Assessing Spectator Positions

A Case Study from Cochasquí, Ecuador

Irmela HERZOG, The Rhineland Commission for Archaeological Monuments and Sites, Bonn, Germany
Alden YÉPEZ, Pontifical Catholic University of Ecuador, Quito, Ecuador

Keywords: *GIS — close-range visibility analysis — Ecuador*

CHNT Reference: Herzog, I., and Yépez, A. (2021). 'Assessing Spectator Positions', in CHNT – ICOMOS Editorial board. *Proceedings of the 26th International Conference on Cultural Heritage and New Technologies.* Heidelberg: Propylaeum.

Introduction

One of the most extensive and impressive pre-Inca and pre-hispanic sites in the Andean region is situated at a straight-line distance of about 50 km NNE of Quito in Cochasquí, Ecuador (Fig. 1). Located at an altitude of about 3000 m, the site encompasses 15 truncated pyramids, nine of these with ramps, and several burial mounds. For both the more or less rectangular pyramids and the round burial mounds the term *tola* is used. The *tolas* date back in the second phase of the site ca. 1250–1550 AD. Ugalde and Landázuri (2017) come to the conclusion that the site was not settled, but used for ceremonial purposes. They assume that the large quantities of sherds found in this and similar sites are remains of festivities involving the distribution of abundant food and drink.

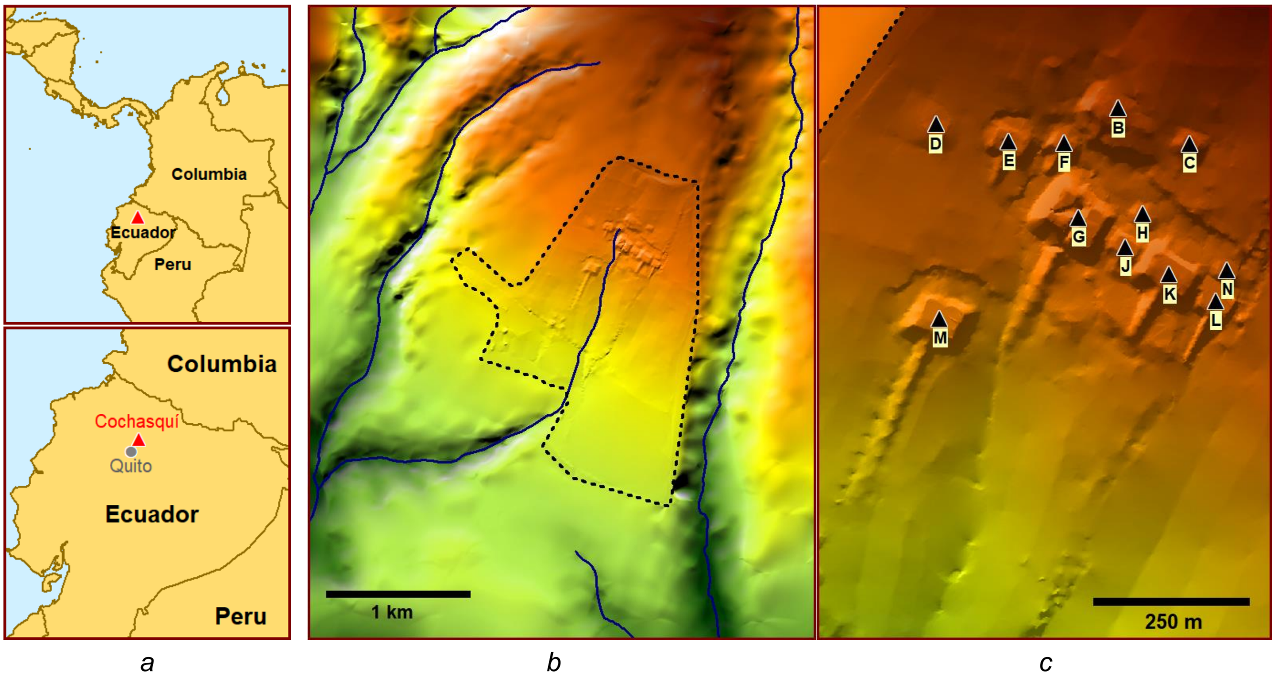

Fig. 1. Cochasquí, Ecuador a) location; b) archaeological park and surroundings; c) central part, the tolas are designated by capital letters (© Irmela Herzog; based on elevation and water course data provided by Ecuadorian authorities).

