Full Length Research Paper

Integrating Social Network Analysis and correlation in agricultural extension: Case of climate change adaptation communication

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Abstract

Communication plays a critical role in climate change adaptation; farmers faced with this challenge are continually sharing information and adopting appropriate agricultural technologies. This study used Social Network Analysis (SNA) to study how farmers adapting to climate change communicate. SNA was used to assess the effects of social network structures on climate change adaptation communication among farmers in Sakai sub-location in Makueni County in Kenya and correlation analysis to determine factors that determine access to information. The study focused on how information flows through a social system. SNA is a relatively new methodology that has gained currency due to its ability to combine graph theory, statistics and computer programmes to produce visual sociograms and indices that assign values to relationships in a network. Correlation was used to show the association between study variables. The integration of correlation in SNA is shown to increase the understanding of heterophily and homophily in group communications.

KEY Words: Social Network Analysis, homophily, climate change adaptation, information flow

INTRODUCTION

Agricultural extension will certainly play a critical role in the whole process of climate change adaptation among farmers owing to their proximity and relations. Swanson & Claar (1984) definition of agricultural extension as an ongoing process of getting useful information to people and then assisting those people to acquire the necessary knowledge, skills and attitude to effectively utilize this information and technology concurs with (Demiryurek, 2000) statement that communication is a major concern for agricultural extension services. Chambers et al. (1989) in Farmer First approach emphasize information and knowledge exchange between different actors in its generation, dissemination and utilization. The various actors in the agricultural extension system can be viewed as audience groups that act as sources, channels or targets of agricultural information and technologies within a social setting.

Some of the adaptation practices include growing of drought resistant crops, conservation farming, use of irrigation, natural resource management, rain water harvesting among others. Farmers have indigenous knowledge on coping with adverse climatic conditions and therefore are not passive receipts of such information but actively share this information through horizontal channels of communication. The question is how can this communication process be studied?

Grothman and Patt (2003) argue that decision on climate change are socially constructed and negotiated; to exploit such a system it is important to understand how information flows through these social systems and the role of various actors in the communication process. Risbey et al. (1999) differentiated the adaptation process into four stages namely;- information collection (awareness), planning and design, implementation

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(decision making), monitoring and evaluation of the outcomes of such decisions. This compares well with Hovland et al. (1953) stages of a communication process which they enumerated as attention/reception of the message, comprehension, yielding and action.

Participatory models increase interactivity and therefore diffusion of information which is a prerequisite for the adaptation process. Farmers are rational human beings that make choices and decisions that best suit their needs; they will thus learn from sources that offer relevant information to their local farming systems needs. Farmers are not passive listeners but they actively select messages that best meet their needs as posited by the uses and gratification theory. According to Nitsch (1991) farmers apply adaptive rationality which is a product of continuous interaction among visions and experiences. Adaptation to climate change can be enhanced through a participatory learning process to increase rural agricultural productivity by using assisted self-reliance and appropriate learning modes Uphoff et al. (1998).

Social capital in the form of groups is used in communities worldwide, especially in the rural areas as safety nets to cope with risks and for mutual assistance (ILRI, 2008). The advantage of social capital is its availability thus it is relatively easy to exploit in community mobilization and sensitization. Rural communities interact within and across social levels on various risks and this form a crucial component in their resilience to uncertainties.

Studies show that social networks have a significant influence on the adoption decision of individual farmers (Bäerenklau 2005, Conley and Udry 2001, Matuschke et al. 2007). Adaptation occurs in a physical, ecological and human system and involves changes in social and environmental processes, perceptions of climate risks and thus practices that serve to lessen the resultant adverse effects while exploiting the new opportunities.

Interpersonal communications channels and frequency of interaction between individuals influence attitude change (Kadushin, 1966). Individuals are likely to be influenced by the members whom they interact with most and have some similarity. These networks are important in collective community actions (Crona and Bodin 2006, Granovetter 1973). The characteristics of the social networks in a community influence successful Natural Resource Management (NRM) due to their profound effect on the diffusion of information and knowledge (Crona and Bodin, 2006).

