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Research Article

The Co-Evolution of Aerial Survey Technology and Epistemic Injustice: From Colonial Instruments to Digital Scanners in Cambodia

Sayumphu Ros [1*]

[1] PhD Student, School of Graduate Studies, Cambodia University of Science and Technology, Phnom Penh, Cambodia
* **Corresponding Author:** sr8024010001@camtech.edu.kh

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ABSTRACT

This article investigates the co-evolution of aerial survey technology and epistemic injustice in Cambodian archaeology, tracing developments from French colonial photogrammetry to contemporary LiDAR mapping. Using Science and Technology Studies (STS) approach grounded in Actor–Network Theory (ANT), it examines how human and non-human actors, colonial surveyors, satellites, algorithms, GIS systems, interact to shape heritage narratives and constrain Khmer epistemologies. The analysis is enhanced by four conceptual tools that aim to highlight the differences in meaning across epistemic systems, insider versus outsider interpretations, and its potential impact on the erasure of local knowledge systems. These frameworks reveal how aerial technologies embed asymmetrical power relations, privileging etic, external classifications over emic, local understandings, and reclassifying spiritual and living heritage as static data points. The article contributes to the ongoing decolonization of digital archaeology, particularly the shift from participation alone to network reconfiguration, and to propose an enforceable ethics architecture, instead of siloed efforts such as research permits, MoUs, data-deposit rules, and co-interpretation protocols, to secure data sovereignty, shared authorship, and community benefit. While LiDAR offers unprecedented mapping capabilities, its deployment without equitable access, co-interpretation, and community benefit risks reproducing colonial legacies. The article concludes with structural reform proposals such as data sovereignty clauses, dual interpretive layers, and capacity-building measures to reconfigure archaeological networks toward epistemic justice and ethical technological integration, ensuring Khmer heritage is understood and represented on its own terms.

Keywords: Khmer Epistemologies; Epistemic Ineqality; Lidar; Aerial Digital Surveys; Data Ethics.

INTRODUCTION

Cambodia has experienced significant political upheaval throughout its history. The country reached its peak during the Angkorian period, when its sphere of influence included modern-day Thailand, Vietnam, and Laos (Chandler, 2008). Looking back, Cambodian society at its peak was not by chance, but rather a sophisticated empire with proper governance and management of its society. It is also important to note that the construction of the majestic Angkor Wat temple, a UNESCO World Heritage site, was neither magical nor unplanned, but rather stemmed from the Khmer ability to understand science and technology, such as the placement of the Angkor Wat so that it can create an equinox phenomenon twice a year and continues to this day (Inayat, 2021). Saying that does not imply that there is no cultural or religious meaning or explanation for the temple's construction, which is just as important, if not more, than the scientific rationale. It is also worth noting that Cambodia is the only country in the world with a temple on its flag, which demonstrates the high value the people place on their cultural heritage (Chandler, 2008). Cambodia, on the other hand, has reached its lowest point during the Khmer Rouge, when targeted killings were implemented to eliminate those whom the Khmer Rouge perceived to be intellectuals and treated as enemies of the state (Kogure & Takasaki, 2024). According to reports, between 1975 and 1979, approximately 2 million Cambodians were killed (Kogure & Takasaki, 2024). Cambodia was forced to

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start from scratch, rebuilding the country, forcing to accept and try to heal from this tragedy, while also laying fertile groundwork for future generations. Due to this rollercoaster journey, Cambodian history and archaeology has also been affected, particularly during the Khmer Rouge, with additional damage and destruction to the remaining sacred text or ancient script, hindering archaeological work and studies, and deprioritizing the importance or need of preserving the Khmer cultural heritage and some cultural heritage sites have also been affected (Evans & Moylan, 2013).

This phenomenon has also had an impact on aerial survey technology and archaeological projects in Cambodia. Prior to the Khmer Rouge, there was a potential archaeological project on the ground and from the sky by the French, who had a significant influence in the region because they colonized Indochina, which included Cambodia, Laos, and Vietnam (Evans & Moylan, 2013). Archaeological projects and the field of study only returned after the end of the Khmer Rouge, but progress was slow because there was no complete peace until 1998 (Piphal et al., 2023). It is because about two decades after the Khmer Rouge, Cambodian has been divided into different factions of control. It is not possible to commute from one area to another or from one province to another because each faction has militarized the area, and some of the area is also filled with landmines (Arensen, 2022). Regardless, as of 1998 and until as of now 2025, Cambodia has achieved complete peace, and various international experts lead numerous archaeological projects underway in various parts of the country. However, when considering the evolution of Cambodia's history, it is clear that Cambodian flags, whether the current flag or flags from previous political systems, always include the Angkor Wat temple as a symbol, implying that cultural heritage is important to the Cambodian people (Sotheavin, 2018). For the aerial archaeology, there is no doubt that it is becoming a popular tool for assisting archaeologists in Cambodia (Landauer et al., 2025). However, it is also true that foreign experts have influenced and dominated this field, as we previously stated. This raises the question of whether foreigners' understandings of cultural heritage are the same as those of the Cambodians. And, given its ups and downs in the past and only episodic involvement in archaeological activities, can Cambodia interpret and share its history with its nation and international communities? Or is this mostly a one-sided view of the foreigner? It is further complicated by the use of technology that Cambodians and Cambodian archaeologists are unable to participate in, as well as how to arrive at the interpretation or outcome that the machine provided, raising the question of whether there is a risk that the Khmer culture has been accurately interpreted or narrated as the Cambodians have.

