Climate Risk Management 32 (2021) 100298

Contents lists available at ScienceDirect

Climate Risk Management

journal homepage: www.elsevier.com/locate/crm

Cultural consensus knowledge of rice farmers for climate risk management in the Philippines

Clarissa Ruzol [a,b,*], Laizha Lynn Lomente [a], Juan Pulhin [a,c]

[a] Integrated Natural Resources and Environment Management, University of the Philippines Los Baños, Philippines
[b] Department of Anthropology, London School of Economics and Political Science, United Kingdom
[c] Department of Social Forestry and Forest Governance, University of the Philippines Los Baños, Philippines

ARTICLE INFO

Keywords:
Consensus knowledge
Weather forecasting
Agriculture
Climate risk

ABSTRACT

Despite efforts and investments to integrate weather and climate knowledges, often dichotomized into the scientific and the local, a top-down practice of science communication that tends to ignore cultural consensus knowledge still prevails. This paper presents an empirical application of cultural consensus analysis for climate risk management. It uses mixed methods such as focus groups, freelisting, pilesorting, and rapid ethnographic assessment to understand farmers' knowledge of weather and climate conditions in Barangay Biga, Oriental Mindoro, Philippines. Multi-dimensional scaling and aggregate proximity matrix of items are generated to assess the similarity among the different locally perceived weather and climate conditions. Farmers' knowledge is then qualitatively compared with the technical classification from the government's weather bureau. There is cultural agreement among farmers that the weather and climate conditions can be generally grouped into wet, dry, and unpredictable weather (*Maria Loka*). Damaging hazards belong into two subgroups on the opposite ends of the wet and dry scale, that is, tropical cyclone is grouped together with La Niña, rainy season, and flooding season, while farmers perceive no significant difference between El Niño, drought, and dry spells. Ethnographic information reveals that compared to the technocrats' reductive knowledge, farmers imagine weather and climate conditions (*panahon)* as an event or a phenomenon they are actively experiencing by observing bioindicators, making sense of the interactions between the sky and the landscape, and the agroecology of pest and diseases, while being subjected to agricultural regulations on irrigation, price volatility, and control of power on subsidies and technologies. This situated local knowledge is also being informed by forecasts and advisories from the weather bureau illustrating a hybrid of technical science, both from the technocrats and the farmers, and personal experiences amidst agricultural precarities. Speaking about the hybridity of knowledge rather than localizing the scientific obliges technocrats and scientists to productively engage with different ways of knowing and the tensions that mediate farmers' knowledge as a societal experience.

1. Introduction

Weather and climate information is integral to climate risk management that aims to systematically reduce risks from climate

* Corresponding author at: Department of Anthropology, London School of Economics and Political Science, United Kingdom.
E-mail address: clarissa.ruzol@gmail.com (C. Ruzol).

https://doi.org/10.1016/j.crm.2021.100298
Received 17 October 2020; Received in revised form 26 February 2021; Accepted 7 March 2021
Available online 12 March 2021

variability, while taking advantage of opportunities to improve resilience. The system of assessing climate risks revolve around studies on climate modeling, technologies to mitigate carbon emissions and adaptation to reduce damages. These paradigmatic approaches that define the present discourse of climate risk management narrow our gaze and our knowledge on how weather and climate information are generated and interpreted. A study on climate change adaptation in Bangladesh, for example, finds out that an overemphasis on technology overlooks cultural mechanisms based on informal, community institutions (Islam and Nursey-Bray, 2017).

Philippine scholarship on the broad topic of climate studies has been shaped by the international discourse on vulnerability and adaptation as early as the 1980s. International funding flows into the country's research institutions under the unquestionable premise that the Philippines is one of the most vulnerable countries in the world to climate change. The dominant approaches that have prevailed and valorized among research institutions in the Philippines, and in climate policy in general (Adger et al., 2013), have largely focused on its material aspects such as modeling the impacts of climate hazards and events on livelihoods and lives, and the institutional dimensions of adaptation strategies. In the Philippine academic and policy parlance, it is conventional to frame climate and disaster studies around public perception of climate change, coping strategies, capacity building, community-based organizing, and local knowledge. However, while researchers and practitioners acknowledge the interactions between society, communities, institutions, and the climate system, very sparse studies have dealt in great depth into this subject matter (See for example Peñalba et al., 2012; Pulhin et al., 2016). Interestingly, the discourse of disaster capitalism that that directly links state and economic arrangements together with the otherwise apolitical responses to disasters have been received with marked attention by Filipino scholars after the devastation of Typhoon Haiyan in 2013 (e.g. Uson, 2017; Yee, 2018; Porteria, 2015). There were calls There call to emphasize the cultural dimensions of climate risks and adaptation, for example by Adger et al. (2013) and from several empirical writings, still research looking into the immaterial dimensions of how people interact with the weather and climate systems are marginal. This paper sets out to contribute to this marginal literature.

The value of this paper could be most effectively communicated if placed in comparison to studies that look into climate risk perception. While farmers' perception are important in climate risk management (Mase et al., 2017; Abid et al., 2016), the analyses provide an incomplete interpretation of accumulated content and information from surveyed individuals that exclude the perspective of the collective. This method of assessment undermines the fact that several of the serious contemporary environmental problems and risks, including climate change, are invisible and cannot immediately be perceived by our individual senses. Perception is not only driven by the individual's senses, but also by consensus knowledge, a single culturally correct answer to a question. People believe the set of facts, or alternative facts, that support the worldview they share with their community. Despite the many literacy efforts to communicate climate risks, strategies remain ineffective because worldview and not scientific understanding largely influences climate risk perceptions (Stevenson et al., 2014).

In this study with smallholder rice farmers in Barangay Biga, Calapan City, Philippines, cultural consensus analysis was used to address this limitation in climate risk management and, in particular, local perception and awareness studies. Cultural consensus analysis is a method developed in the 1980s by cognitive anthropologists (Zanotti et al., 2010). The consensus method is one of the analytical techniques in cultural domain analysis. It estimates the culturally best responses determining shared cultural beliefs and the informant's reliability in a cultural domain (Weller, 2007). This analytical method has been commonly used in ethnobotanical/ecological studies, for example, to elicit local understandings of flora and fauna for conservation and management (Gollin et al., 2004; Nekaris et al., 2018; Van Holt et al., 2010). However, there is no research on the local understandings of the weather and the climate using cultural consensus analysis except perhaps the study by Carothers et al. (2014) in northern Alaska where they found out that local observations of climate changes are experienced within the context of social and economic changes shaping rural Alaskan communities.

In this paper, the types of weather and climate condition (*lagay ng panahon*) experienced by rice farmers in Calapan City in Oriental Mindoro were examined and compared with the technical classification from the Philippine government's weather bureau with the aid of cultural consensus analysis. At present, there are numerous weather and climate products from the government's weather bureau, the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). This set of processed technical information is readily available to the farmers online and through broadcasts from the television or the radio. However, it would be problematic to assume that farmers organize their own knowledge about the weather and the climate similar to that of PAGASA by reducing and classifying observable data into categories like advisories, forecasts, and warnings. The paper highlights the value of pairing cultural consensus analysis with ethnographic information to gain a better understanding of how farmers' knowledge of weather and climate conditions is situated within the societal context of farming. This study encourages researchers to look at climate risk management from a political and moral standpoint, and to view local knowledge as a result of persistent oscillations between different knowledge traditions—that of the farmer's experiential and relational knowledge and the technobureaucrat's scientific categorization of the weather and the climate. The next section emphasizes the fundamental need to contextualize, particularly the cultural meaning of 'farmers' and 'farming' in Oriental Mindoro, Philippines, as part of the research methodology.

