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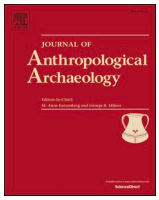

Archaeologies of people and space: Social network analysis of communities and neighborhoods in spatial context

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ABSTRACT

Applications of SNA to interpret archaeological evidence have been increasing dramatically, as has an interest in identifying communities and neighborhoods. Social Network Analysis (SNA) can be a lens and a tool to explore neighborhoods and communities with archaeological datasets from a range of temporal periods and regions. The spatial distribution of material culture facilitates the creation of spatially located networks that demonstrate social linkages between individuals or communities. Yet, limitations exist in using archaeological data; we cannot directly ask individuals who they interacted with or for how long – and we must work to combine data and theory in reconstructing emic perspectives. Communities exist interstitially at multiple scales through a combination of relational and categorical identities. Neighborhoods represent a specialized form of community (one of spatially co-located residents with frequent face-to-face interaction that exhibit a union of relational and categorical identity). The articles in this special edition use network theory to identify, reconstruct, and test the presence and extent of communities and neighborhoods in the past, and in doing so they open avenues of research with applicability beyond archaeology.

Social Network Analysis (SNA) has been used by archaeologists and social scientists for decades, but the past twenty years have seen interest in these tools and methods skyrocket (see overviews in Mills, 2017; Peeples, 2019). At the most basic level, SNA is a way of formally defining and tracking relationships among some set of social entities, be they individuals or larger collectives. Historically, SNA builds off of the mathematical field of graph theory (van Steen, 2010), and has seen parallel research trends between physicists – interested in how initial conditions create and perpetuate systems through mathematically modeled networks (Newman, 2008) – and social scientists – who tend to be more interested in understanding historical trends and interactions in a given time and place or the specific situation and characteristics of individual nodes over time (Borgatti et al., 2009). In terms of broader anthropological theory, thinking about networks and interactions provides a useful metaphor for understanding social phenomena and moving forward with new conceptualizations of past societies (e.g., Hodder, 2012). In short, a variety of approaches, fields, and perspectives have all found the fundamental concept of networks useful for a variety of research questions and contexts.

Network analysis in archaeology has been applied to a wide range of questions and data contexts. This includes analyses of transportation and movement focused on networks of roads or trails (e.g., Menze and Ur, 2012; Pailes, 2014), analyses of documentary evidence from building inscriptions and texts (e.g., Munson and Macri, 2009), and material culture analyses relating to the presumed movement (e.g., Bernardini, 2007; Golitko et al., 2012) or similarities in the attributes or frequencies of objects found in archaeological contexts (e.g., Mills et al., 2013a; Mills et al., 2013b; Peeples, 2018). Although not always explicitly treated as such, most archaeological networks are explicitly spatial. In most cases, however, even if the spatial dimension of social networks is considered, it is often only after the fact and network analyses and spatial analyses have most often been self-contained. While past research on both communities (Canuto and Yaeger, 2000) and neighborhoods (Arnauld et al., 2012) has focused extensively on spatial relationships in the archaeological record, we contend that the combination of network techniques with spatial data provides a more complete picture of both

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neighborhoods and communities.

This special edition presents a set of studies that directly combine social network analysis with spatial analyses to aid in the identification and interpretation of past communities and neighborhoods by looking at identities and interactions on landscapes. Each article considers past studies, problems, and limitations and then uses network thinking – and the change in perspective network analysis provides – to recontextualize and better understand the research problem at hand. SNA provides a tool in the anthropology toolkit, but considering both space and place enhances its potential utility. In the remainder of this introduction, we outline several themes and commonalities that highlight both important aspects of the papers in this collection and essential properties of archaeological network research.

