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Social Networks and Access and Utilization of Weather and Climate Information: The Case of Upland Farming Communities in the Philippines

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Abstract

Social norms and structures are vital factors that shape people's behavior and attitudes. It is therefore useful to analyze such underlying forces in the creation of strategies that are meant to influence behavior and activities. Agricultural extension services such as information dissemination and farmers' training are some of the interventions that can benefit from such analyses especially within a context of limited human and financial resources. The idea is to use the lessons learned from the analysis of social networks and norms in identifying potential local knowledge and information disseminators, thereby aiding the extension services. It also helps in the formulation of more contextualized approaches for reaching the underserved and hard to reach areas. Applying this approach, this study used the case of a remote upland area in Atok, Benguet, a major vegetable producer. This study used social network analysis to develop insights for designing more effective extension strategies. The results show that interventions like information and education campaigns can be improved by acknowledging the nuances in social relation structures.

Keywords: social network analysis, information and education campaign, Philippines, Benguet farming, upland farming

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Social Networks and Access and Utilization of Weather and Climate Information: The Case of Upland Farming Communities in the Philippines

Aubrey D. Tabuga, Anna Jennifer L. Umlas, Katrina Mae C. Zuluaga, and Sonny Domingo[1]

1. Background

There is an increasing need to understand the role of networks in people's activities and behaviors. The prevailing way of thought is that these networks have certain characteristics and structures that reflect norms which must be examined if one seeks to influence how people act or behave. For instance, program implementers can take advantage of existing social structures for more efficient dissemination of information and delivery of programs and services especially when faced with constraints such as limited resources and manpower. In agricultural communities located in areas vulnerable to natural calamities and sudden weather changes like the Philippines, the access and utilization of up-to-date weather and climate information is important in managing risks. It is, therefore, important to examine farming households' ability to access and utilize such information, more so for upland farmers from Benguet Province whose products are sensitive to the amount of rainfall but with limited access to the Internet and reliable phone service. In such rural and remote areas, people tend to rely on their personal networks for support and information when needed. This study is about the importance of social networks in the access and utilization of weather and climate information.

Social networks vary – from kinship, friendship ties and information networks to mere acquaintances – to farmers' organizations and other aggregations and, of course, linkages to trading/marketing networks and extension workers. Knowing how these networks are structured can enable us to use information about that structure for practical purposes. For instance, gathering many smallholder farmers for purposes of educating them on the merits of utilizing weather and climate information in their farm-related decisions may be costly from the administrative side. But there may already be a viable system of communication and interaction in place, perhaps dictated by social norms, in the communities that agricultural extensions and other program implementers can take advantage of, so that efforts meant to disseminate information can be made more manageable yet more effective. In networks that consist of many components or unlinked clusters, identifying the central members in each component who are more likely to influence their network members is therefore essential. These 'central' members can act as hubs who can become easy candidates for program beneficiaries because there is an expectation that they can disseminate the knowledge to their circles more efficiently. In others where the network structure is much more diffuse, getting

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the information to as many members as possible may be more challenging and a different approach can be designed.

Designing program approach in this manner is crucial given the very small number of agricultural extension workers in Benguet - 134 serving 84,087 farmers and fisher folks. In a workshop on the barriers and opportunities in accessing and utilizing weather and climate information participated by municipal agricultural officers and LGU disaster risk reduction and management staff in Benguet held on July 23, 2019, some participants noted that one key challenge is – how to effectively disseminate information to farmers? Apart from disseminating information, there is also the issue of how to motivate farmers to utilize such information in their farm decisions. Given that the ratio of AEWs to farmers in Benguet is 1: 627, there is clearly a need to explore strategies that are effective in reaching out to farmers in the area.

The role of social networks particularly in a developing country is important because access to government services and information such as weather and climate services and adaptation practices are limited. The social capital entrenched in a community can be tapped to disseminate information effectively. Many agriculture development projects target key farmers in the hope that they spread the information and influence adaptation practices of their peers and the larger population. However, it is essential to understand the characteristics of the network first in order to create interventions for effectively disseminating information, reaching target beneficiaries, and preventing vulnerable sectors to be left out.

To ground our own analysis, it is helpful to understand how social networks are observed and mapped in different scenarios; what attributes such networks may have; how these networks are compared to each other, if at all; and what characteristics central nodes may have in similar scenarios. While there are fewer studies discussing this in context of the spread and uptake of weather and climate information, many others discuss this considering adoption of agricultural technologies as well.

Many studies use network surveys and open-ended interviews to explore this and describe a social network at its core. Nidumolu et. al. (2018) selected 125 of 270 marginalized farming households in an Indian village to survey. Each respondent was asked to nominate up to five names for each question on who asks whom for a kind of advice. This, and subsequent semi-structured interviews, led to a description of the network wherein village knowledge centers, extension workers and farmer producer companies had a high in-degree of centrality. Their results also tackled networks for seasonal climate forecasts and suggested that these should be distributed through venues that farmers already use, such farmers meetings and farmer field days. Spielman et. al. (2010) on the other hand used focus group discussions and key informant interviews at 10 purposively selected study sites in Ethiopia to build a network map of rural innovation systems, finding that extension workers and public administration are instrumental in agricultural innovation in the area compared to private companies and market mechanisms.

Wood et al (2014) did an experiment with pastoral farmers in New Zealand to investigate farmer networks and facilitation of information. A series of network surveys are done to identify the persons farmers shared their knowledge with before and after an experiment. In addition, open interviews supplemented the discussion by determining the significance of these contacts. Results of the study showed that farmers discussed the experiment with their contacts, most of whom are farmers as well. Moreover, farmers with dense connections and the same occupation-related contacts grew networks more than farmers with loosely-connected networks and have varied occupations. The discussion shows that farmers value knowledge delivered in person rather than roles, primarily contacts fellow farmers, and seek information from farmers they know have similar farms and experiences (social homophily). The study also highlights that communication in relation to new agricultural knowledge is likely to happen in day-to-day interactions or socializations rather than in organized meetings. As such, it is important to include participation of central actors in the generation of knowledge.

Fewer studies employ one or a blend of face-to-face interviews, experiments, and econometric analysis to evaluate a community's social network. Beamann and Dillon (2017) fully enumerated the household heads and household members in 52 villages in Mali, were there were an average of 35 households per village. They asked the community who they speak to about farming information (primarily pointers on agricultural practices) to map networks and find measures of degree and centrality. In the experiment phase, the researchers conducted a training on composting with farmers with either high degree or betweenness, and furnished these farmers with placards on composting to distribute to whomever they wished. All farmers were tested on composting later on, to assess the spread of information (a non-rival good), and were also asked if they received the informational placard (a substitute for a rival good, like farming inputs). Econometric analysis were then used to determine the relationship between outcomes (receiving a calendar and having a high score on the composting test) and an individual's distance from the closest information source, and the relationship between outcomes targeting nodes with high degree and betweenness. Hoang et. al. (2006) on the other hand, use semi-structured interviews for 73 out of 82 households in Pieng Lieng, Vietnam to ask who talks to whom (discussion network), who asks who for advice (advice network), and who follows whose advice (action networks). They followed up with in-depth interviews with key informants to understand connections between villagers and formal institutions, and what the role of these institutions and extension has been thus far. A previous survey had also already yielded the socioeconomic data of the residents. The consequent results were processed as matrices in UCINet and modelled in Krackplot. The study made use of factorial correspondence analysis, cross tables, and chi-square distance tests to understand the relations among discrete variables.

Results of these studies and many like it give useful insights on the structure and composition of farmers' networks. Ramirez (2013) finds kin and fellow farmers as main sources of adaptation information in a farmer's social network, citing trust as a significant reason that farmers would rely more on each other than outside information sources. Similarly, a study by Nidumolu et.al. (2018) finds that information sharing mechanisms in India includes farmer relationships, and both formal and informal institutions. Institutional information sources with high in-degree of centrality were found to be village knowledge centers, cooperative representatives, and government and private extension workers, while weaker ties were to shop owners and government officials.

The composition and structure of farmer's information networks also vary by gender. In Cadger et. al. (2016), it was found that women farmers have smaller networks than male farmers. Female farmers also had less network connections with individuals from other communities. In Beaman and Dillon (2018), men were also more likely to receive information and farming outputs than women were. Women in the study had 63% less contacts and were less central in the village. In villages where information was first targeted to more central nodes to disseminate, women also had significantly lower knowledge than when the information was given to random nodes. Hoang et. al. (2006) also corroborate that while targeting central nodes to disseminate information is sufficient to reach a broad circle, it may not be enough to reach nodes on the periphery, like women.

Influence within a social network, on the other hand, seems tied to individual characteristics such as educational achievement and access to other important resources. Studies of a village in Northern Vietnam differentiate between discussion, advice, and action networks in the community, and find that while discussion networks are fairly random, villagers approach village heads, identified opinion leaders and better-educated individuals for advice. Higher influence in the community is linked to positions in local government, which in turn is linked to larger kin networks, greater education, greater access, and more frequent visits from extension workers. Interviews with villagers revealed, however, that while these individuals were very central in the network, they were not necessarily good farmers and would also not necessarily be the best at extension work and disseminating information beyond a broad circle. Thus, in stark contrast to the advice networks, action networks (networks of those whose advice they follow) revolved primarily around kin, who villagers see have their best interests in mind (Hoang et al 2006).

Social networks have impacts within extension activities and farmer training, as well. Prawiti (2017) describes how farmers who have more friends within a training group are more likely to score higher on the end-of-training examination. These results imply that farmers' knowledge-seeking behaviors are positively related to the size of their network. Furthermore, farmers who are more central in their network also exhibit higher end test scores, likely related to their outside of classroom ability to effectively coordinate resources and problem-solving activities. On the other hand, the study found that advice networks (networks with extension workers as opposed to only peers) may be detrimental to farmers' knowledge depending on the crop grown. For growers of an established crop like coffee in Indonesia, larger advice networks have a significant positive impact on end-of-training test scores, while advice networks for cacao growers did not. This is likely because of the quality of advice available for arguably younger farmers and extension workers in a newer field.

Other studies do show that beyond pure social ties, an individual's actions (like choosing which crop to grow) can also impact adoption decision. In Villanueva et.al. (2016), larger farmer networks are associated with growing more crops, having more land, and subsequently more yield and economic value for crops sold. Farmers with larger networks had also diversified into improved crops and crop varieties. Cadger et al (2016) also found that the size of knowledge networks also varied with the different crops that farmers produced.

Wossen and other authors (2013) also report that distance from an adopter of technology will also determine an individual's adoption behavior. Having larger networks with more relatives, friends, and neighbors, as well as the distance between network members and physical location of plots near adopters' farms, increases the chances of adoption of new farming and resource management practices. Proximate social distance from the giver also impacts the distribution of rival goods such as farming inputs, Beaman and Dillon (2018) found, though the effect was not as pronounced with non-rival goods such as information.

Overall, a network's size and a farmer's position in it would depend on participation in development and training, crops cultivated, and individual characteristics such as gender and educational achievement. Social ties, physical proximity and the involvement of government and institutional actors also shape the interactions of agricultural stakeholders in the community and form important communication mechanisms between nodes.

Ways to leverage this information, moving forward, are varied. Arguably, a robust social network would aid greatly in bringing climate resilient agriculture initiatives up to scale. Beaman and Dillon (2018) found that farming information on a placard, in this case a calendar for display in homes in Mali, was an effective way to distribute information in some cases. This is especially so when the calendars are given to random nodes in the community to distribute compared to tapping highly central individuals, who tend to miss out on peripheral nodes. In a study in Ghana, researchers also identified a gap between information access and use for smallholder cocoa farmers. They also find that agricultural extension could benefit from taking advantage of the spread of information from farmer to farmer, and recommend localizing, laymanizing and framing information on adaptive techniques in a way that farmers can understand (Maguire-Rajpaul et al 2020).

Technological adaptation, on the other hand, includes the widespread adoption of cellphones among African agriculture entrepreneurs. This facilitates long-distance interaction and the development of the weaker social ties that provide access to new resources and opportunities (Mehta et al 2011). In the case of India, many private and public Information Communication Technologies are being leveraged to try to disseminate agricultural information. E-Choupal, for instance, is a platform that acts as a market channel that provides transparent pricing and thus eliminates intermediaries, while e-Sagu is a personalized extension advice platform. However, reports on the usefulness of these and many other platforms note that impact could be improved if farmers awareness and capacity are built to better make use of them, while the lack of supporting infrastructure is also addressed (Kukreja and Chakrabarti 2013).

These studies illustrate the importance of social networks in agricultural production and technology adoption. But no one seems to have examined yet the influence of social networks in farmers' access to weather and climate information in a context of high susceptibility to weather and climate changes. This study fills this gap by examining the case of farming households in three upland communities in one of the country's key vegetable-producing regions.

The main goal is to inform programs and policies relating to local strategies for information dissemination and in improving connections among farmers, extension workers and knowledge producers. Specifically, it seeks to – 1) characterize the social, economic and information networks in the study areas, 2) examine any variation in the structure of different types of information networks, 3) analyze any association between network connectivity and farmers' ability to access and utilize weather and climate information, and 4) to provide recommendations for purposes of improving the design of information and education campaign and related interventions of agricultural extension workers in the area.

The research questions this study seeks to explore are:

a. What is the structure of social networks of farmers and/or households in the selected areas? Who among the households in the community are the central actors the networks

and are most likely to be the best disseminators of information? Who are those in the periphery who may be reached through a different approach?
b. Are there different networks for different types of weather and climate information?
c. How is connectivity correlated with ***access*** and utilization of W&C information?
d. What are the lessons/insights learned from this exercise that can inform the design of information and education campaign of extension workers and other local programs?

2. Weather and climate information in farm decisions

Much of the weather and climate information this study refers to are those that come from the Philippine Atmospheric, Geophysical, Astronomical Services Administration (PAGASA), the country's lead government agency mandated to provide "adequate, up-to-date data, and timely information on atmospheric, astronomical, and other weather-related phenomena using the advances achieved in the realm of science.[2]" This mandate separates PAGASA from other providers of weather and climate information. Indigenous weather forecast practices and non-PAGASA sources of weather and climate are also included in the study although greater emphasis is provided on PAGASA products.

PAGASA provides various weather and climate products and are grouped based on the period covered. Table *1* provides a list of PAGASA products.

a. Warnings refer to the information reported hours before the occurrence of the actual weather event.
b. Weather forecast refers to the state of atmosphere (or the weather situation) at a particular location over a short period.
c. Climate outlooks and advisories describes information for a "season" that may range from one month to one year.
d. Climate projections provides information on a likelihood of something to happen in climate several decades or centuries in the future.

Table 1 List of PAGASA Products and Services

Type of information			Time Covered/ Issuance	Area Covered	Description
Weather Warnings	TROPICAL CYCLONE/TYPHOON WARNINGS				
	Severe weather bulletins	Alert	12 hrs. /as need arise (11am and 11pm)	Nationwide	Released during events of TC passage over the Philippine Area of Responsibility (PAR)
		Warnings	3 to 6 hrs. / as need arise (6-		

[2] Lifted from the PAGASA website: http://bagong.pagasa.dost.gov.ph/mandate-and-functions (accessed on July 19, 2021).

		hourly, but 3-hourly for 24-hour before landfall)		
	Tropical Cyclone Warning for Agriculture	24-hour/as need arise	Nationwide	24-hour Tropical Cyclone Warning Advisories (TCWA) for Agriculture activities
	Weather advisory	*Once a day (11am during heavy rainfall event)*	Nationwide	Weather advisory issued during heavy rainfall event
	HEAVY RAINFALL AND THUNDERSTORM ALERTS			
	Rainfall Warning System	*3 – 6 hrs. / As need arises*	*Provincial*	*Special report for selected areas during significant rainfall events*
	Thunderstorm Alert System	*3 – 6 hrs. / As need arises*	*Provincial*	*Special report for selected areas on impending thunderstorm events*
	DAILY WEATHER FORECASTS			
	Weather Forecasts	Daily / Daily	Nationwide	24-hour public weather forecast for specific region (released at 5:00 am and 5:00 pm)
	Regional Weather Forecasts	Daily / Daily	Regional	24-hour public weather forecast (released at 5:00 am and 5:00 pm)
	Farm Weather Forecast and Advisory	Daily / Daily	Nationwide	24-hrs Farm Weather Forecast Advisory (FWFA) Released at 8am
Weather forecasts	**BI-WEEKLY AND WEEKLY FORECASTS**			
	3-day weekend Agri-weather forecast	3 days/ Once a week	Nationwide	3-day weekend forecast for farm operations
	10-day Forecast	10 days / daily	Municipal	10-day weather outlook for farm operations (Temperature, Rainfall, Total Cloud Cover, Rel. Humidity, Wind) for selected Municipalities
	10-day Probabilistic Forecast	Running 10 days/ Every Thursday	Nationwide	10-day probabilistic forecast of rainfall and temperature for PAGASA Synoptic station

	10-day Agri-weather Information	10 days/Every 10th day (Decadal)	Regional	10- day agri-weather forecast and crop phenology for farm operations per Region
Climate Outlooks and Advisories	**MONTHLY FORECASTS**			
	Monthly Climate Assessment and Outlook Advisories	Monthly/ Monthly	Nationwide	Monthly issuance of observations for the past month and forecast for the next month, includes other weather systems that will likely influence the country
	Monthly Agro-climatic Review and outlook	Monthly	Nationwide	Review of the previous month and outlook of the following month farm advisory and crop stages
	Monthly Regional Forecast Quick Outlook	Monthly/ Monthly	Regional	Monthly issuance of Rainfall forecast and climate outlook per Region.
	Monthly Tropical Cyclone Forecast	Monthly/ Monthly	Nationwide	Forecast number of Tropical Cyclone that will enter/occur in the PAR
	2-6 MONTH CLIMATE FORECASTS			
	Seasonal Climate Assessment and Outlook Advisories	6 months/ Every 6 months	Nationwide	6 months issuance of observations for the past six months and forecast for the next six months, includes other weather systems that will likely influence the country
	Monthly Rainfall Forecast	6 months/ Monthly	Nationwide	Monthly issuance of 6 months deterministic forecast for rainfall
	Monthly Temperature Forecast	6 months/ Monthly	Nationwide	Monthly issuance of 6 months deterministic forecast temperature
	Monthly Probabilistic Forecast	6 months/ Monthly	Nationwide	Monthly issuance of 6 months probabilistic forecast
	ENSO AND DRY SPELL FORECASTS			
	El Niño/ La Niña Advisories, El Niño/ La Niña Watch	During occurrence ENSO phenomena	Nationwide	El Niño Southern Oscillation (ENSO) status; “Advisories” speak of the current ENSO phase whereas “watch” refers to the forecast of ENSO phase based on PAGASA ENSO alert system

	Drought and Dry Spell assessment and forecast	As need arises	Nationwide	Issuance of Drought and Dry observations for the past months and forecast for the next six months particularly during ENSO events
	Impact Assessment for Agriculture	Monthly	Regional	Assessment of agricultural performance based on the Generalized Monsoon Indices (GMI) and the Yield Mean Indices (YMI) and other relevant extreme weather incidents (e.g. heavy rainfall, drought, typhoon passage)
	NARRATIVES			
	Press Release	During a significant climate phenomena (I.e., ENSO)	Nationwide	Issued for Onset and Termination of: *Northeast Monsoon (Amihan) *Southwest Monsoon (Habagat) *Rainy Season Includes other climate phenomena (i.e., ENSO)
	El Niño/ La Niña Advisories, El Niño/ La Niña Watch	During occurrence ENSO phenomena	Nationwide	El Niño Southern Oscillation (ENSO) status; “Advisories” speak of the current ENSO phase whereas “watch” refers to the forecast of ENSO phase based on PAGASA ENSO alert system
Climate projections	**CLIMATE PROJECTIONS**			
	Climate projections for the Philippines	Mid-21st Century (2036-2065), Late 21st Century (2070-2099)	Nationwide; per province	Climate projections for the Philippines by province for temperature and precipitation based from all available downscaled climate change data that were simulated under three scenarios; A1B (Socioeconomicdriven scenarios), RCP 4.5 and RCP 8.5 (Emission-driven scenarios); Representative Concentration Pathways (RCP)

Source: PAGASA

According to the Municipal Agricultural Office in Atok, most of the smallholder farmers in the municipality depend on rainfall as the primary source of irrigation. There are supplemental sources of irrigation such as water delivery services and use of water pumps. However, these are costly to the farmer and in the case of water pumps for supplemental irrigation, the sources of water also depend on rainfall. As a result, information on rainfall are very crucial to various farming decisions. For example, information about the onset of rain is important since it determines the start of the planting period. If the farmer plants and there is insufficient rainfall, the crop will not sprout. If there is too much rainfall, the seeds will be washed away. Other farm decisions affected by rainfall are crop choice and use of supplemental irrigation, among others. Benguet has a Type I climate wherein there are two pronounced seasons, dry season from November to April and wet for the rest of the year. The municipal agriculturist has reported that lately, wet and dry season in Atok is not distinct anymore so it is more difficult for farmers to plan their activities.