2. The farmers in the context of rice farming in Oriental Mindoro, Philippines

The island of Mindoro in the Philippines is divided into two provinces, Oriental and Occidental Mindoro, by mountain ranges that traverse from the northeast to the southwest. Mindoro Island is one of the largest producers of rice in the country but this was not the case before the turn of the 20th century. Prior to the American occupation in the 1900s, two-thirds of the island of Mindoro that has a total land area of approximately 10,572 km^2 was covered with forests. The Mangyan ethnolinguistic groups are the indigenous peoples on the island who practice shifting cultivation in the forest. The forest area in the study site, Calapan City in Oriental Mindoro, was converted into agricultural lands particularly during the construction of the Calapan South Road that connected the city capital to its southern towns. By 1920 when the road finished its construction, migrant settlers were encouraged to occupy and clear forestlands in Oriental Mindoro, and both the Mangyan and the forest were regarded as obstacles to the development of the island (Schult, 2001). With deforestation and the migrants' encroachment into ancestral lands, the Mangyan settled in the island's interior or in reservations (Schult, 1991).

This short historical background informs this research that the deforestation in Mindoro and the social status of the Mangyan shape how rice farmers in Barangay Biga in Calapan City today see themselves and their farming. A farmer (*magsasaka*, *magbubukid, magtatanim*) in Barangay Biga in Calapan City pertains to those who own or rent the land they are farming. Mangyan farm laborers are not considered as one of the farmers because they don't have a farmland and are being contracted only as laborers when the farmer needs help usually during planting and harvesting. For instance, the Mangyan are never referred to as "*magsasaka*", "*magbubukid*" or "*magtatanim*", but as Mangyan or *katutubo*, despite essentially doing the same farm work. There is also another term called *traskuhan* who works as a farm overseer/supervisor when the farmer is too old to work in the fields. In Oriental Mindoro, the term Mangyan, and elsewhere in the Philippines with the term *katutubo* (indigenous peoples or native), is a historically charged term with connotations of "backwardness" and a "poverty-stricken life". The Mangyan descend from the mountains and stay near cultivated fields for paid labor. In Barangay Biga, there is a Mangyan family who is living in one of the farmlands during months when they can earn wages from farm work. With the permission of the farmer, they built a traditional Mangyan house and even planted rice in a small plot next to the house. The rice grains they used were drop seeds picked out in the fields from the previous harvest. The rice farmers in Biga work hard to disassociate themselves from the stigma by welcoming modern agriculture including the use of mechanized technologies and hybrid varieties.

3. Methods

The design of the cultural consensus analysis in this study was informed by key informant interviews with farmer leaders and extension workers, and preliminary visits to the sites. It used a mix of informal and formal methods in data elicitation and analysis, namely, focus group workshops, rapid ethnographic assessment, and the consensus method. Information from these three separate data collection activities was triangulated in order to increase the reliability of the analysis.

The first data collection activity was the focus group workshop with farmer leaders in Barangay Biga, Calapan City on July 4, 2019. With the aid of extension workers in the area, purposive sampling was used to gather 10 rice farmer leaders who were assumed to be the knowledge holders of the different types of weather and climate conditions. The main objective of the workshop is to document all items under *lagay ng panahon* using freelisting. Participants were asked questions that pertain to the different kinds of weather and climate conditions they experience in their years of farming. Questions that were asked include: "*Anu-ano po ang mga nararanasan ninyong lagay ng panahon?"* (What are the different weather and climate conditions that you experience?); *Pakilista po lahat ng kondisyon ng panahon na alam ninyo* (List down all the weather and climate conditions you know). Redundant questioning, prompting with -semantic cues, and asking taxonomic questions were employed to elicit the freelist. It is important to probe and not settle for what the participants just say. Examples of probing questions include: "*May mga kagaya pa ba ng X?"* (Are there others that are like X?); "*May iba-iba pa bang uri ng X?* (What other kinds of X are there?); "*May alam pa ba kayong halimbawa ng X na kagaya ng Y?"* (Try to remember other kinds of X that are like Y.) We kept asking these questions until the participants said they could not mention any more Y.

A taxonomic tree of the weather and climate conditions for Barangay Biga was produced through a pilesorting exercise during the workshop. The workshop setting helped each participant recall other items that they otherwise would forget to mention. Through an open discussion, meanings of certain items in the cultural domain were clarified among participants. In this workshop, it was assumed that farmer-leaders with at least 20 years of experience have comprehensive knowledge of the different types of weather and climate condition. The freelist from the workshop was used in the consensus method.

During the consensus method, individual rice farmers were asked to do pilesorting of pairs generated from the freelist. The pilesorting exercise was repeated with 20 randomly selected farmers, a typical number to start with, and may increase depending on the amount of variability in responses (Borgatti, 1998). In a pilesort task, the farmers independently pile together with the types of weather and climate conditions they think were similar. The items in the freelist were written on 3″x5″ index cards with a unique ID number on the back of each card. The pilesort began by randomly shuffling the stack of cards containing the different weather and climate conditions with the following instructions: *"Narito po ang set ng cards na nagrerepesenta sa lagay ng panahon. Pakitingnan po isa-isa. Meron po ba kayong nakita na hindi kayo pamilyar? Alin po dito? Pakihiwalay." (*Here is a set of cards that represents different weather and climate conditions. Please look at them one by one. Is there anything that is not familiar to you? Which is it? Please separate it). After separating those that they are not familiar with (if any), they were asked to further confirm it. The description of the item that they were unfamiliar with was read again. If they say they indeed know about the item, the item is placed back in the set of cards and if they say they have an alternative name for the item, it would be noted. The remaining cards were sorted into piles twice and each time a pile was made, the respondent was asked to describe how the items in it were similar. The attributes they named that distinguish the items from one another were noted.

Pilesort data were processed in ANTHROPAC 4.0 (Borgatti, ANTHROPAC 4.0, 1996). The responses from the 20 farmers fit the consensus model (Eigenvalue: 11.307, Eigen Ratio: 4.556) which means that the responses have no clear evidence of subcultural variation and that the data collected can be attributed to the group as a whole. Pilesorting measures the similarity of the items with one another by the proportion of farmers who put a given pair in the same pile. Multi-dimensional scaling (MDS) and aggregate proximity matrix of items in the cultural domain were also done in ANTRHOPAC 4.0. The aggregate proximity matrix determined the similarity of the items with one another, while MDS illustrated the coordinates of the items (nodes = 16 in 38 iterations) in a multi-dimensional space to identify underlying perceptual dimensions of how the farmer group classifies the items. The MDS was compared with that of the taxonomic tree elicited from the focus group workshop. Typically, pilesorting can determine clusters and subdomains but it cannot tell which items are important in the cultural domain. To determine which weather and climate conditions are important to the rice farmers, the paired comparison was done as a final activity in the consensus method. Each farmer was asked which one in a pair of weather and climate conditions is more important for them to know (i.e. *Drought* vs. *La Niña*, and so on). Their votes were counted and summed to determine the ranking of the items in the freelist. The item with the highest score was ranked one. The ranking indicates the weather and climate information that the farmers prioritize over the others when making farm decisions.

Lastly, the third data collection activity was the rapid ethnographic assessment done from 12 to 17 September and 1–6 October 2019 in Barangay Biga, when the main author stayed in the home of a farmer leader located in Sitio Bagong Pook. The rapid ethnographic assessment includes participant-observation, semi-structured interviews, and casual conversations that explored the farmers' knowledge of the weather and climate conditions and how it is related to farming decisions. Anecdotes from farmers were collected and included in this paper anonymously. Rapid ethnographic assessment was also used in understanding how PAGASA collect, interpret, and articulate its weather and climate data during meetings, in published weather bulletins, and press conferences.

The farmers' consensus knowledge was qualitatively compared with that of the technical classification of weather and climate conditions by the governments' weather bureau (Table 1). The analysis used empirical data to generalize the phenomenon under study taking into account the logical propositions that may also explain or be replicated in similar phenomena in question.

