



Spatial network analysis of a terminal prehispanic and early colonial settlement in highland Peru

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ABSTRACT

This study uses GIS-based spatial network analysis (SNA) to simulate patterns of foot traffic and analyze the manipulation of the built environment of a small Inka imperial outpost that became an early Franciscan doctrina (doctrinal settlement) in the Andean highlands of southern Peru. Excavations show evidence for growth and remodeling of the site's public and domestic spaces over its short use life as a doctrina, pointing to an increasingly orthodox regime of indoctrination. The results of SNA-based walking simulations show specifically how movement through the site was rerouted to isolate the old Inka ceremonial core, producing new rhythms of interaction and directing public processions to the colonial plaza and chapel of the doctrina. The complementarity of SNA with other established forms of access analysis and its broader utility for archaeological research design, sampling strategies, hypothesis testing, and interpretation are discussed.

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Most systematic studies of the built environment of archaeological settlements rely on variants of space syntax analysis (Hanson, 1994, 1998; Hillier, 1985, 1989, 1996; Hillier and Hanson, 1984; Hillier et al., 1987a,b). Space syntax analysis is of proven utility for characterizing scale, integration, and relative asymmetry of spatial connectivity within archaeological settlements (e.g., Banning and Byrd, 1989; Dawson, 2002; Fairclough, 1992; Ferguson, 1996; Foster, 1989; Hopkins, 1987; Moore, 1992; Parker Pearson and Richards, 1994; Shapiro, 1999; Van Dyke, 1999). Its graph-based schematic representations, however, visually dissociate analysis from the architectural plan, making its legibility and interpretation less intuitive.

This paper uses a complementary but distinct method – Spatial Network Analysis (SNA) – as the basis for simulation and analysis of movement through the built space of a well-preserved terminal prehispanic (1450–1532 C.E.) and early colonial Franciscan *doctrina* (doctrinal settlement) (ca. 1540–1570 C.E.) in Peru. The GIS-based SNA analyses presented provide a quantitative, visually-intuitive, and reproducible means of simulating and characterizing

movement through the built space of an archaeological site. Developed and used primarily for modern urban planning, SNA is readily adaptable to the modeling of foot traffic through archaeological settlements. In this case study, SNA reveals striking reorganization of pedestrian movement through a settlement as it was transformed from a small local Inkaic imperial outpost into a doctrina in the early years following the Spanish invasion. By extension, it shows the potential of SNA for other contexts, as well as its applicability for guiding the formation of hypotheses and sample selection criteria for excavation.

A focus on the built environment is especially appropriate in the context of early evangelization in the Americas. The Spanish invasion of the Americas was ideologically and legally predicated on the spiritual “salvation” of the indigenous populace. While the *entradas* and initial period of violent conflict made significant impacts on indigenous lifeways (Beck et al., 2010; Murphy et al., 2010), religious personnel – usually Mendicant friars – constituted the only sustained Spanish presence in many rural hinterland settings in the early years following initial invasion. Following early campaigns of mass baptism and extirpation of idolatry, the longer-term project for a more penetrating religious transformation was intimately tied to a larger colonial social engineering program that viewed

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urbanism as the pathway to a Christian social order (Cummins, 2002; Gose, 2003; Kagan, 2000; Lara, 2004). The foundation of mission settlements was central to that project (Deagan, 1990; Graham, 1991, 1998; Hanson, 1995; Jacobi, 2000; Pendergast, 1991; Thomas, 1988, 1993; Wernke, 2007, 2011, in press).

In fact, colonial policy thinking by the mid-16th century was predicated on a rather deterministic view of the role of the built environment in the constitution of Christian subjects. *Civitas* (orderly urban community life) was thought to be not just reflective of ideal social order (*policía*), but actually generative of it (Cummins, 2002; Kagan, 2000: pp. 26–28). The built environment was thus considered a key medium for social control. New kinds of Christian communities were to emerge through the inculcation of new daily practices and public rituals shaped by the novel spatial configurations of planned colonial towns. Mission settlements were usually the first of these to be constructed (Deagan, 1988; Fraser, 1990; Gisbert and Mesa, 1985; Graham, 1998, 2011; Hanson, 1995; Lara, 2004; McEwan, 2001; Thomas, 1991; Wernke, 2007). Andean peoples, for their part, were accustomed to the manipulation of the built environment as a dimension of imperialism (Dean, 2010; Hyslop, 1990; Niles, 1999). On the eve of the Spanish invasion of the Andes, Inka imperial consolidation was negotiated in many social practices and material media analogous to those of Spanish evangelization – especially through elaborately staged, public ritual in plazas and associated ceremonial buildings (Coben, 2006; Dillehay, 2003; Morris and Thompson, 1985; Wernke, 2007). New urban forms were therefore not such a straightforward means of social control as Spanish colonial policymakers thought. In addition to the complications stemming from cultural differences (disparate

beliefs and practices associated with the built environment), architecture and associated spatial practices had become variably hegemonic and contested as a dimension of imperial control under Inka rule.

How were these spatial practices and ideologies sequentially negotiated in situ? Documentary sources only obliquely refer to this key dimension of the experience of colonial rule, so the only way to address the question in a rigorous manner is through systematic archaeological and architectural analysis. Here it is explored through quantitative, GIS-based spatial network analysis that tracks the restructuring of built space – and movement through it – at an Inka provincial outpost that became an early doctrina in the Colca Valley of southern highland Peru (Fig. 1). This site – known as Malata today – was established as a doctrina by a small group of Franciscan friars sometime between the 1540s and 1560s, and forcibly abandoned during a viceroyalty-wide colonial resettlement program in the 1570s (Wernke, 2011). It thus provides a chronologically-controlled window into domestic and ritual practices in a provincial evangelical complex during the critical period of sociocultural transition during first generation after the Spanish invasion.