In addition to rainfall information, typhoon information is also significant to the farmers because it can cause surface run-off and damage to farms due to the municipality's mountainous terrain. The terrain also causes varying microclimatic condition in the area. Hence, it is also important to consider indigenous forecast methods on rainfall and typhoon.

Indigenous information on rainfall refers to the set of traditional beliefs about obvious, observable conditions in nature that forecast the arrival of rainfall well ahead of time. For instance, the farmers in La Trinidad and Atok believe that the arrival of the "siyet" or "indokit" bird in December signifies the beginning of the cold season, which is characterized by scattered showers and gusty winds.

Indigenous information on typhoons similarly refers to the set of traditional beliefs about obvious, observable phenomena in nature that forecasts the arrival of typhoons. Farmers in La Trinidad and Atok believe, in this case, that the arrival of another migratory bird called "killing" heralds the start of the dry season; one day and one night after the bird's appearance, as well, a typhoon will usually follow. Farmers stated however that both the "siyet" and "killing" birds are becoming less accurate signs to predict the weather by.

PAGASA utilizes various venues to disseminate weather and climate information. The foremost source is the PAGASA website http://bagong.pagasa.dost.gov.ph/. The agency also has an official social media channels such Twitter, YouTube and Facebook and holds periodic climate forums which can also be accessed in their official accounts. In case of extreme weather events such as typhoons and extreme drought such as El Nino, PAGASA directly coordinates with the National Disaster Risk Reduction and Management Council who in turn sends information and warns the public via SMS.

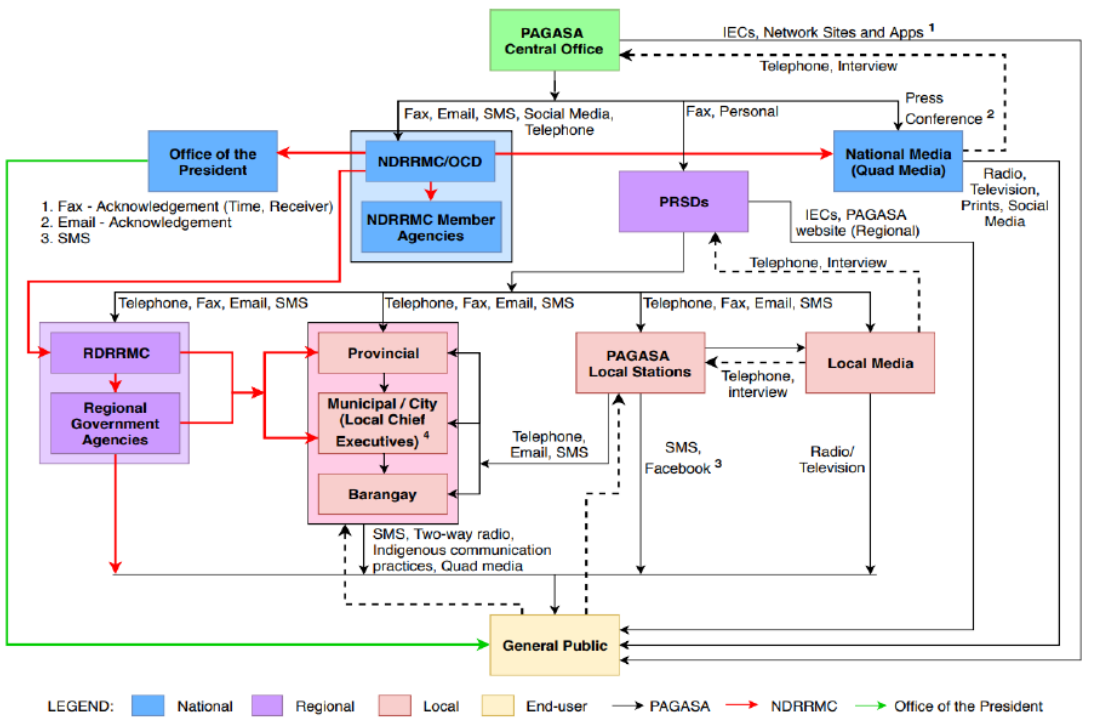
There are also initiatives from PAGASA to make weather and climate information more accessible and user-friendly to the public in general. In 2016, PAGASA launched a new mobile application named "DOST-PAGASA". The mobile application contains weather and climate information such as weather bulletin, flood information, tropical cyclone warning and rainfall and thunderstorm warning[3]. The state weather bureau also has another mobile application named "Payong PAGASA" which was launched in 2018. It features information on daily monitoring of rainfall and temperature, monthly climate assessment and outlook, farm weather forecasts and advisory, 10-day regional agri-weather information and 10-day weather outlook, among others. PAGASA has also developed and used various warning systems that aims to

[3] https://www.jica.go.jp/philippine/english/office/topics/news/160615.html

make it easier for the public to understand climate and weather information and its possible impact. Moreover, they have created simplified information and educational materials about weather events such as tropical cyclone warnings, information on flood, La Nina and El Nino and rainfall warnings, and features their mascot aptly named as “Ella the Umbrella”.

Figure 1 shows the information dissemination flow of weather warnings and forecasts. The PAGASA central office’s direct communication to the public are through IECs, PAGASA mobile app, website and social media accounts. They also disseminate information to key government agencies such as the National Disaster Risk Reduction and Management Council, PAGASA regional offices and national media outlets.

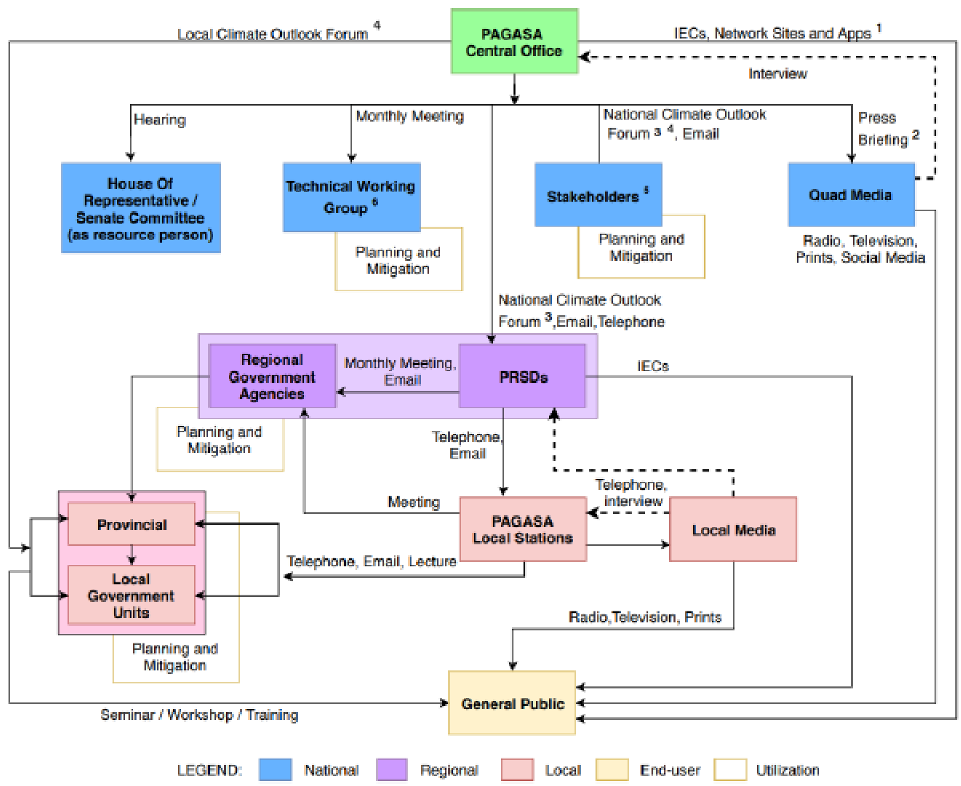
Figure 1 Information dissemination flow of weather warnings and forecasts



¹ *IECs, PAGASA website, PAGASA mobile app, PAGASA Common Alerting Protocol (CAP) through Google Public Alert and PAGASA social media accounts (Facebook, Twitter, Youtube and Viber)*
² *in the event of typhoon passage*
³ *weather information written in dialect*
⁴ *As soon as the DRR of the LGUs receive a weather bulletin/advisory from PAGASA, the Mayor will form a meeting as head of municipal/city council. The Mayor will then also convene and give information to barangay leaders, city level leaders/officials.*

Figure 2 shows the information dissemination flow of seasonal climate forecasts. Like weather warnings and forecast, PAGASA central office’s direct communication to the public are through IECs, PAGASA mobile app, website and social media accounts. This information is also distributed using quad media. The agency also attends hearings at the House of Representatives or Senate committees as resource persons, participate in technical working groups related to planning and mitigation and conducts National Climate Outlook Forum for various stakeholders.

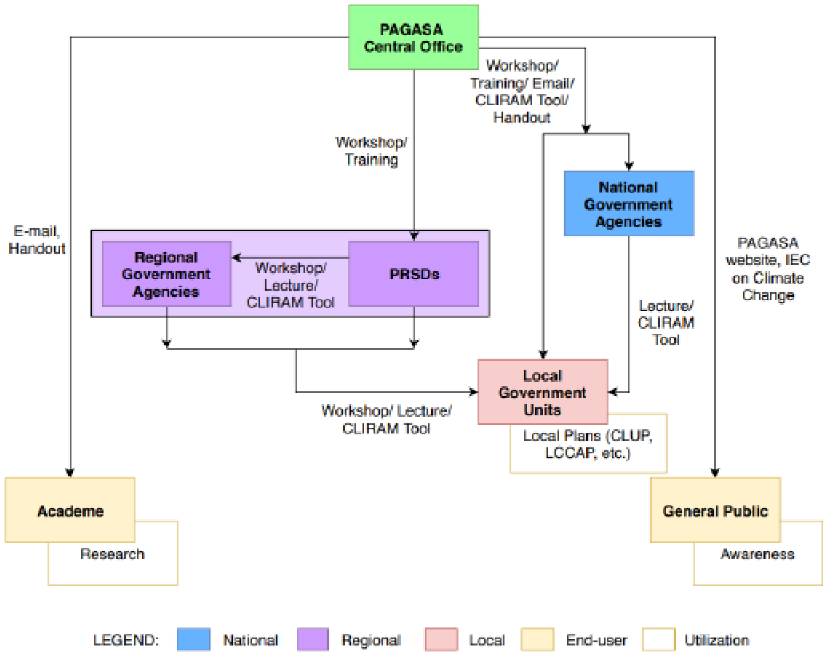
Figure 2 Information dissemination flow of seasonal climate forecasts



[1] IECs, PAGASA website, Payong PAGASA mobile app, and PAGASA social media accounts (Facebook,Twitter and Youtube)
[2] during ENSO and other extreme events
[3] live streaming via Youtube/Facebook live
[4] physical attendance
[5] NGAs, attached agencies, NGOs, GOCCs, academe, business and private sectors
[6] Technical Working Group on (a) Angat Dam Operation and Management, (b) Food Security committee, (c) PCAF committee, and (d) El Niño Task Force

Figure 3 shows the information flow for climate projections. The IEC on climate change is uploaded in the PAGASA website. They also conduct workshops with the national government, regional government agencies and with local government agencies to aid them in crafting their local plans.

Figure 3 Information dissemination flow of climate projections



Despite these efforts and initiatives from PAGASA, the state weather bureau is still not the main source of weather and climate information and have limited reach to the farmers. Among others, the identified barriers to access and utilization of weather and climate information from PAGASA are the limited internet access of farmers and the complexity of PAGASA information that makes it difficult for farmers to understand.

Agricultural extension workers can play a key role in bridging PAGASA and smallholder farmers. They are aware of the local conditions faced by the farmers and knowledgeable of the impact of weather and climate to farming decisions. It is also easier and practical to train agricultural extension workers in understanding weather and climate information compared to all farmers since training the latter requires a huge amount of resources due to their vast number and various backgrounds and skills. Hence, agricultural extension workers are in a strategic position to disseminate weather and climate information and make the information useful to the farmers.

3. Data and methodology

3.1. Survey data

This study uses primary data collected from 239 households in three sitios in Atok, Benguet. The primary data gathering activities for this study was conducted in October 2019 up to the first week of December 2019 through a structured survey instrument administered through face-to-face conversation/survey. All data were recorded in a tablet-based platform. The data collection process for the survey which included social networks is relatively expensive and arduous. As a requirement, it is crucial that the study selects areas where there is very low constraint to complete enumeration and where there is an existing census data of all households in the area. Ideally, the study areas should have enough farm households for the crop of interest, and enumeration of kinship and friendship ties (and other links) is politically feasible. Linkages or connections data are highly confidential and sensitive information, and some people may not be very keen at disclosing this information. Hence, there is a caveat that although there is a complete enumeration, there is an assumption that the resulting data do not perfectly capture all the networks. Another requirement for data gathering is that local government units and barangay officials of the study areas provide full support to the field operation.

This study selected three sites in Atok, Benguet so that comparison is possible. One of the criteria is that these should vary in terms of geography or location. The other criteria are that full enumeration is feasible and that the crops of interest (cabbage, carrot, and potato) are produced in these areas. The PIDS team conducted site visits in Atok, Benguet and held discussions with Benguet State University, the partner university, the municipal agricultural officer, and selected barangay officials in the area on April 15, 2019. These consultations were important since they are more aware of the local conditions of Atok, the study site.

The municipality of Atok is in the province of Benguet and approximately 300 km north of Manila. It has a land area of 22,385.4958 hectares and is centrally located with municipalities of Kibungan ang Buguias on the north, Kabayan ang Bokod in the east, Kapangan on the west and Tublay on the south (see Figure 4). It is upland and produces high value crops such cabbages, potatoes and carrots as well as cut flowers. Two-thirds of the land area has 40-60 percent slope and is characterized as hilly to mountainous, while the remaining one-third has 60 percent above slope and characterized as rugged mountain areas. Because of the landscape, the municipality develop varying micro-climatic conditions and hence the role of weather and climate information are of value to the small-holder farmers. It also emphasizes the role and need for agricultural extension workers in effectively delivering weather and climate information to the farmers, among others, to help address and prepare against the adverse impacts of extreme weather and climate events. Most of the farmers depend on rainfall as a primary source of irrigation. Though the conditions in Atok make an interesting case for social network analysis on access and use of weather and climate information, it makes data collection more strenuous because of the distribution and location of households and the knowledge of local partners more important.

Figure 4 Map of Benguet Province and its municipalities

From the consultations with the Atok Municipal Agricultural Office, barangay representatives of Barangay Paoay and Cattubo and from our partners from the Benguet State University, we have identified three sites for the survey in Atok, Benguet. Full enumeration of a barangay is not advised because of population, challenges in transportation and budget constraints. Barangay Paoay is initially not considered because of respondent fatigue in the area and the huge number of households. The other barangays are characterized as too far from the center and with low probability of a complete enumeration since the households are more dispersed from each other. Hence, the political unit is reduced to a “sitio” to make full enumeration feasible.

Table 2 Population of Atok, by barangay in 2015

Barangay	Number of households in 2015*	Number of respondents in the ACIAR 2018 survey	Population in 2015*
Abiang	406	29	1,757
Caliking	708	31	3,402
Cattubo	601	64	2,482
Naguey	346	0	1,723
Paoay	1,069	64	4,395
Pasdong	279	0	1,193
Poblacion	454	13	2,077
Topdac	515	0	2,639

*Source: 2015 Census of Population

Barangay Paoay and Cattubo are major producers of cabbage, carrots and potatoes based on the discussion with the municipal agricultural office. The sites chosen are sitios Proper Paoay in Barangay Paoay and sitios Tulodan and Macbas in Barangay Cattubo. Specifically, the sites together comprise of 315 households, with 89 in Macbas, 94 in Tulodan and 132 in Proper Paoay. The primary data collection, therefore, covers these 315 households. All the sites are communities of 70-80% rain-fed vegetable farms, but with arguably varied potential for the spread of information as well: while Proper Paoay is a denser *sitio* and nearer to the municipality, households in Macbas and Tulodan are more disperse and are located far away from the center of the barangay and Atok itself. Each sitio also had an available household listing that the researchers obtained from the LGU. Overall, these *sitios* are well-delineated and of geographies that allow for complete enumeration; they are also comparable but at the same time possess unique characteristics that could make drawing parallels between respective networks more interesting.

There were some notable difficulties during the field survey. Prior to the start of the survey operations, the project team collected household lists per sitio from the barangay. These lists were used as the basis of the household survey. The respondents are all farming and non-farming households living in sitios Proper Paoay in Barangay Paoay and sitios Tulodan and Macbas in Barangay Cattubo. Based the barangay lists, the total number of interviews expected was 315 households. However, only 239 interviews were completed. The survey team faced difficulties in doing the household interviews. Some of the respondents were no longer residing in the study sites and so were not included in the survey. It was also difficult to schedule and conduct the interviews because of the farmer's schedule. They leave their place of residence to tend to their farm early morning and return home in the afternoon before sunset. Hence, the enumerators had a small window to conduct the interviews and at most could only conduct 3 interviews in a day. The locations of the houses were significantly far from each other, and some were in uphill areas that could only be reached by walking. Moreover, modes of transportation were limited within a sitio.

Table 3. Number of completed interviews

Barangay and Sitio	Freq.	Percent	Cum.
Sitio Proper Paoay, Brgy Paoay	119	49.79	49.79
Sitio Toludan, Brgy Cattubo	74	30.96	80.75
Sitio Macbas, Brgy Cattubo	46	19.25	100.00
Total	239	100.00	

3.2. Social network data

This study collected various types of networks including the quality of the relations. These relations contain social capital that people can convert into other forms of capital. Social capital represents the resources, actual or virtual, that people have accumulated through their "more or less institutionalized relationships of mutual acquaintance and recognition" (Bourdieu and Wacquant, 1992: 119).

Networks can be role-based like kinship (i.e. relations by blood and marriage) and friendship ties. It is essential to capture these relations as these may be considered the intrinsic source of social capital of people in a community. They may not always share information and other resources, but they are highly likely to connect from time to time, as the need arises. In addition to kinship and friendship ties, this study collected data on information networks such as but not limited to weather and climate information networks. However, obtaining information network related to weather and climate information alone may not suffice to capture an actor's extent of connectivity with other nodes which is useful for designing future information and education campaign strategies. If the information being shared in a W&C information network pertains to recent or current W&C information (which is less prone to recall error), the network data collected is likely to reflect the current or recent network structure. Although it would be useful in explaining the constraints and opportunities for accessing and utilizing W&C information in recent times, it may lose some relevance for informing future strategies. The idea is to get an understanding of the structure of the social networks of farmers and households in the community (i.e. networks that are measured quite exhaustively or in different ways) so that the knowledge generated is more likely to reflect the true networks and can be utilized for future program design purposes, and not just to explain the current situation. Hence, in addition to the abovementioned role-based networks and information networks, the study also collected farm inputs and advice networks.

This study collected data on social networks of the household head and spouse. The social relations of each of these individuals were collected – starting from the kin, then friends, then economic contacts, then individuals to whom they share information and resources. The unit of analysis is both at the household and individual farmer levels. Networks of focus are those situated within the selected communities. If the individuals/households have key contacts outside of the community such as extension workers, trader, marketing agents, external suppliers, who play an important role in their farming activities, these too were included in the network data collection. Details on the data collection process are discussed in the succeeding sub-section.