4. Results

There is a total of 16 items in the freelist of weather and climate conditions generated from the focus group workshop with rice farmer leaders (Table 2). Asking questions regarding the weather and the climate in Tagalog was rather an ambiguous task. The Tagalog for weather and/or climate, *panahon*, also translates to 'a phenomenon', 'an event', or 'an occasion' associated with a certain time and place such as a recollection or a memory. For instance, during the workshop, there were queries about *noong panahon ng lindol* (the time when the earthquake hits) or *panahon ng pagrelease ng tubig mula sa irigasyon* (the schedule of release of water for irrigation) in which it was clarified that the *panahon* we meant was about the weather and the climate, which is colloquially understood as the *lagay ng panahon*. All items in the freelist refer to the types of weather and climate conditions experienced by the smallholder rice farmers. However, this Tagalog worldview of *panahon* remains significant to the farmers' construction of knowledge on the weather and the climate.

The term *Maria Loka* among rice farmers describe this *panahon* as a weather where one cannot distinguish if it's a rainy or a sunny day because both happen at the same time. They also refer to this day as the day "*na may kinakasal na tikbalang*" (*tikbalang*, a mythical creature with a human body but has a head of a horse, is being wed), or "*umuulan habang mataas ang sikat ng araw*" (it is raining while the sun is shining brightly). The other term that they use to refer to this weather condition is "*talanding panahon*" (fickle weather). The same term is being used among corn farmers in the nearby town of Gloria. In comparison, corn farmers associate the term *Maria Loka* to the impacts of climate variability; they have observed a change in the rainfall pattern and dry spells in the past three years. For instance, corn farmers observe that "*kahit maraming bituin sa gabi, kinabukasan uulan pa rin*" (even though the night sky was clear, i.e.

Table 1
Technical classification of PAGASA products.

PAGASA Products	
Warnings	*Seasonal Climate Forecasts*
• Severe Weather Bulletins • Tropical Cyclone Warning for Agriculture • Tropical Cyclone Warning for Shipping • Weather Advisory • Gale Warning Information • Storm Surge Warning • Rainfall Warning System • Thunderstorm Alert System	• 10-day Forecast • 10-day Probabilistic Forecast • 10-day Agri-Weather Information • Monthly Climate Assessment and Outlook Advisories • Seasonal Climate Assessment and Advisories • Monthly Regional Forecast Quick Outlook • Monthly Rainfall Forecast • Monthly Temperature Forecast • Monthly Probabilistic Forecast • Monthly Tropical Cyclone Forecast • Drought and Dry Spell Assessment and Forecast • El Niño/ La Niña Advisories, El Niño/ La Niña Watch • Monthly Agroclimatic Review and Outlook • Impact Assessment for Agriculture
Weather Forecasts	*Climate Change*
• Weather Forecasts • Regional Weather Forecasts • Farm Weather Forecast and Advisory • 3-day weekend Agri-weather forecast • Shipping forecasts	• Climate Projections for the Philippines

Source: Hayman et al., 2019.

Table 2
Freelist of weather and climate conditions (*lagay ng panahon*) experienced by rice farmers.

No.	Item	Translation/Description
1	Tag-ulan	Rainy season (September-December)
2	Tagbaha	Flood season
3	Tag-init	Hot/ summer season
4	Tagtuyot	Drought season; dry spells
5	Maalinsangan	Sultry/ hot and humid
6	Maria Loka	Unpredictable weather; a sudden change in weather condition, e.g. when it is raining on a bright sunny day
7	La Niña	La Niña/ extreme rainfall
8	El Niño	El Niño/ extreme drought
9	Bagyo	Typhoon/ Tropical Cyclone
10	Subasko	Squall; a sudden gust of wind and rain especially from the sea; a localized storm
11	Habagat sa tag-araw	Warm breeze from the sea during summer; does not bring rain; Directly translates as the "southwest monsoon in the summer"
12	Habagat sa tag-ulan	Rain that brings wind coming from the sea; happens during the rainy season; Directly translates as the "southwest monsoon during the rainy season)
13	Kulog at kidlat	Thunder and lightning/ thunderstorm
14	Panakanakang pag-ulan	Isolated rain showers but no wind
15	Ulang mayaman	long duration of light rainshower that extends through the week; ample rain; Directly translates as "a wealthy rain"
16	Pabugso-bugsong pag-ulan	sudden heavy rain with gusts of wind; heavy outpour that suddenly stops and resumes throughout the day or week

stars were visible—an indication of good weather in the morning—rain will still fall in the next day) or "*may ulan na bumubutas na ng bubong*" (there are rains so intense it would drill holes on the roof). *Maria Loka* among corn farmers in Gloria is being compared to "an old woman who is in her menopausal stage" especially when they could not predict when the rain would fall and for how long. They remarked during the workshop that "*matanda na ang panahon*" (the weather is old). They also describe *Maria Loka* as "*pabago-bagong panahon*" (changing climate/climate variability), "*may sumpong*" (grumpy, capricious), or "*reyna ng tag-ulan at tag-init*" (queen of the wet and dry season). The difference in the semantics of *Maria Loka* between rice and corn farmers in the same province could be because of the varying innate relationship with the weather and the climate between rice and corn farmers; corn farming is rain-fed, while rice farming is irrigated. We can assume that corn farmers have observed changes in the weather/climate because they solely rely on the pattern of the rain and summer seasons, in contrast to the rice farmers who depend on the irrigation system to flood their paddies. This comparison is significant in our attempt to elicit how rice farmers understand the weather and the climate discussed in the next section.

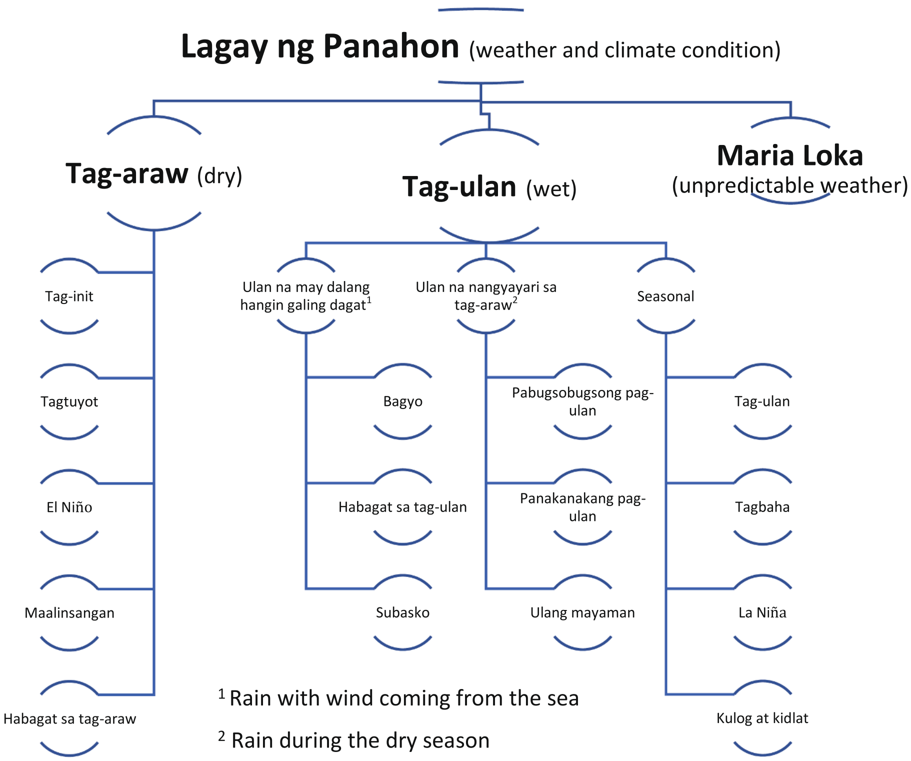

Fig. 1. Taxonomy of weather and climate conditions according to rice farmers in Calapan City.