Fig. 2. Festival "Mushuk Nina" in Cochasquí, Ecuador, on 21-March-2013 (© Alden Yépez).

In recent non-pandemic years, a large festival at the time of the spring equinox took place in the archaeological park of Cochasquí (Fig. 2). The festivity hypothesis by Ugalde and Landázuri (2017) and the modern festival inspired research into the suitability or the location for staging events that can be observed by a large audience. This paper presents a close-range visibility analysis that investigates several event scenarios. For each event scenario, the spectator pixels, i.e., 1 x 1 m squares in the area surrounding a proposed stage location, are identified. Each pixel allows two sitting pre-hispanic persons to view the events. To assess the viewing properties of each spectator pixel, a 3D model of the site's surface is required, i.e., elevation data.

Digital Elevation Data

An AutoCAD contour line layer (vertical distance: 1 m) commissioned by the local authorities of Pichincha covers an area of 241 hectares (delimited by a dotted black line in Fig. 1b). The nodes of the contour lines are the basis of a raster DEM with a cell size of 1 m generated using the linear option of triangular interpolation. For covering a larger study area (Fig. 1b), additional elevation data was derived from a scanned topographic map depicting contour lines with a larger vertical distance.

Below a layer of a depth of up to 1 m, excavations uncovered circular, baked-clay floors on the pyramid platforms. These features have been interpreted as remains of houses (Bray 2008; Wurster 1981). Most likely, a house was erected on the centre of each platform, accompanied by additional smaller houses. Burnt wood and grass indicate the houses' destruction by fire. Wurster (1981) discusses a clay artifact that might represent a pyramid with a house. The platform of this clumsy 3D model is encircled by a wall or fence, blocking the view on the platform except at the house entrance.

Event scenarios

Excavations of pyramid E revealed trough-like cavities of hard-fired clay on the clay floors of the houses. These are interpreted as hearths, possibly for the preparation of special feasts or ritual offerings (Bray, 2008; Wurster, 1981). According to Ugalde and Landázuri (2017), the large hearth features in the houses allowed preparing food for hundreds of people. Similar features were also documented on the ground surfaces between the *tolas* (Bray, 2008). Ugalde and Landázuri (2017, p. 212) suggest that the long ramps to the pyramid platforms were ascended by people taking part in some festivity. According to Bray (2008), some chiefs were probably living in houses on *tolas* and ceremonies were performed there as well. Based on this hypothesis, the first scenario assumes that the audience awaited the appearance of a person at the doorstep of a central house bringing new food prepared on the hearths inside. In the second scenario, persons walking on the long access ramps to the pyramid platforms play an important part in the ceremony. A third scenario is based on the fact that additional hearth remains were found between the *tolas* and that the action at the modern festival also takes place in the fairly flat terrain between the pyramids (Fig. 2). In past reality, two or all three of these scenarios might have been combined.

Methodology for assessing spectator positions

Standard viewshed analysis requires information on the viewpoint height, in this case, the height of the eyes of the sitting spectator. A conservative standard observer height of 1.50 m was chosen for the computations. A table presented by Nixdorf (2006, p. 34) suggests that the height of the eyes of a sitting person is about 52% the height of the person resulting in a viewpoint height of 0.78 m. Moreover, standard viewshed analysis allows entering an offset value to account for the size of an object that is being viewed. This study assumes that the spectators want to see persons carrying vessels with food or drink that are typically carried well above navel height. Nixdorf's table suggests a navel height of 0.58% of the person's height, resulting in an offset value of 0.87 m.

According to Ogburn (2006), the distance at which an object reaches the standard limit of human recognition acuity is related to the object's size, i.e., the limit is at the point at which the object subtends a visual arc of 1'. For recognizing the facial features of actors in a theatre, a limit of 24 m is adequate. The limits for a modern track and field stadium are 230 m, allowing the detection of features such as the yellow card (11 x 8 cm) in a soccer game. Based on this data, the comfortable and the tolerable range of the distance values were selected (Table 1, first row).

Table 1. Spectator parameters. Some of the parameter values are compromises between different statements in the publications referenced.