To obtain social relations data, the survey enumerator asked the respondents (household head and spouse in each household) to identify a maximum of 50 social (kinship and friendship) contacts and all direct contacts related to weather and climate information within the sitio of interest. The information on social networks that were gathered were precise. For example, the respondent was asked to identify whether the social contact is a parent, a cousin, an Aunt or Uncle. Table 4 shows the social links that were collected through the survey. The variables of interest – weather and climate information were segregated based on the outcome of the validation/technical analysis conducted with PAGASA, local officials and agricultural extension workers.

Table 4 Social relations gathered

Friends and Neighbors	Work-related contacts in the past 3 years	Kin	Weather and climate information networks	Other social networks
Close friends	Employer	Parent-child	Heavy rainfall and thunderstorm alerts	Farm advice
Childhood friends	Worker	Siblings	Tropical cyclone warnings/ typhoon	Farm inputs
Neighbors	Co-worker, colleague	Children	Daily weather forecasts	Credit links
Kailian	Hired labor	Aunts/uncles	Bi-weekly and weekly forecasts	Health information
Churchmate	Suplay	cousins	2-6 months forecasts	
	Creditor	niece, nephew	ENSO forecasts, El Nino, La Nina	
	Trader	Grandchildren	Narratives	
	Disposer	In-laws	Climate projections	
	Trucker		Indigenous forecasting information	
	Private technician		Non-PAGASA information	

In the collection of social network data, the progression of the survey interview is that the respondent was asked to identify all friends and neighbors first, followed by work-related contact and then, lastly, kin. The enumerator then asked whether the respondent obtain or share W&C information, have established links involving farm advice and farm inputs, and credit with the social relations identified. Since it is possible that there are links outside the person's social relations, the enumerator also asked for other contacts (outside social relations) whom the respondent have had interaction with in relation to the abovementioned variables of interest (e.g. whom they obtain and share W&C information, farm inputs or advice, and credit).

The survey focuses on the internal networks, that is – people living within the same sitio as the respondent. Limiting the network to within-sitio contacts renders the survey operation more feasible. External networks were collected only in instances where the respondent identifies significant contacts outside of the sitio. Furthermore, the focus on within-sitio network rests on the assumption that people in more geographically isolated areas (such as those in Atok where there is limited access to information due to poor mobile phone signal and limited mobility) depend more on proximate contacts and social relations.

Initially, the study required full enumeration of units within a geographically-bounded community, in this case – a sitio (sub-unit within a barangay). If the enumeration is partial (i.e. it does not cover the entire community or sitio for instance), the parameters may not fully reflect the precise connectedness characteristics of the households in the community. But as discussed in the foregoing sub-section, not all the targeted households were interviewed due to various reasons. Though this presents a limitation, the parameters yielded still constitute 76 percent of the actual network which is acceptable given the extreme geographical constraints encountered by enumerators. Also, relations data can be obtained from either side of the link; it is not required to confirm it from both sides, the relation is still considered reciprocal. Given that many of the targeted respondents which were not included were in remote locations, it is highly likely that they are less integrated with the rest of the community. This gives us a reason to assume that the true social cohesion parameters may be lower (that is, the communities are less cohesive) than the ones calculated from the actual data gathered.

3.3. Access to weather and climate information

Based on encyclopedia.com, "information access is the ability to identify, retrieve, and use information effectively."[4] The weather and climate information made available by PAG-ASA do not necessarily reach the end users, in this case, the farmers. This study examines farmers' access which is narrowly defined by having received, voluntarily or involuntarily, such information through any platform, media or person (Internet, SMS, traditional mass media, or neighbors) in a given time, regardless of the individual's understanding of the information and subsequent choice of whether or not to act on it. Other ways for determining and examining *access* like level of awareness, whether the person actively searches for such information, the type of information he/she seeks, whether he/she obtains what he/she needs in a timely manner, and the specific sources of weather and climate information were also gathered.

For every category of PAGASA product as well as indigenous and non-PAGASA sources of weather and climate information, the following questions were asked to examine "access" of the respondent.

1. Have you heard of this type of weather and climate information?
2. If yes, do you feel you need further explanation on this information?
3. Do you actively seek this information for any of your farming decisions?
4. Are you able to access this information when needed? (5-point Likert scale from 1-Always to 5-Never
5. What are the sources of these information?

3.4. Utilization of weather and climate information

Even if farmers can obtain weather and climate information, utilizing these for farm decision-making is not guaranteed. In this study, utilization is operationalized as when the weather and

[4] https://www.encyclopedia.com/computing/news-wires-white-papers-and-books/information-access (accessed on July 19, 2021)

climate information has affected the farmer's farm-related decision such as but not limited to the timing of planting and harvesting, the choice of crop to plant, or whether to invest in supplemental irrigation. This may also be supplemented by information search done by the farmer. Actively searching for weather and climate information roughly means that the farmer intends to use it in his farming decisions.

1. Do you actively seek this information for any of your farming decisions? (Y/N)
2. Did you ever use this information for decision-making in your farming activities? (Y/N)
3. From 1-5, how useful do you consider the information?
4. During the last cropping season, did you (or any other member) visit the PAGASA website, including official social media channels such as Facebook or Youtube to get information on weather and climate?

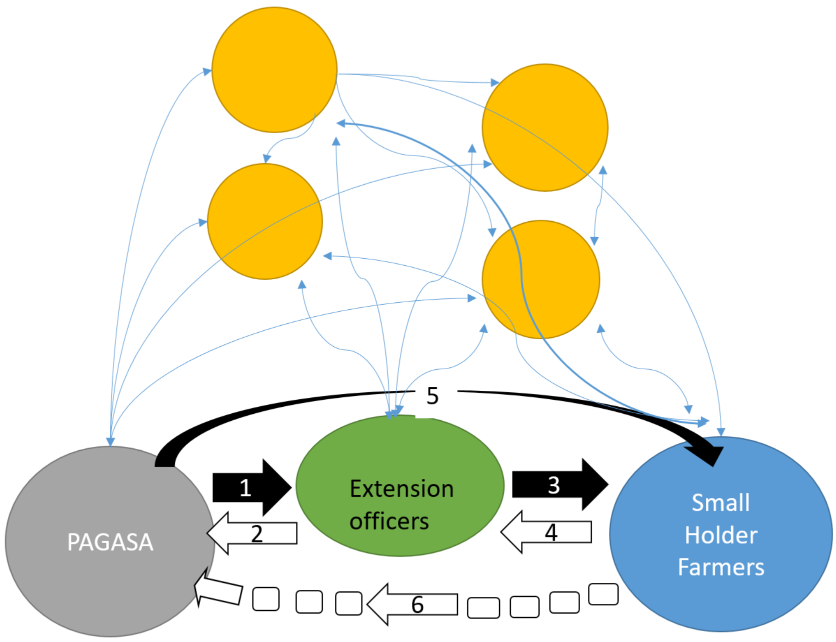
3.5. Other variables

It was also useful to gather data about the respondent's educational attainment, marital status, ethnic group, membership in organizations, primary occupation, farm characteristics, availment of credit, and other individual-level information. Information on whether the individual has ever attended farmer field school, local government meeting, and have ever interacted with an agricultural extension worker in the past were also collected. The survey also collected information on household variables like number of members and assets (e.g. vehicles, smartphones, tractors, etc.). A variable for physical proximity was also included in the survey – this is the reported physical distance between the household dwellings and the place or venue that they frequently visit wherein they can meet people as this may help in explaining people's ability to reach others. The importance of physical proximity on social influence is highlighted in Meyners, Barrot, Becker and Goldenberg (2017) which is assumed to have a great role as well in the analysis of this paper's chosen context.

3.6. Data analyses

To examine the role of social networks in the access and utilization of W&C information in selected communities in Atok, Benguet, the key methodology is social network analysis (SNA). SNA is a paradigm that focuses more on relations rather than attributes. It examines the structure of ties among social actors or nodes which can be persons, homogenous groups, organizations or nations, and provide a way to make correlations possible.

Figure 5 Schematic of Agricultural Knowledge Information System (AKIS) in Benguet and Mindoro.



The proponents of this paradigm note that many constraints and opportunities that people face are influenced not necessarily by who they are but who they are connected with and the structure of social networks they operate in. In Figure 5, although some information can be directly obtained from data sources like PAGASA or from extension officers, others can be relayed or disseminated by social relations, who farmers often interact with. In contagion models, such as those that explain the diffusion of infectious diseases, the higher the density of the network (that is, more connections relative to total possible connections), the faster the rate of spread of the disease (Banerjee, Chandrasekhar, Duflo, and Jackson, 2012). The theory of social influence also lends insights in examining social networks and their potential influence. This school of thought notes that social influence in a function of social proximity whether by structural cohesion (close social relation) or structural equivalence (having similar attributes or coming from a homogenous group).[5] Therefore, the more cohesive social network allows for more social influencing and greater diffusion of information. Social cohesion is operationally defined as the extent to which people within a community share resources and have trust for each other. The objective measure for social cohesion is network density. Individual connectedness or centrality is also important. The actor or person who is well-connected is likely to be the most effective influencer or broker of information and other properties that flows through the network. Network actors who have more connections are in a better position to receive and share information than those who have very few connections, or not connected at all (Jackson, Rogers, and Zenou, 2016). If one seeks to influence people to use scientific knowledge in their farming such as weather and climate information from PAGASA, the act of influencing others may be more challenging given a more diffuse network and when he or she has very few connections, all else being equal. A more closely bonded community, on the

[5] See Marsden & Friedkin, 1994

other hand, would be more conducive for knowledge diffusion and social influencing amongst its community members.

The SNA is the most fitting methodology for understanding social networks and their likely influences. Through its meso-level approach, it has the ability to enrich individualistic analyses like regression analyses that this paper also uses for more formal analysis of the relationships. SNA also provides a visual representation of the social linkages, a unique way of illustrating and understanding the social network structure. Through this, one can examine the flow of weather and climate information among network actors.

The SNA software package, UCINET, was used to yield network parameters such as density (actual ties divided by total number of possible ties), components (number of distinct clusters), geodesic distance (the length of the shortest path between any pair of network actors), and diameter (the shortest distance between the two most distant actors in the network). It also calculates, at the individual network actor level, parameters of connectedness such as degree, betweenness, closeness, 2-step reach, and eigenvector centrality, among others. Each parameter measures a specific aspect of connectivity. The degree gives the total number of nodes or actors which an actor of interest is directly connected to. The 2-step reach centrality is the number of actors one can reach in 2 or less steps; provides the extent of an actor's indirect links. Betweenness, meanwhile, is the proportion of pairs of actors in which a particular actor acts as a broker because it lies within their shortest path. Removing an actor with high betweenness score is likely to lead to disruption of the channels of communications. The eigenvector centrality simply shows how central an actor's connections are. Closeness centrality measures how close one is to all other actors in the network.

Identifying centrality is essential because it gives a notion of the hubs, the potential influencers and bridges that bind communities together (Jackson et al, 2016). These bridges are also potentially the most effective information disseminators and influencers. If information is coursed through them, it is expected that they are able to disseminate it in a more efficient way. Similarly, this analysis also provides the nodes at the periphery, that is - those who are least connected than the rest, and their characteristics. These people/households may benefit from a more direct approach of information dissemination because they have fewer connections.

The study provides the network graph for each of the selected sites, and by type of networks (i.e. social networks, information networks). The network graphs are usually presented at the household level. This means that the total number of nodes is equivalent to the total number of households included in the survey. At time, they were also segregated based on the sex of the identifier such that the paper can show both the male-identified network of households and the female-identified network. Note that the respondents are both household head and spouse (if any). Attributes of actors or households have also been reflected in the network graphs for more nuanced appreciation. Examples of these are networks that show, through node coloring, the households which have ever interacted with an extension worker. The node size can also be differentiated based on centrality scores.

It is important to note that this paper does not account for how networks are formed nor is it about the causal relations between social connectivity and access to information or other outcomes of interest. All analyses are exploratory and correlational.

3.7. Regression analyses

To formally estimate the correlation between connectedness and the variables of interest – access and utilization of weather and climate information, we implement logit regression analysis. The network parameters calculated for each respondent in the study can be used as explanatory variables in the regression analysis of access and utilization of W&C information. For instance, let Y1 denote access and utilization such that Y1= 1 if actor have access and utilize the information; 0, otherwise. We want to know how the network scores correlate with the probability of getting a positive outcome. The hypotheses that can be tested is that the more (less) connected the household/farmer is, the more (less) likely that the household/farmer accesses and utilizes W&C information, holding other factors constant. Note that, at the minimum, such analyses are correlational, not causal or attributional. Causal analysis is difficult to implement in this study. A fundamental criticism of using parameters from social network analysis in regression analyses comes from the potential endogeneity issue of networks. That is, networks may have developed from certain activities related to the outcomes. For instance, one who has limited access to some useful information may intentionally link up with a person known to have more connections so that she can obtain the needed information. The dependent variable which is having or not having access to the information/knowledge is influencing the connectedness of the individual – a simultaneity that violates the exogeneity assumption in most regression analyses. Networks, therefore, are unlikely to be exogenous. Blood relations do not have this kind of problem because one cannot self-select himself to the family (i.e. it is a given), but friendship ties and acquaintances, economic networks, and organization-related ones are likely to be endogenous.

4. Results and discussion

4.1. Profile of survey respondents

The average age of the household head is 43 years old and ranges from 19 to 84 years old. Most (88%) of the household head are male. Nearly half (46.6%) completed at least high school. All the household heads are members of an organization or beneficiary of government programs. Almost all (94.1%) heads are engaged in farming with an average of 17.44 years of farming experience.

Most of the households have a radio and TV, which are particularly important sources of information. 76 percent has a basic phone meaning it can call and text but cannot access the internet, while 69 percent has a smartphone. Internet use is low because only 36.84 percent reported having access to the internet. None of the respondents has a landline. Ownership of means of transportation is limited. Only 15.5 percent owns a motorcycle and 31.8 percent owns a vehicle.

The importance of social networks manifests in upland households' economic activities. In this survey, households who availed of credit last year reported that the most common sources of credit are relatives and friends where 42 percent of the 72 respondents confirmed such as their source. In contrast, only 30 percent noted they borrowed from credit cooperative, 15 percent did from disposer, and only 3 percent did from banks. In choosing market channels, respondents consider convenience (n=102) as the primary factor, followed by trust in the market channel (n=89), high price or return (n=72) as well as friendship (n=46).

As farmers, the majority of the household heads across all three sitios are involved in growing vegetables, with 196 respondents naming this as their primary farming activity. Other minor farming activities include growing cut flowers, primarily alstromerias, and the cultivation of ornamental plants. Vegetable growers across all sitios on the other hand reported planting cabbage the most, followed by potatoes and then carrots. 26 percent of the respondents specified cabbage as the crop with the highest contribution to income, followed by potatoes (23 percent) and carrots again (11 percent). 10 percent of the respondents reported that lettuce and radish contribute the most to their income.

In terms of farm resources, most of the households do not own a water pump (61.09 percent), tractor (73.64 percent) and greenhouse (87.45 percent). The average farm size operated in the previous cropping season is 1.23 hectares. Spring (45.80 percent), rivers (28.99 percent) and rain (10.50 percent) are the primary sources of farm water. Meanwhile, Hose/sprinkler irrigation is the most common form of farm irrigation (57.14 percent) followed by Surface water pumping (13.45 percent) and Private tanks (11.34 percent).A significant amount of communication may happen through physical interaction given the poor signal of mobile phone in the areas. Also, despite the proliferation of smart phones and computers, 31 percent of the households are yet to acquire their first smart phones and only 7 percent possess a computer. None of the respondents have landline phone though three-quarters do have basic mobile phones.

Many of the respondents convene in Sayangan (n=152), where the municipal office, public market and transportation hub is located for errands and other purposes – places where they can interact with other people in the area. Other mentioned places are the barangay hall (n=100) and church (n=65).

Table 5. Frequently Visited Places by Household Head and Spouse

Frequently visited places	Household head	Spouse	Total
Barangay hall	58	42	100
Sayangan	95	57	152
Cooperative	14	9	23
Church	37	28	65
Greenhouse	9	5	14
La Trinidad, Trading Post	17	10	27
Baguio	5	2	7

*some respondents mentioned multiple places visited

Other venues of learning and communication exchanges can be through government programs. Attendance in farmer field schools is low at only 22.84 percent. Only 40.17 percent of the households has interacted with a government agricultural extension worker. The common ways of interaction between the farmer and government agricultural extension worker are by the

AEW visits to the farmer and AEW giving a presentation. On the other hand, attendance in local government meetings is relatively higher compared to farmer field schools. 39.33 percent of the households reported attending a meeting organized by the LGU. These meetings are in the form of farm related seminar (30.13 percent) and disaster-preparedness seminar (11.72 percent). Most of the farmers are also open to adopting new technology. From a scale of 1 to 5, with 1 means unlikely and 5 means "definitely", the average answer is 3.98.

4.2. Access and Utilization of Weather and Climate Information

Among the types of weather and climate information, tropical cyclone warnings, heavy rainfall warnings, daily forecasts and ENSO are well-known to the households. On the other hand, 2-6 months forecasts and climate projections are the least known. Indigenous forecast information is heard of 30 percent of the respondents.[6]

Table 6 Respondent who have Heard of Weather and Climate Information

Variable	Obs	Mean	Std.Dev.	Min	Max
Typhoon	363	.99	.12	0	1
Heavy rainfall	363	.93	.25	0	1
Daily forecast	363	.88	.32	0	1
Bi-weekly forecast	363	.29	.45	0	1
Monthly	363	.03	.18	0	1
2-6 month forecast	363	.01	.1	0	1
ENSO	363	.89	.32	0	1
Press	363	.46	.5	0	1
Projections	363	.06	.24	0	1
Indigenous	363	.3	.46	0	1
Non-PAGASA	290	.19	.39	0	1

Tropical cyclone warnings, heavy rainfall forecasts, daily forecasts and ENSO are also actively sought by the respondents. Except for ENSO forecasts, this information has shorter coverage from time issuance to actual event, which is usually less than 24 hours before the occurrence of the event. It also influences farm activities since typhoons, heavy rainfall and ENSO can bring devastation and losses. These forecasts are also distributed through various platforms and in case of typhoons can receive broad media attention. Weather forecasts and seasonal climate forecasts with the exemption of ENSO, and climate projections are the least sought after (Table *7*).

[6] Please see Appendices

Table 7 Actively seek Weather and Climate Information

Variable	Obs	Mean	Std.Dev.	Min	Max
actively seek typhoon	363	.88	.32	0	1
actively seek heavy rainfall	363	.7	.46	0	1
actively seek daily forecast	363	.68	.47	0	1
actively seek bi-weekly forecast	363	.17	.38	0	1
actively seek monthly forecast	363	.02	.16	0	1
actively seek 2-6 month forecast	363	.01	.09	0	1
actively seek ENSO	363	.64	.48	0	1
actively seek press releases	363	.3	.46	0	1
actively seek climate projection	363	.03	.17	0	1
actively seek indigenous forecast	363	.13	.33	0	1
actively seek non PAGASA info	363	.13	.34	0	1

It can be caused by the long-time frame of forecast coverage especially for climate change projections. The level of forecast localization also affects interest since this are at the provincial, regional, or national level. In addition to the time frame, the level of localization also adds to its complexity and weak interest of the end-user. Weather forecasts and climate projections are mostly accessible using the PAGASA website and mobile app and do not receive media coverage at the same level as typhoons, heavy rainfall, or ENSO announcements.

Table *8* showed reported utilization of weather and climate information. Weather warnings and ENSO forecast are often used by the households while weather forecasts, climate projections and indigenous forecasts are the least used. It can be that these weather and climate products are not well-known and so has low utilization. Moreover, farmers find it difficult to relate the information to their personal experiences in the farm in addition to the length of time from issuance to occurrence of the event. There is a low proportion (16%) of respondent-households who have ever visited the PAGASA website.

Table 8 Utilization of Weather and Climate Information

Weather and Climate Information	Obs	Mean	Std.Dev.	Min	Max
Typhoon	396	.8	.4	0	1
Heavy rainfall	396	.68	.47	0	1
Daily forecast	396	.63	.48	0	1
Bi-weekly forecast	396	.2	.4	0	1
Monthly	396	.02	.15	0	1
2-6 month forecast	396	.01	.09	0	1
ENSO	396	.66	.47	0	1
Press	396	.29	.45	0	1
Projections	396	.04	.19	0	1
Indigenous	396	.16	.36	0	1
Non-PAGASA	396	.17	.37	0	1

Table *9* shows the access of respondents to various weather and climate information by sitio. Warnings namely typhoon, heavy rainfall and daily forecasts are known to the sitios. Monthly, 2-6 months forecasts and climate projections are less heard off. It also interesting that Tulodan and Macbas have higher proportion of respondents who have heard of ENSO and press releases.