The taxonomic tree of weather and climate conditions produced during the focus group workshop among farmer leaders is illustrated in Fig. 1. There are three main categories of weather and climate conditions: 1) Rainy or Wet; 2) Sunny or Dry; and 3) *Maria Loka* or unpredictable weather. Generally, the weather and climate conditions are organized into Wet and Dry seasons. Under the Rainy or Wet, there are three sub-categories, namely, rain with wind coming from the sea, rain during the dry season, and seasonal rain.

The MDS (Multidimensional Scaling) map shows that the more proximal an item is from the other, the more similar they are. The distribution of the nodes coincides with the categories found in the taxonomic tree (Fig. 1). The items were grouped into three main categories, namely, Dry, Wet, and *Maria Loka* (unpredictable weather). Based on the comparison between the results of the CDA workshop and the individual survey, rice farmers in Barangay Biga, Calapan City have a localized categorization of weather and climate conditions. Clusters separated by wide-open spaces in the MDS map represent subdomains that reflect the categorical attributes that dominate the farmers' thinking. In Fig. 2, 6 subgroups of items can be identified: (1) *Bagyo*, *Tag-baha*, *La Niña*, and *Tag-ulan*; (2) *Kulog at Kidlat*, *Pabugso-bugsong pag-ulan*, *Habagat sa tag-ulan*, *Panakanakang pag-ulan*, and *Ulang mayaman*; (3) *Habagat sa tag-araw* and *Maalinsangan*; (4) *El Niño*, *Tag-init*, and *Tag-tuyot*, (5) *Subasko*, and (6) *Maria Loka*, which can be generally grouped into the three main categories. On the extreme opposite ends of the wet-dry scale is the subgroup of hazards that induce most damages to farming. It is also remarkable that the local categorization is based on how one weather condition may result in another. In the farmers' worldview, the weather and climate condition (*lagay ng panahon*) is perceived as an event (*panahon*) that cannot be simply isolated from other *panahon.* For example, farmers cite that *Bagyo* (Tropical cyclone), *Tag-ulan* (rainy season), and *La Niña* causes *Tag-baha* (flooding season). Or *Kulog at kidlat* (thunder and lightning) is an indicator of the incoming rainy season. The cropping cycle (May/June during the Wet Season and November/December during the Dry Season) begins when the irrigation canals have opened up and flooded the fields. In particular, seeds would be hardened if the amount of water were inadequate during sowing. While planting relies on the schedule of irrigation, farmers plan the timing of fertilizer and pesticide application based on rainy days. The soil should be sufficiently watered prior to fertilizer and pesticide application during transplanting and tillering to ensure nutrient intake and proper growth. Heavy wind, particularly during the monsoon and typhoon seasons, could lodge standing plants during the milk, dough, and mature stages. In comparison, there is no remarkable difference between El Niño, *Tag-init* (dry season), and *Tag-tuyot* (drought and dry spells) although the three weather and climate conditions are lexically different from one another. This is perhaps compared to other types of weather and climate conditions these three items are culturally understood to be almost similar, particularly because the perceived impacts of El Niño, *Tag-init,* and *Tagtuyot* are not indistinguishable from one another (Fig. 2). This may mean that the dry season, dry spells, and drought are observed to have effects as extreme as that of El Niño, on one hand. On the other hand, irrigated rice are also more resilient to drought and seasonal heat than rain-fed rice in the lowlands.

The pilesort data were also interpreted using the aggregate proximity matrix (Table 3). This matrix determines the percentage an item is grouped together in a pile with another item on the freelist. The closer the value is to one, the more similar the item is with one another. For instance, *Tagbaha* (Flooding season) is placed 75% of the time with *Tag-ulan* (Rainy season), and hence, is more similar to each other than *Maria Loka* (0.25) or *Subasko* or squall (0.2).

Theoretically, an item should gain a value of 1 when compared with itself. However, in the pilesorting exercise, there were respondents who were not aware of some of the items in the freelist, in particular *Maria Loka* (10 out of 20), *Subasko* (4 out of 20), *Habagat sa tag-araw* (1 out of 20), *Habagat sa tag-ulan* (4 out of 20), *Panakanakang pag-ulan* (1 out of 20), and *Pabugso-bugsong pag-ulan* (1 out of 20). Since the freelist that was used for the pilesorting exercise during the consensus method was generated and verified by farmer leaders and elders, it is anticipated that some of the farmers randomly selected from the study population can be unaware of some items in the freelist. Nonetheless, the software (ANTHROPAC 4.0) still supports that there is a consensus among respondents who did the pilesorting. What we can gain from this data is insightful. Since 50% of the respondents were not aware of *Maria Loka*

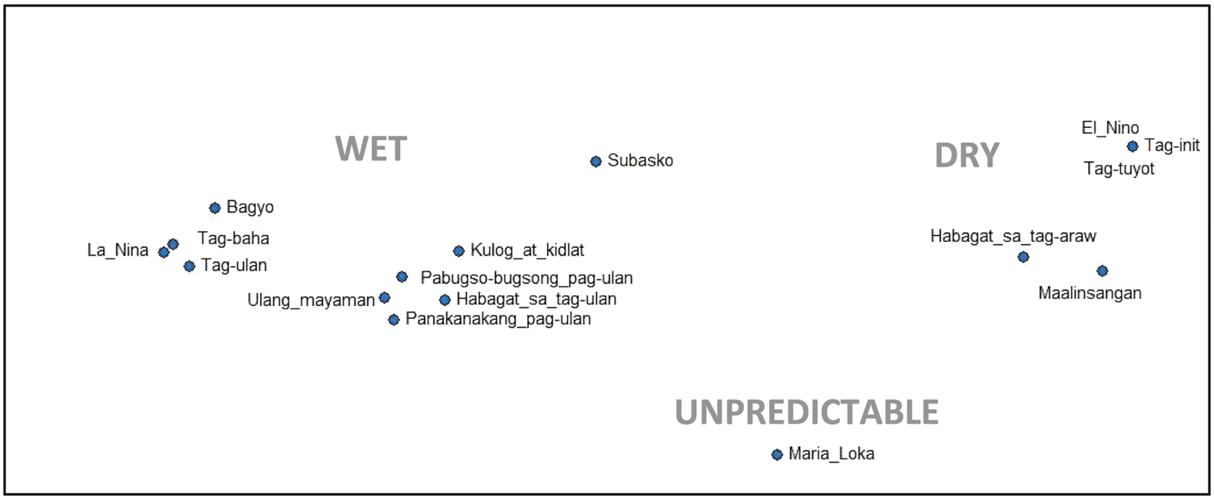

Fig. 2. MDS map of items in the domain of weather and climate condition according to rice farmers in Biga, Calapan City.

Table 3
Aggregate proximity matrix of items in the cultural domain by rice farmers in Biga, Calapan City.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	**1**	0.75	0	0	0	0	0.8	0	0.5	0.1	0	0.35	0.4	0.4	0.45	0.3
2	0.75	**1**	0	0	0	0.05	0.85	0	0.65	0.2	0	0.25	0.3	0.25	0.3	0.25
3	0	0	**1**	1	0.4	0.05	0	0.95	0	0.1	0.35	0	0	0	0	0
4	0	0	1	**1**	0.4	0.05	0	0.95	0	0.1	0.35	0	0	0	0	0
5	0	0	0.4	0.4	**1**	0.2	0	0.35	0	0.05	0.65	0.05	0.05	0	0.025	0
6	0	0.05	0.05	0.05	0.2	**0.5**	0	0.05	0.05	0.05	0.1	0.05	0.15	0.1	0.2	0.1
7	0.8	0.85	0	0	0	0	**1**	0	0.55	0.1	0	0.3	0.25	0.35	0.35	0.3
8	0	0	0.95	0.95	0.35	0.05	0	**1**	0	0.1	0.3	0	0	0	0	0
9	0.5	0.65	0	0	0	0.05	0.55	0	**1**	0.25	0	0.3	0.25	0.2	0.25	0.25
10	0.1	0.2	0.1	0.1	0.05	0.05	0.1	0.1	0.25	**0.8**	0.15	0.2	0.3	0.25	0.25	0.35
11	0	0	0.35	0.35	0.65	0.1	0	0.3	0	0.15	**0.95**	0.15	0.1	0.05	0.05	0
12	0.35	0.25	0	0	0.05	0.05	0.3	0	0.3	0.2	0.15	**0.8**	0.4	0.5	0.5	0.45
13	0.4	0.3	0	0	0.05	0.15	0.25	0	0.25	0.3	0.1	0.4	**1**	0.4	0.5	0.45
14	0.4	0.25	0	0	0	0.1	0.35	0	0.2	0.25	0.05	0.5	0.4	**0.95**	0.8	0.7
15	0.45	0.3	0	0	0.025	0.2	0.35	0	0.25	0.25	0.05	0.5	0.5	0.8	**1**	0.7
16	0.3	0.25	0	0	0	0.1	0.3	0	0.25	0.35	0	0.45	0.45	0.7	0.7	**0.95**

