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Social Network Analysis: A Tool to Improve Understanding of Collaborative Management Groups

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Abstract: Social network analysis (SNA) is a tool used to analyze the connections between people and organizations. However, despite its usefulness to the study of these relations, there have been relatively few applications to situations in agriculture and natural resources. SNA was applied to the study of a watershed collaborative group in southern Arizona. We found that even a fundamental application of SNA was valuable to a watershed initiative and, furthermore, believe that U.S. Extension professionals are positioned to advance the effectiveness of participatory resource management groups through more widespread use of this methodology.

Introduction

Extension's main task is reaching out to the public, and this often means dealing with individuals and groups. Social network analysis (SNA) is a tool available for modeling, visualizing, and analyzing the interactions between individuals within groups and organizations. Disciplines such as sociology, business management, and public health have made extensive use of SNA for a variety of organizational and network situations. However, the methodology is still underused in agriculture and natural resource applications. Therefore, the purpose of this article is to demonstrate the development and application of a SNA via a "real world" situation similar to those encountered by U.S. Extension professionals.

In our illustrative example, social network analysis (SNA) was applied to the study of a collaborative watershed initiative operating in the Cienega Watershed situated in southern Arizona. Watershed initiatives are groups made up of citizen volunteers and partnering organizations that work collaboratively to bring about improvements in watershed management. A step-by-step procedure is outlined for conducting a SNA, along with examples of how this technique might be used to analyze community engagement in resource management activities.

A Brief Review of Social Network Analysis

Since its emergence in the 1930s (Wasserman & Faust, 1994), SNA has developed into a methodology that provides complementary visual and statistical components for analyzing the traits of individuals and their relationships (Scott, 1988). SNA has been used in a diversity of applications, including analyzing corporate business partnerships (Macaulay, 1963), studying the transmission of communicable diseases (Klovdahl, 1985) and examining how ideas and information are transferred amongst a field of professionals (Coleman, Katz, & Menzel, 1957).

The importance of social networks has been discussed in the natural resources literature. Social networks are essential for managing global resources (Pretty & Ward, 2001), responding to natural disasters (Adger, Hughes, Folke, Carpenter, & Rockstrom, 2005), and enhancing the resilience of social-ecological systems in the face of climate change (Millennium Ecosystem Assessment, 2005; Tompkins & Adger, 2004). Characteristics of effective networks have also been discussed, highlighting the fact that the structure of an organization affects stakeholders' ability to manage natural resources effectively (Bodin, Crona, & Ernstson, 2006) and that desirable qualities for one network are not necessarily important to another (Newman & Dale, 2005).

While recent applications have demonstrated the utility of SNA for providing empirical information about resource management networks (Mandarano, 2009; Prell, Hubacek, & Reed, 2009; Wolf & Hufnagl-Eichiner, 2007), the methodology remains underused for many practical applications. This article seeks to add SNA to the many tools available to help Extension professionals working with collaborative groups such as watershed initiatives (Knoot, Grudens-Schuck, & Schulte, 2006; Mahler, Seago, Simmons, & Fedale, 2008; Meeker, Tate, Czapar, & Vaughan, 2005).

Watershed Initiatives and the Study Area

Kenney (1999) defined watershed initiatives as "ad hoc, voluntary associations typically featuring both governmental and non-governmental actors organized together to collaboratively seek new strategies for addressing water and related natural resource problems at physically relevant regional scales." The Cienega Watershed Partnership (CWP) is such a group that performs these functions within the Cienega Watershed, which is located approximately 45 miles southeast of Tucson, Arizona. The Cienega Watershed comprises a mixture of federal, state, county, and private ownerships, and includes the 45,000-acre Las Cienegas National Conservation Area managed by the Bureau of Land Management.