In terms of access, Macbas has the lowest share of respondents who have access to typhoon, heavy rainfall, and ENSO information. These are also the information Macbas residents actively seek. Tulodan seems to have the higher share of respondents who have access to weather and climate information and continues to seek for more information. On the other hand, lower share of residents from Proper Paoay seek for more information on typhoon, heavy rainfall, and daily forecasts.

Table 9 Proportion of respondents with access to weather and climate information, by sitio and type of information

Weather/climate information	Proper Paoay		Tulodan		Macbas	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Heard of	N=176		N=125		N=62	
Typhoon	0.99	0.08	0.98	0.15	0.98	0.13
Heavy rainfall	0.93	0.26	0.93	0.26	0.95	0.22
Daily forecast	0.89	0.32	0.88	0.33	0.89	0.32
Bi-weekly forecast	0.21	0.41	0.42	0.50	0.23	0.42
Monthly	0.01	0.08	0.09	0.28	0.00	0.00
2-6 month forecast	0.00	0.00	0.03	0.18	0.00	0.00
ENSO	0.82	0.39	0.97	0.18	0.92	0.27
Press	0.39	0.49	0.55	0.50	0.47	0.50
Projections	0.02	0.13	0.15	0.36	0.00	0.00
Indigenous	0.21	0.41	0.50	0.50	0.16	0.37
Non-PAGASA	0.19	0.40	0.19	0.40	0.18	0.39
Access when needed	N=188		N=129		N=79	
Typhoon	0.93	0.25	0.95	0.23	0.78	0.41
Heavy rainfall	0.87	0.34	0.90	0.30	0.75	0.44
Daily forecast	0.83	0.38	0.85	0.36	0.70	0.46
Bi-weekly forecast	0.20	0.40	0.41	0.49	0.18	0.38
Monthly	0.01	0.07	0.09	0.28	0.00	0.00
2-6 month forecast	0.00	0.00	0.03	0.17	0.00	0.00
ENSO	0.77	0.42	0.95	0.23	0.72	0.45
Press	0.37	0.48	0.54	0.50	0.37	0.49
Projections	0.02	0.13	0.14	0.35	0.00	0.00
Indigenous	0.19	0.39	0.45	0.50	0.13	0.33
Non-PAGASA	0.18	0.39	0.24	0.43	0.14	0.35
Actively seek	N=176		N=125		N=62	
Typhoon	0.84	0.37	0.90	0.31	0.98	0.13
Heavy rainfall	0.64	0.48	0.72	0.45	0.84	0.37
Daily forecast	0.61	0.49	0.78	0.41	0.66	0.48
Bi-weekly forecast	0.08	0.27	0.34	0.48	0.10	0.30
Monthly	0.01	0.08	0.06	0.25	0.00	0.00
2-6 month forecast	0.00	0.00	0.02	0.15	0.00	0.00
ENSO	0.48	0.50	0.76	0.43	0.85	0.36
Press	0.22	0.41	0.42	0.50	0.27	0.45

Projections	0.01	0.08	0.08	0.27	0.00	0.00
Indigenous	0.08	0.27	0.22	0.41	0.08	0.27
Non-PAGASA	0.07	0.26	0.19	0.40	0.18	0.39

Table *10* shows utilization and if the respondents need more explanation of weather and climate information. Again, typhoon, heavy rainfall, daily forecast, and ENSO projections are more utilized compared to the other weather and climate information. However, there is lower share of utilization in Macbas and highest in Tulodan. Comparing the share of those who heard or has access to those who utilize, the share is lower for utilization. This supports the gap between access and utilization. Seasonal forecasts except ENSO and climate projections are less utilized. Among the three sitios, respondents in Sitio Tulodan needs more explanation of weather and climate information that they have heard of.

Table 10 Proportion of respondents who utilize and needs more explanation on weather and climate information, by sitio and type of information

Weather/climate information	Proper Paoay		Tulodan		Macbas	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Utilized	N=188		N=129		N=79	
Typhoon	0.82	0.39	0.84	0.37	0.70	0.46
Heavy rainfall	0.69	0.47	0.71	0.46	0.63	0.49
Daily forecast	0.64	0.48	0.71	0.45	0.46	0.50
Bi-weekly forecast	0.12	0.33	0.37	0.49	0.09	0.29
Monthly	0.00	0.00	0.07	0.26	0.00	0.00
2-6 month forecast	0.00	0.00	0.02	0.15	0.00	0.00
ENSO	0.57	0.50	0.84	0.37	0.59	0.49
Press	0.22	0.42	0.44	0.50	0.18	0.38
Projections	0.01	0.07	0.11	0.31	0.00	0.00
Indigenous	0.10	0.30	0.29	0.45	0.09	0.29
Non-PAGASA	0.14	0.35	0.22	0.42	0.14	0.35
Need explanation 1/						
Typhoon	0.21	0.41	0.34	0.48	0.08	0.28
Heavy rainfall	0.17	0.37	0.32	0.47	0.00	0.00
Daily forecast	0.17	0.38	0.32	0.47	0.00	0.00
Bi-weekly forecast	0.27	0.45	0.49	0.50	0.00	0.00
Monthly	0.00	.	0.45	0.52	.	.
2-6 month forecast	.	.	0.25	0.50	.	.
ENSO	0.19	0.40	0.34	0.48	0.14	0.35
Press	0.14	0.35	0.32	0.47	0.10	0.31
Projections	0.00	0.00	0.37	0.50		
Indigenous	0.08	0.28	0.16	0.37	0.00	0.00
Non-PAGASA	0.12	0.33	0.19	0.39	0.00	0.00

1/ Various numbers of observations depending on type of information and sitio

In terms of sources of weather and climate information, radio and television are the most common sources of information across the different weather and climate information except for indigenous forecasts. Indigenous forecasts are usually made by the respondent or taken from other persons and even extension workers. None of the respondents answered PAGASA as a direct source. This implies that information from PAGASA travels to different channels before it reaches the user or is not aware that the information came from PAGASA. Moreover, PAGASA also reported while weather segments on the local news use their information on typhoons and heavy rainfall, they often use other sources for day-to-day weather and temperature forecasts. Beyond this, print materials such as broadsheets and tabloids are also not identified as sources of any weather and climate information. Aside from indigenous forecasts, extension workers are not sources of weather and climate information in general. Meanwhile NDRMMC are sources only of typhoon and heavy rainfall information but not of other information such as ENSO and climate projections. Information that are relatively short term in nature such as typhoon and heavy rainfall warnings are well distributed and accessed through various sources, compared to those of longer in nature such as climate projection and seasonal climate forecasts with the exception of El Nino forecasts. This is likely because it is typhoons and heavy rainfall that have the most tangible and devastating impacts on property and human safety, so it becomes more important to effectively distribute this information.

We looked at how respondents gauge the quality of forecast. It is not enough that weather and climate information is produced but other aspects of information should be considered as well. Respondents were asked to rate the different weather and climate information based on timeliness, accuracy, and usefulness. A higher score means a better rating. The exact question is "From 1-5, how [timely/accurate/useful] do you consider the [information]?"

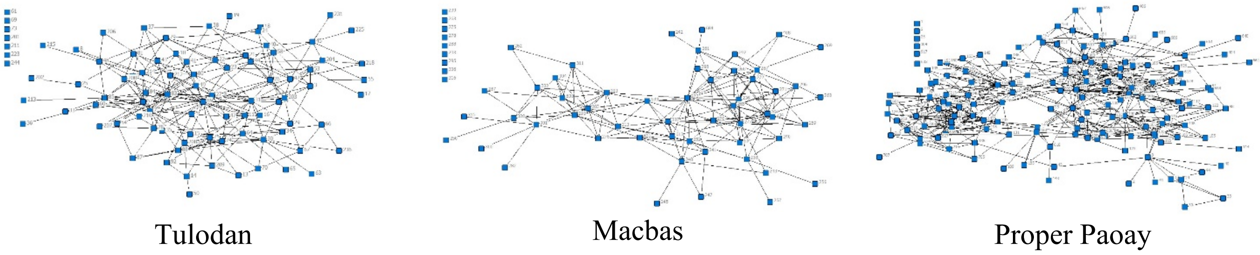
Typhoon information gather the highest ratings for timeliness, accuracy, and usefulness. Heavy rainfall and daily forecasts also received relatively higher ratings. The short-term nature of these information which is hours from release of information to an actual event, where forecasting yields more accurate results, might have an influence on the rating.

Typhoon, heavy rainfall, and daily forecasts have the highest ratings for timeliness but at best this is only 3.6/5. ENSO forecast is rated moderately. The general rating for accuracy among weather and climate information is moderate. This reflects views in Atok that PAGASA forecasts is different from their experience on the field and calls for localized forecasts. Usefulness ratings are generally higher compared to timeliness and accuracy ratings. Again, typhoon, daily forecasts and heavy rainfall have higher ratings. Indigenous forecasts are rated relatively low.

4.3. Social networks – Inter-household

Figure 6 shows the graphs of kinship, friendship and economic ties in the three areas namely – a) Tulodan, b. Macbas, and c) Proper Paoay. In each graph, a node pertains to a household in the sitio. A link (denoted by a line) is drawn between any two pair of nodes if there is at least one direct social or economic connection between them. Note that the lines are undirected (without arrows) to denote reciprocal relations.

Figure 6 Network of inter-household social relations by sitio



The three study areas exhibit varying network cohesion parameters. Based on the specified social ties, Sitio Macbas is the most cohesive while Proper Paoay is the least cohesive. In Macbas, the whole network has a density of 0.086. In other words, 8.6 percent of all possible ties are actual ties. This is relatively lower in Tulodan (6.1 percent) and Proper Paoay (4.4 percent). Macbas also has the lowest average geodesic distance of 2.8 which means that it is relatively easier to reach other nodes (as it would take fewer steps, on the average) than those in Proper Paoay (3.3) and Tulodan (2.8). In terms of degree, or the number of direct links, households in Proper Paoay have relatively greater connectivity at 6.8 links per household. That in Macbas (5.3) and Tulodan (5.4) are relatively lower.

Table 11 Whole network attributes by sitio

Parameter	Proper Paoay	Tulodan	Macbas
Density	0.044	0.061	0.086
Average degree	6.800	5.400	5.302
Diameter	7.000	6.000	6.000
Average geodesic distance	3.322	2.858	2.779
No. of nodes	155	90	63
No. of ties	1054	486	334

To gain any idea about how these network parameters would compare to another setting in the Philippines, the network density of a lowland, rural, fishing village in Tabuga (2018) is 0.067 with an average geodesic distance of 2.9. The rural village of interest in that study, though considered rural, is situated near the national road, making it far more accessible than the Atok sites.

It is important to present the above findings alongside the other characteristics of the areas. As mentioned earlier, Proper Paoay is considered least rural among the three sitios as it is the one nearest to the municipality center. Households here are more plentiful and their dwellings are located closer together. Sitio Tulodan, as a community, occupies a wider map area and thus seems more disperse, but closer inspection shows close clusters of households. It is these clusters of households that are in turn located relatively far from one another. On the other hand, the households in Sitio Macbas as a whole, live closer together within a smaller map area, but exhibits no clusters of households like in Tulodan, and has no dense hub of activities the way Proper Paoay does. Sitio Macbas and Tulodan are also more remote than Proper Paoay.

The demographics of each sitio also seem to differ. While sitio-level data on the socioeconomic standing of the communities is scarce, there is information from the Community Based Monitoring System (CBMS) that disaggregates data down to the barangay level. Per the 2014-2017 CBMS, Barangay Paoay, where sitio Proper Paoay is located, experiences lower levels of poverty (8.3%) than Barangay Cattubo (32.8%), where sitios Macbas and Tulodan are located. Other indicators that Barangay Paoay is better off than Barangay Cattubo include greater access to safe water supply (~35% versus Cattubo's 7%) and access to sanitary toilets (96% against 81%). Both barangays have similar rates of children aged six to fifteen not in school, both at close to 1%, while Barangay Paoay has a lower unemployment rate (0.2% against 1.9%).

Given these characterizations of the number and spread of household dwellings in the study areas, it is expected that households living close to each other in a relatively small geographic area, such as Macbas, would be more socially cohesive. Being remote also suggests that it attracts few in-migrants, creating a relatively tightly knit community. The difference in the network cohesion between Macbas and another remote area – Tulodan, maybe attributed to the clustering of household dwellings and for being scattered in a wider physical area in the latter. On the other hand, Proper Paoay, the one which has relatively greater economic activities than the other two sitios, is most likely to attract people from other areas, which tends to make social relations, as a whole, less cohesive because of their inclusion. This is also possibly due to its better accessibility, relative to the other sitios.

4.4. Social networks of men and women

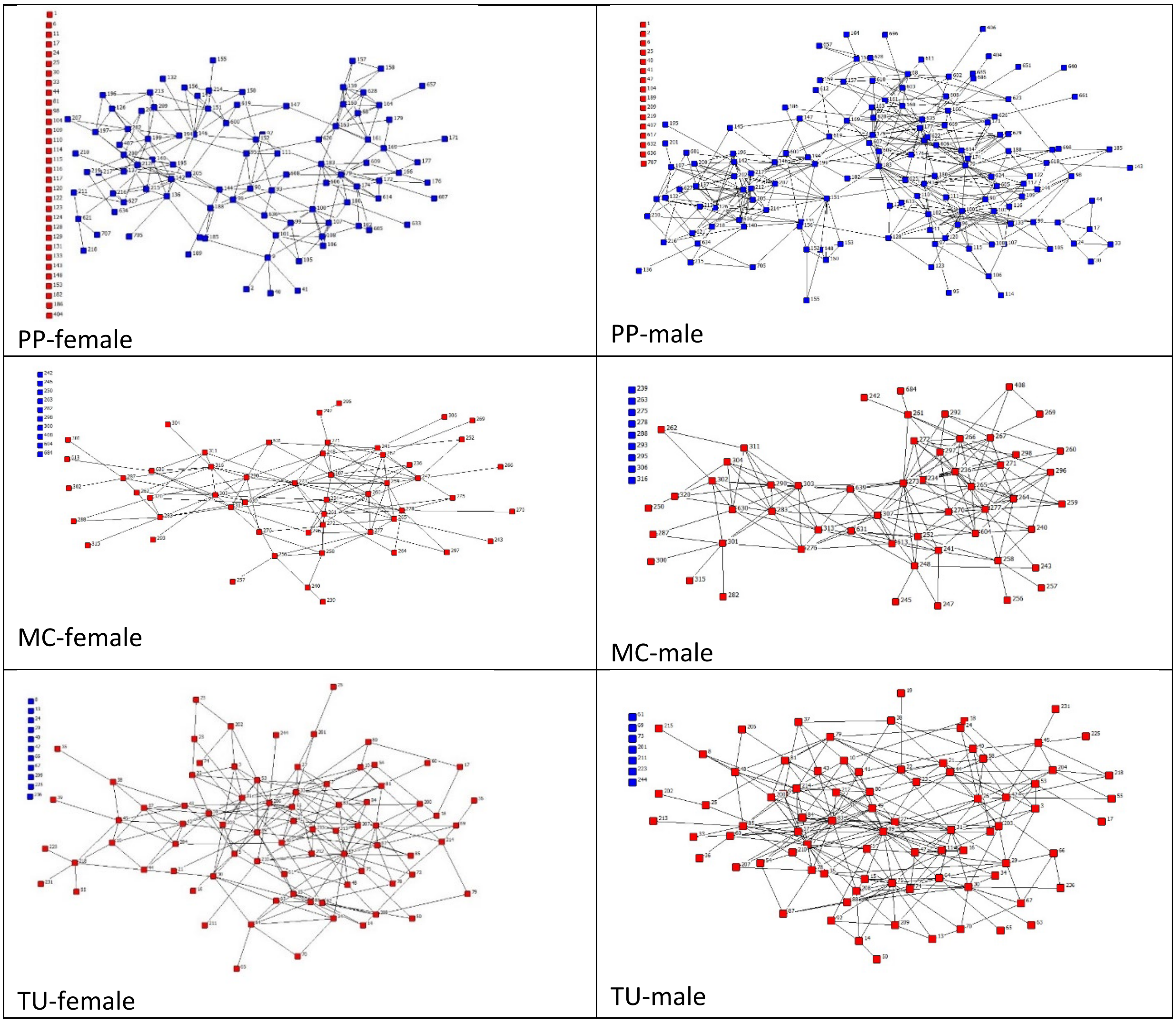
While the preceding graphs show the networks among households regardless of the point of reference (i.e. whether head or spouse), the ones below show the household networks identified by the sex of the point of reference (Figure 7). Such graphs allow us to appreciate any variation in the networks of men and women. A visual appreciation shows that the network identified by men appears to differ with that by women in each sitio. The network parameters calculated from these graphs consistently show that household networks of male respondents are relatively more cohesive as shown by higher density, higher average degree, and shorter average distance. The calculations are based uniformly on the total number of households. If those for the female respondents were normalized based only on the total number of households or nodes with female respondents, the parameters become relatively at par with those of the male respondents. In any case, these results suggest that there is complementarity in the networks of men and women.

Table 12 Social cohesion measures by sex and by sitio

Parameter	Social links			Peer advice and resource network	
	Female	Female*	Male	Female	Male
Proper Paoay					
# of nodes	155	105	155	155	155
# of ties	434	378	806	336	806
Average Degree	2.8	3.6	5.2	2.168	5.2
Density	0.018	0.035	0.034	0.014	0.034
Components	60	22	17	62	14
Connectedness	0.382	0.638	0.804	0.366	0.839
Fragmentation	0.618	0.362	0.196	0.634	0.161
Closure	0.251	0.242	0.264	0.198	0.274
Average Distance	3.855	3.658	3.624	4.328	3.606
Diameter	9	9	9	10	7
Macbas					
# of nodes	63	54	63	63	63
# of ties	250	210	334	186	294
Average Degree	3.968	3.889	5.302	2.952	4.667
Density	0.064	0.073	0.086	0.048	0.075
Components	11	10	10	19	10
Connectedness	0.706	0.662	0.733	0.507	0.733
Fragmentation	0.294	0.338	0.267	0.493	0.267
Closure	0.262	0.261	0.35	0.295	0.333
Average Distance	2.902	2.753	2.779	3.075	2.904
Diameter	7	6	6	8	6
Tulodan					
# of nodes	90	81	90	90	90
# of ties	396	390	486	256	410
Average Degree	4.4	4.815	5.4	2.844	4.556
Density	0.049	0.06	0.061	0.032	0.051
Components	12	6	8	20	11
Connectedness	0.769	0.88	0.85	0.62	0.789
Fragmentation	0.231	0.12	0.15	0.38	0.211
Closure	0.198	0.2	0.243	0.194	0.216
Average Distance	3.105	3.028	2.858	3.74	3.067
Diameter	7	7	6	8	7

*Normalized based on number of households with female respondents only

Figure 7 Social networks by sitio and sex, node color by component



Note: Graphs may include alters outside the sitio

4.5. Weather and climate information networks among households

One of the study's objectives is to examine weather and climate information by type, that is – whether networks vary by type of information. Comparison of the information networks is done both visually and objectively by looking at network cohesion parameters. Are some networks more cohesive than others? Do networks share the same central nodes? The graphs are shown as directed graphs (with arrows) where a line that connects any pair of nodes (that represent the households in the sitio) denotes the flow of information. The direction of the arrow illustrates the direction of the information flow. An arrow emanating from a node shows that the node shares information to the one at the receiving end of the arrow. There are instances when there is an arrow going out and coming in which mean that the node is both a recipient and a disseminator of information. Regardless of the extent of connections, we call each graph a 'network.'