1. Network analysis and datasets

In network analyses arising out of the social sciences, nodes often represent individuals and ties are related activities or traits that connect these nodes. This involves decision-making by the researcher about which groups or categories of actions, objects, or activities are allocated into a network structure of links and nodes (see Chapter 2 in Brughmans and Peeples, 2023). This creates bins (even if fuzzy math is used) and can lead to different interpretations of underlying phenomena; however, this issue can occur anytime that nominal data categories are used in archaeology (Peeples and Roberts, 2013; Wylie, 2002). As with any research task, the scholar needs to justify the binning of the data as it relates to the research question (e.g., Smith, 2015; Smith, 2017), but for SNA this process requires an understanding of the archaeological markers that allow us to both differentiate individuals or communities and then the traits that indicate shared interactions between them (see Mills et al., 2013a; Mills et al., 2013b).

The research in this special edition provides multiple examples of how to combine and consider a wide variety of archaeological data for multiple regions and time periods. These include spatial analysis of landscapes, historic and ethnographic records, survey and excavation datasets, and even hieroglyphic records. In each instance the authors have engaged with existing data sets – archaeological, archival, and ethnographic – to develop data categories appropriate to SNA.

1.1. Network thinking in action

Kamp-Whittaker (2023) tests archaeologically visible patterns against archival ones to critically evaluate our ability to identify neighborhood-based communities in the archaeological record. This ties together settlement archaeology with historic archaeology to better understand community formation in the unique environment of World War II Japanese-American internment camps. The US government forced the Japanese-American community into internment camps, like Amache, during World War II, which means that past relationships, hometowns, and lives changed in an instant. Within Amache residents had to forge new connections with new neighbors while also working to maintain existing social ties. Kamp-Whittaker (2023) draws on two primary datasets to examine the process of community formation. The first is a historic dataset of people, events, and places included in newspapers as a written record of social events and the people involved. The second is the archaeological survey data recorded from Amache itself. Data from each sample is organized based on the types of social interactions that were facilitated to create a comparative sample that allows for different methods of identifying neighborhoods in the past to be evaluated. Each of these datasets augments the weakness of the other. By testing similarity of built environments in residential blocks versus the historic records, this research helps show how historic patterns of neighborhood ties are visible on the ground. In addition to providing a contrast between archaeological and historical datasets, this research provides new information on neighborhood formation.

Chase (2023) uses lidar data for 200 square kilometers of Caracol in Belize to spatially reconstruct potential neighborhoods based on models of likely movement and frequent interaction near residences, in agricultural fields, on the way to and from public plazas, and in major public plazas. The spatial data is then contrasted against archaeological data representing repeated, cyclical household ritual events. This analysis created a set of 373 potential neighborhoods within Caracol, Belize. Eight of these reconstructed neighborhoods contain 59 residential groups that have been excavated and are used to test the model; in other words, this exercise tests the spatial model of neighborhoods against the actual archaeological record. In the developed model, neighborhoods are built on three ideas. First, greater local similarities should exist across space helping create neighborhoods. Second, neighborhoods should have a higher proportion of strong ties between neighbors with weaker ties between others in different neighborhoods, thus creating boundaries. And third, for frequent face-to-face interaction to occur, neighborhoods would exist below critical cognitive limits on frequent human interaction. Given these parameters, the analysis of archaeological data within residences holds with statistical analysis showing greater similarity of ceramics and dental modifications within a defined neighborhood than between other reconstructed neighborhoods. Instead of generating similarity networks, this study tests if spatial modes are predicted by those similarity networks and then tests these networks against reconstructed neighborhoods.

Munson et al. (2024) show how communities can cover large spatial areas and yet maintain cohesion through analysis of similarity networks among hieroglyphic texts. Drawing on the known epigraphic record of Maya hieroglyphic texts and analyzing patterns in the use of specific terms and words to describe ritual practices against the spatial distribution of these texts allows for a multiscalar analysis of Maya ritual structure by focusing on variation in ritual practice between communities. Mapped spatially, multiple groups using similar terms, phrases, and concepts provide overlapping, and wide-spread, communities among the elite subset of the population in these settlements. Both similarities and differences help highlight how communities (and their identities) can be seen as overlapping, polythetic sets. Additionally, the paper critiques the improper use of the term “moral community” by past researchers and redefines it to be consistent with the large populations and social complexity exhibited by the Classic Period Maya (roughly 250 – 900). The localized ritual patterns, performances, and events are tied into the hieroglyphic record, providing a view into the “open moral communities” of the ancient Maya. The analysis highlights connectivity between dispersed Maya communities created by shared ritual practices and cultural understandings that varied throughout the Maya world. This research moves from a focus on political elites and categorical distinctions to one examining how moral and imagined communities were created through ritual practice.

