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Article

Performance Space, Political Theater, and Audibility in Downtown Chaco

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Abstract: Chaco Canyon, NM, USA, was the center of an Ancestral Puebloan polity from approximately 850–1140 CE, and home to a dozen palatial structures known as "great houses" and scores of ritual structures called "great kivas". It is hypothesized that the 2.5 km^2 centered on the largest great house, Pueblo Bonito (i.e., "Downtown Chaco"), served as an open-air performance space for both political theater and sacred ritual. The authors used soundshed modeling tools within the Archaeoacoustics Toolbox to illustrate the extent of this performance space and the interaudibility between various locations within Downtown Chaco. Architecture placed at liminal locations may have inscribed sound in the landscape, physically marking the boundary of the open-air performance space. Finally, the implications of considering sound within political theater will be discussed.

Keywords: archaeoacoustics; soundscapes; open-air performance space; political theater; Ancestral Puebloan; Chaco Canyon

1. Introduction

Chaco Canyon, San Juan County, NM, USA, was the center of an Ancestral Puebloan (also known as "Anasazi") polity from approximately 850–1140 CE. This location was home to a dozen palatial structures known as "great houses" and scores of ritual structures called "great kivas". Most of these were located in a 2.5 square kilometer region referred to as "Downtown Chaco", centered on the largest great house, Pueblo Bonito (Figure 1). We hypothesize that this downtown area served as an open-air performance space for both political theater and sacred ritual. Indeed, it is believed that ritual and politics were tightly bound together in Chaco, much like other early states, and similar to the nature of leadership within modern Pueblo communities.

Our purpose for this paper is to further explore the relationship between the built environment of Chaco and its soundscapes, a situation that we approached in various conference papers [1–3], and in a previous article, "Soundscapes in the past: Investigating sound at the landscape level" [4]. In our article, we reported that the physical relationship between modeled soundscapes and the locations of shrines throughout the wider landscape may be evidence of ritual performance space, where the shrines themselves marked the bounds of that space.

Our goals for this article are threefold. First, we briefly provide a literature review for those unfamiliar with the study of archaeoacoustics, particularly how it relates to the landscape scale. Secondly, we review the results of the initial study and then interpret those results with two linked bodies of anthropological theory: performance theory and political theater. Performance theory describes how activities gain their meaning in the context of group involvement [5], and political theater describes how elites utilize performances to present themselves as they want to be seen in order to legitimize their status [6]. These two interrelated theories can help researchers develop a stronger

understanding of the nature of landscape experience at Chaco, illustrating how Chacoan elites may have guided the construction of specific landscape features to both anchor and bound socio-cultural performance space, and to serve as a stage for political theater for the legitimation of their roles. Finally, we show how both of these functions interacted simultaneously to construct and reify political power in the 10th and 11th century CE.

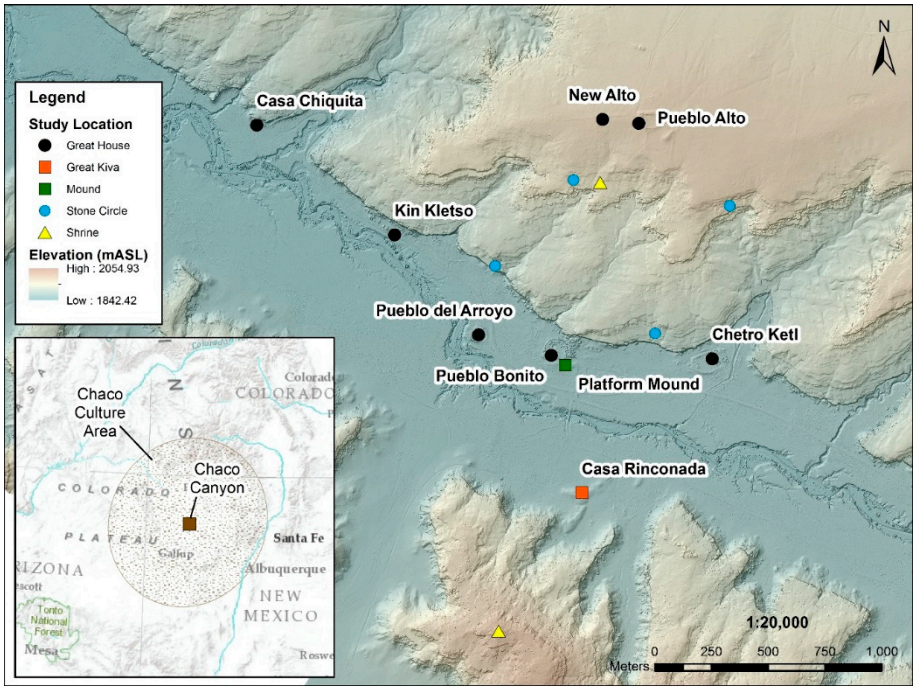

Figure 1. Map of "Downtown Chaco", Chaco Canyon, NM, USA.