The CWP collaborates with Cienega Watershed land managers on numerous issues, including wildlife habitat, water quality and quantity, public policy, education and outreach, fundraising, recreation, cultural and historical resources, livestock grazing, invasive species, and built environment and development issues. The CWP is examined here as part of an on-going longitudinal study (i.e., one with multiple observations of a group through time) regarding the involvement of stakeholders in the management of the Cienega Watershed. In the study reported here, participants were asked a series of questions related, generally, to their involvement in watershed issues and their contact with other participants. Following are the steps used to conduct the SNA.

Step 1: Identifying the Network

The first step in an SNA study is to identify the members of the network (Knoke & Yang, 2008). This may be generally difficult if individuals are frequently moving in or out of the network, as may be the case with members of watershed initiatives. Participants in the Cienega Watershed initiative were identified with the assistance of watershed initiative leaders and through sign-up sheets from a series of meetings and events. In 2008, 52 individuals were found to be participating in the CWP's watershed activities.

Step 2: Collecting Social Interaction Data

Social network analyses can examine several types of interactions among individuals, such as transactions, communication, authority and power, and kinship and descent (Knoke & Yang, 2008). In the study reported here, the Tailored Design Method (Dillman, Smyth, & Christian, 2008) was used to develop a survey instrument to gather information regarding collaboration between individuals with respect to specific Cienega Watershed management issues.

Each participant was asked to indicate his or her frequency of collaboration with each of the other participants about Cienega Watershed issues. These responses were separated into a dichotomized framework, with contact frequencies less than once per year being coded with a "0" and contact frequencies greater than or equal to once per year being coded with a "1." Participants selected this framework after determining that collaboration occurring at least once per year should be considered as part of their network and that collaborations occurring less frequently should not be considered. This dichotomization scheme could be changed depending on the specific situation (Wasserman & Faust, 1994).

Additionally, each participant was asked how frequently he or she participated in projects related to each of 10 issues of concern: wildlife habitat, water quality and quantity, public policy, education and outreach, fundraising, recreation, cultural and historical resources, livestock grazing, invasive species, and built environment and development issues. With this information it was possible to determine which stakeholders were involved in certain issues and their frequency of collaboration with other people who were working on the same issue.

This information was then used to create a series of data matrices that indicate whether collaborative relationships exist between participants. The example presented here (Figure 1) deals with 25 participants who, in 2008, collaborated among themselves on the issue of invasive species. To provide anonymity, participant names have been replaced with the alphabetic letters shown on the column and row headings. Identical column and row letters correspond to the same person. A "1" in a cell indicates that two people collaborated on invasive species issues at least once in 2008, whereas a "0" indicates that the people did not. For example, participant D collaborated with participant A in 2008, but participants D and B did not interact.

Figure 1.
Matrix for Cienega Watershed Participants Collaborating on Invasive Species Issues in 2008