Excellent architectural preservation enabled detailed mapping of buildings and paths at the site via mobile GIS (see Tripcevich and Wernke, 2010), which in turn enabled spatial network analysis as a means of simulating patterns of foot traffic through it. The results of this analysis demonstrate how movement through the site changed dramatically as the site was transformed from a provincial Inka to Franciscan doctrinal outpost. The marked changes in site layout point to a perhaps surprising degree of penetration of

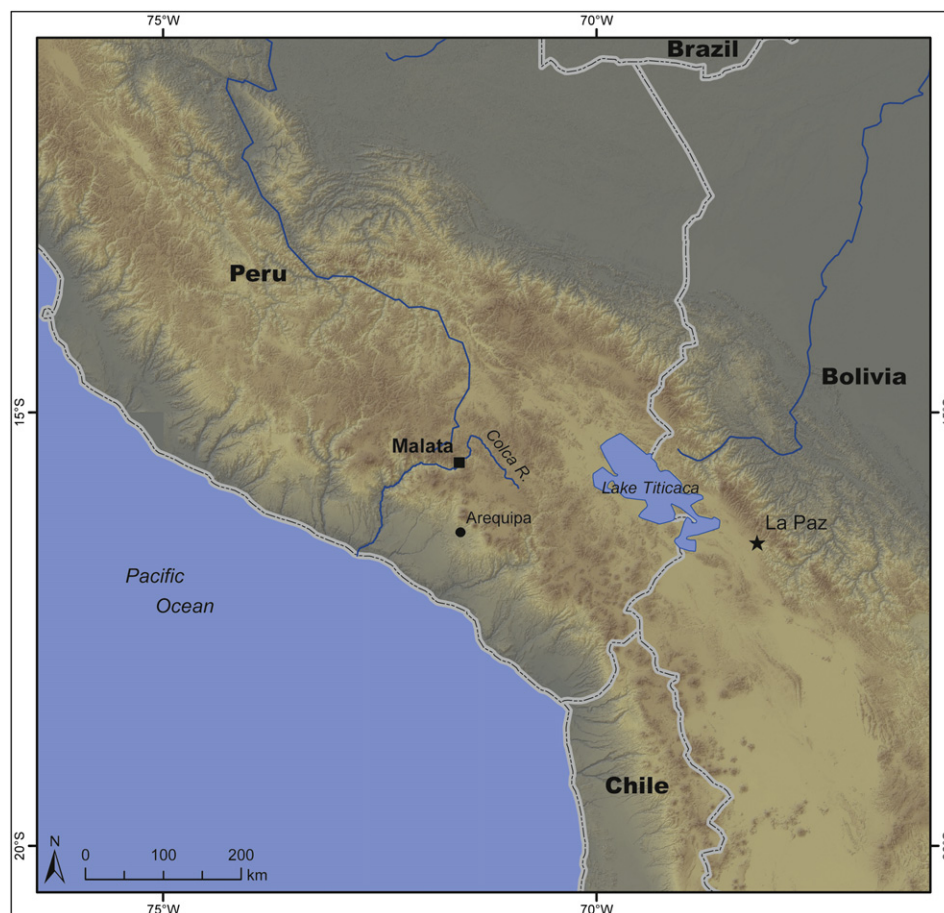


Fig. 1. Location of Malata in the southern highlands of Peru.

Spanish urban ideals for such an early timeframe in a small rural village. But the effectiveness of this spatial regime as a means of social control must have depended partly on its resonance with prehispanic antecedents. As will be shown, such antecedents were readily at hand in the form of distinctive Inka imperial architecture and ceremonial spaces used as stagings for public ritual at the site. Spatial Network Analysis thus enables a visually-intuitive, reproducible, and quantitative method for simulating and tracking patterning of movement through the site. The methodology is readily adaptable to other contexts and shows general potential for moving beyond impressionistic interpretations of site layout and movement through settlements in a manner that is complementary but distinct from space syntax analysis.

1. Malata: an Inka provincial outpost and early franciscan doctrina

Malata is located high in the Colca Valley at 3840 m above sea level in a transitional ecozone between the agricultural core of the valley and high altitude grasslands. A mixed agro-pastoralist economy continues to be practiced by local residents today. The village, composed of 80 standing fieldstone structures in a 1.6 ha core habitational area, occupies a shallow draw in a broad alluvial terrace above the deep gorge of the Colca River (Fig. 2). Similar to other doctrinas in the valley, Malata features Inkaic and Catholic public and ritual spaces in close spatial association: at the western end of the site, a small, great hall-like Inka structure and its associated plaza is situated to the south of a rustic chapel and atrium fronting a plaza with a large building in the center of its south edge (Figs. 3 and 4). A few domestic compounds lie between them, while the main residential sector of domestic structures stretches downslope to the east, and a handful of domestic buildings are situated apart from the rest of the settlement on higher slopes to the northwest. To date, it is the only early doctrina site to have been extensively excavated in the Andean highlands.

1.1. Malata under Inka rule

Prior to becoming a doctrina, Malata probably functioned as a tertiary-level outpost during the Inka occupation of the Colca Valley in the Late Horizon (1450–1532 C.E.). However minor a role the site played in imperial administration, it retains elements of Inka settlement planning found at other administrative sites in the valley. Top-tier settlements from the preceding period of autonomous rule during the Late Intermediate Period (LIP; 1100–1450 C.E.) were not radically reorganized in their conversion into secondary centers, but instead the architectonic pairing of Inka plazas and “great hall” structures – long, gabled, rectilinear single room buildings with multiple trapezoidal doors – was prominently situated within the local settlements (Wernke, 2006). To date, great halls and plazas have been documented at nine Late Horizon sites in the Colca Valley, including Malata (Doutriaux, 2004; Wernke, 2003, 2006, 2007). In most of those cases, the halls range in size from 20 to 30 m long and 7 to 10 m wide, with three to seven trapezoidal doorways. The great hall at Malata is smaller and more rustically constructed than most of the others in the valley, measuring only 9.7×6.0 m (exterior), with two trapezoidal doorways facing a high terraced plaza on the western end of the site.