Background

Archaeoacoustics is the study of the evidence of sound in the archaeological record. This can be achieved by studying the acoustical properties of artifacts, sites, or landscapes. An important method for understanding past people and cultures, archaeoacoustics provides an integral, albeit often ignored, component of the human experience. Most of the previous work on sound in the archaeological record has focused on the artifactual or site level [7–24], yet recent research has expanded to the landscape level [4,25–32].

Most recognized amongst landscape theories is phenomenology, an interpretive framework which explains that landscapes are places where memory, meaning, and identity interweave as integral parts of the lived experience [33–42]. Phenomenology, however, has been critiqued as methodologically weak, as it has traditionally relied upon qualitative, personal observations [34,35,43–49]. Our tools, described below, are being developed to answer this critique. Simultaneously, the tools also respond to claims that Geographic Information Systems (GIS) and other "abstracted experiences" are positivistic [39,50,51], by combining the strengths of both GIS and phenomenology to answer Tim Ingold's call that anthropologists adopt a greater awareness of the lived experience [52].

Our tools model the extent to which sounds, including those originating from the human voice and musical instruments, can be heard throughout the wider landscape. We hypothesize Chacoan elites to be practiced orators, able to speak for extended periods with a raised voice. For example, the historic Zuni (a Puebloan group) maintained a Priest of the Sun: "whose title, Pekwin, means, literally, Speaking Place . . . It is at the solstices that the sun is celebrated with great public ceremonies . . . In winter the public ceremonies are opened by the Pekwin's announcement made from the housetop at dawn. At this time he orders the people to make prayer sticks for their sun father and their moon mother" [53] (p. 512).

Within the American Southwest, musical instruments have been recovered from the pre-Hispanic period. These include bone flutes and whistles, wooden planks (i.e., "foot drums"), copper bells, and conch shell trumpets [54–58]. These instruments are linked to ritual and public performances, as illustrated by the ethnohistoric and archaeological records [57,59–62], as well as shown by use in modern contexts [63]. These performances take place within ritually charged locations such as enclosed kivas and open-air plazas. The recovery of conch shell trumpets and other instruments from similar ritual contexts in the archaeological record may illustrate similar use in the pre-Hispanic period [59,64].

The importance of sound in the past has recently been recognized by archaeologists working in the American Southwest, borrowing from researchers working in Europe and South America [15,30]. This recognition has primarily resulted from the work of Richard Loose, who has studied the acoustic properties of artifacts (such as conch shell trumpets), structures (such as the great kiva at the Aztec Ruins National Monument, San Juan County, NM, USA), and landscapes (such as Chaco Canyon and Casamero Pueblo, McKinley County, NM, USA) [65–69], but the topic is now receiving wider attention [4,25]. Within Chaco, the importance of sound is most clearly illustrated by Tse Biinaholtsa'a Yałti, Navajo for "Concavity in the Bedrock that Speaks". This feature is an alcove located on the north wall between Pueblo Bonito and Chetro Ketl, near the stone circle 29SJ1565. The alcove, which was modified by the removal of approximately 360 m^3 of bedrock, is associated with an altar and rock art panel, and is considered a portal to the dimension of Navajo deities [65,70]. The projected circle of the alcove's amphitheater, some 340 m in diameter, is "clearly a delineated space that is level, and conspicuously devoid of features and material culture" [70] (p. 206). Acoustical studies have been conducted by Richard Loose and colleagues, illustrating that this site creates a "virtual sound image" [68,69], resulting in a phenomenon that is described as filling the canyon floor with sound, and "a sensation of being 'bathed' in sound as standing waves of sound formed along the axis of the amphitheater" at certain frequencies [70] (p. 208). Other tests indicate the existence of other auditory phenomena, including echoes, reverberations, and the cancelling out of sound at various locations [65]. From this feature, it seems obvious that sound was intentionally manipulated as an aspect of landscape within Chaco Canyon and it likely played an important role in Chacoan rituals.