4.5.1. WCI network: Tulodan

Figure 8 shows Tulodan's internal (within-*sitio*) information networks of different weather and climate information. Only six types of WCI networks (i.e. tropical cyclone warning, heavy rainfall warning, daily weather forecast, weekly forecast, ENSO, and non-PAGASA information) were drawn. There is very minimal sharing of information regarding monthly and two to six-month forecasts, as well as narratives, climate projections and indigenous weather and climate information, hence no graphs were created for these. Among the types of W&C information, those that have relatively greater extent of being shared across households are heavy rainfall and tropical cyclone warnings as shown by the smaller number of isolated nodes (i.e. nodes that are not connected to the rest, shown in left side) in these graphs. The number of households involved in the sharing of tropical cyclone warning is the highest (88), followed by heavy rainfall warning (84). There are also relatively more households included in the information network of daily weather forecast (74) when compared to the networks involving ENSO, weekly forecast and non-PAGASA. These three networks (i.e. tropical cyclone, heavy rainfall warning, and daily weather forecast) are also characterized by the presence of a large network component or a cluster of households connected to each other. Interestingly, the non-PAGASA network shares this same characteristic as it is composed of one big component and many isolated households. In contrast, the rest of the network graphs – weekly forecast, and ENSO, are relatively sparser, made up of several 'star' graphs connected to each other, where large numbers of nodes are isolated from the main component (i.e. main cluster). A pure 'star' graph is one where there is one node (central node) that is connected to several nodes which are themselves not connected to each other but only through the central node. Such centralized system presents some limitation as the central node controls the flow of information. In the weekly forecast and ENSO graphs, these star sub-graphs are connected to each other by one of the surrounding spokes of the star.

Using more objective measures of cohesion calculated using the UCINET software package, the analysis shows that information networks involving tropical cyclone and heavy rainfall warning are more cohesive than the other networks. The density of the tropical cyclone network is 8.9 percent while that for heavy rainfall warning is 5.7 percent. Both densities are higher than those in other networks. These two also have lower number of components or groups. Note that an isolated node is considered as a component such that the more isolated nodes there are, the greater the number of components and the more fragmented the network is. The measure fragmentation score illustrates this because the two networks have the lowest score. The average degree in the tropical cyclone network is the highest at nearly 8. In other words, a typical node is directly connected to 8 other nodes. In heavy rainfall warning network, the average degree is 5. The rest of the networks have lower average degrees. Another measure of cohesion that shows the two networks being more cohesive is average geodesic distance or the average number of steps a node can reach other nodes. The tropical cyclone network has an average distance of 2.5 while the rainfall warning network has 2.9. It takes relatively fewer steps for one node to reach the rest of the nodes in tropical cyclone network than in the other WCI networks.

The two most cohesive WCI networks in Tulodan share significant number of core nodes or households. Majority of the core households in heavy rainfall warning network are shared with tropical cyclone warning network. In the latter, 15 out of 19 (or nearly 80 percent) core households can also be found in the former. Note that the core nodes act as a glue that binds the network together. It is important to note that the tropical cyclone network, the most cohesive among the WCI networks, approximates the network parameters of Tulodan's social and economic networks. The two networks have similar average geodesic distance at 2.5. There are 770 ties in the social network while there are 709 ties in the tropical cyclone network. They have comparable network densities. Furthermore, 17 of the 19 core nodes in tropical cyclone network (or 17 out of 27 core nodes of the social network) is shared with the sitio's social network. This suggests that the tropical cyclone network is a subset of the sitio's social network as roughly the same actors bind the networks together.

Figure 8 Weather and climate information networks by type, Sitio Tulodan

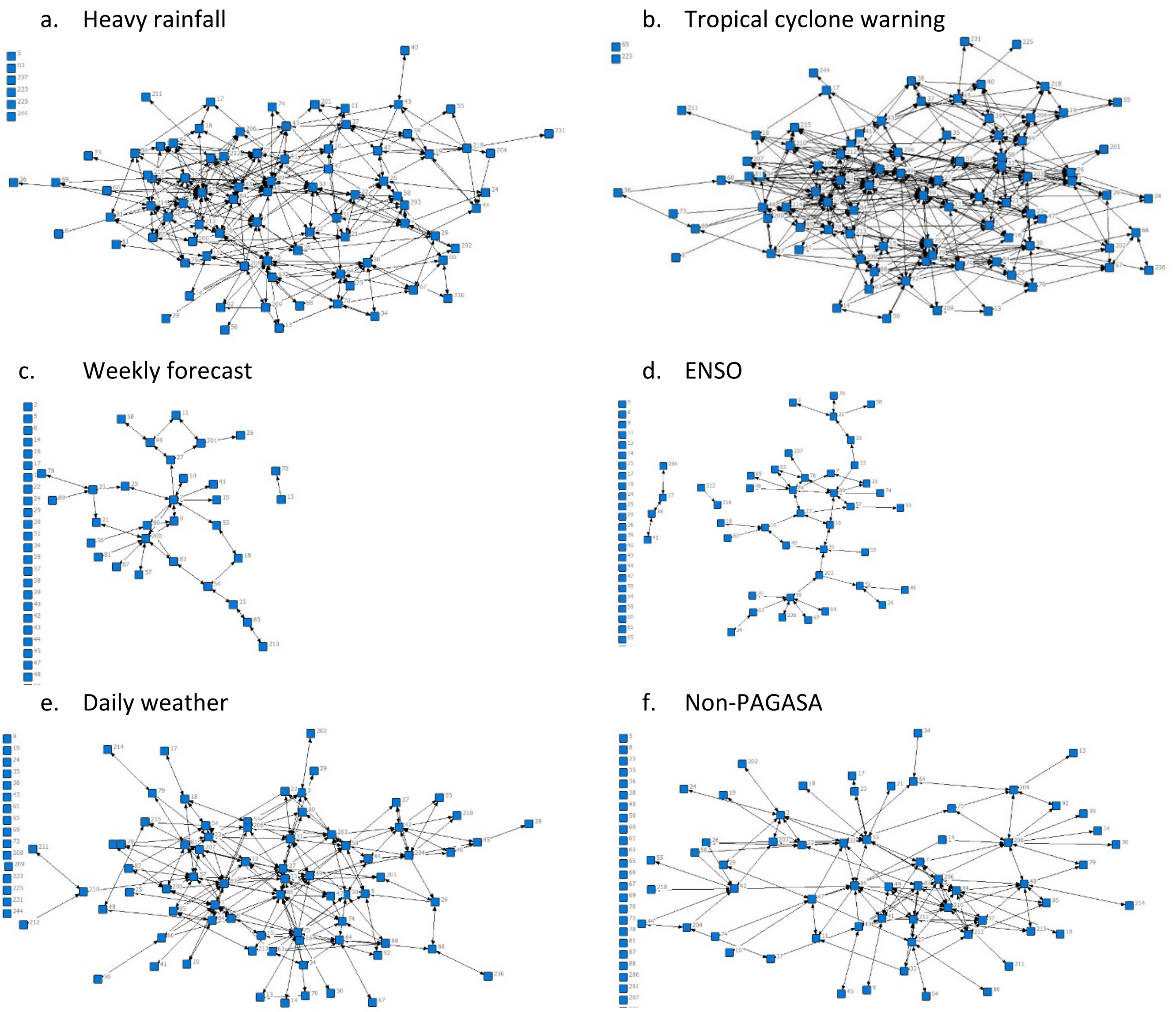


Table 13 Measures of whole network cohesion by type of weather and climate information, Sitio Tulodan (No. of nodes = 90)

Measure	Tropical cyclone	Heavy rainfall	Daily weather	Weekly Forecast	ENSO	Non-PAGASA
No. of ties	709	459	330	61	78	225
Ave. Degree	7.878	5.1	3.667	0.678	0.867	2.5
Density	0.089	0.057	0.041	0.008	0.010	0.028
Components	3	11	18	66	62	33
Fragmentation	0.044	0.171	0.335	0.926	0.933	0.565
Closure	0.270	0.195	0.219	0.047	0.077	0.162
Ave. Distance	2.526	2.927	3.144	3.411	3.448	3.176
Diameter	5.0	7.0	7.0	9.0	8.0	8.0

4.5.2. WCI network: Macbas

Figure 9 shows the information networks of the different weather and climate information (WCI) in Macbas. Only six graphs were drawn, and these are for heavy rainfall warning, tropical cyclone warning, daily weather forecast, ENSO, narratives and non-PAGASA WC information. There is very limited sharing of weekly forecasts, monthly, and two- to six-month forecasts, climate projections and indigenous information. Thus, no network graph is drawn for each of these WCI. For those with network graphs, a visual appreciation reveals stark differences across types of WCI.

As in the case of Tulodan, the graphs show that the tropical cyclone network is the most cohesive among all types of networks. There is more sharing of this type than other types based on its smallest number of isolated nodes. The information networks involving narratives (e) and non-PAGASA (f) information are shown to be more fragmented – that is, many of the households in the sitio are not linked to the connected component of the sitio network. The panels a, c, and d, corresponding to heavy rainfall, daily weather and ENSO are more cohesive than the other two networks (i.e. narratives and non-PAGASA) because of the presence of a large single component despite some isolated nodes. Except for the tropical cyclone network, there seems to be few nodes acting as bridges between major clusters that would otherwise be disconnected in WCI networks.

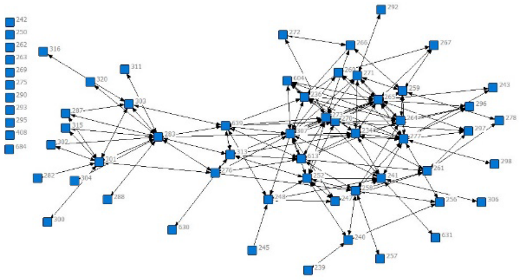
Table 14 more objectively illustrates how the tropical cyclone warning network is more cohesive than the others. In this network, the average node has a degree or direct connections of around 7.5 which is highest among all the graphs. Its density of 12.1 percent is also the highest. This is because it has higher number of ties (i.e. 471) than the rest of the WCI networks. The networks of heavy rainfall and ENSO have densities of 6.9 and 6.1 percent, respectively. The rest have very low densities compared to these three networks.

In terms of components or groups, there are much fewer network components in the tropical cyclone network than the rest. Each node in this network, is, on the average, at a distance of 2.5 (geodesic distance) from all other nodes/households. This number (average geodesic distance) is slightly lower than those in the other networks - heavy rainfall, daily weather and ENSO. This further means that actors in these other networks (i.e. heavy rainfall, daily weather and ENSO) take relatively longer paths to reach all other members of the network, hence the longer average distance. It should be noted that although the networks for narratives and non-PAGASA have lower average distance, the connected networks are way smaller. It takes fewer steps to reach others because there are not that many other network members as most nodes are not part of the connected network; they are isolates. The closure score merely reflects the same idea that the average distance shows; it is highest in tropical cyclone network because of the relative ease in a node's ability to reach other nodes. Again, it is important to note that the tropical cyclone network is at par with the kinship and friendship network in terms of level of network cohesion.

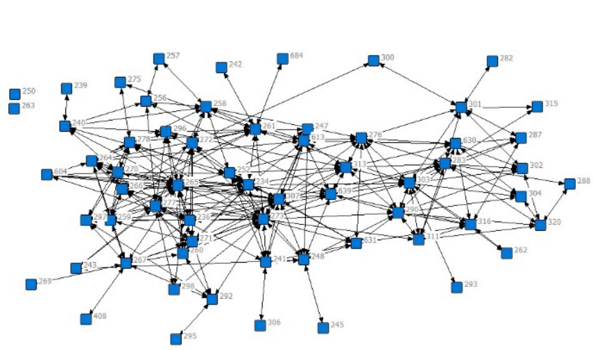
There are also significant similarities among networks of WCI as far as central nodes are concerned. Majority of the central nodes in tropical cyclone network is similar with those in heavy rainfall warning network. This is also the case of daily weather forecast network with that of the tropical cyclone network. Albeit the differences in the whole network attributes, it is important to note such similarities.

Figure 9 Weather and climate information networks by type, Sitio Macbas

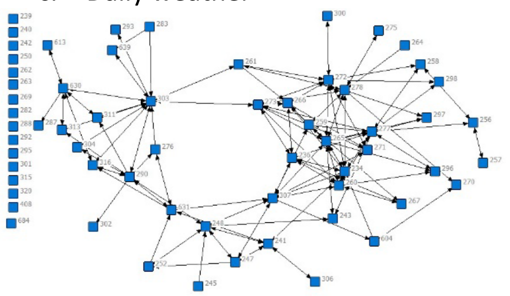
a. Heavy rainfall



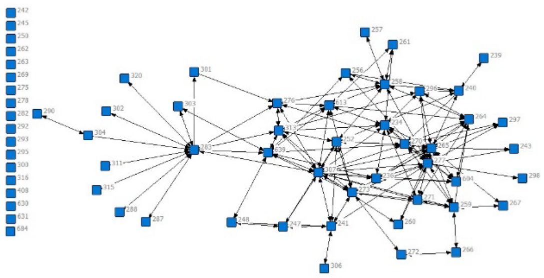
b. Tropical cyclone warning



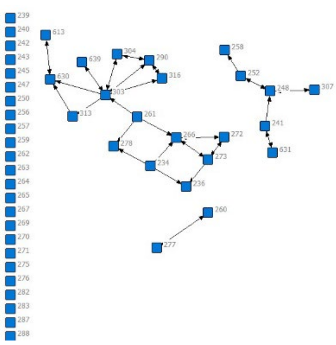
c. Daily weather



d. ENSO



e. Narratives



f. Non-PAGASA

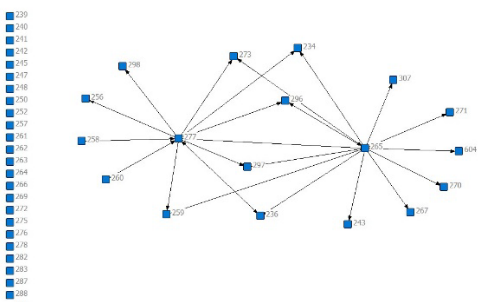


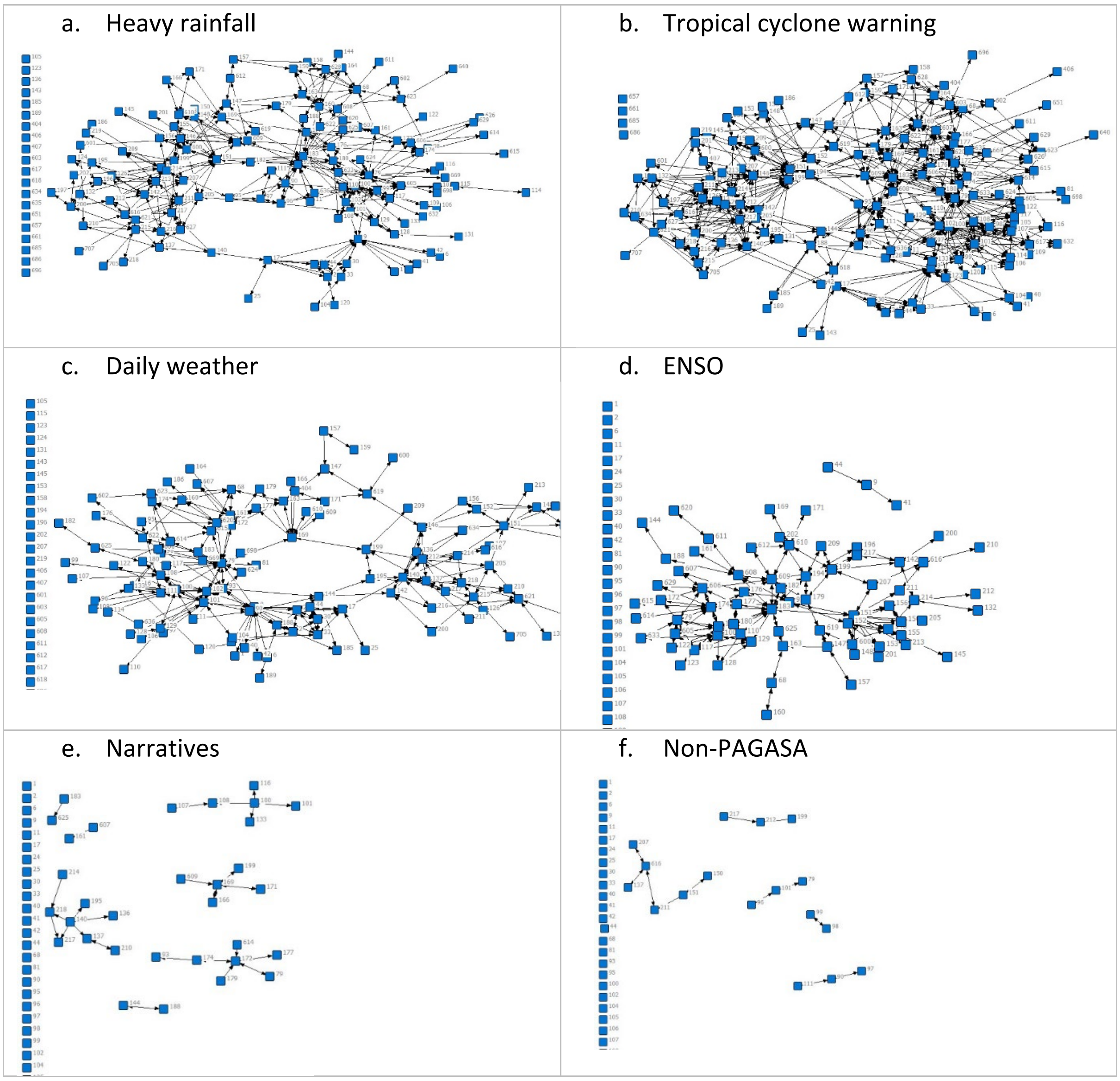
Table 14 Measures of whole network cohesion by type of weather and climate information, Sitio Macbas (No. of nodes= 63)

Measure	Heavy Rainfall	Tropical Cyclone	Daily Weather	ENSO	Narratives	Non-PAGASA
No. of ties	268	471	178	238	40	28
Ave. Degree	4.254	7.476	2.825	3.778	0.635	0.444
Density	0.069	0.121	0.046	0.061	0.010	0.007
Components	14	3.0	25.0	20.0	52.0	57.0
Fragmentation	0.347	0.063	0.537	0.515	0.978	0.970
Closure	0.323	0.364	0.261	0.317	0.333	0.131
Ave. Distance	2.749	2.472	2.970	2.512	1.678	2.286
Diameter	6.0	5.0	7.0	6.0	4.0	4.0

4.5.3. WCI network: Proper Paoay

The WCI networks by type shown in Figure 10 mimics the pattern in the other sitios. Among the information networks, those of heavy rainfall warning and tropical cyclone warning are more extensive and cohesive than the other types. The tropical cyclone network, in particular, includes the most number of households as there are only 4 isolated households; the overwhelming majority are connected in one big network component. This is also the case of heavy rainfall warning network although it has more isolated nodes than in the tropical cyclone network. The daily weather forecast and ENSO networks also show significant sharing among a number of households as shown by a large component. In contrast, there is very little sharing of information with respect to narratives and non-PAGASA information. The other types of WCI (i.e. weekly, monthly, two-to-six month, climate projections and indigenous) are not included because of very minimal to no information sharing among households.

Figure 10 Weather and climate information networks by type, Sitio Proper Paoay (No. of nodes=155)



The calculated network parameters provide more details about the comparison. The number of ties involved in tropical cyclone warning, at 1,071, is the highest, followed by that in heavy rainfall (616), daily weather forecast (403), ENSO (268), narratives (33) and non-PAGASA (21). Tropical cyclone network also has the highest average degree, density, and closure. It has the lowest fragmentation score and number of components or groups. Apart from narratives and non-PAGASA networks, tropical cyclone network has the lowest average distance which indicates the ease of reaching other nodes. The low average distance in narrative and non-PAGASA networks are typical of networks with small groups. Within a component, it is relatively easier to reach others because there are fewer members.

In terms of similarities in the composition of the central nodes, majority (58%) of these in tropical cyclone network is shared with that in heavy rainfall network while 62% of ENSO central households are shared with the tropical cyclone network.