The linkages that connect actors in agricultural extension system facilitate the exchange of information, transfer, uptake and utilization of research findings and technology (Chema et al. 2003). In most developing economies information on which extension advice is based isn't generated within the extension organizations but in separate systems (National Agricultural Research Institutes, universities, private research firms) and such

management systems give little weight to extension agents and farmers' opinions and priorities (Anderson and Feder 2004).

The weak linkages challenge, traces back to the initial agricultural extension efforts in Kenya; for example the World Bank sponsored Integrated Rural Development Project (IRDP) in 1970s did little to link farmers to researchers and the private sector (Davis, 2008). Chema et al. (2003) in their evaluation of concepts and practices of agricultural extension in developing countries found out that many organizations dealing with research and development in developing countries are faced with poor participation and cooperation by end users in research activities. Smith and Pilifosova (2001) acknowledge that there is very little empirical research literature on the process of adaptation decision making by farming communities on climate change.

Social Networks Analysis (SNA)

SNA is the analysis of relationships among agents, groups or entities. SNA studies the patterns of relations among individuals, organizations and other social groups such as states (Wasserman and Faust, 1994). Social Network Analysis focuses on the relational aspects of social behaviour and views social structures as arising from patterns of interaction between individuals (Wasserman and Faust 1994). The SNA methodology has been used in disciplines like sociology, business management and public health but remains underutilized in agriculture and natural resource management (Springer and de Steiguer, 2011).

The relationships provide channels for resource transfer e.g. money, information; they also present opportunities and barriers to an individual's actions (Wasserman and Fuast, 2005). SNA is focused on uncovering the patterning of people's interactions by answering the questions; who is the main actor in a network, who is most influential member, who acts on the periphery, who offers the most important connections and which kind of information is shared through the network. SNA is an interdisciplinary methodology that incorporates anthropology, communication, mathematics, statistics and computing disciplines into a very versatile research method used in a wide array of disciplines (Scott 2000). Statistical methods have been applied to SNA e.g. correlation analysis have been introduced to identify the determinants of network positions or to estimate the likelihood that a relation exists between two or more actors within a network (Brieger 2004).

The actors in social networks are linked together by relationships called ties; the nodes represent the actors involved in the relationship. Sociocentric networks are composed of all the actors within a population while ego-networks are composed of a selected group of actors. This research will analyze ego-networks. There are numerical and graphical techniques used in the

description and measure of networks to assess the flow of resources (Matuschke 2010).

Using Social Network Analysis to Study Agricultural Communication

Social Network Analysis (SNA) when applied to communication about agriculture in rural communities reveals regularly used sources of advice on agriculture and conversely those who are not well connected to established networks (Grotham , 1993). SNA has been used in evaluation of educational programmes by William et al. (2006); their research showed that SNA is an effective tool for evaluating school programmes that foster greater collaboration. Zack, (2000) applied SNA to measure effects of organizational systems on social communication structures. Zack demonstrated that SNA can be used to understand information flow and communication patterns in organizations. While Bartholomay et al. (2011) used this method to map out the University of Minnesota Department of Agricultural Extension outreach; they found out that SNA offers a unique method for describing and measuring extension outreach to the internal and external actors and can inform better knowledge management. They recommend SNA as a strategic approach that can be used in developing internal collaboration, communication and in conducting system-wide impact evaluations.

Few researches explore the nature of social networks in the diffusion of climate variability and change information. Three studies; described below applied social network analysis to study natural resource management along the Kenyan coastal region, the uptake of integrated pest management among tomato farmer groups in Kiambu and diffusion of innovation among farmer groups in Kenya and Ethiopia. All these studies analyzed social networks at the group level; analyzing social network characteristics at the individual level provides more information on the roles of actors in the diffusion process.

Darr and Pretzsch (2006) used social network analysis to study the spread of innovations within formal and informal farmers groups in rural communities in Kenya and Ethiopia. They studied group characteristics that affect the diffusion of innovations in a group setting. The study areas had received previous support from the development donors in support of tree planting. The findings revealed cohesive groups with intensive information exchange or collaborations among members facilitated the spread of innovation. It also found out that the spread of farming practices was effective through interpersonal interactions and communication among the rural communities.