2. Modeling Methods

In 2016, we developed Soundshed Analysis Tool, beta version 0.9.2, part of an Archaeoacoustics Toolbox which models the spread of sound throughout a landscape [1–4]. Written in the Python programming language for ArcGIS 10.3, it is based upon SPreAD-GIS, a toolbox developed to model the propagation of engine noise within wildland settings [71,72]. The following year the acoustical modeling tool was updated [73,74], and the Archaeoacoustics Toolbox now includes preset versions of the Soundshed Analysis Tool which utilize elevation datasets with 1, 1.5, and 30 m resolutions. In addition, modeling at alternative resolutions is possible with minor adjustments to the Python script. For this analysis, our soundsheds feature a 1.5 m resolution based on LiDAR data.

Modeling the spread of sound in a GIS environment places an emphasis on the spatial location and extent of the soundshed, rather than a detailed acoustical reconstruction. This allows archaeologists to incorporate acoustics into their analyses of relationships between sites and features within the landscape, and study the cultural implications of those relationships. While noise analysis software can be cost-prohibitive or otherwise inaccessible to archaeologists, GIS is a prevalently used tool that most archaeologists can access and operate; we hope that, when complete, the Archaeoacoustics Toolbox will introduce many archaeologists to acoustical modeling as an open-source addition to readily available GIS software.

2.1. Model Inputs

Input variables for the model include environmental data and archaeologically derived cultural data, as illustrated in Table 1. Environmental inputs include an elevation dataset and information used to determine the physical characteristics of the spread of sound in air. These are typically gathered

from the literature and include the percentage of relative humidity [75], the air temperature in degrees Fahrenheit [75], and the ambient sound pressure level (dB(A)) of the study location [76]. Cultural data describe the sound source. These consist of the location of the sound source, the output height (ft) of the person or instrument creating the sound (which can be derived from osteological data and/or the artifact assemblage), the sound pressure level of the source (dB(A)), the distance (ft) at which the sound pressure level of the source was measured, and the frequency (Hz) representing the fundamental tone or peak long-term average frequency at which the sound source was measured [66,77,78]. Specific modeling inputs used for this paper are provided in Table 2.

Table 1. Soundshed Analysis Tool v0.9.2 Input Variables.

Environmental Inputs	Cultural Inputs
Percentage of Relative Humidity	Location of Sound Source
Air Temperature (°F)	Height of Sound Source (ft)
Ambient Sound Pressure Level (dB(A))	Sound Pressure Level of Source (dB(A))
LiDAR-based DEM	Measurement Distance of Source (ft)
	Frequency of Source (Hz)

Table 2. Soundshed Analysis Tool v0.9.2 Modeling Inputs.

Modeling Inputs		Elite Orator with a Raised Voice: Afternoon in June	Conch Shell Trumpet: Dawn in June
Environmental Inputs	Percentage of Relative Humidity	30%	30%
	Air Temperature	89.6 °F (32 °C)	55.4 °F (13 °C)
	Ambient Sound Pressure Level	20.7 dB(A)	20.7 dB(A)
Cultural Inputs	Height of Sound Source	5 ft (1.5 m)	6 ft (1.8 m)
	Sound Pressure Level of Source	84 dB(A)	96 dB(A)
	Measurement Distance of Source	3 ft (0.9 m)	4 ft (1.2 m)
	Frequency of Source	325 Hz	330 Hz

2.2. Modeling Steps

The Soundshed Analysis Tool is a geometric-type model which assumes sound is travelling through the air along straight-line paths. Currently, the model does not incorporate wave effects such as reverberation which require more processing power than a 32-bit GIS environment presently provides. The tool uses formulae of outdoor sound propagation, calculating free-field sound attenuation following ISO 9613-2 [79], atmospheric absorption loss following ANSI 1.26 [80], topographic loss following ISO 9613-2 [79], and barrier effects based on Maekawa's optical diffraction theory [81,82]. The results are output in soundshed rasters that indicate audibility over background noise levels, and provide a viewshed analysis for that site. Within this paper, "audibility" refers to the perception of sounds and does not necessarily implicate the intelligibility of speech. Rasters can be created for any frequency, however the examples presented herein match the fundamental tone or peak long-term average frequency of the sound source. Each study location is modeled independently, although a second tool being developed for inclusion in the Archaeoacoustics Toolbox can create cumulative soundsheds for sound sources propagating from multiple landscape locations simultaneously. Due to the environmental nature of the Chacoan landscape, vegetation attenuation and ground effects are not modeled in v0.9.2, however the script is currently under revision to include these calculations following ISO 9613-2 [79,83]. Absorption due to structural surfaces is also not modeled in the current tool.