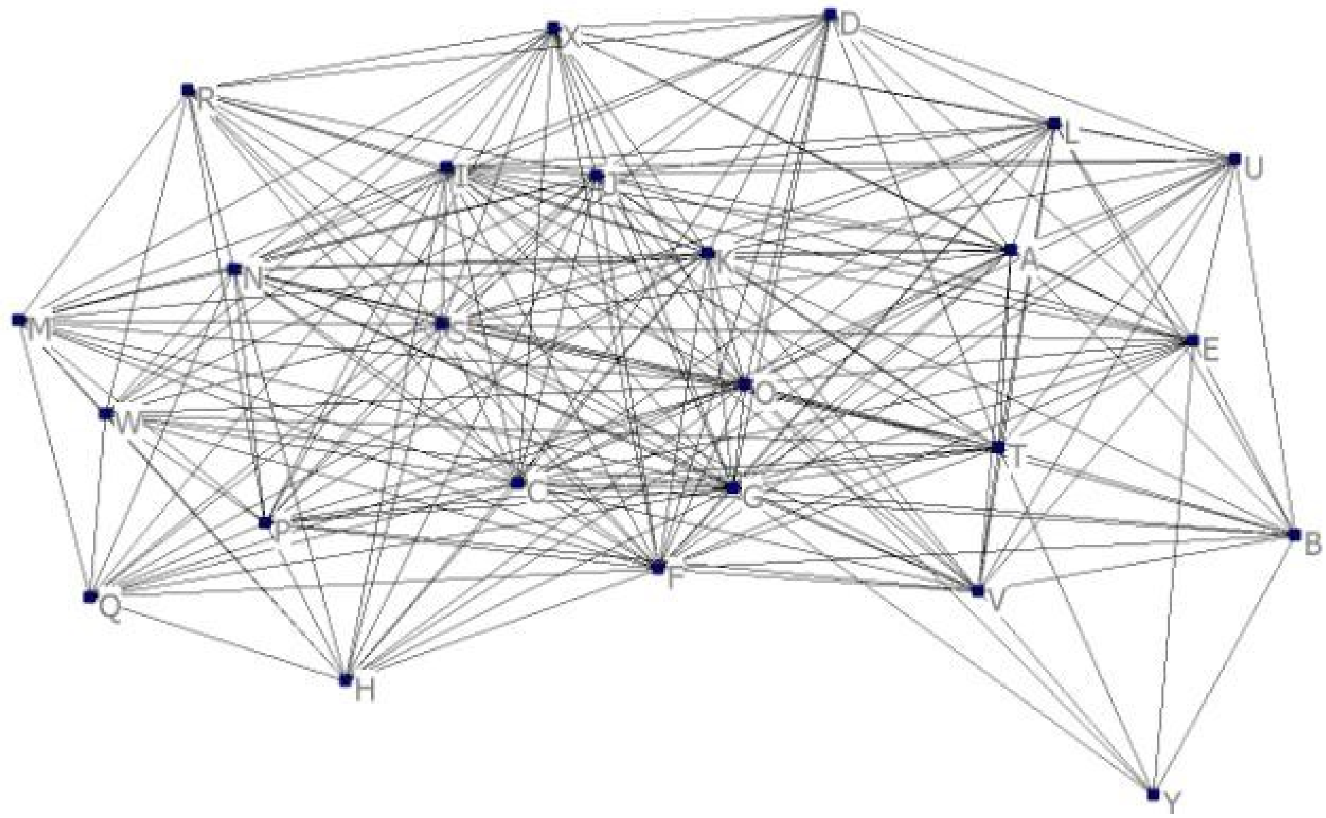
Participants

Participants	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
A		1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	0	1	0
B	1		1	0	1	1	1	0	0	0	1	1	0	0	1	0	0	0	0	1	1	1	0	0	1
C	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0
D	1	0	1		1	1	1	0	1	1	1	1	0	1	1	0	0	1	1	1	1	0	0	1	0
E	1	1	1	1		1	1	0	1	1	1	1	0	0	1	0	0	0	1	1	1	1	0	1	1
F	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
G	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
H	1	0	1	0	0	1	1		1	1	1	0	1	1	1	1	1	0	1	0	0	0	1	0	0
I	1	0	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
J	1	0	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
K	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	0
L	1	1	1	1	1	1	1	0	1	1	1		0	0	1	0	0	0	1	1	1	1	0	1	0
M	0	0	1	0	0	1	1	1	1	1	1	0		1	1	1	1	1	1	0	0	0	1	1	0
N	1	0	1	1	0	1	1	1	1	1	1	0	1		1	1	1	1	1	1	0	1	1	1	0
O	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1
P	0	0	1	0	0	1	1	1	1	1	1	0	1	1	1		1	1	1	1	0	1	1	1	0
Q	0	0	1	0	0	1	1	1	1	1	1	0	1	1	1	1		0	1	0	0	0	1	0	0
R	0	0	1	1	0	1	1	0	1	1	1	0	1	1	1	1	0		1	0	0	0	1	1	0
S	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	0	1	1	1	0
T	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	0	0	1		1	1	1	0	1
U	1	1	0	1	1	1	1	0	1	1	1	1	0	0	1	0	0	0	0	1		1	0	1	0
V	1	1	1	0	1	1	1	0	1	1	1	1	0	1	1	1	0	0	1	1	1		0	0	1
W	0	0	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	0		1	0
X	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	0	1	0	1		0
Y	0	1	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	