Such great halls and open plaza spaces were central features in Inka settlements throughout the empire (Gasparini and Margolies, 1980; Hyslop, 1990; Protzen, 1993). The Inka architectural canon is made up of a small range of structural forms, and great halls, like most other forms, served a variety of functions. Principle among these, however, was their use as staging grounds for the elaborate processional and commensal ritual events in their adjoining plazas (Coben, 2006; Moore, 1996; Morris, 1982). Commensal rituals were central forums for the negotiation of imperial–local relations in the Inka empire (Bray, 2003; Coben, 2006; Moore, 1996; Morris, 1982; Murra, 1956; Rowe, 1946). In these commensal rituals, imperial representatives (whether local elites or ethnic Inkas) enacted an imperial ideology of state beneficence through the conspicuous redistribution of staple and prestige goods in reciprocity for

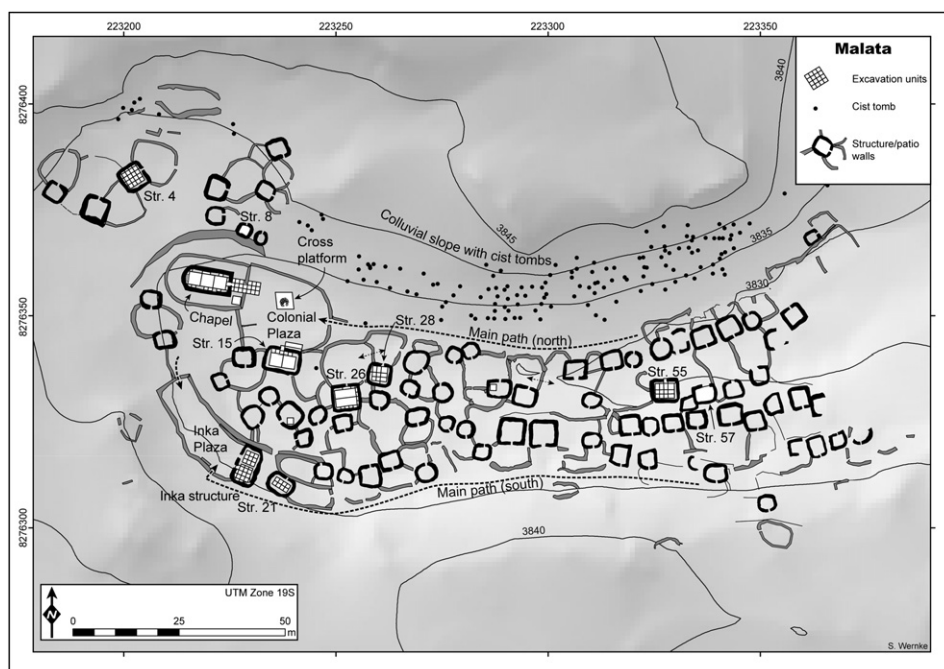


Fig. 2. Architectural map of Malata, showing excavated areas.



Fig. 3. 180 panorama of Malata from the north. Chapel is at far right.

subjects' loyalty and labor (see, e.g., Bray, 2003; Coben, 2006; Dillehay, 2003; Ramírez, 2005).

The prominence of the great halls and plazas within local settlements in the Colca Valley seems consistent with a commensal function (perhaps among others), and the findings of our excavations in the great hall structure at Malata (which exposed nearly the entirety of its interior) are consistent with this hypothesis. Among the 99 rim sherds recovered from floor level contexts in the great hall, 92% were serving vessels and just 8% were cooking vessels. This compares to domestic contexts ($n = 756$ rim sherds), in which serving vessels made up 74% and cooking vessels 26%. The proportion of serving vessels in the great hall is significantly greater than in domestic contexts ($\chi^2 = 14.72$, $p < .01$, d.f. = 1, $N = 855$).

Of the serving vessels in the great hall, plates were the predominant form ($n = 50$), followed by *aribalos* ($n = 33$) – the long-necked, flaring rimmed jars used for the decanting of *chicha* (maize beer) typical of imperial Inka assemblages. A strong predominance of serving vessels in great hall assemblages has been documented elsewhere and has been taken as a reliable index for commensalism (Morris, 1982; Morris and Thompson, 1985). The great hall and its plaza were thus evidently a focus for public ritual within the village during Inka times.

1.2. The transformation of Malata into a doctrina

Following the Spanish invasion of Peru, the Colca Valley was one of the earliest locales of evangelization in the highlands by the Franciscan order (see Tibesar, 1953: pp. 46–47, 65–68). This early intervention likely owes to the regional economic and political importance of the valley and its large populace (Cook, 2007). Though coeval documentation of their initial entry are lacking, a Franciscan memorial written around 1585 recounted the arrival of a small group of friars headed by Fray Juan de Monzón, along with Fray Juan de Chaves, about forty years previous – that is, sometime around 1545 (Tibesar, 1953: pp. 65–68). The Franciscans expanded and formalized their mission in the Colca Valley in the years

following the defeat of the Pizarrist rebellion in 1548. By the 1560s – the height of the Counter Reformation in Europe – Church institutions throughout the Peruvian Viceroyalty were similarly moving toward more uniform doctrine and methods of indoctrination (Durston, 2007: p. 71; Estenssoro, 2003: pp. 139–145). These changes following the experimentations of the First Evangelization were in line with the decrees of the Council of Trent, which called for greater doctrinal rigidity and uniformity, more complete catechetical guidance, and full sacramentation for all Christians (Estenssoro, 2001, 2003). By the mid-1560s, a more complete system of doctrinas seems to have been in place in the Colca Valley (Cook, 2002), most likely one of convents and secondary doctrinas. In this system, Malata would have functioned as one of the smaller secondary doctrinas, probably under the jurisdiction of the convent in the village of Callalli (about 20 km upvalley to the northeast).

Prior archaeological survey in the central section of the Colca Valley has documented chapels at four settlements with major Late Horizon (AD 1450–1532) occupations, which almost certainly constitute four of the early doctrinas described in the ecclesiastical sources (Wernke, 2003: pp. 302–330, 2007). A pattern of establishing doctrinas at former nodes of Inka administration is therefore apparent, and Malata fits this pattern. Close spatial associations between Inka great halls and plazas within these sites, sometimes reusing the same spaces as chapel atria, suggests that the Franciscans initially leveraged spatial analogies that linked Catholic ritual and indoctrination with former ritual loci of Inkaic state ritual and administration (Wernke, 2007).