3. Modeling Results

Using the above described tool and inputs, we modeled the spread of sound emanating from various sources at locations throughout Chaco Canyon [4]. Here, we continue the discussion by drawing attention to one specific location, the two platform mounds located immediately south of and in front of Pueblo Bonito, the largest great house in the Puebloan world, measuring approximately 90

by 150 m, or 1.2 ha in size (Figures 2 and 3). At this location, we modeled two scenarios: a practiced orator addressing a crowd, and an individual playing a conch shell trumpet.

Figure 2. Eastern platform mound at Pueblo Bonito (covered by vegetation). Man provided for scale.

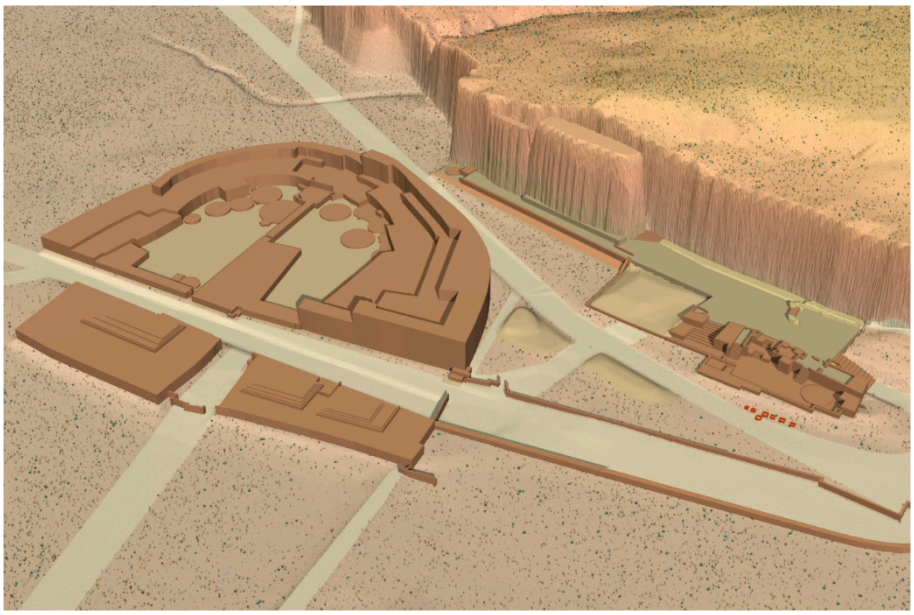

Figure 3. Reconstruction of the Pueblo Bonito architecture. Reproduced with permission from Richard Friedman, in The Architecture of Chaco Canyon, New Mexico; published by University of Utah Press, 2007.

The platform mounds were important features of the landscape. The 3–4 m tall, rectangular mounds were constructed during the Classic Bonito Phase, from 1040–1100 CE, as indicated by ceramic dating [84,85]. The mounds were built up with adobe embankments, steps, and masonry retaining walls [84,86,87], as interpreted in Figure 3. The mounds contained artifacts that mostly reflect household refuse, with equivocal evidence for large scale feasting and specialized production [88,89]. However, the presence of relatively larger numbers of exotic goods such as turquoise, Narbona Pass chert, cacao residue, and macaw remains reinforce claims that Pueblo Bonito was a residence of Chacoan elites, and may indicate that ritual deposition occurred here [90].