Wallis and Pluckhahn (2023) focus on large-scale communities as defined by their ceramics and the imprints of wooden stamps on the ceramics as maker’s marks. Their dataset organizes ceramics both by type of pottery and by the “maker’s mark” of a wooden paddle imprint on the vessels. The unique designs of these wooden paddles suggest direct face-to-face interaction via the use of a singular paddle on multiple ceramics and at multiple sites. The intricate paddle designs serve as a form of relational identity since a single wooden paddle can be matched on multiple ceramics while the ceramic type itself serves as a form of categorical identity. Taken together, this pattern of decoration and type help identify changes in community formation and interaction over long timespans. Widespread distributions over multiple settlements sets the stage for long-distance interactions and an examination of the contrast of artifact, design, and spatial datasets. They also showcase the role of long-distance connections and interactions between multiple villages and highlight the role of “translocal communities” with individual members located over large spatial areas, meaning that communities exist over multiple settlements.

Peeples and Bischoff (2023) use a large dataset of ceramic material culture from the U.S. southwest/Mexican Northwest to highlight

different falloffs in ceramic networks across several hundred years based on travel time. Ceramics are separated into wares by type, decoration, and temper for comparison. While the overall sample covers nearly 500 years between CE 1000 and 1450, it is subdivided into 50-year intervals. Spatially, this dataset covers a massive region from Colorado in the north to Sinaloa in the south and from Texas in the east to California in the west. The large areal extent of the analysis is complemented by a diachronic focus on nine 50-year intervals. Their research highlights the importance of spatial distance and proximity to resulting networks. However, the key finding is that critical scalar thresholds emerge at 35, 81, and 151 km in multiple periods, which suggests that these distances – each indicating more than one day's travel on-foot – acted as critical thresholds to ceramic networks and community connectivity in the U.S. Southwest/Mexican Northwest. These thresholds also may be significant in other contexts beyond ceramic exchange, especially as other research has identified 60 km as a significant threshold for pre-European, Mesoamerican military power projection – of direct military control – based on a likely three-day marching distance from urban centers (see Chase and Chase, 1998; Hassig, 1988, 2016).

Golitko (2023) draws on ethnographic data to recreate past networks that contrast spatial and archaeological data from the island of New Guinea. The ethnographic dataset includes 1720 communities and their spatial location on the island. In contrast, the bone dagger dataset includes 827 daggers made between 1845 and 2002 and codes their stylistic elements to compare communities of similarity against their spatial distribution. This research demonstrates the power of using existing collections with over 200 years of data and coding the manufacturing techniques and decorative elements of these bone daggers. While the assumption might be that ethnographic connections would predominate, these data help show that geospatial proximity can greatly affect similarity in materials across a large network. This research suggests that research using similarity networks should consider the implications of space on community interaction and not assume that network measures will always work as intended or accurately reflect the underlying social processes. In other words, multiple lines of evidence should be considered.

As outlined above, all of the articles in this special edition focus on the conjoined application of social network analysis and spatial analysis. While they cover different regions, time periods, and datasets, each aimed to identify and test the existence of neighborhoods and communities in their respective regions. To do this each author identified the archaeological markers of what defined separate communities or neighborhoods and how ties or patterns of interaction within or between communities could be identified. This combination of datasets, regions, temporal horizons, and approaches has strong suggestions about local neighborhood interactions, communities that extend beyond individual settlements, and the role of geography in those larger communities. The combination of multiple datasets provides more insight into each context and helps showcase the potential utility of SNA.