This article will focus on aerial surveying technologies used in Cambodia before and after the Khmer Rouge, with a particular emphasis on the interpretation of Khmer cultural heritage and archaeological data. The article will examine technology from a science, technology, and society (STS) perspective, attempting to demonstrate that technology is neither neutral nor objective. The technologies used may be embedded in networks or assemblages of power, politics, and epistemology. For example, the framing of research questions, the deployment of technology, data collection and classification of data, and interpretation all involve uneven human-technology relationships that result in epistemic injustice.

In other words, the purpose of this article is to investigate how aerial surveying technology and systems have defined or set the archaeological record from the outside in or external views of Cambodia and not vice-versa, resulting in the privileging of categories, workflows, or what should be considered knowledge, culture, and practice in Cambodia, causing it be less to recognize Khmer epistemologies and community memory practices less. That being said, the article will look at the historical and technical evolution of mapping practices, from colonial instruments to modern LiDAR systems, particularly in Cambodia, to demonstrate how the country's heritage has continued to be scanned, segmented, and interpreted through ontologies that prioritize outsider control. The article will investigate how digital tools, such as EFEO's 1920s aerial photography, Cold-War satellite programmes, and twenty-first-century LiDAR, affect Khmer epistemologies and whether process of digital archaeology remain prioritizing outsider control. The article will also argue that in order to decolonize aerial digital archaeology in Cambodia, the reconfiguration of the actor-network is essential, as a concerted effect, in data production, access, and interpretation, not only adding local participation, but particularly through enforceable protocols embedded in permits, MoUs, and funding.

THEORETICAL FRAMEWORK

As previously stated, rather than focusing into the discussion of the outcome of archaeology, which is supposedly produced by a sound method and reasoning, the article aims to demonstrate the process of producing the outcome, involving both human and non-human interaction, through an STS lens instead. The article uses the actor-network theory (ANT) as a key concept to explore epistemic injustice from a network perspective, as the approach has an interdisciplinary theoretical foundation that incorporates various perspectives such as

philosophy of science, anthropology, and postcolonial epistemology. ANT is important because it allows to investigate how aerial surveying technologies are embedded in the structures of knowledge production networks and ethical assumptions (Ros, 2024). In other words, ANT believes that the epistemic outcome of biased knowledge or asymmetry of knowledge is not limited to humans, but that any entity is capable of influencing the outcome (Ros, 2024). In this case, colonial technology and current aerial surveying technology, such as LiDAR, will be examined to demonstrate how archaeological knowledge was and is co-produced by humans and technology, while also shaping or having an effect on research direction and leading to epistemic hierarchies (York et al., 2023). Although the outcome of scientific knowledge is sound or publishable, it is a combination of how tools, datasets, funding structures, soft and hardware, as well as the narrative and interpretation decisions that these networks become standardized and accepted, leading to one specific ontology or idea of the past (Inomata, 2024). Furthermore, what is shown by Lidar or other forms of aerial digital technology is not simply the truth; rather, the picture or map that is rendered is the result of a negotiated network of power, classification, and what is permitted to be seen (Chase et al., 2020).

This epistemic assessment will be further examined using several key concepts to crystallize the importance and acknowledge that the outcome of research, research results, or even publication is subjective, not objective. It is hardly neutral, with a black box covering power relations as well as ethical implications of the process, particularly aerial surveillance technology and archaeology (Lekka-Kowalik, 2010). These key concepts will help with understanding knowledge and epistemic injustices by examining whose knowledge or understanding is prioritized and whose is excluded, as it is critical to understand the ethical entanglements and epistemic hierarchies in a supposed neutral mechanism or process.