	Parameter	**Comfortable range**	**Tolerable range**
1	Distance to the performance (m)	0 to 24	24 to 230
2	Slope of sitting location (%)	14 to 30	10 to 14, 30 to 40
3	Horizontal rotation of the head and eyes, i.e., turn left or right (°)	0 to 30	30 to 60
4	Vertical angle of vision, up (°)	-	0 to 20
5	Sitting Person: Vertical angle of vision, down (°)	5 to 25	0 to 5, 25 to 35

For assessing each event scenario, the first step is to identify the 1 x 1 m pixels where the events are taking place, for these the term event pixels is used. All other pixels at a distance of less than 230 m from event pixels are the initial spectator candidate pixels. An accumulative viewshed reduces the candidate set of spectator pixels. For each resulting spectator pixel candidate, a line of sight can be established between this pixel and an event pixel. These lines of sight are assessed by taking the parameters presented in rows 2 to 5 of Table 1 into account. The preferred slope of sitting locations (Table 1, row 2) was derived from photos of the Mushuk Nina festival where ample space allowed people to choose their sitting location freely. The spectator positions were mapped approximately on the DEM and their slope computed. The resulting slope values are in the range of 14–40%. The upper limit of the comfortable range was reduced to 30% because it is difficult to walk on a slope of 30% or more. The view quality of spectator positions in soccer stadiums presented by Nixdorf (2006) is most relevant for this close-range visibility study, the parameters in Table 1, rows

3 and 5, were chosen according to his data. For spectators looking up to an event, the work of Higuchi (1983, pp. 40, 46, 55) provides relevant data (Table 1, row 4).

Fuzzy viewsheds allow modelling the probability of detecting objects by a distance decay function (Ogburn, 2006). In this study, a very simple distance decay function is applied, which is 1 in the comfortable range, 0.5 in the tolerable range and 0 beyond. Equivalent functions are defined for all other parameters in Table 1. The overall assessment of a line of sight connecting a spectator pixel with an event pixel is the geometric mean of these functions. The event viewing potential of a spectator pixel is the sum of the line-of-sight assessments for all relevant lines of sight.

Discussion and Conclusion

The main aim of this paper is to introduce the methodology for analysing the potential of a location as a stage and for assessing the number of possible spectators. Simple viewshed analysis as available in most off-the-shelf GIS software packages is merely a minor step in this methodology. For modelling agents sitting and watching comfortably a stage event, additional parameters must be taken into account.

The close-range visibility results of the different event scenarios will provide new insights in the ritual landscape of Cochasquí. The computationally intensive approach presented allows assessing the maximum number of people that could comfortably watch the events.

Funding

Part of Alden Yépez' work was done during office hours at the Pontifical Catholic University of Ecuador. Mostly spare time without funding was used for this project.

Author Contributions

Conceptualization, Data curation, Formal Analysis: Irmela Herzog, Alden Yépez
Investigation, Resources: Alden Yépez
Methodology, Software, Visualization, Writing – original draft: Irmela Herzog

References

Bray, T. (2008). 'Late Pre-Hispanic Chiefdoms of Highland Ecuador', in Silvermann, H. and Isbell, W.H. (eds.) *Handbook of South American Archaeology*. New York: Springer, pp. 527–543.

Higuchi, T. (1983). *The Visual and Spatial Structure of Landscapes*. Cambridge, MA: MIT Press Classic.

Nixdorf, S. (2006). *Sichtlinien und Sicherheit. Tribünenprofile moderner Sport- und Veranstaltungsstätten.* PhD. RWTH Aachen. https://publications.rwth-aachen.de/record/52815/files/Nixdorf_Stefan.pdf (Accessed: 15 July 2021).

Ogburn, D. E. (2006). 'Assessing the level of visibility of cultural objects in past landscapes'. Journal of Archaeological Science 33, pp. 405–413.

Ugalde, M.F. and Landázuri Narváez, C. (2016). 'Sociedades heterárquicas en el Ecuador preincaico: estudio diacrónico de la organización política caranqui', *Revista Española de Antropología Americana*, 46, pp. 197–218. DOI:10.5209/REAA.58294

Wurster, W. (1981). 'Zur Rekonstruktion von Rundbauten auf den Rampenpryramiden von Cochasquí, Ecuador', in Deutsches Archäologisches Institut Bonn (ed.), *Allgemeine und vergleichende Archäologie, 2*. München: C. H. Beck'sche Verlagsbuchhandlung, pp. 459–486.