Note: ID number is based on Table 2:
1 Tag-ulan 5 Maalinsangan 9 Bagyo 13 Kulog at kidlat
2 Tag-baha 6 Maria Loka 10 Subasko 14 Panakanakang pag-ulan
3 Tag-init 7 La Niña 11 Habagat sa tag-araw 15 Ulang mayaman
4 Tag-tuyot 8 El Niño 12 Habagat sa tag-ulan 16 Pabugso-bugsong pag-ulan

(unpredictable weather), a term that also exists in the vocabulary of corn farmers in a neighboring town that is several municipalities away from Calapan City, mean that the unpredictable weather may not be as observable in the lens of rice farmers who rely on the irrigation system.

We focus then on which among these items in the comprehensive list of weather and climate conditions are considered to be priority information when it comes to farm decisions. This is answered by the data we get from the paired comparison (Table 4). In the paired comparison, rice farmers give preference to these top weather and climate conditions: *Bagyo*, *El Niño*, *La Niña*, and *Tag-ulan*. This means that rice farmers would like to know more information about these particular weather and climate conditions over the others on the freelist.

5. Discussion

This section presents the in-depth analysis from the rapid ethnographic assessment and triangulating it with the information collected during the focus group workshop and the consensus method. The discussion here highlights the forecasting methods of the farmers and the kind of information that matters in aiding them in various farm decisions. Both contribute to our understanding of how local knowledge is constructed based on the farmers' all-encompassing experience of relating themselves to the *lagay ng panahon*, including sourcing information from the top-down, technical knowledge of the government's weather bureau.

The forecasting methods of rice farmers in Barangay Biga, Calapan City are several and all are being put together to make sense of the *panahon* (weather and climate condition/event). In a survey conducted for a different study of this research project, the most common source of weather and climate information, especially on the tropical cyclone, is the television, but rice farmers have other ways of reading the weather. For example, they forecast the day's weather by observing the cloud pattern over Mt. Halcon, a prominent landscape feature in Mindoro Island: "Kapag natatakluban ng ulap ang Mt. Halcon at hindi maganda ang sikat ng araw sa Silangan, uulan buong araw." (If clouds covered Mt. Halcon and the sun did not shine brightly in the east, it would rain the whole day.") such as in (a) of Fig. 3, or "Naliwanag na ang bundok, kumonti na ang nakataklob na ulap. Baka gaganda ang panahon bukas." (Mt. Halcon is getting clearer with less cloud cover. Maybe the weather tomorrow will be better.") such as in (b) of the same figure. Other features of the mountain also inform the farmers in their *pagbasa ng panahon* (reading the weather), in particular the marble boulder on the slope of Mt. Halcon, which can be seen from the paddy fields of Sitio Bagong Pook. The president of the Biga Farmers Association described "Kapag makinang ang marmol sa may bundok, mainit ang sikat ng araw." (If the boulder shines brightly, it will be sunny the whole day.) indicating that the sky is clear over at Mt. Halcon (northwest) and the sun has risen brightly in the east. It is not an unusual sight to see a rice farmer observe Mt. Halcon early in the morning or late in the afternoon or to greet another farmer about the weather while referring to the clouds over Mt. Halcon, especially during the harvest season (September and October) when the fieldwork for this study was done.

Seasonal change is also being forecasted locally based on the color of the mountain or how distant it appears to be. If the mountain appears to be green and one can see the forest as if it's nearer than usual *(malapit na bundok*), the wet season is approaching. But if the mountain appears to be color blue and farther than it usually is (*malayong bundok*), that is, one can't distinguish its features such as the outline of the trees, then it indicates the beginning of the dry season.

Forecasting based on how the clouds, the sky, the wind, the sun, or the rain interact with Mt. Halcon is combined with knowledge on bioindicators of the weather. For example, the presence of a particular bird can tell the farmer if the bad weather will persist or not: "*Kapag lumabas ang layang-layang lalo na at matayog ang lipad, masama o di maganda ang panahon. Kapag maganda ang init, maya ang lalabas dahil manginginain.*" (If the swiftlet is out flying high in the fields, the weather is bad. But if the maya bird (sparrow) is out feeding on the fields, the day is always sunny." The flight of the *layang-layang* bird (swift) indicates whether the summer season (flying low) or the rainy/typhoon season (flying high) is approaching. Similarly, farmers also observe the behavior of insects such as

Table 4
Ranking of importance of weather and climate conditions based on paired comparison.

Rank	Weather and Climate Condition
1	El Niño
2	Bagyo
3	La Niña
4	Tag ulan
5	Tag baha
6	Tag tuyot
7	Tag-init
8	Kulog at kidlat
9	Pabugso-bugsong ulan
10	Habagat sa tag-ulan
11	Ulang mayaman
12	Panakanakang pag-ulan
13	Habagat sa tag-araw
14	Maalinsangan
15	Subasko
16	Maria Loka

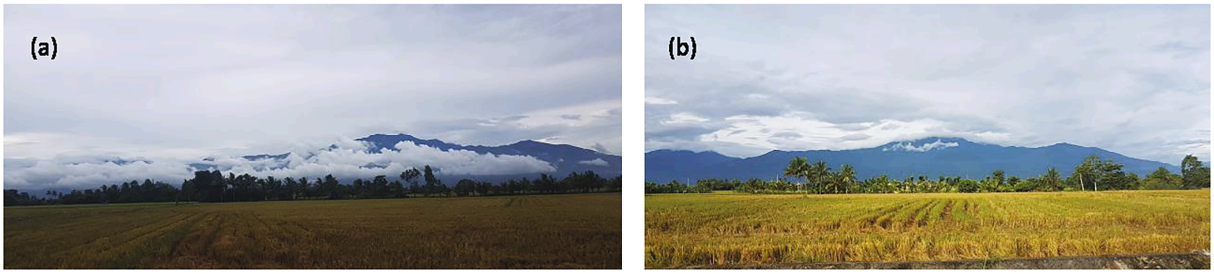

Fig. 3. Clouds over Mt. Halcon as seen from Sitio Bagong Pook in Barangay Biga, Calapan City (a) indicates a whole day of rain and (b) indicates a chance of getting clearer skies and more sunshine tomorrow.

dragonflies (*tutubi*) and ants (*guyam*). If insects fly low, summer is beginning. But when red and black ants start hoarding food, the rainy season is about to start.

Some rice farmers in Barangay Biga also consult the *Kalendarioḡ Tagalog ni Honorio Lopez* (Tagalog Calendar of Honorio Lopez) (Fig. 4) when deciding about the different farming activities, in particular, the lucky days (*maswerteng* araw) when to plow (*mag-aararo*), plant (*magtatanim*), and harvest (*mag-aani*). The Tagalog Calendar, or Honorio Lopez as called by the farmers, is an information pamphlet on a wide range of topics including a briefer of significant world events (e.g. the Brexit), a self-help guide on fertilizers and pesticides, healthy dietary options, the schedule of the high tide and the low tide, the horoscope, some relevant Catholic events, and many more. Farmers also consult the calendar regarding the prevailing *lagay ng panahon* (weather and climate condition) of the month.