It is unclear if Malata and the other archaeologically-documented doctrinas originated in the initial incursion in the 1540s or in the subsequent expansion of the Franciscan mission in the 1560s. What is clear is that the site both grew considerably and was significantly remodeled according to distinct Spanish colonial urban design principles during the site's short occupation, before it (and the other doctrinas like it) was forcibly abandoned during the general resettlement of the *reducción* program of the Viceroy Francisco de Toledo in the 1570s.

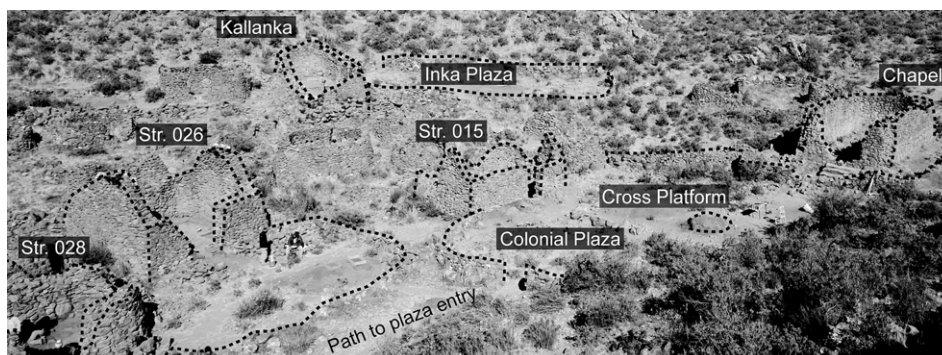


Fig. 4. The colonial plaza area, showing single entrance in front of structure 26. Note the rough alignment of the central cross platform with the entrance to the plaza, the doorway of structure 15, and the entry to the chapel.

As discussed elsewhere (Wernke, 2011), excavations in front of the chapel at Malata show that it was originally built on the natural hill slope and fronted by four entry steps, without the enclosing atrium or fronting plaza. The stratigraphic sequence shows modifications to the chapel space during its brief period of use: all but one of the chapel entry steps were later buried by a terraced atrium around the chapel. The fill for the atrium was retained by the western wall of the central plaza at the site. Once this retaining wall was in place, new steps were built from the plaza up to the entry of the atrium. So the atrium, plaza, and steps leading to the atrium from the plaza were added after the initial construction of the chapel (Wernke, 2011).

The plaza itself, which measures 20 × 16 m, was not extensively leveled but instead is irregularly shaped to fit the sloping landscape. Nonetheless, its layout and features reveal a clear sense of planning. In the center of the plaza are the remains of a three-tiered circular fieldstone feature (2 m in diameter) that almost certainly served as a platform for a central cross. This platform aligns roughly with the single entry to the plaza to the east and the steps up to the chapel atrium to the west, such that one entering the plaza from the east (the only legitimate entrance) would have seen the Christian cross straight ahead with the chapel entry directly beyond. The cross platform also aligns with the doorway of a large colonial structure (structure 15) fronting the south side of the plaza (Fig. 4). Excavations in this structure established that it was not a domestic structure and likely served as a public or administrative building (Wernke, 2011; Wernke et al., in press).

A few core elements of Spanish urban planning are therefore present in rustic and diminutive form at Malata: church, atrium, plaza, cross, and civic building. They were not all built at once, but fitted to an existing settlement and constructed or renovated over time, beginning with the construction of the chapel on the natural hill slope, and then at some later date, the atrium and plaza elements were retrofitted, perhaps during the 1560s as the Franciscan mission in the valley expanded.

Evidence from the residential area also points to significant growth and the addition of newly-configured domestic compounds during Malata's colonial occupation (Wernke, 2011). In general terms, the residential areas of the site are divided between two areas: 1) an older core of predominately circular domestic structures, arranged in agglutinated patio groups; and 2) new additions on the eastern and western ends of the village, where houses are predominantly rectilinear in form, and arranged either singly (as at the western extreme of the site) or within enclosed patios facing each other in rows, in the manner of streets (as at the eastern extreme of the site). The older core of 24 circular structures that almost certainly constituted the original Inka-era residential area, is surrounded by an additional 41 rectilinear domestic structures likely made up of households resettled from nearby settlements during the brief use life of the settlement as a doctrina. A large terminal prehispanic settlement (the site of Aukimarka) is located less than 1 km north of Malata, and is a likely origin place for at least some of these resettled households.

There are exceptions to this distribution of domestic buildings at Malata: a few circular structures break the linear arrangement of rectilinear houses at the eastern end of the site, but these likely represent a few original structures that were not built over when the site was expanded in the early colonial era. Conversely, there is a very large rectilinear house (structure 26) that shares a patio complex with a smaller ovoid structure (structure 28), directly adjacent to the colonial plaza. In fact, structure 26 is the largest domestic structure at the site, and is especially distinctive for its great height and volume. Notably, any visitor wishing to access the patio or doorway of this structure was required to first pass the patio and doorway of the smaller, much more expediently built (and

ungabled) structure 28. In space syntax terms, structure 26 is the only domestic building with a depth value greater than one. The intrusive position of this domestic compound, its adjacency to the colonial plaza, and its excavated contents all point to colonial-era construction and habitation. As argued elsewhere (see Wernke, 2011, in press; Wernke et al., in press), this patio group was likely the residence of the principal kuraka (native lord) of the doctrina.

In sum, these architectural and excavation data indicate that Malata grew and was significantly reorganized according to a distinct urban model during its time as a doctrina. The precise relationship between the establishment of a new domestic neighborhood with rectilinear structures at the eastern end of the site and the construction and formalization of the chapel and plaza is unclear, but given the short span of the colonial occupation at Malata, the two areas of new construction are likely related, as an increasingly formalized spatial order was implanted to inculcate new rhythms of interaction and ritual.

2. Spatial network analysis at Malata

Though modest in scale, Malata thus presents a rare opportunity for detailed in situ analysis of how the built environment of a settlement was altered during the transition from Inka to Spanish colonial rule. A significant portion of our research at the site was focused on documenting its standing architecture and the horizontal stratigraphy of walls and wall joins that separate different areas of the site. Those data are foundational to reconstructing the architectonic changes and the flow of movement through the site as individuals would have walked from their houses to the Inka and colonial plazas. The same walls that delineate domestic patio groups at Malata also define the pathways through the site. After extensive brush clearing, a precise map of all walls, including data on wall joins, heights, widths, and a range of other architectural data was completed using two total stations (Wernke et al., in press). Most of these walls are only waist height or lower (at present) and probably did not necessarily physically block ingress/egress, although the spiny stems of cacti (abundant in the neighboring river gorge) could have been placed atop them to block passage (a common modern practice in the region). In any case, their construction delineates a sanctioned routing; deviations were presumably considered transgressions.