Our scenarios were modeled at this location because the platform mounds were earthen architecture that were intentionally built. Researchers have hypothesized that the mounds are ritually charged due to their astronomical alignments, location, directionality, and ability to direct access to Pueblo Bonito [87,91–94]. While others have argued that the features, which were constructed of

household refuse, resulted from the occupation of Pueblo Bonito, they are too large to be the result of only the relatively small population of the great house [95,96] and must have included imported materials. However, even if these mounds were merely domestic middens (or were meant to replicate domestic middens in some sense), they may still have been considered sacred places as middens were often the location of burials. Indeed, modern Puebloan people consider middens to be sacred for that reason [97,98]. Nevertheless, these mounds were important and may have served as performance stages, similar to Mesoamerican pyramids and Hohokam platforms [99]. Ruth Van Dyke states: "Standing atop them, with the great house and the north face of Chaco Canyon towering behind, ritual leaders would have been a very impressive sight. Ceremonies performed atop the mounds would have been highly visible to masses of people who, perhaps, did not have access into the great house itself" [97] (p. 130). For these reasons, we consider the mounds to be more than mere trash dumps (see also [100] for a discussion on the similar role of plazas in later Puebloan sites).

The modeling results are presented in Figures 4 and 5. The figures illustrate the amount by which the two sounds rise over ambient noise levels; hence, they also indicate a positive signal-to-noise ratio. While our study does not approach speech intelligibility as a specific topic of investigation, work by Alvarsson and his colleagues has shown that the signal-to-noise ratio is highly correlated to the Speech Intelligibility Index (SII) and may be used as a proxy of the SII outdoors [101].

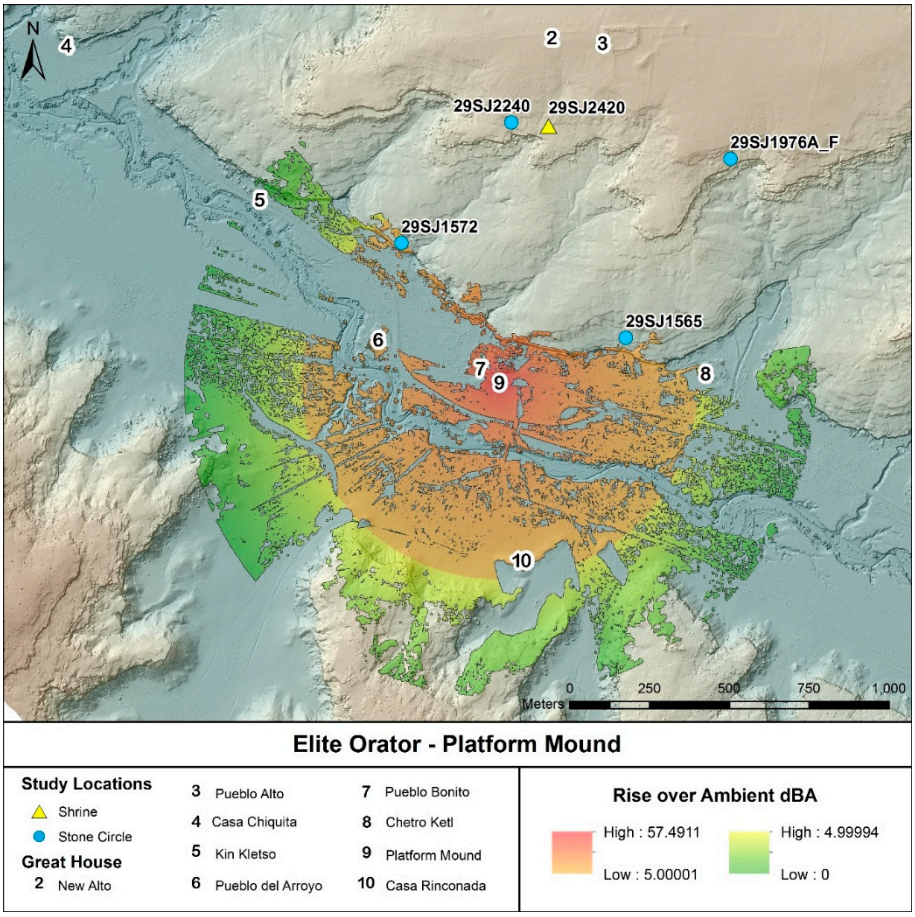

Figure 4. Soundshed of an elite orator speaking at 84 dB(A) with a peak long-term average frequency of 325 Hz.