The first concept is semantic incommensurability, coined by Thomas Kuhn, which contends that the meaning or understanding of a particular thing will undoubtedly differ and cannot be compared due to differences in background, worldview, or paradigm, even if common words are used (Kuhn, 1970). In other words, it means that the meaning or understanding of the words is not the same or aligned with the different systems (Gefaell & Saborido, 2022). For a foreign expert, heritage is an object and a monument, whereas for a local, it is a living site with spiritual significance. For example, Lidar can only capture features of the rock, but the locals see it as a spirit or a spiritual being, or Neak Ta in Cambodia's case.

The second concept is the emic and etic perspective, which is derived from the words phonemic and phonetic and was developed by linguist Kenneth Pike to depict the differences in understanding of insider and outsider perspectives (Pike, 1967). In linguistics, phonemic refers to the sounds of a specific language that are unique to that language (Bowling & Fitch, 2015). In contrast, phonetic refers to the speech sound or the general physical characteristics such as how air flows through the throat, tongue, and lips (Laver, 2017). In archaeology, emic can represent local knowledge and interpretation, as well as local culture, whereas etic represents external opinion and supposedly objective analysis (Bornet, 2019). Bronisław Malinowski's concept of participant-observer, well-known in anthropology, emphasizes the importance of living among the locals to fully immerse oneself in the experience and gain an insider's perspective (Malinowski, 2002). However, the purpose of this article is to examine the emic and etic from a reflexivity network-oriented perspective, drawing on STS, with a focus on the relationships of actors, both human and non-human, in the archaeological process, as well as the structural positions they hold (Webmoor, 2013). It seeks to use reflexivity to investigate how Cambodian archaeologists and locals are positioned during colonial mapping and contemporary LiDAR. This is significant because, in the case of aerial digital surveys, the issue is that etic, or outsider opinions, are typically based on scientific categories but in contrast, emic, or insider opinions, such as cultural understanding, meanings, beliefs, and feelings, are not represented (Bornet, 2019; Ros, 2024).

The third concept is epistemic injustice, which refers to the unfairness of knowledge as a result of a process or prejudices, which can be a case of testimonial injustice, not believing or being ignored, or hermeneutical injustice, not having a concept to explain to outsiders, which can also result in dismissal of their understanding or belief (Wong & Palá Gutiérrez, 2025). While downgrading or ignoring is one example, there is also a phenomenon known as epistemic theft, in which power groups extract or take information and knowledge from local communities without attribution, consent, or benefit sharing and frequently rebrand as scientific discovery, which can be equated to knowledge colonization (Tynan, 2024).

All of these concepts, when combined, form a solid foundation for just epistemic and knowledge production. In particular, lidar data or mapping in the past has been concerned with not only locating or identifying a specific point, but also with how to find it, who is involved, and what the point means. However, the purpose of this is not to explain how to design archaeology, but rather how archaeology is currently practiced and how it can be improved.

KHMER WAYS OF RECORDING HISTORY: EPISTEMOLOGIES BEFORE THE FRENCH

Before examining into the discussion of the aerial survey and the unequal epistemologies that accompany it, it is critical to understand the differences in how the Khmer people recorded, shared, and valued historical knowledge, as opposed to how the West, particularly the French at the time, introduced documents and cartography to record history.

Instead of considering the supposed neutral or secular way of recording scientific information from an extraneous etic lens, the Khmer, emic, has its system of member that relates to spiritual legitimacy, cosmology, and ethics, where is maintained a rich form of historical recording and sharing through oral, performative, symbolic, and sacred through monastic, toral, or day-to-day life, which is different from the western positivist transitions (Piphal et al., 2023). By uncovering this, it is important to understand that the topic of epistemic injustice is not a new issue, but has always been embedded, carried with, and exacerbated since the French colonized Indochina (Thun, 2020). This Khmer tradition of recording history can also be reflected in landscape mapping, as the landscape is not entirely mapped or understood through scale, measurement, or geometry alone, but also through belief, ritual, and the meaning of social life, and Angkor Wat is a perfect example of the combination of the two aspects, one of which is considered scientific and the other is local epistemology and ontology (Kasiannan, 2006).

The Khmer used several methods to record their activities, including stone carvings. This method includes not only word inscriptions but also the carving of stories about kingship and cosmic order, as well as the daily activities of citizens, their surroundings, and their relationship to the king (Sotheavin, 2015). While from a foreign perspective, in this case, France, see the inscription as merely data and data sets to which they can add narrative (Sotheavin, 2015). The name of the Khmer temple in the inscription may differ; for example, from what the French scholars believed to be and from what they published (Sotheavin, 2018). The interpretation of words, similar the temple names, from the inscription by the French, which has already been published, also needs to be revised because they might have missed or assumed how the old Khmer or Sanskrit in the Cambodian context works, which is not the case (Sotheavin, 2018). Furthermore, ancient Khmer society believed in a cycle of life, reincarnation, and cosmic rebirth, which is emphasized through names, but this is not the same as the French linear and positivist approach (Piphal et al., 2023). That being said, the two different understanding of the system may also lead to two different interpretations of the same thing.