The most notable feature of this routing is that the focal points of the doctrina – the plaza and chapel – are accessed through only a single entrance on the east side of the plaza. The entrance was accessed via a single path leading along the north edge of the residential area to the east (Fig. 4). All paths converge adjacent to the elite domestic compound (structures 26 and 28), which is in turn directly adjacent to the colonial plaza. Entering the plaza, the central cross, the steps up to the atrium, and the chapel doorway would have been directly in front of the person walking. The convergence of paths thus literally created a processional past the elite domestic compound (structures 26 and 28) and into the plaza and chapel beyond (Wernke, 2011). In the field, we noted that the rows of rectilinear buildings in the “new neighborhood” at the eastern end of the site appeared to have more ready access to the colonial plaza than the circular houses, which are more concentrated around the Inka great hall structure and its plaza.

2.1. Spatial network analysis: data model and methods

The experience of moving through the site, which emerged from a growing familiarity with its pathways during the course of three seasons of mapping and excavations (2006–2008), led to consideration of spatial network analysis as a means of systematically analyzing connectivity between domestic compounds and

the Inka and colonial plazas at the site. This was accomplished using the Network Analyst extension of ESRI ArcGIS. Network Analyst is designed for planning and optimizing transit through modern road or multi-modal transportation networks, but many of its functions can be easily adapted to archaeological contexts sites with preserved architecture and paths.

In this case, two vector themes were created and used to create the network dataset. The first was a polyline theme (called “edges” in the network dataset) representing the pathways from the doorways of each structure through the site. These pathways were recorded and verified in the field. Secondly, a point theme (called “junctions” in the network dataset), snapped to the ends of the polylines, represented the doorways of each domestic structure (the starting points in the network). Terminal points in each of the plazas were also plotted. The network was coded for two-way travel along all paths, with no turning restrictions at intersections.

It is important to recognize that SNA essentially requires the complete population of edges and nodes of the network in question (which could be an entire site or well-preserved sector of a larger site), since it is designed to analyze and optimize traffic patterns through the entirety of a transportation system. It is therefore best suited to well-preserved sites in which paths and termini can be confidently identified in the field.

Spatial network analysis simulates movement through a network by resolving the least-distance network path (defined by the shortest travel time) from any given pair of starting and end points in the network. Rational actor assumptions therefore underlie the modeling of movement in SNA (as it is based on the generation of least-cost network paths between starting and end points), but the significance of the results need not depend entirely on such assumptions. As a heuristic, the modeling of foot traffic in this manner provides a composite view of the way in which movement was likely routed (as a general rule) through a transportation network. It is possible, even likely, that it is incorrect in some of the details of how people actually used a given network in the past, but it provides a set of measures and a reasonable basis for modeling movement.

Speed and impedances can be modeled in the simulation. At Malata, walking speed was calibrated based on actual walking times by the author at the site – specifically, from the doorway of a structure at the eastern end of the village to the cross platform in the center of the colonial plaza. Three walking trips were timed, and the average speed – 68.9 m per minute – was used in the SNA walking simulation. Elevation differences within the habitational area of the site are minimal – most houses are within 10 vertical meters of each other over very moderate (<3%) slopes, so differences in walking times caused by changes in slope (i.e., changes in impedance) would be very small and are not included in the model.

The resulting network dataset permits a variety of measures and analyses for characterizing the spatial organization of the site. In the results that follow, each analysis was run twice: once using the Inka plaza as the destination and once using the colonial plaza as the destination. Though many of the colonial-era rectilinear domestic structures were not yet built when the Inka-era great hall and its adjoining plaza were used, modeling movement to it from all domestic structures is still useful on two grounds: 1) as is known from excavations in the great hall, the structure did continue to be used during the colonial occupation, and 2) modeling movement to the Inka plaza provides a point of synchronic comparison to the colonial plaza, thereby giving insights into the changes effected during the foundation and formalization of the doctrina.

Three kinds of analysis were conducted. First and most basically, a map of the least-distance routes used by households to arrive at each of the plazas was generated (using the “Closest Facility” tool in Network Analyst) to provide a first measure of the organization of

the site during each period and how it changed after colonial remodeling. Second, isochrone maps in which the contour lines represent walking time intervals to each of the plazas were created (using the “Service Area” function in Network Analyst) to provide an intuitive means of visualizing how walking times between different houses varied relative to each of the two plazas (and thus, over time). Finally, given the small size of the settlement, the absolute distance of a given domestic structure from either of the plazas was probably not as salient as its position relative to other households, so the ranked position of each domestic structure to each of the plazas was calculated as another measure of change from the Inkaic to colonial doctrina spatial organization of the site.

3. Results

The results of the least-distance route analysis show very different network patterns for the two plazas (Fig. 5). In Fig. 5, the line thickness for each path segment varies by the amount of traffic on it. Examining routes from individual structures to each of the plazas reveals which paths were most heavily trafficked and which households were most central to the ceremonial center of the site during both Inka and colonial periods of use. In the network directed to the Inka plaza (Fig. 5A), the patio group of circular domestic structures just north of the great hall are nearest, while the rows of rectangular structures added later in the use life of the doctrina to the east are very distant. Conversely, when movement is directed toward the colonial plaza (Fig. 5B), the nearest houses are those of the elite domestic compound to the adjacent east of the plaza, followed by the rows of domestic structures in the “new neighborhood” to the east.

Just as illuminating is a comparison of which paths were unused in each scenario. In the network directed toward the Inka plaza, sections of the main path to the colonial plaza were not used at all (at least under least-cost conditions), while traffic seems to be directed toward a southern pathway. By contrast, the network to the colonial plaza shows a marked change: the paths in and around the Inka plaza are not used at all, leaving it isolated in the network. The two plazas are not just lacking in integration, but could be said to be connected to networks that are near mirror-images of each other. The reorganization of the site by the Franciscans, in this sense, appears to have “turned its back” to what was formerly the ceremonial focus of the site during Inka times.