1.2. *Defining communities and neighborhoods*

The identification of communities (with neighborhoods acting as a specific sub type of community) in the archaeological record is a varied process. Broadly, they can be seen as either spatial or social units. As spatial units, we look for groupings of structures, particular architectural features, or sets of objects with the goal of finding distributions of shared attributes or spatial clusters. As social units we look for evidence of artifacts or features that indicate common social practices, shared beliefs, or other evidence of person-to-person interactions. A combination of these spatial and social parameters tends to lead to stronger arguments for the existence of specific communities in the past.

Communities exist at variable scales from local categories, like a group of close friends, to an international organization (Nexon, 2009; Tilly, 1978). In contrast to neighborhoods, which exist locally within settlements, communities can also exist between settlements. The flexibility of community as a concept leads to a variety of methods and tools for describing them from the relational – direct person-to-person – and categorical – perceived similarities – to identities behind "connected communities" (Peeples, 2018) to the shared literacy networks and national myths of "imagined communities" (Anderson, 2006). In this context, communities – like networks – provide a malleable idea that can be shaped to the research context in question.

Multiple processes of identifying communities in network analysis exist, but are often similar. One way of thinking about communities in a network would be to treat them as spatially isolated clusters, hyper-connected subgroups, subcomponents in a larger network graph, or something that can be pulled out algorithmically focusing on communities as loci of density (e.g., Swanson, 2003). A more nodal approach could look at communities based on overall similarities between the actors instead of the links themselves and distinguish communities by the categories of actors linking networks (Jennings, 2016; Peeples and Haas, 2013; Scholnick et al., 2013). Each of these approaches utilizes different methods of network thinking about communities as groups of overlapping actors and their relationships, but highlights the range of meanings and kinds of social organization that fall under that broader label of "communities." In addition, thinking about the similarities between actors and nodes ties ideas about community directly to notions of categorical identity (their perceived similarities) while thinking about the similarities between the positionality of actors and their relationships ties ideas of community directly to relational identity (their direct connections).

Communities exist interstitially and overlap with other communities, and they also exist at multiple geographic scales from the locally embedded to the pan-national or global. In contrast, neighborhoods represent a very specialized form of a community, one where a union of relational and categorical identities crystalizes to form "neighborhood communities." Neighborhoods defined by social interaction and shared identities are formed by spatially co-located residents with frequent face-to-face interaction; their interactions in a specific place and geographic location leads people to exhibit a union of relational and categorical identities and create, reinforce, and regenerate the neighborhood identity of its residents. This contrasts with neighborhoods defined solely by administrative or geographic boundaries which are often more visible archaeologically than the social ties and face-to-face interactions that facilitate the development of neighborhood communities. Both Kamp-Whittaker (2023) and Chase (2023) focus on these communally defined neighborhoods – and each echoes the need to look for proxies of face-to-face interactions. Kamp-Whittaker (2023) adds that neighborhoods are "natural communities" facilitated by a complex mixture of spaces for interaction, shared social traits, and activities that create shared identities; these neighborhood communities emerge even under the constraints of forced movement into internment camps. In contrast, Chase (2023) expects to see neighborhoods form and persist based on 1) spatial proximity of residences as a proxy for social interaction, 2) a higher ratio of strong bonds within neighborhoods with primarily weaker bonds connecting different neighborhoods, and 3) cognitive limits on human interaction that limit absolute neighborhood sizes.

However, not all communities had to be locally based and tied to individual settlements. Wallis and Pluckhahn (2023) focus on "translocal communities" or groups of individuals connected into communities that exist between multiple settlements and dependent on an interconnected set of villages, interactions, and movement. People are not plants, meaning that they could move over large distances, facilitating many different communities and permitting people to belong to many places and exhibit different identities across time and space. Similarly, the "open moral community" investigated by Munson et al. (2024) exists beyond and in addition to the "real," "natural," and "imagined" communities of Maya settlements with the idea that these communities cover broad spatial areas while still permitting other, overlapping communities to exist for local groups of people within each settlement.