Coded responses contained in data matrices, such as Figure 1, were imported into social network software. Several such software programs are available to conduct a wide array of statistical analyses for network characteristics as well as to facilitate the creation of graphical representations of social networks, called "sociograms" (Figure 2). The UCINET (Borgatti, Everett, & Freeman, 2002) software program used for the study reported here is popular for SNA applications. It has been described as "a general purpose, easy to use, program that covers the basic graph theoretical concepts, positional analysis and multidimensional scaling" (Scott, 2000).

Figure 2.

Sociogram for Cienega Watershed Participants Collaborating on Invasive Species Issues in 2008



Step 3: Data Analysis

Data imported into UCINET can be examined visually through sociograms and statistically through a variety of metrics. Sociograms are graphical representations of social interactions that conceptualize individuals or organizations as points, called "nodes," and their relationships as lines between the nodes, which are called "ties." Two individuals with a relationship receive a tie between them in the sociogram, whereas two nodes without a tie indicate that a relationship does not exist. Nodes can be symbolized by color, size, and shape according to individual level characteristics. Similarly, ties can be symbolized by any characteristic of the relationship such as frequency of communication or strength of the relationship.

Numerous SNA metrics are available for analyzing groups and the individuals within groups. Bodin et al. (2006) highlight a few common measures used in social network analyses relevant to natural resource issues, such as the degree to which an individual controls information or resources within the network (i.e., "betweenness"), the power of a person in a network (i.e., "centrality"), and the number of intermediary contacts between any two individuals (i.e., "reachability"). Longitudinal studies that examine how these statistics change over time can be particularly valuable to understanding how to foster more effective collaborations.

Discussion

Following the data analysis, a presentation of the results was made to participants in the study to discuss the structure of the overall group as well as the networks for each of the ten issues of concern. At the conclusion of the presentation, volunteers were recruited to participate in a focus group to discuss the results of the project. Fourteen people participated in the focus group, in which a series of semi-structured questions were asked the participants regarding their perceptions of the findings and how the group might use this SNA-generated information in strategic planning.

All fourteen focus group participants reported the SNA information as being "valuable" or "highly valuable" in helping the group develop strategies for improving collaboration. Stakeholders who had participated for many years stated that they had a poor understanding of how individuals and organizations were involved with the group and that the SNA made the structure of the organization more transparent and understandable.

In a subsequent meeting, stakeholders voted to participate in repeated analyses at 1-year intervals to examine how the group was changing over time. This information will enable the group to evaluate the success of their efforts to recruit participation in specific issues and strengthen their collaborations in parts of the network that were found to be weak.

Conclusion

Social network analysis has much to offer studies of watershed initiatives and other forms of participatory resource management. This methodology can provide new insight into the structure and functionality of collaborative initiatives. With its complementary visual and statistical elements, social network analysis provides information that can be used to analyze the characteristics of groups and provide information to stakeholders about their groups.

This article has provided a step-by-step procedure for conducting a social network analysis with examples from the Cienega Watershed in Arizona. Only the most fundamental steps necessary to conduct a social network analysis have been discussed, yet we found even a basic analysis to be valuable to participants. Having established relationships with collaborative initiatives, Extension professionals are positioned to address the deficiency of social network analysis studies in agriculture and natural resources. Extension professionals can simultaneously provide valuable information to collaborative initiative participants while advancing the understanding of how these groups function. Those interested in this technique will find a rich body of well-developed theory and methodology available for more in-depth and widespread application to participatory resource management groups and other forms of collaborative initiatives.

