on a thesis during this pandemic has really taught me a lot, both in an academic context and for life. With all its limitations, the results of this research are my maximum efforts to express what I learned while studying Food and Nutrition Security at Van Hall

Larenstein University of Applied Science. I would like to contribute thoughts about what is experienced by smallholders in Tepus using the approach from my study at VHL.

Chapter 6 Conclusion and Recommendation

Conclusion

The conclusion of this study will use a part of the sustainable livelihood framework and research questions to explain the results of the research. The vulnerability context faced by Tepus residents is indicated by three main things which are sudden-shock disasters in the form of pests and diseases, seasonal disturbances in the form of a trend to go to work to the city, and climate change as a long-term vulnerability. As I explained earlier in the findings and discussion section, *Ngawu-awu* is part of the livelihood strategy that is still used by small holder farmers in Tepus to achieve the livelihood outcome.

When the star constellation cannot be used as a guide by *Ngawu-awu* practitioners to indicate when the first rain will fall, the existence of the traditional *Pranata Mangsa* calendar system needs to be discussed. From the field findings, three signs are used in *Pranata Mangsa*. Apart from the position of the constellations, the other two signs that are relevant for use are animals and plants behaviour and natural water resources. Smallholder farmers in Tepus who practice *Ngawu-awu* now only use constellations signs to determine the days when they can carry out rituals. Other *Pranata Mangsa* signs except star constellation can be used by local farmers in determining when to sow.

Climate change definitely affect to smallholder farmers' livelihood in Tepus. Unpredictable weather conditions due to climate change have had an impact on smallholder farmers. As disclosed by BMKG that the five major disasters facing Indonesia are related to hydro-metrology disaster related to water, farmers who's their livelihood are closely related to water are the most suffered. More specifically, smallholder farmers practicing *ngawu-awu* face the direct impact of the difficulties of weather predictions as most of them are rain fed farmers.

Findings from the field and previous literature review shows that smallholder farmers in Tepus still practices *ngawu-awu* even though there have been some adjustments. The community still applies the *ngawu-awu* farming system, due to reasons such as limited natural resources, rain fed agriculture, and the need for the local farmers to work elsewhere when the rainy season comes. Among the advantages that can be learned from this study is that co-planting in the same time of *ngawu-awu* can reduce the risk of pests and plant diseases and is able to manage human resources for small scale farmers.

In the other hand the negotiation with the agricultural government rules and regulations, the researcher reviewed three major change in rural development in Indonesia; green revolution, decentralisation and Indonesian Village Law No. 6/2014 which had an influence on traditional agricultural practices in Tepus. Changes in the regulatory system related to agriculture also makes these traditional agricultural practices adaptable. Furthermore, the farmers also had to adjust the indigenous knowledge that they held for several generations.

With the arrival of the green revolution, farmers needed greater access to basic agricultural technologies such as ploughing, new crop varieties, and fertilizers, before they can benefit fully from weather forecasts. In light of this, if the local rice seeds "gogo" used by local people together with traditional systems had been planted consecutively, the locals can develop according to local natural needs, including dealing with local pests.

The recognition of the farmers, upland rice has only changed to IR 32 since agricultural modernization came to Indonesia in the 1970s. This modernization then led to the success of making Indonesia a self-sufficient country in rice in the 1980s. Many literatures state that Indonesia also began to lose hundreds of local rice seeds because the government structurally continued to insist on boosting rice production with technical standards that were able to increase rice production.

The arrival of village funds and Law 6/2014 gave new hope for villages to develop local potencies. However, the lengthy bureaucratic process remains a challenge for farmers. When local farmers practicing *ngawu-awu* have to wait for the rain to fall first before determining the planting period, the government has limitations in issuing village funds at the end of the year. The limitations of village funds, which, although they are readily available, are inflexible in terms of access, are a challenge for smallholder farmers practising *ngawu-awu*.

Recommendation

Based on the findings, discussions and conclusions that have been presented, the following recommendations are proposed.

1. When a natural sign becomes a benchmark for smallholder farmers in Tepus to predict rainfall and determine when seeds should be sown, special attention should be given to gain a better understanding on *ngawu-awu*. Further studies on *pranata mangsa* and *ngawu-awu* institutions should involve physical field observation so that researchers are not separated from the object of study by distance. In addition, further research using measurable scientific methods to investigate advantages and disadvantages of the natural signs used by local residents is required. There is a need for academic institutions like UGM, PSPK to carry out trans-disciplinary research on *pranata mangsa* and *ngawu-awu*. The complete assessment result of trans-disciplinary research can be used as a reference for planning development, including the formulation of regulations and regulations that accommodate the advantages of *ngawu-awu* and *pranata mangsa*.

UGM has an annual community service program equipped with several resources and funds and also involves researchers and students. PSPK can take advantage of this annual program to realize a deeper research plan on *pranata mangsa* in Gunungkidul. Trans-disciplinary needs planning and must be done in consequently and sustainable in a long run from planning, research process until program implementation. Apart from using UGM internal resources, PSPK can collaborate with other research institutions and private sectors or local governments in carrying out long-term programs in Gunungkidul to implement the programs plan.