These contrasts can be quantified and visualized with the second analysis, which produced isochrone maps of walking time contours to each of the plazas (Fig. 6). A comparison of walking times to each plaza illustrates how the site plan became a mirror image of itself in the transformation from an Inka outpost to Franciscan doctrina. The circular domestic compounds that most proximate to the Inka plaza (Fig. 6A) became among the most isolated and distal relative to the colonial plaza (Fig. 6B). Thus, despite being very close to the colonial plaza in Euclidean (straight line) distance, these circular structures near the Inka great hall were among the most distant from the colonial plaza when measured by their access patterns through the network of paths to it. In mirror fashion, the rows of rectilinear houses at the eastern end of the site, especially those to the north, are very distal to the Inka plaza, while they are comparably near to the colonial plaza in terms of walking time, despite their location at the far end of the settlement in Euclidean measures. The construction of the plaza, atrium, and northern pathway therefore drastically changed the direction of movement through the site. The central plaza and chapel became the focus of the doctrina, while the northern pathway integrated the newly-resettled households located at the eastern end of the site. Meanwhile, the Inka plaza and households

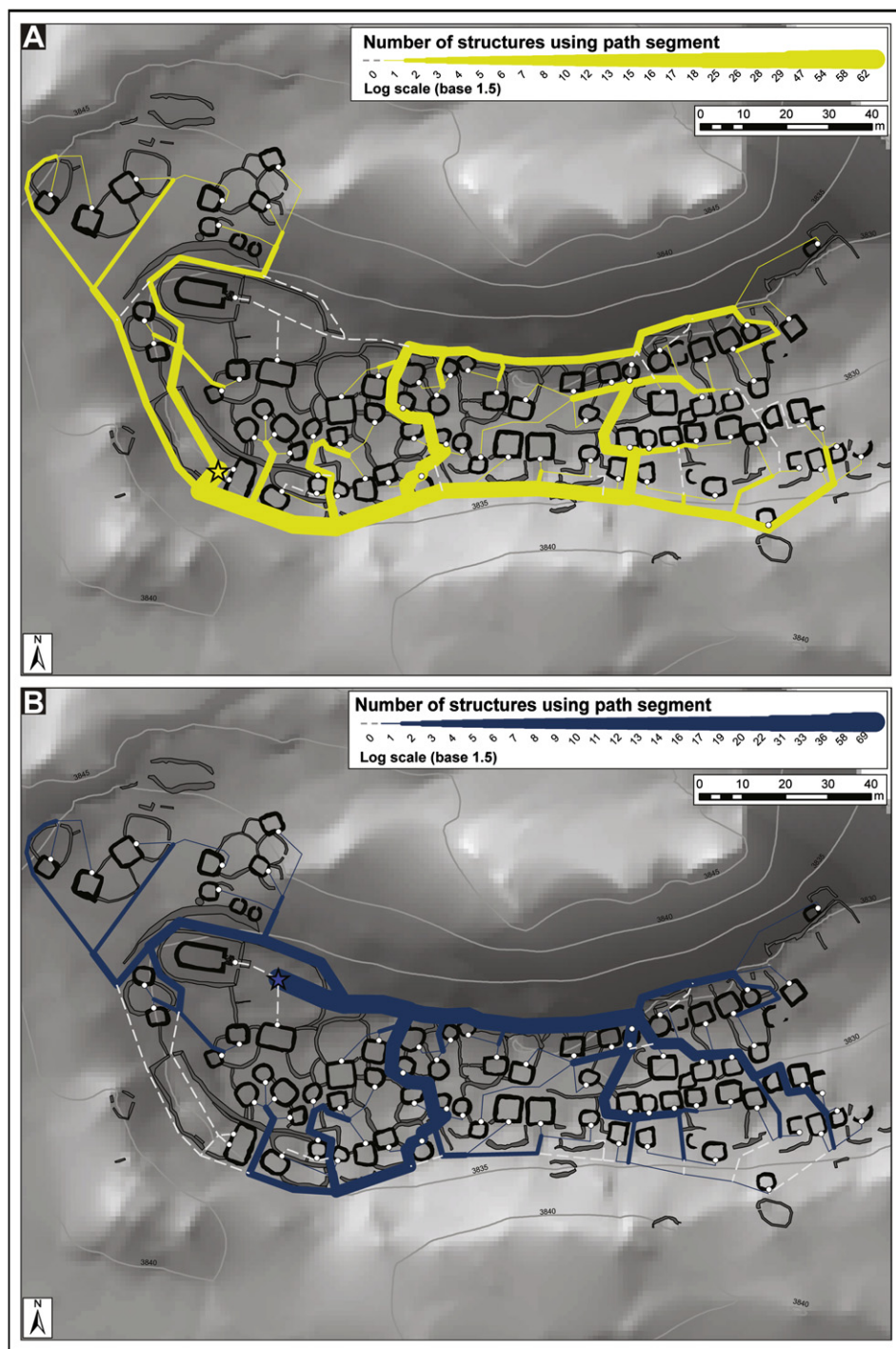


Fig. 5. Least-distance network paths to the Inka plaza (A) and colonial plaza (B) from each domestic structure.

most proximate to it became peripheral and distant in the network directed toward the colonial plaza and chapel.

Rank-ordering of domestic structures in relation to their distance from the plazas shows more clearly the change in relative position of households as the site focus shifted. In Fig. 7, domestic structures are symbolized in ascending rank by their distance to the Inka (Fig. 7A) and colonial (Fig. 7B) plazas. Here, the domestic compounds of circular structures rank high in terms of proximity to the Inka plaza, while they are among the lowest ranking in proximity to the colonial plaza and chapel. Conversely, the rectilinear domestic structures at the eastern end of the site are among the

lowest ranking in proximity to the Inka plaza, but are high ranking in proximity to the colonial plaza, especially relative to their absolute distance from it.