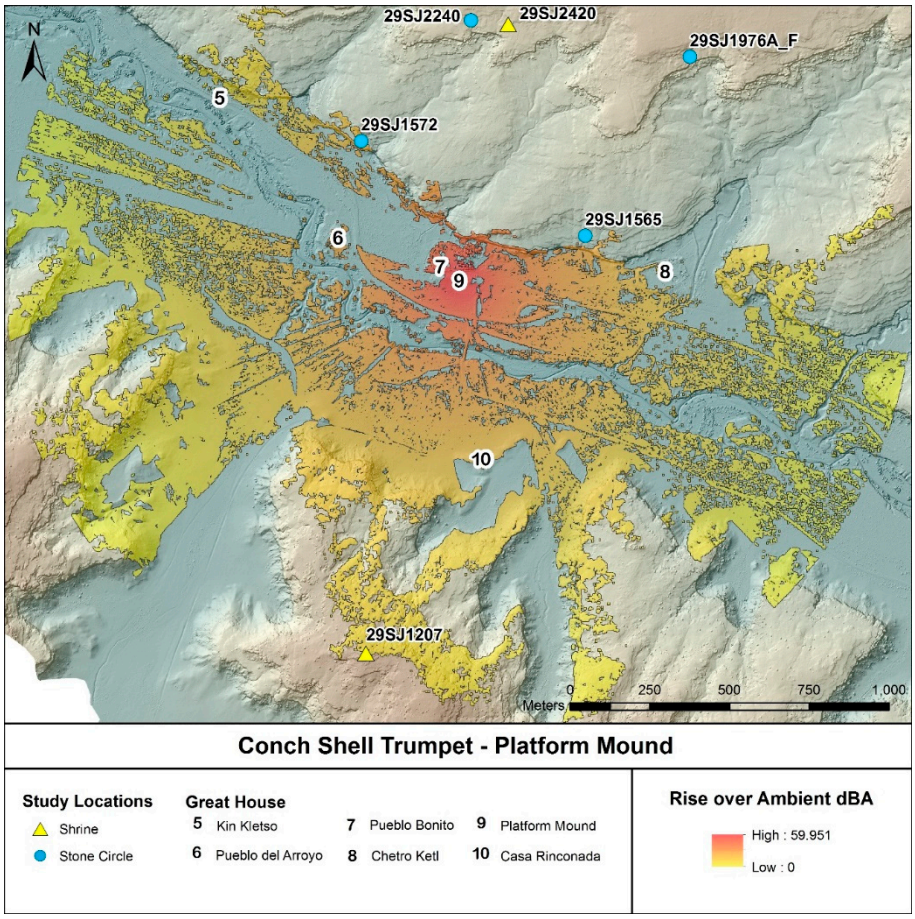

Figure 5. Soundshed of reconstructed conch shell trumpet at 96 dB and a fundamental tone of 330 Hz.

Figure 4 represents a person standing on the eastern mound (9), speaking loudly as if orating to a crowd. Studies have shown that male speakers accustomed to oration, such as actors or preachers, have reached a maximum vocal level of 90 dB(A) when addressing a crowd [102–104]. This individual, with a vocal level of 84 dB(A) and a peak long-term average frequency of 325 Hz, could be heard throughout Downtown Chaco. Using the signal-to-noise ratio as a proxy for SII, the 5 dB(A) contour, indicated by the abrupt shift between the orange and yellow shading, would equate to an approximate SII of 0.6 in a free field according to modeling conducted by Larm and Hongisto [105] (Figure 12 in the reference). Furthermore, Lazarus [106] (Figure 1 in the reference) and Jovičić [107] (Figure 5 in the reference) indicate that a signal-to-noise ratio of 5 dB(A) would equate to an approximate speech intelligibility (SI) score greater than 80 and 85 percent, respectively. Therefore, Figure 4 also indicates the extent to which an individual's speech may have been understood over environmental background noise given an absence of intervening noise sources, illustrating an approximate degree of speech intelligibility at the Pueblo Bonito (7), Pueblo del Arroyo (6), and Chetro Ketl (8) great houses, as well as the Casa Rinconada great kiva (10). Additionally, people at Kin Kletso (5) may have been able to hear the individual if they listened carefully for the sound of his voice, but likely would not have been able to understand what he was saying, as Kin Kletso is located beyond the contour indicating the SII of 0.6.

Figure 5 shows the spread of sound from a conch shell trumpet, an instrument that has been recovered in association with elite burials in Pueblo Bonito [59,66,108], and which was used in historic Puebloan rituals [59]. As illustrated by these figures, the sound of a reproduction trumpet, with an output of 96 dB and a fundamental tone of 330 Hz, spreads an additional 435 m beyond the output indicated by Figure 4, and individuals at the 29SJ1207 shrine overlooking the canyon from the south

would have been able to hear the instrument. Additionally, individuals at the 29SJ1565 and 29SJ1572 stone circles on the north canyon rim may have heard both events. These shrines, in effect, inscribe and demarcate sound within the Chacoan landscape.