For Munson et al. (2024) the periodicity of specialized ritual interactions provides a separate aspect to more localized communities and ties into shared values, practices, and understandings. In each case, local settlements and sub-groups of residents engage in activities with broader actions that move beyond the archaeological site to incorporate perspectives on the larger world.

Communities can also be viewed through their resulting networks in research that emphasizes the power of SNA to elucidate "underling" groups. Peeples and Bischoff (2023) define community as "a sub-group of nodes that is densely connected internally." This underscores their diachronic analysis over a large region to define communities based on ceramic patterns of trade, exchange, and interaction. Similarly, Golitko (2023) focuses on communities, defined as the various settlements defined ethnographically in New Guinea, with "neighborhoods" emerging from clustering algorithms that identify "nodes that are substantially more connected to each other than they are to other nodes in the network under study." Instead of focusing on interactions within a singular settlement, both studies look at large-scale areas to better understand how multi-day distances impact networks of interaction.

In summary, articles in this special edition apply varying definitions of community and neighborhoods that range from the local to the regional – with foci on neighborhoods within settlements to communities spread across multiple settlements. This showcases how SNA permits analysis at multiple geographic scales, but also highlights the importance of defining terms like community for specific research goals. In one sense, these semantic differences are relatively minor and more reflective of the wide range of communities that existed in the past. By applying SNA to archaeological data each paper is able to more clearly interpret past social interactions, consider alternative causal patterns, or consider nuances in their operation that might otherwise be difficult to observe.

2. Conclusion

The research in this special edition provides many unique uses of SNA, with each article enhancing its analysis through its consideration of people and space. Chase (2023) and Kamp-Whittaker (2023) both highlight the importance of small-scale social interactions and neighborhood formation with groups of hundreds of people in a 7th century Maya city and with smaller groups in WWII internment camps respectively. Wallis and Pluckhahn (2023) and Munson et al. (2024) focus on the definition of larger communities and cohorts of people to reflect on translocal communities in the Middle and Late Woodland period of the American Southeast and on moral communities among the Classic period Maya. Finally, Peeples and Bischoff (2023) and Golitko (2023) address the issues of long-distance movement and interaction in the US Southwest / Mexican Northwest and in Papua New Guinea, showcasing the importance of distance and how geographic proximity affects network structures.

Taken as a whole, these research endeavors move our understanding of communities and neighborhoods forward by focusing on underlying theory and how it interacts with network and spatial thinking in various areas of interest. By considering both people and space, this focus moves beyond some of the issues identified in past research. Space and place influence the nature of social interactions by facilitating or impeding interactions, but social and cultural considerations are not determinable directly from environment alone. Conjoined considerations of both the actors and their spaces provide theoretical models to investigate and better understand past peoples, with SNA providing one tool in the archaeological toolkit. Network thinking provides a versatile frame for thought and for analysis, as well as providing a useful means for helping identify trends and patterns in underlying data that might otherwise be difficult to find.

SNA provides a useful tool for understanding the past by recontextualizing the way we see archaeological data. The node and link framework does not change the underlying data, but rather enables new perspectives and facilitates new analyses. By providing alternative ways of seeing, ways of approaching, and ways of framing our research, social network concepts can help elicit connections in the data and reveal underlying relationships for further investigation. Going beyond exploratory data analysis, social network research forces scholars to integrate theory with their datasets, thereby tying together concepts about materials with the remains of peoples and spaces in order to gain a better understanding of the past.

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Adrian S.Z. Chase: Conceptualization, Writing – original draft, Writing – review & editing. **April Kamp-Whittaker:** Conceptualization, Writing – original draft, Writing – review & editing. **Matthew A. Peeples:** Conceptualization, Writing – review & editing.

Declaration of competing interest

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

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