Darr and Pretzsch (2006) recommended for a study to be done at the individual level using a qualitative approach to get more insight into the diffusion process. Studies done in India by Matuschke and Qaim (2006) showed that indeed individual networks as opposed to village networks played a significant role in the adoption of hybrid wheat.

Raini et al. (2005) carried out a study on the Integrated Pest Management (IPM) information flow using SNA combined with descriptive statistics. Their research specific objectives were to:- Asses how the density of selected social networks shape tomato IPM stakeholders interaction and to examine the structural patterns of connections as induced by social relations and the role they play in IPM information flow. This was the first study to apply SNA in the study of information flow among the tomato stakeholders using IPM. The study was done in central Kenya in 2004 and mainly characterized social networks in terms of size and density. They found out that the density of social relations influence IPM stakeholder's interaction behaviors and induce various structural patterns of connection.

Crona and Bodin (2006) carried out a study among the coastal communities on how occupational (defined by the fishing gear) and relational social networks affected the diffusion of information and knowledge on natural resource extractions. They used knowledge as the dependant variable and its distribution among resource users was qualitatively compared to map out the group relations. They found out how influential groups of non-fishermen who had limited communication with the various fisher groups. The type of fishing gear influenced social network formation and provided channels of communication. Groups with strong intergroup relations and same pattern of relations had strong influence on other with the same occupations; this is in tandem with Wasserman and Faust (1994) assertion. This study was at the group level and the resultant social network.

Study Site

Sakai Sub location is approximately 24.5Km^2, covers five villages of Kathamba, Muiu, Kiteani, Linga and Nthongoni with a population of 4,866 and composed of about 520 households. Sakai sub-location is located in Waia location, Kisau division and Mbooni East District, Makueni County as in Figure 1. The framers in this sub-location have since time immemorial depended on rain fed agriculture but this has increasingly come under threat from the climate variability and change phenomenon which has hit the area. Farmers we talked to gave accounts of how rainfall patterns were regular and how they used to harvest a lot of crops. Over time the rainfall patterns have become erratic and crop production has dwindled.

METHODOLOGY

The flow of information on the agricultural adaptive measures was the dependent variable in the study. Social networks can either have positive or negative

Figure 1: Map of Sakai sub-location showing the five villages that were studied (Source CSTI)
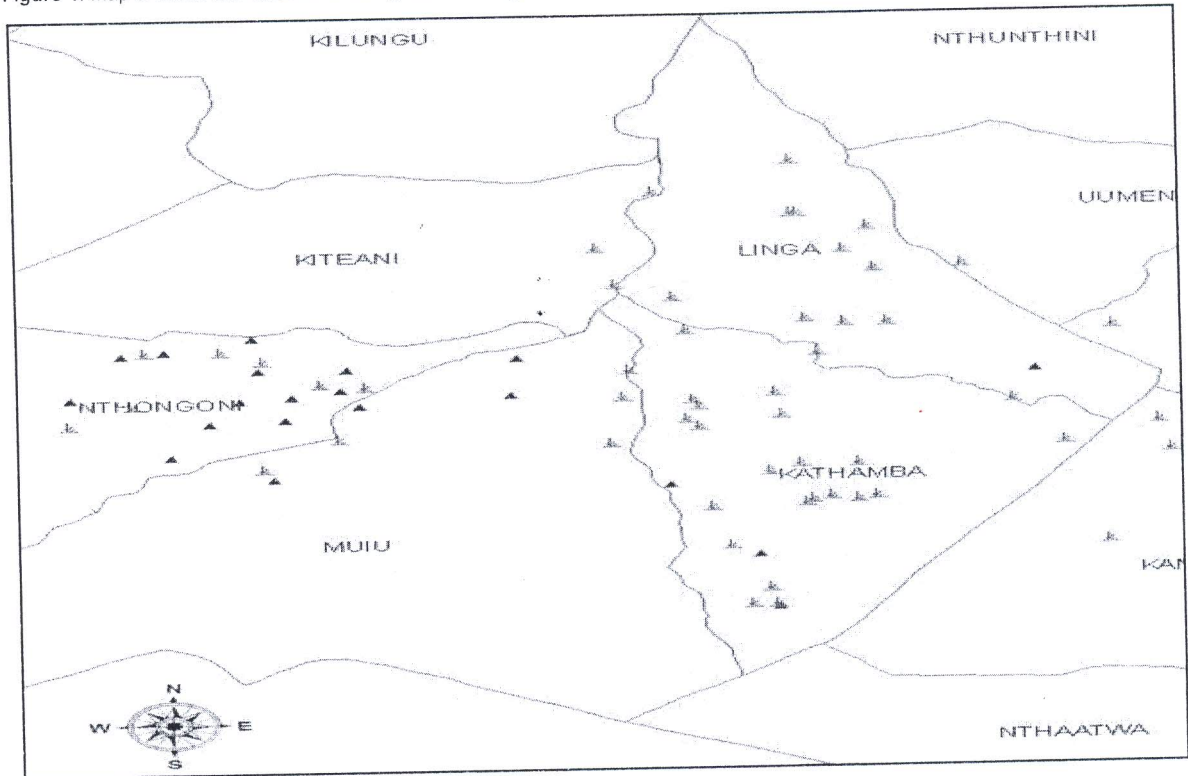
effect on information flow and this was determined by asking farmers questions on their sources of climate change adaptation information and who they shared with such information. Among the independent variables was the land acreage owned by each household, age of the household head, level of education, marital status and group membership.