4. Discussion

We interpret these results through complementary aspects of performance theory and political theater. As mentioned previously, performance theory describes how activities gain their meaning in the context of group involvement [5]. Similarly, political theater describes how elites utilize performances to legitimize their status [6]. Thomas Luckman stated that "legitimation is making sense of power...to those who exercise power, to those who are subject to the exercise of power, or to both" [109] (p. 111). Inomata and Coben discuss the relationship between performance theory and political theater: "it is probably true that the development of large, centralized polities would have been impossible in any historical context without frequent public events, in which agents of political power presented themselves in front of a large number of spectators and the participants shared experiences through their bodily copresence" [5] (p. 11). Furthermore, "these events have profound implications for the understanding of any society, particularly in terms of the integration of communities and the establishment and maintenance of asymmetrical power relations, which are intricately intertwined with each other" [5] (p. 22). We believe that this is true for Chaco, and that the mounds in front of the largest great house served as a stage for these public events.

The involvement of the community (or, at least, various portions of the community) as audience within these events was a key requirement for the creation, reinforcement, and manipulation of power relations between elites and non-elites, as well as among different elites [110,111]. The mounds, as illustrated by our modeling, would have served as ideal locations for political theater. The audience would have included all within Downtown Chaco, not only the other leaders that occupied the various great houses in the vicinity, but also the commoners that lived within small sites throughout the area.

Yet Downtown Chaco was not merely the location of political theater. Whiteley stated that "ritual action, because of its intent to affect instrumentally the conditions of existence, is simultaneously political action" [112] (p. 68). We believe the converse may also be true at Chaco, especially considering how political power at the location has been so intimately tied up with ritual [113]. Therefore, the performance space of Downtown Chaco was also sacred space. Although the soundshed should be considered circumstantial evidence, the above illustrated locations of shrines and stone circles in relationship to the mounds' soundshed provide additional evidence for this claim.

However, the concepts of political theater and elite legitimation only begin to explore the meaning behind these platforms, and for this we return to performance theory. As mentioned earlier, these mounds contained more material than could be contributed by the occupants of Pueblo Bonito alone [96]. This material included trade items from throughout the Chacoan sphere, as well as much farther afield: Narbona pass chert, Chuska Gray Ware pottery, macaw remains, and cacao residue within rare ceramic vessel forms have been recovered from the mounds [88]. Yet as the papers within Crown's 2016 volume, "The Pueblo Bonito Mounds of Chaco Canyon", illustrate, the majority of the artifacts recovered from the mounds reflect normal, non-elite residential patterns. It is likely that debris from throughout the canyon's small house residences, as well as from visitors from throughout the American Southwest, was purposefully accumulated over the course of sixty years during occasional communal feasting and its accompanying performances of conspicuous consumption and ritual deposition.

As these platform mounds were constructed, the people of Chaco Canyon were in essence forming the stage for the political theater enacted by the elites of Pueblo Bonito. When seen in this light, instances of communal feasting take on a much more nuanced interpretation. Not only were these occasions organized by the elites (and thus served to formalize their role in comparison to others), but they physically shaped the political and sacred performance space utilized by those elites. As the mounds were created, not only did they become prominent features of the Chacoan landscape,

but the extent of their soundscapes grew to encompass Downtown Chaco. If this soundscape is interpreted as an integral part of the legitimation of the Chacoan religious and political system, it was the performances of the Puebloan people themselves that reinforced the elite power structures.

5. Conclusions

As illustrated, specific features within a landscape can provide clues as to how people related to that place. While the platform mounds at Pueblo Bonito imply aspects of political theater and public performance, placing those features into a context of landscape archaeoacoustics highlights just how important a role they played within Chacoan society and culture. The mounds were constructed in an ideal location to serve as the stage for political theater that would have been observed by all within Downtown Chaco and perhaps farther afield. Their construction was an act of public performance, indicating that both elite and non-elite individuals participated in the creation of that stage and its resulting soundshed.

Sound is an integral part of the lived experience, and one that is becoming increasingly acknowledged by archaeologists. Chaco Canyon provides an example of just how important it may have been during the development of complex societies.

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