Table 15 Measures of whole network cohesion by type of weather and climate information, Sitio Proper Paoay (No. of nodes=155)

Measure	Heavy Rainfall	Tropical Cyclone	Daily Weather	ENSO	Narratives	Non-PAGASA
No. of ties	616	1071	403	268	33	21.0
Ave. Degree	3.974	6.910	2.6	1.729	0.213	0.135
Density	0.026	0.045	0.017	0.011	0.001	0.001
Components	25	7.0	48.0	89.0	148.0	146.0
Fragmentation	0.265	0.064	0.479	0.803	0.998	0.998
Closure	0.259	0.288	0.230	0.259	0.043	0.000
Ave. Distance	3.725	3.223	4.111	3.312	1.483	1.632
Diameter	8.0	7.0	9.0	7.0	3.0	4.0

4.5.4. Network sources of WCI

Do people get WCI from closer, more trustworthy relations than from weaker ties or from random sources? We investigated the nature of links among respondents who have shared any of the top 3 types of weather and climate information with one another. The table below shows the results. Specifically, it provides the proportion of the information exchanges by relation categories. Note that if two individuals (from different households) had shared information to each other, these were counted as two exchanges. The data did not include intra-household exchanges. The categories included are not mutually exclusive, neighbors can also be members of peer advice networks. The categorization aims to have a more nuanced look at the nature and characteristics of relations involved in WCI sharing.

In Proper Paoay, there were 806 information exchanges that happened between individual respondents. An overwhelming majority (83%) of the exchanges happened among members of peer farm advice network. Farm advice is defined as any form of advice being exchanged pertaining to farm activities. Many people (73%) who are sharing WCI are also linked to one another via other peer advice network (i.e. health). In terms of social ties, the more common sources of WCI are neighbors (46% of the exchanges). Less than half, 43 percent, of the exchanges involved kinship relations. A non-negligible proportion (40%) of the exchanges also happen among members of peer resource networks - these are farmers/farm workers sharing farm inputs and other resources.

Tulodan's and Macbas' cases have quite similar patterns - the types of links that prevailed in these communities are peer advice networks (health and farming), which is also the case of Proper Paoay. Their difference from Proper Paoay is that kinship sources are more common among individuals in the two smaller sitios compared to neighbors, friends, and economic networks. In all the communities, the least common type of links among those who share information about the top 3 types are economic or work-related networks.

Note that these figures approximate those in the total links which means that some types are prevalent than others in terms of sources of WCI because these are in fact the more common types of ties that exist in the communities, in general. Nonetheless, there are relatively higher proportions for peer advice networks and resource networks (for all the sitios) and also neighbors (for Proper Paoay and Macbas) compared to that in the total links. It appears that WCI is just among the things shared by these network members. This therefore suggests that sharing of WCI happens among people who trust each other and physically proximate with one another (such as neighbors). This is understandable because of WCI's characteristic; it is useful only for a certain period of time. One is likely to get from common conversations and routine interactions with people inside social circles.

Table 16 Sources of any weather and climate information (heavy rainfall, tropical cyclone warning, daily weather forecast) by nature of relation

Type of relation	Sources			Total links (individual-level)		
	Proper Paoay	Macbas	Tulodan	Proper Paoay	Macbas	Tulodan
	(1)	(2)	(3)	(4)	(5)	(6)
Kin	43.4	68.8	64.7	44.2	69.5	64.5
Close friends	13.4	6.6	14.8	13.7	7.1	15.0
Neighbor	45.8	57.4	41.1	44.5	54.8	41.7
Other friends	10.9	11.4	12.5	10.9	10.7	12.1
Economic network	13.8	0.6	2.3	13.7	0.6	2.4
Peer farm advice network	82.6	66.1	74.7	80.0	64.4	72.9
Peer resource network	39.2	44.4	42.4	37.3	42.9	41.5
Peer health advice network	72.8	91.0	80.5	69.9	89.8	79.2
Total exchanges/information ties	806	333	601	857	354	619

4.5.5. WCI network comparison with other networks

It is interesting to examine whether WCI networks are similar in characteristics with other types of networks in the communities. This helps us understand better the networking dynamics in the areas of interest. This is likewise useful because if WCI networks are found to be similar with other networks, then efforts that are aimed at improving access and utilization of WCI can tap on just any network, and these can still yield the desired outcomes. Such improvisation is valuable in contexts of high resource constraints.

Figure 11 shows the merged WCI network along with farm advice and inputs network, and health information network. The merged WCI network is formed from a consolidation of sharing in any type of WCI. The farm advice and input networks show the links among households in terms of sharing farm-related advice and farm inputs, while the health information network reflects the sharing of health information among households. In Figure 11, the comparison should be made on a per column basis.

A visual appreciation shows that their similarities are quite striking in that almost all households are integrated in the main component. The number of ties is highest in the WCI for all sitios, though, which suggest greater interaction compared to health information and farm inputs and advice. WCI network, likewise, has the highest average degree and density. It has the lowest average distance though the difference is very minimal. This means that the WCI network is the most cohesive among the three.

In terms of the central nodes that bind the networks together, the similarities are likewise evident. In the case of Tulodan for instance, 17 nodes were determined by the UCINET software as the core nodes in WCI network. Of this number, 14 or 82 percent are shared with the farm advice and inputs network while 15 or 88 percent are shared with the health network. To supplement the comparison, we obtained the correlation of various parameters across types of networks. In Tulodan, being a core (or central) household returns a correlation coefficient ranging from 0.55 to 0.63. This means that being a core in one type of network is correlated to being one in the other types. The correlation coefficient among centrality measures degree, betweenness, and eigenvector is high ranging from 0.71 to 0.88.

In Macbas, being at the core in WCI, farm and health networks is highly correlated with a correlation coefficient ranging from 0.6495 to 0.7611. In Proper Paoay, the correlation coefficient of being core among the three networks ranges from 0.4280 to 0.6397. This is relatively lower than in Tulodan and Macbas, which means that there is some variety in these networks. The other measures though have high correlation coefficients. On the overall, these three networks have huge similarities with respect to the actors that bind households together.

These therefore suggests that tapping peer advice networks or resource networks or even health information networks for improving households' access and utilization of weather and climate information seems to be a practical approach that is likely to yield an effective outcome.

Figure 11 Whole network graphs by type of network and by sitio

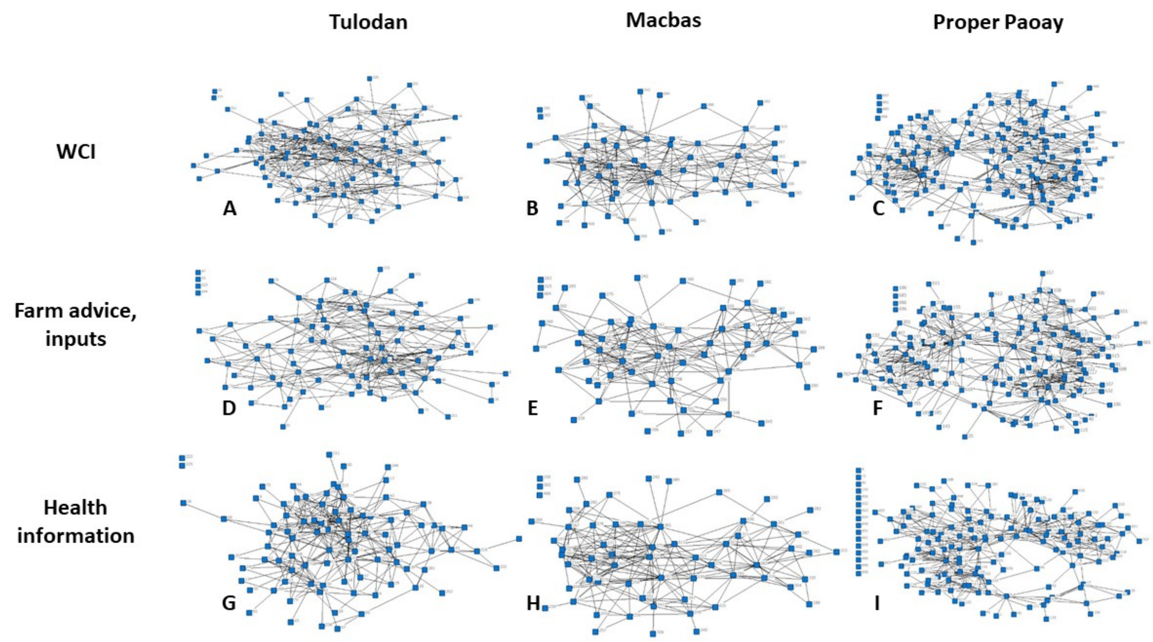


Table 17 Measures of whole network cohesion by type of weather and climate information

Measure	WCI	Farm advice, inputs	Health
Sitio Tulodan (no. of nodes=90)			
No. of ties	754	596	616
Ave. Degree	8.378	6.622	6.844
Density	0.094	0.074	0.077
Components	3	5	3
Fragmentation	0.044	0.087	0.044
Closure	0.281	0.249	0.271
Ave. Distance	2.470	2.684	2.746
Diameter	5.0	5.0	7.0
Sitio Macbas (no. of nodes=63)			
No. of ties	476	408	448
Ave. Degree	7.556	6.476	7.111
Density	0.122	0.104	0.115
Components	3.0	4.0	4.0
Fragmentation	0.063	0.094	0.094
Closure	0.367	0.319	0.345
Ave. Distance	2.464	2.606	2.468
Diameter	5.0	6.0	5.0
Sitio Proper Paoay (no. of nodes=155)			
No. of ties	1128	1020	860
Ave. Degree	7.277	6.581	5.548
Density	0.047	0.043	0.036
Components	5.0	5.0	17.0
Fragmentation	0.051	0.051	0.196
Closure	0.298	0.287	0.302
Ave. Distance	3.155	3.288	3.461
Diameter	7.0	7.0	9.0

Table 18 Correlation coefficient among weather and climate information, farm advice and inputs, and health information networks by sitio

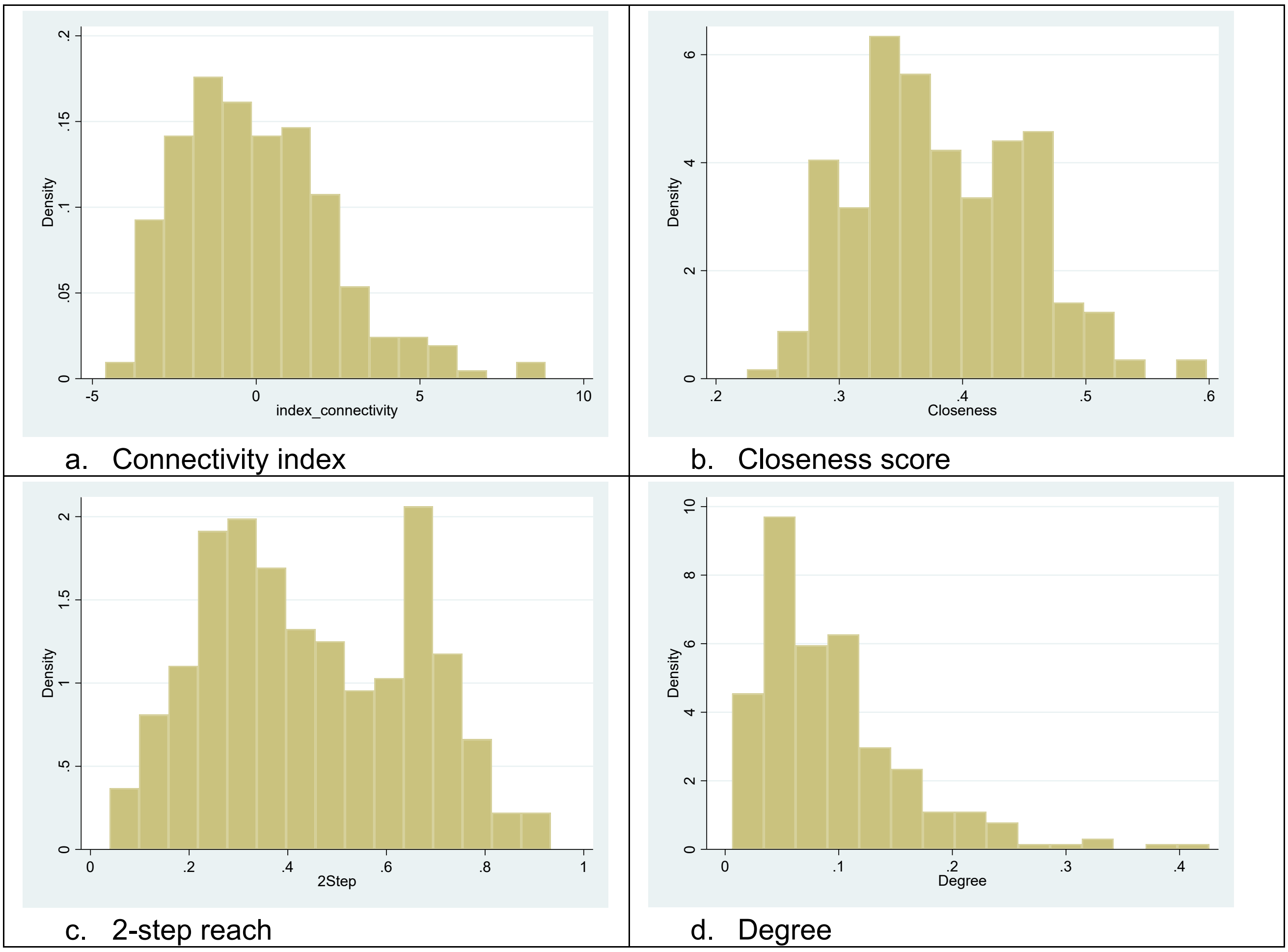
Score	Tulodan	Macbas	Proper Paoay
Being Core	0.5513-0.6319	0.6495-0.7611	0.4280-0.6397
Degree	0.8450-0.9328	0.9287-0.9728	0.8862-0.9695
Betweenness	0.7243-0.8842	0.8854-0.9740	0.8999-0.9802
Eigenvector centrality	0.7410-0.9068	0.8670-0.9643	0.8242-0.9612

4.6. Characteristics of central nodes

Understanding the characteristics of central actors is most useful for identifying potential information disseminators and injection points should there be a need for social influencing like in the use of scientific information and perhaps new technology in agriculture. To determine the correlates of centrality, simple OLS regression models were estimated. The dependent variables are various network parameters calculated through the UCINET based on social ties of the households. We selected only the parameters with distribution that is near-normal or exhibit a bell-shaped distribution – degree, closeness, and 2-step reach centrality. An index for connectivity was also developed via Principal Components Analysis out of several network parameters. The histograms of these variables are shown in Figure 12.

The explanatory variables, meanwhile, comprise of demographic (e.g. age and years of education of the head, number of household members) and economic variables - asset indices (calculated through PCA involving basic phone, smart phone, tractor, water pump), house and vehicle ownership. Farming characteristics such as area of farmland operated, number of years spent in farming by head, and exposure to outside financial resources proxied by availing credit ever were also included. A variable that controls for geographic constraints that can potentially impede a person's ability to interact with many people was also included in the models. This pertains to the distance (in meters) from the respondent's dwelling to the place frequently visited by the respondent – for instance, market or church, etc. The summary statistics of the different variables are shown in Table 19.

Figure 12 Histogram of OLS dependent variables



a. Connectivity index

b. Closeness score

c. 2-step reach

d. Degree

Table 19 Summary statistics in regression estimations, household level

Variable	Obs	Mean	Std. Dev.	Min	Max
Dependent variables					
Degree	228	0.0944	0.0677	0.006	0.426
2-Step reach	228	0.4463	0.2066	0.039	0.933
Closeness	228	0.3832	0.0683	0.225	0.598
Connectivity index	228	0.0056	2.3433	-4.612	8.838
Individual characteristics					
Age of head	229	43.2149	14.5114	19.023	84.019
Age of head, squared	229	2077.183	1370.630	361.859	7059.220
Years of education of head	225	8.2756	3.4582	0.000	16.000
Being Kankanaey	228	0.6842	0.4659	0.000	1.000
Years in farming by head	228	17.1974	13.4302	0.000	57.000
Household characteristics					
No. of household members	229	3.9039	2.4079	1.000	20.000
Vehicles owned	229	0.4672	0.8455	0.000	5.000
House ownership	228	0.7193	0.4503	0.000	1.000
Size of farm operated	229	37.1481	132.1140	0.000	800.000
Ever availed credit	229	0.4847	0.5008611	0.000	1.000
Asset index	228	0.0022	1.310644	-1.613	4.497
Distance to place frequented (km)	229	3.969	13.883	0	120.000

The regression results show that not many of the explanatory variables significantly correlate with node centrality when other factors are held constant. None of the individual person characteristics matter, not even educational attainment, or ethnicity. The most consistent outcome is that households who are more central are those that possess more vehicles. Possession of vehicles in the upland, rural setting with significant geographic constraints is expected to correlate with sociability as these are crucial in farm production and in movement of people. People who ferry products and people from the area to other places are relatively more popular. House ownership seems to associate with having more direct links (degree) but does not significantly correlate with other centrality parameters. Interestingly, the more well-off households, as shown by asset index, are less likely to have high node centrality, based on this sample of upland communities. Perhaps because their need for social support from others is much lower than people who are less endowed. This is an important evidence; it does not provide support for programs that select relatively wealthy people as points of reference, which assume that these are more popular and are more capable of reaching more people.

As expected, being far from venues where people can interact with one another is negatively correlated with centrality. The most central households are those situated near areas of congregations. Those in the periphery of the social network are people who also live in the periphery, in physical terms. There is another interpretation to this result. Since the place people frequently visit differs across households, those who frequently go to farther places are relatively less central than those who just move within the sitios. Those who travel to the city center and even in farther trading posts have fewer chances to interact with the local population and are therefore less known by others in the sitio.

Table 20 Regression results by parameter, all sitios

Variable	Degree		2-Step reach		Closeness		Connectivity index	
Individual characteristics								
Age of head	0.00454	*	0.01498	*	0.0041767	*	0.16063	*
Age of head, squared	-0.00004		-0.00013	*	-3.401E-05		-0.00130	
Years of education of head	-0.00137		0.00254		0.0003599		0.01060	
Being Kankanaey	0.01012		0.05166		0.0198346		0.25735	
Years in farming by head	-0.00060		-0.00178		-0.0006971		-0.01904	
Household characteristics								
No. of household members	0.00324		0.01022		0.003569		0.08983	
Vehicles owned	0.01749	**	0.05876	***	0.0202766	***	0.67442	***
House ownership	0.02714	*	0.05256		0.0230483		0.41831	
Size of farm operated	0.00003		0.00009		2.904E-05		0.00137	
Ever availed credit	0.00008		0.03922		0.0110176		0.01740	
Asset index	-0.01069	**	-0.05047	***	-0.0155509	***	-0.40609	**
Distance to place frequented (km)	-0.00064	*	-0.00224	*	-0.0007685	**	-0.02422	*
Constant	-0.04473		-0.08148		0.2256361	***	-5.10120	**
R2	0.2300		0.2758		0.2904		2084	
N	224		224		224		224	

legend: * p<.05; ** p<.01; *** p<.001

Centrally positioned households do not seem to exhibit different behavior from the rest in terms of the main source(s) of WCI. For heavy rainfall warnings and daily weather forecast, radio and TV are the most common sources, regardless of the relative position in the network. There is deviation in the sources for typhoon warnings. Most (81%) of the time, central households obtained tropical cyclone warnings from TV; in 23 percent of the cases, the sources are other persons. The rest of the households have more varied sources – with radio and TV being the main sources although a quarter reported that they get it from other persons.

Based on the regression analysis, we summarize the profile of central households or actors in upland communities as follows:

1. People who live near venues of social gathering such as Brgy. Hall of Cattubo and church for people in Macbas and Tulodan; Cooperative Store for Macbas, and *Sayangan* market for those in Proper Paoay; proximity to these areas enables people to interact more with others within an extremely challenging physical environment, and where there are limited means of communication due to poor technological infrastructure;

2. Those who possess greater means of transport which is essential for people to navigate the area; even people living in far areas but with means of transport are good candidates for information hubs because their mobility enables them to interact more with other people;

3. Those with the largest dwellings particularly in areas near the business center like Proper Paoay;

4. People who come from largest clans because they are more likely to extend their reach to their relatives; also, original settlers in the areas who probably know other long-term members of the community

5. Those who are members of agricultural cooperative and farmer's organizations in most remote areas like Brgy. Cattubo. Members of farmer's organizations in areas like Proper Paoay may also be selected but only if they also satisfy the other criteria.