To map out how information flows through the social system (five villages in Sakai Sub-location) SNA was done and data was entered into NodeXL version 1.0.1.245. Sociograms were generated and analysed. To show whether independent variables had any effect on the information flow a Pearson's correlation was done.

RESULTS AND DISCUSSION

Sakai social network have a community structure (Wasserman and Faust 1994 and Scot 200) composed of groups of nodes that have high density of edges (relations) within them and lower density of relations between the groups. A visual observation of the nodes in the socio-gram in figure 2 illustrates this social structure.

Sakai sub-location network has a low average Eigenvector centrality 0.002, this index measures the importance of a node (Bonacich1972) and is connected to the power of the node to influence other actors. The low eigenvector centrality implies a lower number of opinion leaders in this community which is in agreement with normal distribution in community structures (Wasserman and Faust 1994, Scott 2000). The maximum Eigenvector centrality of 0.28 shows how influential the most powerful node in this actor is.

To show factors that influence the formation of these groups, a correlation analysis was done. The networks are formed

based on similarities in age, levels of education and farm sizes as shown by the strong correlation co-efficient as relates to access to information in table 2. In other words homophily was central to relationship formation.. These relationships have been build and sustained over time and are highly cohesive.

The Sakai sub-location network structure have strong bonds within the subgroups and weak linkages between sub-groups as shown in the sociogram below (figure 2) at both village and whole network levels at both village and whole network levels. The extent to which people in the Sakai sub-location tend to pair up is highly variable with the highest clustering co-efficient being 0.5 and the average being 0.025. This show a mix of homophilic and heterophilic groups where individuals have a high tendency to connect to other similar individuals while being brought together by an actor isn't similar (heterophilic) to them but who also connects them to other networks. Sakai sub-location has structural advantages that can support flow of information on climate change adaptation techniquesas shown by the mix of strong bonds and weak ties facilitates the flow of information on innovations (Granovetter, 1973).