References

Adger, W. N., Hughes, T. P., Folke, C., Carpenter, S. R., & Rockstrom, J. (2005). Social-ecological resilience to coastal disasters. *Science* 309(5737): 1036-1039.

Bodin, Ã ., Crona, B., & Ernstson, H. (2006). Social networks in natural resource management: What is there to learn from a structural perspective? *Ecology and Society* 11(2): r2. Retrieved from: http://www.ecologyandsociety.org/vol11/iss2/resp2/.

Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). UCINET for windows: Software for social network analysis. *Harvard: Analytic Technologies.*

Coleman, J., Katz, E., & Menzel, H. (1957). The diffusion of an innovation among physicians. *Sociometry* 20(4): 253-270.

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2008). Internet, mail, and mixed-mode surveys: the tailored design method. Wiley, New York.

Kenney, D. S. (1999). Historical and sociopolitical context of the Western Watersheds Movement. *Journal of the American Water Resources Association* 35(3): 493-503.

Klovdahl, A. S. (1985). Social networks and the spread of infectious diseases: the AIDS example. *Social Science & Medicine* 21(11): 1203-1216.

Knoke, D., & Yang, S. (2008). *Social network analysis*. Sage Publications, Inc., Thousand Oaks, California.

Knoot, T. G., Grudens-Schuck, N., & Schulte, L. A. (2006). Watershed learning activity: Coming to terms with geographic scale. *Journal of Extension* [On-line], 44(3) Article 3TOT4. Available at: http://www.joe.org/joe/2006june/tt4.php

Macaulay, S. (1963). Non-contractual relations in business: a preliminary study. *American Sociological Review* 28(1): 55-67.

Mahler, R. L., Seago, J., Simmons, R., & Fedale, S. (2008). Using satellite broadcasts to educate the public about watershed issues on a regional basis. *Journal of Extension* [On-line], 46(3) Article 3FEA5. Available at: http://www.joe.org/joe/2008june/a5.php

Mandarano, L. A. (2009). Social network analysis of social capital in collaborative planning. *Society & Natural Resources: An International Journal*: 22(3) 245.

Meeker, S., Tate, J. L., Czapar, G. G., & Vaughan, T. (2005). A Web-based resource for watershed management in Illinois. *Journal of Extension* [On-line], 43(3) Article 3TOT6. Available at: http://www.joe.org/joe/2005june/tt6.php

Millennium Ecosystem Assessment. (2005). Ecosystems and human well-being: synthesis. Island Press, Washington, D.C., USA.

Newman, L. L., & Dale, A. (2005). Network structure, diversity, and proactive resilience building: a response to Tompkins and Adger. *Ecology and Society* 10(1): r2. Retrieved from: http://www.ecologyandsociety.org/vol10/iss1/resp2/.

Prell, C., Hubacek, K., & Reed, M. (2009). Stakeholder analysis and social network analysis in natural resource management. *Society & Natural Resources: An International Journal*, 22(6): 501-518.

Pretty, J., & Ward, H. (2001). Social capital and the environment. *World Development* 29(2): 209-227.

Scott, J. (1988). Social network analysis. *Sociology* 22(1): 109-109.

Scott, J. (2000). *Social network analysis: A handbook*. (2nd ed.). Sage Publications, Inc. Thousand Oaks, California.

Tompkins, E. L., & Adger, W. N. (2004). Does adaptive management of natural resources enhance resilience to climate change? Ecology and Society 9(2): 10. Retrieved from: http://www.ecologyandsociety.org/vol9/iss2/art10/

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. Cambridge University Press. New York, New York.

Wolf, S. A., & Hufnagl-Eichiner, S. (2007). External resources and development of forest landowner collaboratives. *Society & Natural Resources: An International Journal* 20(8): 675-688.