The impact of the formalization of the site as a doctrina on individual households can be best illustrated by quantifying the difference in rank of each structure relative to each plaza, seen in Fig. 8. Here, the rank of each structure relative to its walking distance to the colonial plaza – the new social and political center of the site – is subtracted from its rank relative to the Inka plaza to display its degree of difference as the site layout was reorganized as a doctrina. Houses that became more centrally-located relative

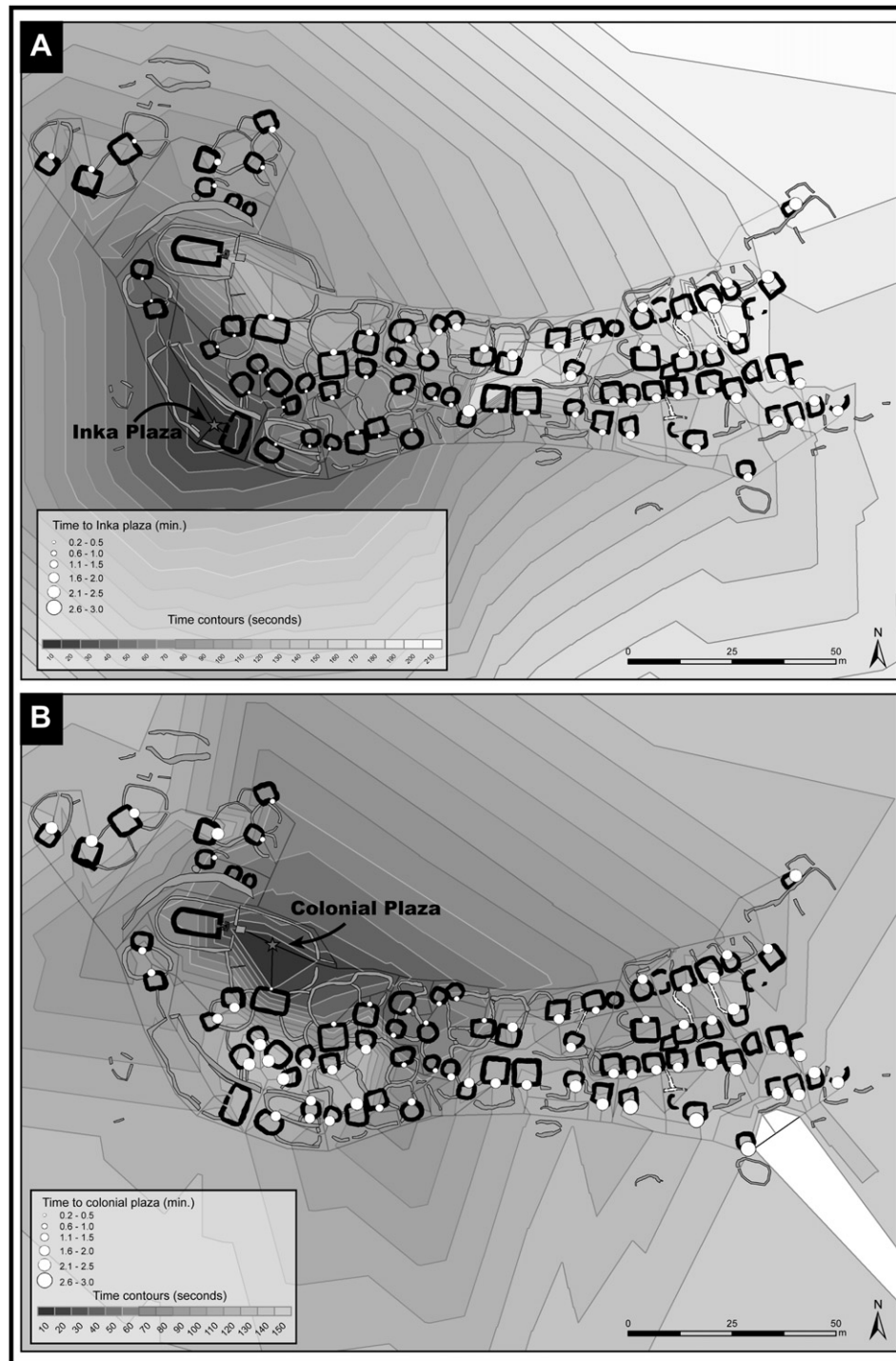


Fig. 6. Walking isochrone maps to the Inka plaza (A) and colonial plaza (B) from each domestic structure. Dot size at each origin point represents one way walking time.

to the colonial plaza therefore have positive values (white circles), while those that became more distal have negative values (dark gray circles). Circle size is relative to the amount of negative or positive change in rank. Thus, the large white circles “gained” the most in terms of centrality, while the largest dark gray circles “lost” the most centrality (i.e., became markedly more distal compared to others, relative to the colonial plaza). The greatest positive difference was experienced among the households located along the northern edge of the new neighborhood at the eastern end of the site, which are clearly well-articulated to the

colonial plaza via the main path into it. The greatest negative change can be seen among the houses to the adjacent north of the Inka great hall and its plaza. This is a striking finding because these were formerly the most centrally-located houses relative to the former social and political core of the site – the Inka ceremonial space – but became among the most distal relative to the new center of the settlement, the colonial plaza and chapel. This analysis therefore shows that these structures, and perhaps the families that lived within them, not only became more peripheral relative to the colonial ceremonial core, but that they were also



Fig. 7. Rank order distances between domestic structures and the Inka (A) and colonial (B) plazas.

the most heavily impacted by this change relative to other houses at the site.