2. The results of the trans-disciplinary study could be a starting point for *ngawu-awu* to have a bargaining power in government regulations. If indigenous knowledge has bargaining power and strength, they could no longer have to keep adjusting their practices with the latest regulations and regulations from government without a reason. Yogyakarta Province has a special law in UU 13/2013 which gives the local communities the right to make their governmental regulations based on local cultures and needs. This chance should be used as an opportunity for the government to give recognition to traditional agricultural practices.

The recognition of indigenous knowledge will be the beginning of combining modern knowledge and traditional knowledge related to the use of *pranata mangsa*. Furthermore, the official weather forecast from the government needs to be updated more often to give a picture of the seasons to rain fed smallholder farmers.

3. Customary leaders, the authority who determine the rituals and customs of *pranata mangsa*, need to be more open to dialogues with scientific modern science to explore the advantages and disadvantages of their indigenous knowledge. This cultural authority should also be more inclusive of all members of its society, including youth and women groups in decision making. The process of inclusivism can be started from introducing indigenous knowledge to all members of society who need to use *pranata mangsa*. Inclusiveness through indigenous knowledge dissemination will also directly preserve local culture which could be extinct without teach it to the next generation. This last recommendation is also depend on the first recommendation of this study was carried out, further trans-disciplinary research.

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APPENDIX

APPENDIX 1 Fieldwork research guideline and checklist

In-depth Interview Guidance

Interview through whatsapp call and being recorded

1. General information for all key informants related to research topic
 - Knowledge about Ngawu-awu
 - Current practice of Ngawu-awu
 - Knowledge about pranotomongso
 - Current practice of pranotomongso
 - How they experience climate change??
 - The changing of traditional farming system due to climate change
 - How the changes of Indonesian agricultural policy?
 - The changing of the practice of traditional farming system due to the changing of agricultural policy in Indonesia

Specific question for each key informant based on their positions and functions

- a. Traditional/cultural leader
 - Explanation about the pranotomongso farming guidance calendar.
 - How to predict the weather through three main aspects of pranotomongso calendar?
 - Explanation of change in the pattern of pranotomongso prediction system due to climate change over years?

- b. Head of Village
 - Five assets/capitals of Sustainable Livelihood Framework in Tepus village.
 - The practice of traditional farming system.
 - The changing of agricultural policy and its relation to the practice of traditional farming system.

- c. Head of farmer community
 - Do they still use pranotomongso currently and how does it influence the production?
 - What is the different practice from past and current times?
 - How does the change during unpredictable weather conditions due to climate change?
 - How does the change of Indonesian agricultural policy influence/affect traditional farming system?

- d. Old farmers representative
 - The original practice of pranotomongso.
 - The original practice of Ngawu-awu.
 - The change of the practice of traditional farming system over years.
 - Why/what do you do/don't do in this traditional agricultural system?
 - How do you communicate this tradition to young farmers? Transfer of knowledge..

- e. Youth farmers representative
 - How they deal with old system and new situations?
 - Do they still have interest in traditional farming system?
 - If you heard about pranotomongso, and how you knowledge about pranotomongso and ngawu-awu? Do you applied this traditional agricultural system?
 - Why/what the do/don't this traditional agricultural system?

Online FGD Guidance

Discussion trough zoom online meeting application and being recorded

Facilitator : researcher (myself)

Co-facilitator : Co-researcher (Agung Kresna Bayu)

Participants :

- Researcher of PSPK
- Head of Tepus village
- Traditional/cultural leader of Tepus village
- Old farmer of Tepus village (2)
- Youth farmer of Tepus village (2)

Video re-enactment guidance

Videos will be taken by researcher assistance in Tepus, Gunungkidul, Special Region of Yogyakarta, Indonesia.

Duration : 30 – 45 minutes

List of videos scene :

- The process and practices of *Ngawu-awu*
- How to using pranotomogso calendar
- Traditional ceremony related to pranotomogso calendar

Video elicitation

Youtube keywords : Gunungkidul, Pranotomongso, Ngawu-awu

Documentary films : “Negeri di Bawah Kabut”, “Pranata Mangsa: The Sign”

Titles will be added if in the process of research found a new documentaries

APPENDIX 2: Consent Form

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Date : 20 September 2020

Name of Student : Mohammad Ghofur

E-mail address : mghofur87@gmail.com

Theme/Study : THE IMPACT OF CLIMATE CHANGE AND AGRICULTURAL REGULATIONS ON SMALLHOLDER FARMERS PRACTISING 'NGAWU-AWU' (A CASE STUDY IN TEPUS VILLAGE, GUNUNGKIDUL, YOGYAKARTA, INDONESIA)

APPENDIX 3 Fieldwork in Corona times

I ran into a tremendous dilemma while doing this research. I had determined the topic long before the corona pandemic spreading through the whole world. Field-work data collection is very important for this research. *Ngawu-awu* is only done once in a year in Gunungkidul, which is two months before the rainy season comes, or around July-August. Being unable to go to the field for data collection, I have to think again about what methods to use. VHL provides guidelines on what methods are possible to use during a pandemic. Several methods, assisted by communication technology, can be sufficient to assist field data collection. Even though it's not really like doing data collection in field research, other methods such as the visual observation method that I use provide sufficient evidence for what I am looking for in this study. We don't know when this pandemic will be completely over. Even if it is finished, it is possible that in the future the pandemic will occur again and social distancing must be enforced again. We must prepare for the 'New Normal', including for academic institutions. The experience of doing research in the midst of this pandemic is a very meaningful lesson for me.