4.7. Correlates of access and utilization weather and climate information

We adapted a more active definition of access and utilization – that is actively searching for all the major types of weather and climate information (i.e. tropical cyclone warning, heavy rainfall warning, daily weather forecast, and ENSO) and utilizing them in farming decisions. The dependent variable is therefore a dummy variable for being both an active seeker of all four major WCI and utilizer of all these types in farm decisions. The unit of analysis is individual person because information for both head and spouse (if any) are available. We are most interested in the relationship between the dependent variable and connectedness or network centrality. We expect their relationship to be positive – that is, the more central a person is, the more likely that he/she utilizes weather and climate information.

The individual-person explanatory variables are age, age squared, estimated years of education, and years in farming. All these variables are meant to control skills level and experience of the individual. The expected associations are positive. Meanwhile, the household characteristics included are number of household members, a dummy variable for having availed credit ever, number of smartphones owned, an asset index that was created through PCA from various durable assets, number of vehicles the households own, distance to place frequented, log of the size of farm the household operated. The number of household members and asset index are standard demographic and economic factors. Access and utilization of weather by people from different segments may also vary. The number of smartphones owned controls for the ability of the household to access information through the PAGASA website, other Internet sources, or through some weather-based applications. The dummy variable for having availed of credit ever controls for the need for sources of financing outside the household. This is likely to be associated with greater likelihood of searching for and utilizing weather and climate information because of greater need to improve productivity; the household may not have adequate resources to compensate for losses. The number of vehicles owned was included because it is possibly linked with greater farm productivity which may motivate people to be more proactive. The variable that controls for physical distance to the person's appointed place of congregation was also included to proxy people's reach, which is possibly positively correlated with access and utilization. The log of size of farm operated is for controlling the risks faced by the household, the bigger the area, the greater the risks to their livelihood, hence the need to be more proactive with farming decisions.

The centrality parameters of interest are degree, closeness, 2-Step reach centrality, and connectivity index (created through PCA from various centrality scores). The more central the person's household is, the more likely that he or she is able to actively search for and utilize information for decisions, including those pertaining to farming. Also, because these people are able to communicate and interact with more people (i.e. more sources of information), their behavior is likely to be more open to scientific information. Being at the center of the social networks suggests being able to have more opportunity to make sense of good quality information.

Note that these network parameters are based on kinship, friendship, and work-related ties, not on information links concerning weather and climate information. This was meant to reduce the simultaneity between information search and connectivity. People who are actively seeking for information may forge friendships to get such. It is quite unlikely that this prevails though because the element of time is larger in weather and climate information than say in other types of information like job opportunities or credit sources. One is unlikely to create ties just to get WCI; they are more likely to get it from their existing social ties who, in turn, may have heard it from the news over the radio.

The robustness of the model was tested through standard process of removing and adding variables to see whether the sign and significance of other variables are sensitive to these alterations. Only those which are significant and not sensitive to these changes are considered correlates. Due to limited sample, we used only one binary variable in the estimations (i.e. having ever availed credit). Sex dummy was not included because it can further divide the limited sample. An iteration of the model using male dummy did not yield any significant result.

Table 21 Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Individual characteristics					
Searched for and utilized all four major types of WCI	388	0.3273	0.4698	0.0000	1.0000
Age of head	388	42.2189	14.0154	14.4914	84.0192
Age of head, squared	388	1978.3590	1295.4240	210.0018	7059.2210
Years of education	378	8.6481	3.4319	0.0000	16.0000
Years in farming	384	15.8542	13.0524	0.0000	57.0000
Household characteristics					
No. of household members	388	4.0902	2.2641	1.0000	20.0000
Ever availed credit	375	0.5013	0.5007	0.0000	1.0000
No. of smartphones	388	1.2500	1.2563	0.0000	8.0000
Asset index	381	0.0282	1.3154	-1.6128	4.4973
No. of vehicles owned	388	0.4923	0.8848	0.0000	5.0000
Distance to place frequented by respondent (km)	388	3.7586	12.5776	0.0000	120.0000
Log of size of farm operated	388	0.1825	1.9974	-3.9120	6.6846
Degree	381	0.0991	0.0694	0.0060	0.4260
2-Step reach	381	0.4589	0.2071	0.0390	0.9330
Closeness	381	0.3874	0.0688	0.2250	0.5980
Connectivity index	381	0.1640	2.3966	-4.6117	8.8381

The estimation results show that not many of the specified variables significantly associate with a positive outcome; suggesting that many other, unobserved, factors may be influencing people's tendency to actively seek and utilize weather and climate information. Or perhaps things are more random than we thought. This may have something to do with timeliness and accuracy of the information provided. For tropical cyclone warnings, although majority of individual respondents reported that such are extremely and very timely, a non-negligible proportion of 44% found these only moderately and slightly timely. This is more problematic for heavy rainfall warning - because 63% thought they are only moderately and slightly timely. Note that the farm products in the study areas are extremely sensitive to the amount of rainfall. If warnings are deemed not very timely, this reduces its usefulness and relevance.

Notwithstanding the limitations of the models, the logit regression shows consistent positive and significant outcome for network centrality, regardless of the parameter used. The more central one's household is, the higher the tendency to obtain and utilize weather and climate information, with all else being equal. Having ever availed of credit has somewhat positive and significant association with the dependent variable. The proxy indicators for skills and experience are highly significant. Age, in particular, has an inverse-U association with the probability to obtain and utilize WCI while years spent in farming also has a positive correlation. Aside from these, no other variable is shown to associate significantly with the dependent variable.

Table 22 Logit regression results (seeking and utilizing weather and climate information)

Variable	Basic		Degree		2-Step reach		Closeness		Connectivity index	
Individual characteristics										
Age of head	0.2765	***	0.2694	***	0.2600	***	0.2621	***	0.2696	***
Age of head, squared	-0.0035	***	-0.0035	***	-0.0034	***	-0.0035	***	-0.0036	***
Years of education	0.0235		0.0276		0.0155		0.0175		0.0206	
Years in farming	0.0636	***	0.0674	***	0.0646	***	0.0662	***	0.0684	***
Household characteristics										
No. of household members	0.0208		0.0104		0.0009		-0.0009		0.0097	
Ever availed credit	0.5850	*	0.5348	*	0.4556		0.4390		0.5555	*
No. of smartphones	0.1741		0.1643		0.2024		0.1963		0.1841	
Asset index	-0.3033	*	-0.2550		-0.2222		-0.2162		-0.2453	
No. of vehicles owned	0.0138		-0.0819		-0.0985		-0.1257		-0.1120	
Distance to place frequented (km)	0.0103		0.0134		0.0142		0.0151		0.0151	
Log of size of farm operated	-0.0315		-0.0399		-0.0574		-0.0557		-0.0570	
Degree			4.6046	*						
2-Step reach					1.9924	**				
Closeness							6.7316	***		
Connectivity index									0.1811	**
Constant	-7.2939	***	-7.4458	***	-7.5623	***	-9.2658	***	-6.9497	***
Pseudo-R2	0.121		0.1336		0.1405		0.1454		0.1433	
N	369		369		369		369		369	

legend: * p<.05; ** p<.01; *** p<.001

4.8. Interaction with government extension workers, participation in LGU meeting, and attendance in farming schools

The survey results about people's interaction with local government extension worker indicate that there is room for improvement in terms of the extent of exposure of farmers to AEW who can deliver important information and opportunities. None of the respondents can identify any form of social relationship with an extension worker. Majority (66%,) of the 353 respondents engaged in farming reported that they have not interacted with an extension worker in Atok in the past nor attended any meeting convened by the local government unit (LGU) in the past year. Of those who have met an AEW, nearly half reported that their interaction happened when the AEW visited the farm or the household, while the others recalled the AEW giving a PowerPoint Presentation. Those who reported that they themselves sought the assistance of government extension worker are close to none (only 3). This shows that people themselves do not normally go to government extension workers, so it is up to the latter to make the connection. Of those who have experienced attending an LGU meeting (67% of total respondents), 76 percent noted that they attended farm-related seminar(s), while the rest attended disaster preparedness. Of the respondents engaged in farming, 24 percent noted they have attended farm field schools.

There is some evidence that extension worker penetration has been quite effective in the past – as far as selecting people who are more central than others (see Table 23). Survey respondents who have ever met an extension worker in the past tend to have statistically higher centrality scores than those who have not met any. This is also the case for those who have attended farm field school. In contrary, those who have attended LGU meetings are not statistically different from those who have not attended such meetings in terms of relative position in the community.

Table 23 Mean centrality scores by type and group, all sitios

Variable		Obs	Degree	Closeness	2-Step reach	Centrality index
Interact with AEW	Yes	130	0.0941	0.3211	0.3665	0.4986
	No	231	0.0779	0.3057	0.3151	-0.1279
T-test (P-value)			**0.0109**	**0.0038**	**0.0043**	**0.0032**
Attend LGU meetings	Yes	157	0.0857	0.3087	0.3377	0.1836
	No	234	0.0784	0.3069	0.3177	-0.1232
T-test (P-value)			0.2246	0.7453	0.2529	0.1324
Attend farm field school	Yes	96	0.0986	0.3277	0.4015	0.7512
	No	286	0.0778	0.3045	0.3086	-0.1587
T-test (P-value)			**0.0023**	**0.0001**	**0.0000**	**0.0001**

When examined in more details at the *sitio* level, however, the statistically higher mean scores between those who have interacted with AEW is only observed in Proper Paoay, a *sitio* that is closest to the municipality center. This higher average score is also observed for those who have attended LGU meetings and farm field school compared to those who have not in the same sitio. This is not the case in Macbas at all. In fact, the attendees of LGU meetings in Macbas have statistically lower centrality scores than those who were non-attendees. The other groups are not statistically different from one another based on centrality scores. In Tulodan, the attendees of farm field school are more central than those who have not attended farm field school. Again, there are no statistically significant differences between the other groups in terms of relative position in the community networks. Therefore, there is clearly a need to improve on the penetration of extension workers and other LGU staff/officials in remote areas like Macbas and Tulodan.

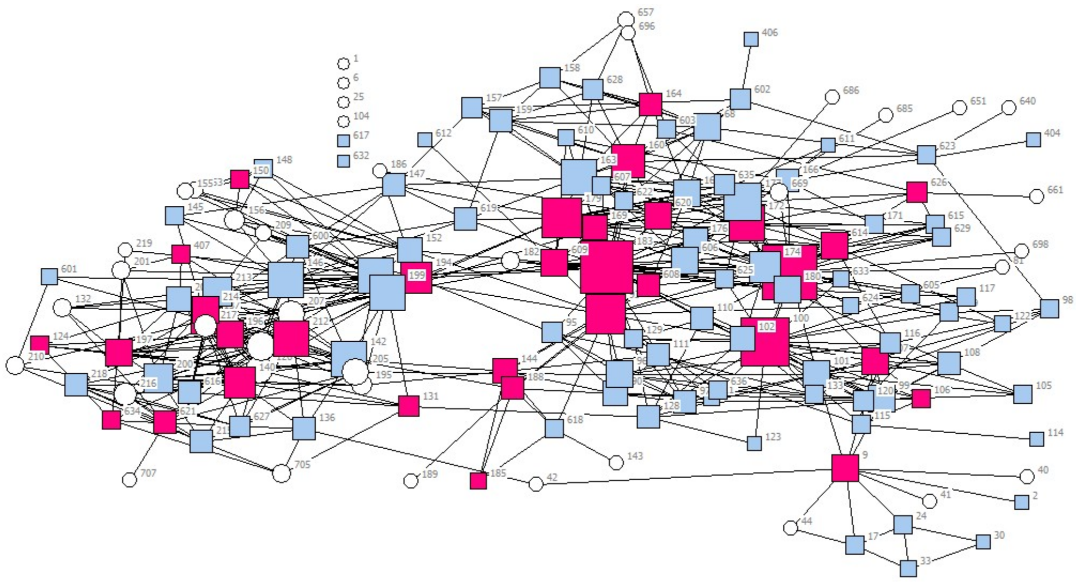
Table 24 Mean centrality scores by type, group, and sitio

Variable		Obs	Degree	Closeness	2-Step reach	Centrality index
Proper Paoay						
Interact with AEW	Yes	43	0.0965	0.3181	0.3243	0.3463
	No	132	0.0628	0.2960	0.2578	-0.6635
T-test (P-value)			**0.0000**	**0.0046**	**0.0030**	**0.0003**
Attend LGU meetings	Yes	46	0.0850	0.3122	0.3047	0.0840
	No	137	0.0649	0.2971	0.2608	-0.6215
T-test (P-value)			**0.0108**	**0.0457**	**0.0446**	**0.0099**
Attend farm field school	Yes	24	0.0835	0.3181	0.3245	0.1325
	No	159	0.0679	0.2983	0.2639	-0.5312
T-test (P-value)			0.1256	**0.0409**	**0.0306**	0.0600
Macbas						
Interact with AEW	Yes	20	0.1331	0.3195	0.4468	1.3118
	No	42	0.1299	0.3091	0.4260	1.0789
T-test (P-value)			0.8681	0.3929	0.6293	0.6869
Attend LGU meetings	Yes	40	0.0895	0.2787	0.3182	-0.1551
	No	39	0.1353	0.3106	0.4385	1.2014
T-test (P-value)			**0.0064**	**0.0204**	**0.0056**	**0.0113**
Attend farm field school	Yes	20	0.1258	0.3210	0.4565	1.1563
	No	50	0.1249	0.3024	0.4030	0.8847
T-test (P-value)			0.9639	0.1491	0.2287	0.6386
Tulodan						
Interact with AEW	Yes	67	0.0809	0.3236	0.3696	0.3537
	No	57	0.0744	0.3255	0.3662	0.2234
T-test (P-value)			0.5130	0.8419	0.9176	0.7248
Attend LGU meetings	Yes	71	0.0840	0.3233	0.3700	0.4390
	No	58	0.0719	0.3275	0.3709	0.1632
T-test (P-value)			0.2156	0.6580	0.9756	0.4444
Attend farm field school	Yes	52	0.0950	0.3348	0.4159	0.8809
	No	77	0.0674	0.3187	0.3397	-0.0672
T-test (P-value)			**0.0050**	0.0909	**0.0175**	**0.0087**

To gain some notion on how AEW penetration can be improved, we examined the spread and position of households who have interacted (through at least one member) with AEW in the past through network graphs. The graphs below pertain to network of kindship and friendship by sitio. There are isolated nodes which means that they do not share such relation with actors in the community. The red nodes are those who have interacted with AEWs in the past (we call these extension workers' initial contacts), light blue ones have not, white circle nodes are those which we failed to interview but were tagged by respondents as part of their advice network. The size of the nodes is proportional to their degree centrality. The bigger the node the more central it is. It would be ideal if the red nodes are also the biggest nodes, which means that AEWs have succeeded in selecting or targeting central actors in their field visits and other interaction. It would also be ideal to see red nodes scattered throughout the network – it means that the selection is done in an even manner that if we use them as information hubs, it is likely that we reach wider segment of the population, all else being equal.

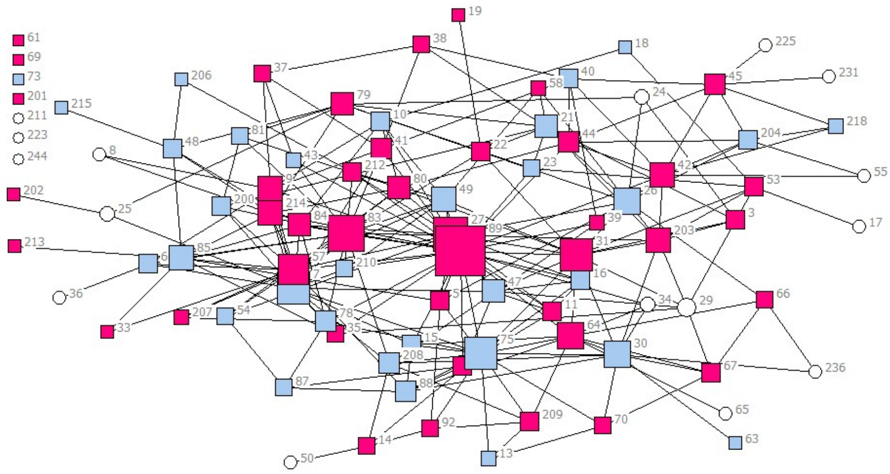
For Proper Paoay, regardless if it was intentional for AEWs to target central actors or not, the initial groundwork has been quite effective because AEWs have already been in touch with more central actors in the area as shown by Figure 13. If we focus on the biggest nodes, many of them are indeed red. The graph also somewhat shows that so far, we can see red in most parts of the network. At least, these are not concentrated in a particular segment of the graph. The AEW penetration in Proper Paoay, therefore, appears to have been effective as far as the criteria mentioned above are concerned. The work therefore must proceed by encouraging these individuals to serve as extension aides or social influencers in disseminating information to other actors, particularly the peripheral ones. A good complementary strategy is to assign local information hubs among those in the periphery and have these hubs be frequently monitored by the local government.

Figure 13 Graph of social relations in Proper Paoay (red – with interaction with AEW in Atok), node size by degree



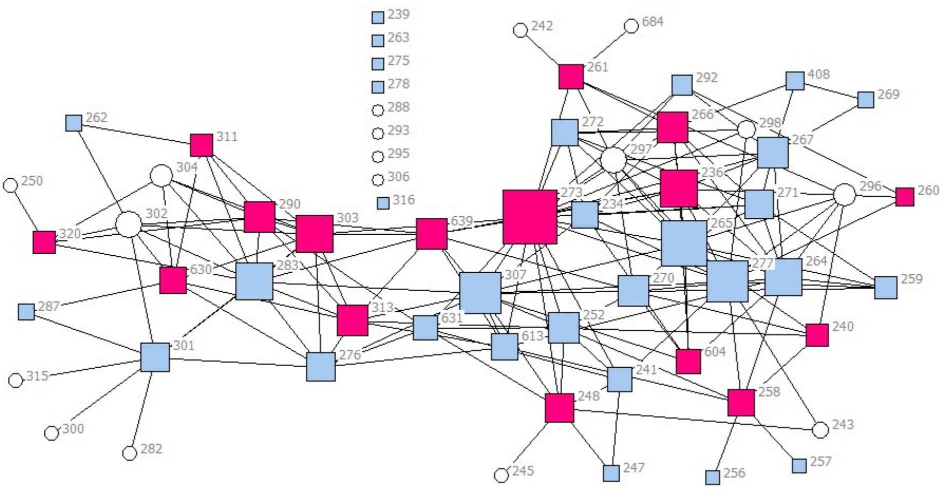
Meanwhile, the situation in Tulodan appears to be that they have worked with more peripheral actors than did Proper Paoay. The red isolated nodes and red pendants (the nodes connected to the graph through just one link) illustrate this. There are also some red nodes that are relatively bigger in size which means that the LGU has targeted some central actors. It is however noticeable that the big reds are not necessarily bigger than the big light blue ones, though there is certainly more even spread of the red in this graph than in Proper Paoay. This means that AEWs may not have succeeded in making initial contact with central nodes, but the promising part is that the spread of households which have been covered by AEWs is relatively dispersed. These households can therefore be good candidates for social influencers in the area.

Figure 14 Graph of social relations in Tulodan (red – with interaction with AEW in Atok), node size by degree



In Macbas, the graph shows that some red nodes are quite well-connected as shown by their bigger sizes. It, however, shows that most of these households are directly linked to one another as shown by the red nodes sitting in some distinct segments while there are some parts of the network which do not have red nodes among them. Perhaps because Macbas is very remote, farm visits may have been done in pockets of related households. This points to the need for a more representative approach in conducting farm visits, presentations, and meetings by government extension workers. AEWs can improve on their work by identifying the central actors in those segments and encouraging them to echo information they obtained. We can also see that some initial contacts are located at the periphery, which is promising because these can serve as hubs in their areas. This is better than not having any red at all among the nodes located at the periphery. Hence, the worst that we can expect, apart from not seeing any red in the graphs, is that if the reds are mostly the smallest nodes which means that they are not good candidates for relaying information, as they have very few connections. We can also see that AEWs need to work harder in Macbas to reach the isolated nodes.