4. Discussion and conclusion

4.1. Charting the organization and transformation of social space

The modeling of movement through the built spaces of Malata afforded by SNA shows that, although the Inkaic and Christian ritual spaces were *spatially near* in absolute (Euclidean) measures, they

were actually quite *socially distant* and in tension with each other in the relative space of the network of pathways through the doctrina. Foot traffic to the colonial plaza and chapel was specifically routed away from the former Inka ceremonial space of the site, and left those that had the most ready access to the Inka plaza among the most distant in the network of pathways to the colonial plaza. In contrast, the inhabitants of newly constructed houses at the eastern end of the site had comparatively direct access to the colonial plaza despite their seemingly remote position within the settlement. The largest colonial-era rectilinear house at the site – likely home of the

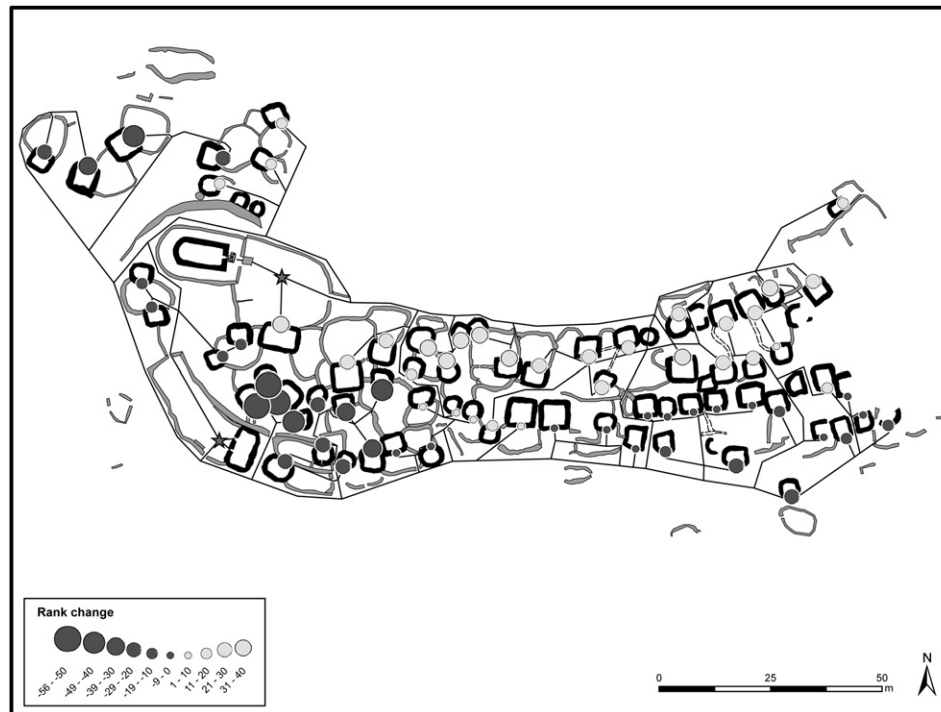


Fig. 8. Difference in rank order of domestic structures relative to the two plazas (rank relative to Inka plaza – rank relative to colonial plaza).

ranking indigenous lord – was clearly emplaced within the newly-configured doctrina to enable surveillance and perhaps orchestration of the processions that passed by his doorways, just before they entered the plaza and chapel beyond.

On one hand, these changes in the spatial organization of such an early doctrina could be read as a more or less straightforward example of the “architecture of conquest” (Fraser, 1990). Given ecclesiastical and policy thinking of the time, this was almost certainly the intent: to inculcate a new Christian lifestyle through the structuring properties of the built environment. But regardless of the attempt to impose orthodoxy, the friars could not impose a *tabula rasa* – either in the built forms of Malata or in their significance to its inhabitants. To the extent that the new plaza, processions, and pageantry were effective evangelical tactics, they were also made legible by reference to their Inkaic cognates. Indeed, their effectiveness must have depended on their resonance with preceding Inkaic notions of the social centrality of public plazas and ceremonial spaces. The construction of a space of indoctrination thus produced a new kind of local place of ambiguous – and likely contested – significance. The changes in spatial organization documented at Malata therefore provide a micro-scale perspective on how new kinds of local places emerged despite the imposition of an increasingly uniform and disciplinary regime of proselytization in the early colonial Andean highlands.

More broadly, the manner in which SNA was adapted to an archaeological context in this study produced a distinctive mode of intuitive visualization, simulation and analysis that is complementary to space syntax analysis. A full comparison of the two approaches is beyond the scope of this paper, but space syntax analysis could be used to produce index values of connectedness and depth for the two plazas, which would complement SNA by providing measures for the structure of the network. In general, space syntax analysis would show a very “flat” network. In terms of access patterns to domestic structures, only structure 26 – the likely residence of the indigenous lord of the settlement – shows any “depth” in its hierarchical arrangement relative to structure 28.

That domestic compound as a whole appears to have performed a monitoring function for all traffic proceeding to the colonial plaza (and chapel beyond). Such measures, however, would not convey the distinctive “flipping” of traffic flows from the southern transverse path leading to the Inka plaza to the northern transverse path leading to the colonial plaza because the graph-based conventions of space syntax analysis are not intuitively connected to the representational space of the architectural plan. Line-of-sight drawings (common in space syntax analysis) could complement SNA by tracking different patterns of surveillance relative to the two plazas, though GIS-based viewshed analysis integrating building heights as barriers seems an equally fruitful avenue for a visibility pattern study within the settlement.

4.2. Diverse prospects for SNA in archaeological research

This study shows how SNA can be used to provide insights at the tail end of the research process, after all phases of fieldwork are completed. But the same analytical tools could also significantly contribute to earlier phases of research. It could be used to form hypotheses for testing via excavation, as criteria for stratification of samples for excavation, and as additional variables in multivariate analysis. Such applications would fit in typical research workflows, since mapping usually occurs first in the process. SNA could be performed after an initial fieldseason of mapping and before proposing excavations. For example, hypotheses regarding social role or status of particular households could be proposed on the basis of rank or position in the spatial network of a site, which could then be tested via excavation. Sampling strata could be defined by histogram breaks in transit times to public or ceremonial foci within the site (such as plazas in this case). If non-random strategies are employed, excavations could be targeted to address specific questions that arise from SNA.

In sum, this article shows the ability of SNA to systematically simulate the patterning of foot traffic through the built environments of archaeological settlements. By quantitatively characterizing the

structure of their internal spatial networks, SNA moves the interpretation of spatial organization beyond impressionistic descriptions and complements established methods of space syntax analysis. This complementarity derives from the capacity of SNA to render in situ simulation and analysis of movement that can be used at several stages in the research process. These range from the formation of hypotheses and sampling strategies, to quantitative analysis of the manipulation of the built environment, and of dwelling within it. The approach therefore strengthens links between theory of place, reconstructions and representations of spatial practices in the built environment, and quantitatively-standardized simulation, by providing reproducible measures of network structure and the patterning of movement through archaeological settlements.

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