Rice farmers in Biga construct their own local knowledge system about the weather and the climate through their generational knowledge as well as from encounters with other modes of classifying the weather such as broadcasted weather forecasts. Using this hybrid knowledge, farmers usually decide on their own, with a spouse, or their *traskuhan*, a farm overseer especially when the farmer is old and can no longer manage the farm on their own. There is some level of coordinated action, for example, when to plant depending on several considerations, such as the schedule of irrigation of paddies; simultaneous cropping of adjacent fields to prevent pests and diseases; and early maturation of parcels on the periphery of the field so the mechanized harvester could begin from the edges. The Biga Farmers' Association and the Irrigators' Federation function as an alliance network that is activated under certain circumstances such as during payments for irrigation canal maintenance, the start of cropping, and program implementation from the City. The president of the association, the extension worker, and the water master of the National Irrigation Authority can call for a gathering to activate this alliance network, which can improve the flow of information among farmers. Information about the abovementioned considerations is highly significant to the rice farmer more than knowing about some of the types of weather and climate condition in the freelist. In fact, when the item "irrigation" was considered in the paired comparison activity, it ranked 5th among the list of the sixteen weather and climate conditions. Rice farmers would prefer to know about the information on the schedule of irrigation rather than knowing the information about *Maria Loka* (unpredictable weather), *Subasko* (squall), *Maalinsangan* (humidity), *Habagat sa tag-araw* (northwest monsoon), *Ulang mayaman* (week-long rain), *Panakanakang pag-ulan* (isolated rain showers), *Kulog at Kidlat* (thunderstorm), *Pabugsobugsong pag-ulan* (sudden heavy rain), and even *Tag-init* (dry season)*, Tag-baha* (flooding season), and *Tag-tuyot* (drought and dry spells).

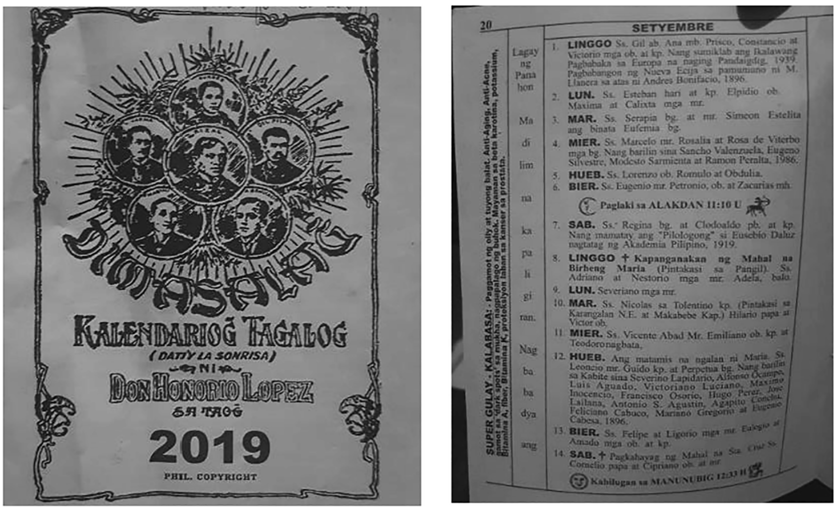

Fig. 4. Kalendarioḡ Tagalog ni Honorio Lopez.

The farmers' knowledge construction about the weather and climate is relational and relies on inductive reasoning rather than deductive thinking. Some examples of which are already mentioned when farmers use the features of the landscape and bioindicators in reading the weather to bring together pieces of knowledge in anticipation of an event (*panahon*), which technocrats do not consider in forecasting. The farmers' understanding of weather and climate conditions is also informed by agroecology such as the occurrence of pests and diseases during the wet and dry season. At the same time, the ways in which farmers anticipate the likely weather scenario of the day, the week, or of the season as a matter of forecasting show the embodiment of the weather into the lives of the farmer. This ontological positioning of one‘s self relative to what constitutes as *panahon* manifests in the continuous thinking about the weather throughout the day, especially during the most crucial stages of the cropping cycle, that is, planting and harvesting. During these times, farmers routinely check the news from the TV or the radio or causally remark about the weather with neighbors in a morning stroll, or with fellow farmers during the Sunday church mass.

Knowledge about the weather cannot also be separated from the knowledge on the life cycle of *palay* (rice). For example, when lodging occurs during the milking stage because of the wind (*Habagat*), the rice grain will not fully develop (*maipa*). This, in turn, results in low-quality rice and low market price. Market relations are significant to the farmers as reflected in the way they construct their knowledge about the weather and climate in relation to the marketability of their harvest. If the farmer was left with no choice but to harvest even when the plant is still dumped, more likely than not the rice grains will be stored wet causing discoloration (*kala*) as seen in Fig. 5. Although logically they would prefer to harvest when it is not raining, farmers care more about the assurance that they can still harvest even in rainy days and sell wet rice (*basang palay*) at a fair price than seeking specific information about the weather and the climate forecasts during the harvest season.

There is anxiety among farmers about the weather and the climate especially when they perceive that nothing can be done if the weather would behave against their favor. One of the ways that comfort the farmers from this anxiety is the use of the Honorio Lopez Tagalog Calendar to refer to lucky days to plow, plant, and harvest, and the unlucky days to avoid:

"*Guide lamang. Maganda rin yung may sinusunod na gabay. Hindi naniniwala nang 100% pero para may konti kang masasandalan. Parang may nagpapayo sayo na 'wag ka magtatanim sa masamang araw. Kinagisnan sa magulang na siya ay nagbabasa lagi ng gay-an*." (It is just a guide and it's good that you follow a reference. I do not believe in it completely but at least you have something to lean on. It is like someone is giving you advice not to plant on unlucky days. My parents did the same thing.)

Rice farming in the Philippines, or modern agriculture in general, is becoming (if not already is) dependent on the actors that control the capital for farm inputs favored by trade liberalization and the free-market state. In the 9th National Rice Technology Forum held in Calapan City in October 2019, the salient theme was to increase yield that would consequently lead to more profit by promoting hybrid varieties and technology adoption. This is when the price per kilo of rice plummeted to less than PhP 10 (USD 0.20) in the Philippines, which many farmers attribute to the import-driven rice policy of the country and the technological and bureaucratic limitations of the National Food Authority. While the event was a venue for seed companies to showcase their products, the local government of Calapan City, also raised the issues of the import-driven program of rice tariffication in the country and how it negatively affects the farmers in Oriental Mindoro. The lack of subsidies for fertilizer and other inputs as well as the need to rehabilitate the irrigation canals were some of the highlights of his speech. However, local government subsidies for seeds, fertilizer, and mechanized technology are not enough to ensure a profit or in some cases even a break-even point. The subsidy-based solution of local governments and the state's department of agriculture will remain unsuccessful without the holistic understanding of agricultural precarities. One instance is from a farmers' meeting where farmers lament *"Ang hirap talaga ng mahirap*." (It is really difficult to be a destitute.). And farmers know that their poverty, and remaining in this precarious state, is a structural consequence of societal stratification that keep them marginalized enabled by the misplaced and disinterested economic policies facilitated by the state:

"Pinapatay kami ng gobyerno. Kapag tumaas ang krudo, binhi, pestisidyo maaapektohan kami. Dapat ang mga magsasaka ay magsama-sama dahil sa dinami-dami ng naging president ay hindi naging priority ang magsasaka." (The government is killing us. If the prices of crude oil, seeds, and pesticides increased, we would be plagued. Farmers should collectively organize because whoever the president of the country is, farmers would never be their priority.)

Another example of marginalization experienced by rice farmers is with the services of the National Food Authority (NFA):

> "*Ang NFA ay hindi bumibili ng maruming bigas ng farmer. Eh san ka makakakuha ng malinis? Yung NFA ay para sa mga magsasakang mayaman lamang*." (The NFA does not buy what they consider as dump, discolored (substandard) rice. How could we produce clean, white rice [when there is no dryer]? The NFA serves the well-off farmers, not us smallholders."