Figure 15 Graph of social relations in Macbas (red – with interaction with AEW in Atok), node size by degree



These visual analyses have enriched our understanding by showing the de-facto outcome of AEWs' efforts of reaching the households in the area and are instrumental in devising relevant strategies for improving AEWs' penetration. Apart from the abovementioned insights that emanated from the visual appreciation of the overall networks, some points can also be deduced by examining gender dimensions.

In the graphs below, we used betweenness to identify the central households because this parameter has wider variations across the nodes. The graphs below pertain to peer advice and resource network of male and female respondents. The nodes represent households, but their connections are defined by the farm-related advice and resources they provide to one another. The AEW penetration based on female advice network (see Figure 17) appears to be concentrated on a few related actors (see many red nodes being linked to one another and concentrating on a some segments and not spread in all parts of the graph); that of their male counterpart (*Figure 16*) appears to be more dispersed and therefore, is a better network for information dissemination. The relatively even distribution of initial contacts of AEW presents an opportunity for reaching different actors in the network.

Figure 16 Advice and resource network of male respondents in Macbas, node size proportional to betweenness score (red= have interacted with AEWs)

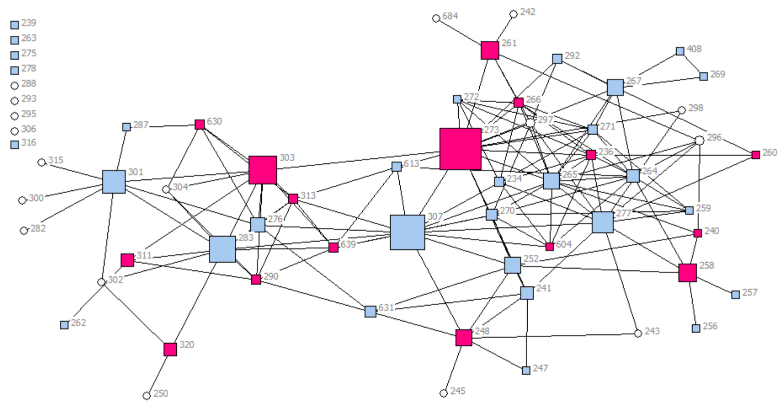
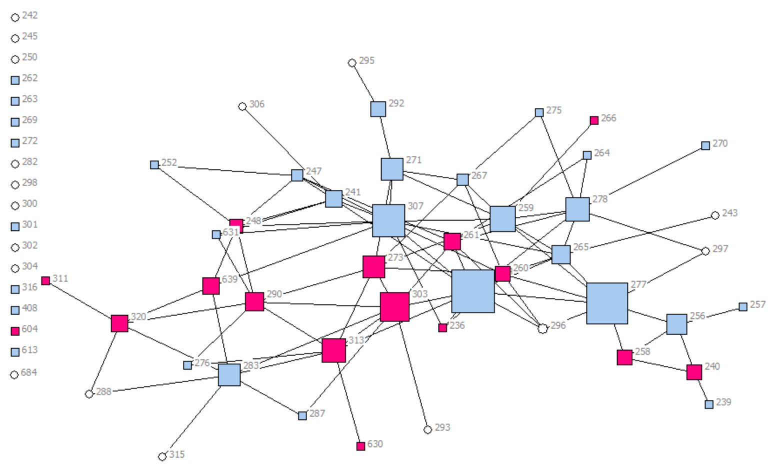


Figure 17 Advice and resource network of female respondents in Macbas, node size proportional to betweenness score (red= have interacted with AEWs)



Based on foregoing discussion, targeting only women as the main approach may not be the most efficient; this analysis shows targeting the men may be better. Nonetheless, complementing the male-targeted approach with the female-focused one will be beneficial as the network of women seems to complement that of the men's peer advice network.

5. Conclusion and recommendations

Based on the primary data gathered from Atok, Benguet, we found varying extent of social cohesion possibly based on physical context. Consistent with expectation, remote communities are relatively more socially cohesive based on density and average geodesic distance. We found however that density is not a perfect measure of cohesion, there is a need to pay attention to isolated nodes especially in upland rural communities. Contrary to expectation that there would be clusters, even communities near the population center can be connected, albeit with a low density, suggesting opportunities for social influencing and more fluid information dissemination.

Physical proximity and mobility are likely to be the key determinants of centrality within the community network in context of significant geographic constraints. Central actors are those living near venues of interaction and those with greater means of transport. Peripheral ones are those who live far from these venues or those who travel far distances to market their goods and do not have means for transport. The most affluent families are not necessarily the most central actors; in fact, these households appear to be on the periphery (they may find less need for social support or too preoccupied for social interaction). There is also some evidence that central households occupy larger dwellings particularly among households living near the business center like Proper Paoay; are members of agricultural cooperative and farmer's organizations. Also, people who come from largest clans and original settlers in the areas are likely to be more centrally positioned than others.

Centrality is a significant factor in access and utilization of WCI, ceteris paribus. Enhancing social interactions and information sharing, therefore, is a relevant strategy for improving access and utilization of WCI. Furthermore, this study found differentiated reach of AEWs depending on the communities. Efforts in areas near the capital like Proper Paoay appear promising but not quite in more remote areas Macbas and Tulodan.

Based on the results of this study, there may be a need for crafting different IEC approaches for different social and physical contexts. There is a need to promote more direct links (promote interaction) between central actors and the LGU and other information sources and producers as well as promote activities that facilitate greater and more meaningful interactions among farmers – to stimulate social learning and influencing.

For more detailed IEC strategy, AEWs and other partners must take advantage of areas that are visited frequently by residents as these are good candidates for convening people for information campaigns. For areas near population centers (still in the upland communities context) – the more immediate concern for AEWs and other stakeholders is how to incentivize initial contacts to effectively disseminate information within their networks. Due to the physical proximity of people in these areas with the municipality center, it is likely that AEWs or the LGU has already made initial contact with people with relatively strategic positions, and so if there are new programs like new technology or maybe innovation, they can just call them back. And these can echo the information. This may be followed with close coordination with these actors so that those in the periphery can also be reached.

For more remote areas – the immediate focus must be the identification of central actors. Because of remoteness of some areas, the AEWs' reach may be limited to some clusters, missing other segments. It is important to gather a set of participants that includes the other segments which may be overlooked in earlier efforts. Once these have been identified, they can be incentivized to act as information hubs for their own networks. It is also important that AEWs make more direct interaction with people in remote areas.

There is a need to strengthen women's organizations; men are normally detained in the farm, while women may have more time to interact and collaborate. We likewise found that it is necessary to improve communication capabilities and invest on mobility/transport of AEWs working in extremely challenging contexts. Also, there is an urgent need to improve access to information through enhancing ICT infrastructure in the area – Atok has very poor mobile phone signal, some can be reached only through SMS

Different communities have different structures and social norms and these differences must be accounted for in the design of IECs and other interventions aimed to promote social influencing and learning. Given that social network mapping is not always feasible and may not always be necessary, there are factors, from this paper, which helps us gain some notion about such characteristics. IEC designs must account for social norms which are associated with physical characteristics of the area, the socio-economic profile, availability and accessibility of venues of congregation or interaction.

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Appendix Tables

Table A.1. Descriptive Statistics: Household Head and Spouse heard of different PAGASA products and other weather and climate information

Variable	Obs	Mean	Std.Dev.	Min	Max
heard typhoon	363	.99	.12	0	1
heard heavy rainfall	363	.93	.25	0	1
heard daily forecast	363	.88	.32	0	1
heard bi-weekly forecast	363	.29	.45	0	1
heard monthly forecast	363	.03	.18	0	1
heard 2-6 month forecast	363	.01	.1	0	1
heard ENSO	363	.89	.32	0	1
heard press releases	363	.46	.5	0	1
heard climate projections	363	.06	.24	0	1
heard indigenous forecast	363	.3	.46	0	1
heard non PAGASA info	290	.19	.39	0	1

Table A.2. Descriptive Statistics: Household Head and Spouse need explanation of heard different PAGASA products and other weather and climate information

Variable	Obs	Mean	Std.Dev.	Min	Max
need explanation typhoon	358	.23	.42	0	1
need explanation heavy rainfall	338	.19	.39	0	1
need explanation daily forecast	321	.19	.4	0	1
need explanation bi-weekly forecast	104	.35	.48	0	1
need explanation monthly forecast	12	.42	.51	0	1
need explanation 2-6 month forecast	4	.25	.5	0	1
need explanation ENSO	322	.24	.43	0	1
need explanation press releases	167	.21	.41	0	1
need explanation climate projection	22	.32	.48	0	1
need explanation indigenous forecast	109	.12	.33	0	1
need explanation non PAGASA info	104	.14	.35	0	1

Table A.3. Descriptive Statistics: Household Head and Spouse actively seeks different PAGASA products and other weather and climate information

Variable	Obs	Mean	Std.Dev.	Min	Max
Variable	Obs	Mean	Std.Dev.	Min	Max
actively seek typhoon	363	.88	.32	0	1
actively seek heavy rainfall	363	.7	.46	0	1
actively seek daily forecast	363	.68	.47	0	1
actively seek bi-weekly forecast	363	.17	.38	0	1
actively seek monthly forecast	363	.02	.16	0	1
actively seek 2-6 month forecast	363	.01	.09	0	1
actively seek ENSO	363	.64	.48	0	1

actively seek press releases	363	.3	.46	0	1
actively seek climate projection	363	.03	.17	0	1
actively seek indigenous forecast	363	.13	.33	0	1

Table A.4. Descriptive Statistics: Household Head and Spouse access to PAGASA products and other weather and climate information

Variable	Obs	Mean	Std.Dev.	Min	Max
access typhoon	396	.91	.29	0	1
access heavy rainfall	396	.85	.35	0	1
access daily forecast	396	.81	.39	0	1
access bi-weekly forecast	396	.26	.44	0	1
access monthly forecast	396	.03	.17	0	1
access 2-6 month forecast	396	.01	.1	0	1
access ENSO	396	.82	.39	0	1
access press releases	396	.42	.49	0	1
access climate projection	396	.05	.22	0	1
access indigenous forecast	396	.26	.44	0	1
access non PAGASA info	396	.19	.39	0	1

Table A.5 Descriptive Statistics: Household Head and Spouse use of different PAGASA products and other weather and climate information

Variable	Obs	Mean	Std.Dev.	Min	Max
use in farm typhoon	396	.8	.4	0	1
use in farm heavy rainfall	396	.68	.47	0	1
use in farm daily forecast	396	.63	.48	0	1
use in farm bi-weekly forecast	396	.2	.4	0	1
use in farm monthly forecast	396	.02	.15	0	1
use in farm 2-6 month forecast	396	.01	.09	0	1
use in farm ENSO	396	.66	.47	0	1
use in farm press releases	396	.29	.45	0	1
use in farm climate projection	396	.04	.19	0	1
use in farm indigenous forecast	396	.16	.36	0	1
use in farm non PAGASA info	396	.17	.37	0	1

Table A.6. Household Head characteristics

Variable	Obs	Mean	Std.Dev.	Min	Max
1/0 HH male	239	.879	.327	0	1
HH head age as of Jan 1 2020	236	43.152	14.384	19.023	84.019
head civil status	238	2.004	.798	1	5
1/0 head completed HS	236	.466	.5	0	1
1/0 HH head is engaged in farming	238	.941	.236	0	1
1/0 HH head is a member of an or	239	1	0	1	1
HH head number of years in farming	237	17.439	13.336	0	57

number of household members	239	3.941	2.404	1	20

Table A.7. Household ownership of items

Variable	Obs	Mean	Std.Dev.	Min	Max
house floor area in sqm	239	107.452	156.23	0	2000
number of radio	239	.908	.485	0	4
number of tv	239	.757	.467	0	2
number of landline	239	0	0	0	0
number of basic phone	239	1.117	.967	0	5
number of smart phones	239	1.289	1.305	0	8
number of computer	239	.075	.295	0	2
number of refrigerator	239	.301	.512	0	3
number of own motorcycle	239	.176	.461	0	4
number of own car	239	.456	.833	0	5
number of own tractor	239	.28	.495	0	3
number of own water pump	239	.397	.507	0	2
number of own greenhouse	239	.264	1.03	0	8
number of own house	239	.996	.394	0	3
1/0 ownership of smartphone	239	.695	.462	0	1
1/0 radio	239	.845	.362	0	1
1/0 own TV	239	.741	.439	0	1
1/0 basic phone	239	.757	.43	0	1
1/0 own vehicle	239	.318	.467	0	1

Table A.8. Credit

Variable	Obs	Mean	Std.Dev.	Min	Max
1/0 ever avail credit	232	.491	.501	0	1
1/0 last year avail credit	232	.31	.464	0	1
1/0 borrow from cooperatives	72	.306	.464	0	1
1/0 borrow from banks	72	.028	.165	0	1
1/0 borrow from private money lender	72	.014	.118	0	1
1/0 borrow from relatives or friends	72	.417	.496	0	1
1/0 borrow from landowner	72	.014	.118	0	1
1/0 borrow from NGOs	72	.014	.118	0	1
1/0 borrow from microfinance	72	.014	.118	0	1
1/0 borrow from input supplier	72	.014	.118	0	1
1/0 borrow from disposer	72	.153	.362	0	1

Table A.9. HH attendance in seminars

Variable	Obs	Mean	Std.Dev.	Min	Max
1/0 attend farmer field school	232	.228	.421	0	1
1/0 interact with gov agricultural extension	239	.402	.491	0	1

interact by AEW visited the farm	239	.176	.381	0	1
interact AEW by farmer went to AEW	239	.013	.112	0	1
interact with AEW by phone online	239	.18	.385	0	1
AEW _online	239	.004	.065	0	1
1/0 HH attend LGU meeting	239	.393	.49	0	1
HH attend farm related seminar	239	.301	.46	0	1
HH attend disaster preparedness	239	.117	.322	0	1
HH attend FDS related	239	.079	.271	0	1
1/0 HH head interacts with private technician	192	.698	.460	0	1
1/0 HH head private tech visits farm	158	.633	.483	0	1
1/0 HH head attend mtg or private ppt	104	.442	.499	0	1
1/0 HH head private interact online	1	1	.	1	1
1/5 household adopt technology (1 – very unlikely to 5- definitely)	232	3.978	1.055	1	5

Table A.10. Sources of information by weather and climate information by type

Descriptive Statistics - Sources of Typhoon information

Variable	Obs	Mean	Std.Dev.	Min	Max
SMS	359	.1	.3	0	1
Internet	359	.2	.4	0	1
Radio	359	.87	.33	0	1
Television	359	.76	.43	0	1
Broadsheet	359	0	.05	0	1
Tabloid	359	0	0	0	0
Extension worker	359	.01	.09	0	1
PAGASA	359	0	0	0	0
Self	359	.01	.09	0	1
Other person	359	.26	.44	0	1
NDRRMC	359	.23	.42	0	1

Descriptive Statistics - Sources of Heavy Rainfall information

Variable	Obs	Mean	Std.Dev.	Min	Max
SMS	338	.01	.11	0	1
Internet	338	.11	.32	0	1
Radio	338	.77	.42	0	1
Television	338	.76	.43	0	1
Broadsheet	338	0	0	0	0
Tabloid	338	0	0	0	0
Extension worker	338	0	.05	0	1
PAGASA	338	0	0	0	0
Self	338	0	.05	0	1
Other person	338	.12	.33	0	1
NDRRMC	338	.01	.08	0	1

Descriptive Statistics - Sources of Daily Forecast information

Variable	Obs	Mean	Std.Dev.	Min	Max
SMS	320	.01	.11	0	1
Internet	320	.04	.2	0	1
Radio	320	.77	.42	0	1
Television	320	.66	.48	0	1
Broadsheet	320	0	0	0	0
Tabloid	320	0	0	0	0
Extension worker	320	0	0	0	0
PAGASA	320	0	0	0	0
Self	320	0	0	0	0
Other person	320	.06	.24	0	1
NDRRMC	320	0	0	0	0

Descriptive Statistics - Sources of Bi-weekly Forecast information

Variable	Obs	Mean	Std.Dev.	Min	Max
SMS	104	0	0	0	0
Internet	104	.07	.25	0	1
Radio	104	.48	.5	0	1
Television	104	.76	.43	0	1
Broadsheet	104	0	0	0	0
Tabloid	104	0	0	0	0
Extension worker	104	0	0	0	0
PAGASA	104	0	0	0	0
Self	104	0	0	0	0
Other person	104	.06	.23	0	1
NDRRMC	104	0	0	0	0

Descriptive Statistics - Sources of Monthly Forecast information

Variable	Obs	Mean	Std.Dev.	Min	Max
SMS	12	.08	.29	0	1
Internet	12	.17	.39	0	1
Radio	12	.92	.29	0	1
Television	12	.75	.45	0	1
Broadsheet	12	0	0	0	0
Tabloid	12	0	0	0	0
Extension worker	12	0	0	0	0
PAGASA	12	0	0	0	0
Self	12	0	0	0	0
Other person	12	.08	.29	0	1
NDRRMC	12	0	0	0	0

Descriptive Statistics - Sources of 2-6 Months Forecast information

Variable	Obs	Mean	Std.Dev.	Min	Max
SMS	4	0	0	0	0
Internet	4	.25	.5	0	1
Radio	4	.75	.5	0	1
Television	4	1	0	1	1
Broadsheet	4	0	0	0	0
Tabloid	4	0	0	0	0
Extension worker	4	0	0	0	0
PAGASA	4	0	0	0	0
Self	4	0	0	0	0
Other person	4	0	0	0	0
NDRRMC	4	0	0	0	0

Descriptive Statistics - Sources of ENSO Forecast information

Variable	Obs	Mean	Std.Dev.	Min	Max
SMS	323	0	0	0	0
Internet	323	.1	.3	0	1
Radio	323	.76	.43	0	1
Television	323	.8	.4	0	1
Broadsheet	323	0	0	0	0
Tabloid	323	0	0	0	0
Extension worker	323	0	.06	0	1
PAGASA	323	0	0	0	0
Self	323	0	.06	0	1
Other person	323	.06	.23	0	1
NDRRMC	323	0	0	0	0

Descriptive Statistics - Sources of Press releases information

Variable	Obs	Mean	Std.Dev.	Min	Max
SMS	168	0	0	0	0
Internet	168	.02	.15	0	1
Radio	168	.72	.45	0	1
Television	168	.75	.43	0	1
Broadsheet	168	0	0	0	0
Tabloid	168	0	0	0	0
Extension worker	168	0	0	0	0
PAGASA	168	0	0	0	0
Self	168	.01	.11	0	1
Other person	168	.05	.23	0	1
NDRRMC	168	0	0	0	0

Descriptive Statistics - Sources of Climate projections information

Variable	Obs	Mean	Std.Dev.	Min	Max
SMS	21	0	0	0	0
Internet	21	.05	.22	0	1
Radio	21	.57	.51	0	1
Television	21	.71	.46	0	1
Broadsheet	21	0	0	0	0
Tabloid	21	0	0	0	0
Extension worker	21	.05	.22	0	1
PAGASA	21	0	0	0	0
Self	21	.05	.22	0	1
Other person	21	.05	.22	0	1
NDRRMC	21	0	0	0	0

Descriptive Statistics - Sources of Indigenous forecast. information

Variable	Obs	Mean	Std.Dev.	Min	Max
SMS	104	.01	.1	0	1
Internet	104	0	0	0	0
Radio	104	.05	.21	0	1
Television	104	.04	.19	0	1
Broadsheet	104	0	0	0	0
Tabloid	104	0	0	0	0
Extension worker	104	.15	.36	0	1
PAGASA	104	0	0	0	0
Self	104	.71	.46	0	1
Other person	104	.4	.49	0	1
NDRRMC	104	0	0	0	0

Descriptive Statistics - Sources of Non-PAGASA information

Variable	Obs	Mean	Std.Dev.	Min	Max
SMS	76	0	0	0	0
Internet	76	.11	.31	0	1
Radio	76	.83	.38	0	1
Television	76	.67	.47	0	1
Broadsheet	76	0	0	0	0
Tabloid	76	0	0	0	0
Extension worker	76	0	0	0	0
PAGASA	76	0	0	0	0
Self	76	0	0	0	0
Other person	76	.03	.16	0	1
NDRRMC	76	0	0	0	0