The socio-gram metrics also show a closely knit social structure with every farmer being near each other as measured by the whole network closeness centrality at 0.01, this translates to a cohesive community quicker access to resources in our case information in figure 2

In order to show whether the independent variables namely age of household head, education level of the household, marital status of the household, size of farm

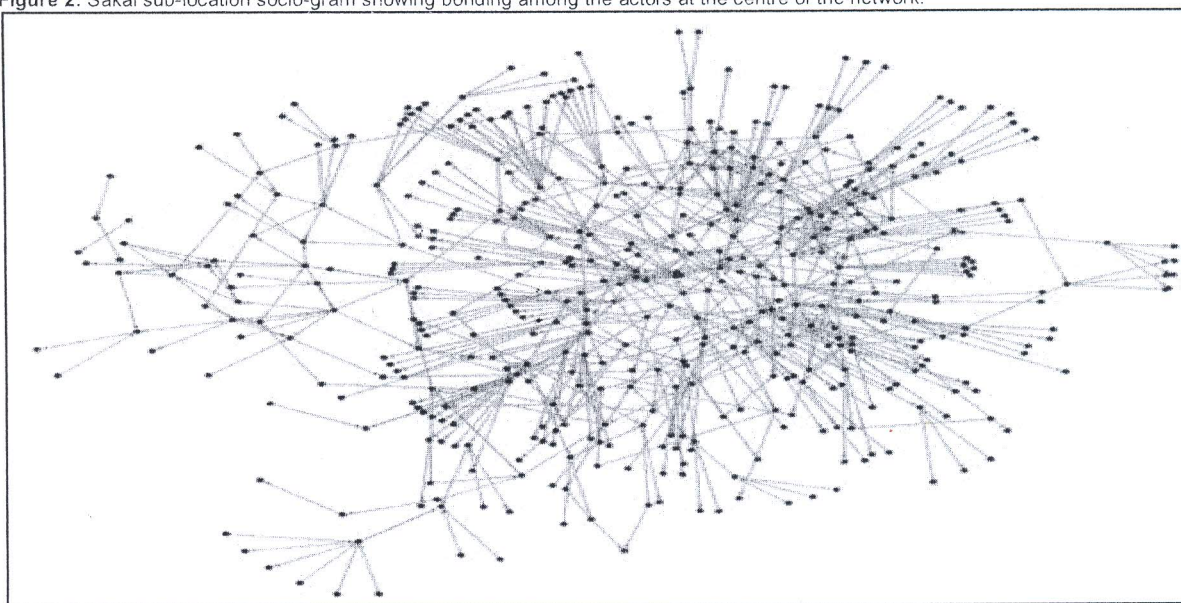**Figure 2**: Sakai sub-location socio-gram showing bonding among the actors at the centre of the network.

Table 1: Pearson's Correlation

		Information access	Age of household head	Education level	Marital status	Size of farm in acres	Group membership
Information access	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	165					
Age of household head	Pearson Correlation	.238	1				
	Sig. (2-tailed)	.026					
	N	165	*165				
Education level	Pearson Correlation	.624	.326	1			
	Sig. (2-tailed)	.019	.000				
	N	165	165	165			
Marital status	Pearson Correlation	.009	.264	.195	1		
	Sig. (2-tailed)	.100	.031	.012			
	N	165	165	165	165		
Size of farm in acres	Pearson Correlation	.509	.292	.108	.027	1	
	Sig. (2-tailed)	.016	.000	.167	.732		
	N	165	165	165	165	165	
Group membership	Pearson Correlation	.173	.022	.185	.060	.020	1
	Sig. (2-tailed)	.038	.074	.017	.442	.800	
	N	165	165	165	165	165	165

Correlation is significant at the 0.05 level (2-tailed).

in acres and group membership had an effect on information flow and hence group formation and homophily correlation analysis was done. See table 1 above.

From the above Pearson's Correlation; the level of education and farm size are strongly correlated to access to climate change adaptation information at 0.624 and 0.509 respectively. Age of the farmer is moderately correlated to access to information on climate change adaptation while group membership and marital status were weakly correlated to access to climate change adaptation at 0.173 and 0.009 respectively.

This findings show that although SNA produces socio-grams that can be visually and statistically analyzed its integration with correlation analysis makes it possible to analyze data in terms of cause and effect. In this study correlation was used to link homophily to group formation and information sharing.

CONCLUSION

The integration of correlation and social network analysis in the study of agricultural communication is effective in understanding the communication process. Correlation analysis fills the gaps in SNA by showing the correlation of between the depend and independent variables in a communication process.

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