Fig. 5. Kala, a brown or red discoloration of the rice grain.

With price volatility, it is not surprising if rice farmers in the Philippines also describe farming as a "lottery", similar to how smallholder farmers in other parts of the world describe the livelihood. For example, a study by Stensrud (2019) in Peru describes that farmers in Majes compare farming to "lottery" where one can win or lose everything after four decades of neoliberal deregulation. Structural agricultural precarities must not be taken out of the picture in climate risk management and should instead be understood as an amalgamation of the historically globalizing capitalist ideas of agriculture and the food systems. This is very relevant because we argue that agricultural precarities significantly influence the farmers' perception of the usefulness of weather and climate information and its impact on their personal experiences.

The rice farmers' knowledge about the weather and climate conditions is experiential and context-dependent associated with an event or phenomenon (*panahon*) remembered in time and recorded in place. While they make use of real-time forecasts, warnings, or advisories from the PAGASA weather bureau, they do not heavily depend on it. In contrast, PAGASA's understanding of the weather and climate condition is deductive reducing the complex event of *lagay ng panahon* into datasets of measurements (refer back to Table 1). These datasets are often isolated from the rest of the phenomenon/ event (*panahon*) as observed by the detached observer gathering information about a fact that exists 'out there'.

Farmers don't blame the PAGASA if the forecast missed. They know the dataset is not localized and instead covers the whole of Mindoro island and the region. The weather bureau is also limited by its primary mandate to produce up-to-date data and information to help the government and the public prepare and minimize their risks. Hope for accuracy is slim, but that does not mean that farmers do not trust the forecast. PAGASA can gain trust and authority through the performative efficacy of forecasting. We can learn from a similar paper by Taddei (2013:247) in Brazil where he states that "forecasting is a performative social action; … it is a form of discourse about the future that affects the way individuals and groups perceive time" or as Adam (2008) puts it: the social construction of temporality. This is because talking and thinking about the future is part of how we live *through* reality (Ingold, 1993). Performativity of forecasting then refers to "how humans perceive the future, how they inscribe it into discourse and representation, and how this is connected to the ways they exist and act in the present." (Taddei, 2013: 246). The ways that farmers exist and act in the present include what we emphasize in this paper, that is, the rice farming context in the Philippines that shape the cognitive and attitudinal responses of farmers on weather and climate information.

Knowledge production and interpretation, whether by rice farmers or climate scientists, have its norms. Normative practices in knowledge construction among epistemic communities are one of the arguments in the social constructivism of science. Satsuka's *Nature in Translation* (2015) is a highly salient work on this topic. Satsuka's ethnographic study shows that in the context of Japanese mass tourism in Canada, supposedly neutral scientific concepts, such as ecological integrity, are in fact packaged within culturally-specific philosophical and aesthetic ideas wherein these terms are translated and understood variably in different cultures. Similarly, climate change, including climate risk management, has been argued to be a "wicked social problem" (e.g. by Grundmann, 2016; Sun and Yang, 2016), while climate communication has conveniently used the concept of *anchoring* and *objectification* to socially represent the complex climate problem (Jaspal et al., 2012). Anchoring refers to making something unfamiliar understandable by relating it to familiar characteristics such as using catastrophic imagery to refer to impacts of climate variability and climate change, while objectification is a process that translates the abstract in "objective" common sense realities, such as the weather and the climate as observed in terms of rainfall intensity or measures of temperature (Moscovici, 1988). However, scientific norms inevitably leave out certain observations and experiences in the margins and instead naturalize privileged narratives in favor of a desirable rhetoric for a "realistic" policy framework inattentive of issues of power. We argue then that the burden to imagine what the other's knowledge meant lies on the less powerful actor, that is, the smallholder farmers. In this paper, we see how this works when rice farming is viewed uncritically by rational institutions of the state, such as the weather bureau and the department of agriculture, as a function of yield, technology, and weather and climate science. Results from the cultural consensus analysis, in comparison, reveal that rice farmers' knowledge about the weather and climate conditions is an entanglement of social, environmental, and economic contexts.

6. Conclusion

There are multiple layers of interpretation that this paper contributes to climate risk management literature. Firstly, framing weather and climate conditions as a cultural domain rather than assuming that farmers follow the same objective understanding of the standard classification of the weather and the climate means that there are different ways of perceiving the changing climate and knowing how to forecast. The term *Maria Loka* among rice farmers refers to the unpredictable weather of the day reflecting the shortsightedness of rice farmers who rely on irrigation as opposed to the three-year observations of climate variability of rain-fed corn farmers. In addition, farmers' knowledge of forecasting is generational and experiential, i.e. how the sky interacts with the landscape and bioindicators, including the use of Kalendarioḡ Tagalog as a mechanism for farmers to cope with anxiety from uncertain climate stresses. Incorporating the consensus method in climate risk management increases the reliability of the study by triangulation with other conventional data collection methods, such as focus groups and survey questionnaires. Cultural consensus analysis is a rapid assessment technique that can supplement individual and aggregated survey data.

Another is that the ethnographic description of farmers' decision-making explains the process of local knowledge construction and its crucial difference with that of the technocracy. On one hand, the farmers' inductive imagination of the different weather and climate conditions is only one of the aspects of an event or phenomenon (*panahon*) which is inextricably related to agroecology, i.e. occurrence of pest and diseases and life cycle of rice, as well as the socio-economic effects of agricultural regulations on farmers, including access to irrigation, price volatility, and capital for subsidies and technologies controlled by the state and the traders. The farmers' relational epistemology is also described by their effort to understand and imagine the way the technobureaucrats think about the weather and the climate. In comparison, the reductionism of the technocrats has affinities with dualist thinking (Boström and

Davidson, 2018) that tend to place local (farmer) and scientific, technical knowledge in a false dichotomy. Rice farming does not only involve technical knowledge, but the farmers' knowledge of weather and climate conditions evidently reflect identity politics with knowledge built from the ground as opposed to technical science's disinterested politics. The top-down perspective of the weather bureau influences its own view of how to organize knowledge and assumes that there is a linear and predictable pathway for climate risk management in agriculture from high risk to low risk under technological interventions or climate communication.

There have been calls to scrutinize climate science by including and considering multiple understandings of the climate, the diverse range of climate knowledges, and the embodied, practical engagements of the people with their environments (Burnham et al., 2016; Yeh, 2016). Pragmatically, this study recommends that weather and climate communication utilize a scenario-based approach in describing the effects of climate variability and climate change to smallholder farmers. These scenarios should not be limited to technical descriptions of cause-effect relationships, but should consider a holistic description of the other components of farming the way farmers would tell the story, e.g. payments and maintenance labor for the irrigation canal, the collective understanding of unpredictable weather as *Maria Loka* and not as climate variability or climate change, actors and factors that control farmgate price (e.g. traders, requirements of the NFA for buying rice, and unavailability of drying facilities) and other circumstances based on the experiences of rice farmers. Using rice farmers' relational epistemology, as opposed to the common assumptions about the localization and downscaling of science, local knowledge is being constructed by encountering and laboring to imagine realities other than one's own, such as the way rice farmers are being subjected to technical categories of the weather and climate conditions. A hybrid knowledge of the weather and climate obliges technobureaucrats and government officials of the weather bureau, the irrigation agency, the food authority, local governments, and others to productively engage with different ways of reasoning of the farmers and the tensions that may arise as locally as possible. A methodologically and epistemologically plural perspective in climate risk management, such as this study, presents multiple representations, measurements, and enactments of the climate (Popke, 2016), and exposes the hegemony of certain traditions of science and its impractical and unrealistic strategies to smallholder farmers.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors are grateful to the workshop participants and interlocutors of the study that is part of the research program "Action-ready Climate Knowledge to Improve Disaster Risk Management for Smallholder Farmers in the Philippines", who so generously contributed their time and knowledge. This research is funded by the Australian Center for International Agricultural Research (ASEM/2014-051) under the auspices of South Australian Research and Development Institute and its Philippine research partners, i.e., UPLB, PIDS, and PAGASA. We also thank Dr. Canesio D. Predo, UPLB Co-Project Leader for his leadership and our colleague, Professor Kevin Parton from our partner university in this project, for his comments.

References

Abid, M., Schilling, J., Scheffran, J., Zulfiqar, F., 2016. Climate change vulnerability, adaptation and risk perceptions at farm level in Punjab, Pakistan. Sci. Total Environ. 547, 447–460. https://doi.org/10.1016/j.scitotenv.2015.11.125.

Adam, B., 2008. Futurescapes and Timeprints. Paper presented at Lüneburg University. Retrieved from http://www.cardiff.ac.uk/socsci/futures/briefings.html#conference.

Adger, W.N., Barnett, J., Brown, K., Marshall, N., O'Brien, K., 2013. Cultural dimensions of climate change impacts and adaptation. Nature Clim Change 3 (2), 112–117. https://doi.org/10.1038/nclimate1666.

Borgatti, S. (1996). ANTHROPAC 4.0. Natcik, MA: Analytic Technologies.

Borgatti, S., 1998. Elicitation techniques for cultural domain analysis. In: Schensul, J., LeCompte, M. (Eds.), The Ethnographer's Toolkit, Vol. 3. Altimira Press, Walnut Creek, CA.

Boström, M., Davidson, D., 2018. Introduction: conceptualizing environment-society relations. In: Boström, M., Davidson, D. (Eds.), Environment and Society: Concepts and Challenges. Palgrave Macmillan. https://doi.org/10.1007/978-3-319-76415-3.

Burnham, M., Ma, Z., Zhang, B., 2016. Making sense of climate change: hybrid epistemologies, socio-natural assemblages and smallholder knowledge: Making sense of climate change. Area 48 (1), 18–26. https://doi.org/10.1111/area.12150.

Carothers, C., Brown, C., Moerlein, K., Lopez, J., Anderson, D., Retherford, B., 2014. Measuring perceptions of climate change in northern Alaska: pairing ethnography with cultural consensus analysis. Ecol. Soc. 19 (4) https://doi.org/10.5751/ES-06913-190427.

Gollin, L., McMillen, H., Wilcox, B., 2004. Participant-observation and pile sorting: methods for elicitng local understandings and valuations of plants as a first step towards informed community participation in environment and health initiatives in Hawai'i. Appl. Environ. Educ. Commun. 3, 259–267. https://doi.org/10.1080/15330150490882001.

Grundmann, R., 2016. Climate change as a wicked social problem. Retrieved from Nat. Geosci. 9, 562–563. https://www.nature.com/articles/ngeo2780.

Hayman, P., Cooper, B., & Parton, K. (2019). Action ready climate knowledege to improve disaster risk management for small holder farmers in the Philippines. Annual report. Australian Center for International Agricultural Research ASEM/2014/051.

Ingold, T., 1993. The temporality of landscape. World Archaeol. 25 (2), 152–174.

Islam, M., Nursey-Bray, M., 2017. Adaptation to climate change in agriculture in Bangladesh: The role of formal institutions. J. Environ. Manage. 200 (15), 347–358. https://doi.org/10.1016/j.jenvman.2017.05.092.

Jaspal, R., Nerlich, B., Koteyko, N., 2012. Contesting science by appealing to its norms: readers discuss climate science in the Daily Mail. Sci. Commun. 35 (3), 383–410. https://doi.org/10.1177/1075547012459274.

Mase, A.S., Gramig, B.M., Prokopy, L.S., 2017. Climate change beliefs, risk perceptions, and adaptation behavior among Midwestern U.S. crop farmers. Clim. Risk Manage. 15, 8–17. https://doi.org/10.1016/j.crm.2016.11.004.

Moscovici, S., 1988. Notes towards a description of social representations. Eur. J. Soc. Psychol. 18 (3), 211–250. https://doi.org/10.1002/ejsp.2420180303.

Nekaris, K.A.I., McCabe, S., Spaan, D., Ali, M.I., Nijman, V., 2018. A novel application of cultural consensus models to evaluate conservation education programs: Cultural Consensus and Education. Conserv. Biol. 32 (2), 466–476. https://doi.org/10.1111/cobi.13023.
Peñalba, L.M., Elazegui, D.D., Pulhin, J.M., Cruz, R., 2012. Social and institutional dimensions of climate change adaptation. Int. J. Cl Chan. Strat. Man. 4 (3).
Popke, J., 2016. Researching the hybrid geographies of climate change: reflections from the field: Researching the hybrid geographies of climate change. Area 48 (1), 2–6.
Porteria, A., 2015. Making money out of people's misery: Has disaster capitalism taken over post-Haiyan Philippines? Philippine Sociol. Soc. 63, 179–206.
Pulhin, J., Peras, R., Pulhin, F., Gevaña, D., 2016. Farmers' adaptation to climate variability: Assessment of effectiveness and barriers and on local experience in Southern Philippines. J. Environ. Sci. Manag. 1–14.
Satsuka, S., 2015. Nature in Translation: Japanese Tourism Encounters the Canadian Rockies. Duke University Press.
Schult, V., 1991. The genesis of lowland Filipino society in Mindoro. Philippine Stud. 39 (1), 92–103.
Schult, V., 2001. Deforestation and Mangyan in Mindoro. Retrieved from Philippine Stud. 49 (2), 151–175. http://www.jstor.org/stable/42634624.
Stensrud, A., 2019. Safe milk and risky quinoa: The lottery and precarity of farming in Peru. J. Glob. Hist. Anthropol. 83, 72–84. https://doi.org/10.3167/fcl.2019.830108.
Stevenson, K.T., Peterson, M.N., Bondell, H.D., Moore, S.E., Carrier, S.J., 2014. Overcoming skepticism with education: interacting influences of worldview and climate change knowledge on perceived climate change risk among adolescents. Clim. Change 126, 293–304. https://doi.org/10.1007/s10584-014-1228-7.
Sun, J., Yang, K., 2016. The wicked problem of climate change: a new approach based on social mess and fragmentation. Sustainability 8 (12), 1312. https://doi.org/10.3390/su8121312.
Taddei, R., 2013. Anthropologies of the future: on the social performativity of (climate) forecasts. In: Environmental Anthropology: Future Directions, 1st ed. Routledge, New York, pp. 246–265. https://doi.org/10.4324/9780203403341.
Uson, M.A.M., 2017. Natural disasters and land grabs: the politics of their intersection in the Philippines following super typhoon Haiyan. Can. J. Dev. Stud. 38 (3), 414–430.
Van Holt, T., Townsend, W., Cronkleton, P., 2010. Assessing local knowledge of game abundance and persistence of hunting livelihoods in the Bolivian Amazon using consesus analysis. Human Ecol. 791–801 https://doi.org/10.1007/s10745-010-9354-y.
Weller, S.C., 2007. Cultural consensus theory: Applications and frequently asked questions. Field Methods 19 (4), 339–368. https://doi.org/10.1177/1525822X07303502.
Yee, D.K.P., 2018. Constructing reconstruction, territorializing risk: imposing "no-build zones" in post-disaster reconstruction in Tacloban City, Philippines. Crit. Asian Stud. 50 (1), 103–121.
Yeh, E.T., 2016. 'How can experience of local residents be "knowledge"?' Challenges in interdisciplinary climate change research: 'How can experience of local residents be "knowledge"?'. Area 48 (1), 34–40.
Zanotti, L., Glover, D., Sepez, J., 2010. Local communities and natural resources: ethobiology in practice. In: Vaccaro, I., Smith, E., Aswani, S. (Eds.), Environmental Social Sciences: Methods and Research Design. Cambridge University Press, pp. 110–131.