Aside from stone carving, the Khmers used sleuk rith, or palm leaf, to write. This method has presumably continued after the Angkor period, which lasted until the 13th century, and there appears to be less stone carving after the Angkorian period (Chandler, 2008). Sleuk rith can be used to record state politics and relationships, as well as for Buddhist script, as Buddhism emerged and continues to have a significant influence in Cambodian society after Angkor (Walker, 2020). The Buddhist script is usually read and recited and placed pagoda and those who wish to study must visit the pagoda or to attend the monk's preaching (Walker, 2020). It can also be considered a living document as well as a performed knowledge, both of which are closely related to religion, spirit, and the social community (Walker, 2020). Although it is equally important in Khmer history, the French's extensive research and references in EFEO publications are limited in comparison to stone carving. Perhaps as a result of the French expert's prioritization, the majority of Cambodian sleuk rith were not thoroughly studied, implying dismissal or devaluation rather than the external expert's interest (Chapman, 2018). It is potentially discredited due to bias and dismissal as unimportant, and it may lack scientific value because it was received through oral preaching, for example, the French dismissed and treated the Khmer scholar during that time as “nonhistory” (Edwards, 2007). As previously stated, ritual, performance, or oral story was treated as unimportant, with some only categorizing them as aesthetic objects for preservation and display, separating them from the court rituals and cosmology from which they originated, and presenting them in fairs by the french, for example, the 1906 Marseille Colonial Exhibition (Edwards, 2007). Alternatively, in the case of landscape memory is also likewise, the EFEO surveyors omitted Buddhist shrines and monks in order to portray Angkor as deserted (Falser, 2013).

In any case, this demonstrates that the Khmer ways of knowing and doing things have been influenced and redefined by external sources and actors. In other words, the etic is stronger than the emic, which led to the application of the French understanding of the world to Cambodia, disregarding the semantic incommensurability, and resulting in epistemic theft and injustice.

HISTORICAL USE OF AERIAL SURVEYING TECHNOLOGIES IN CAMBODIA

As stated in the previous section, the French have dominated Cambodia's archaeology, owing primarily to their colonization of the Indochina region. That being said, when the French were in control, they initiated aerial surveillance in Cambodia in the early 1920s (Evans & Moylan, 2013). In last 1920s, the École Française d'Extrême-Orient (EFEO) and its military launched an aerial photography mission for Angkor using a plane. It is important to note that the project was specifically designed to create topographical maps for archaeological plans in the area (Evans & Moylan, 2013). This, however, is not isolation; aside from the photo being taken, for example, the description of the aerial photo combining with the colonial narrative mapping by prominent figures within the EFEO such as Henri Parmentier, who was merely an architecture at first, use the photo to portray and showcase by reconstructing the site's spatial logic by removing the Buddhist shrine and recollecting Cambodian monks to portray Angkor as dead, instead of a living All of this was also related to attracting tourists to come to Angkor (Falser, 2013).

Following 1920s, the aerial survey photograph was displayed at the Colonial Exhibition in Paris in 1931, primarily to demonstrate the country's technological and scientific prowess and influence over the colonies (Falser, 2013). In this case, the camera, the plane, and the expert who took the photo were not to interpret the Khmer past, but to demonstrate that the French are dominating the Khmer cultural heritage and not intended to explain it from a Khmer perspective, effectively downgrading Khmer culture to secondary status.

The aerial arachnology does not stop here, later another noteworthy aerial survey trip occurred in the 1940s, when French surveyors from Service Géographique de l'Indochine used aerial photogrammetry to survey the land and redraw Cambodian maps (Evans & Moylan, 2013). The data captured was then used for the spatial framing was then translated into guidebooks and tourist maps, which became a common reference tool, and to cement an external view of Cambodia, as evidence, the French created the petite and grand circuit, a road for tourists to come and see the aesthetic and architectural descriptions shown by the temple, but it was not done to show or heighten local cosmological, ritual, and mnemonic geography (Falser, 2013).

Next, in addition to the French-led archaeological survey, in the 1960s, after Cambodia gained independence and before the Khmer Rouge took power, aerial surveys in Cambodia continued to be conducted by foreigners, but this time not by the French with planes, but by the United States with satellite imagers, primarily from the KH-4 Corona and KH-7 Gambit missions (Evans & Moylan, 2013). It is important to note that without the declassification, there may not be an archival repository for the landscape analysis.

Based on the history of the Aerial survey, it is clear that Cambodian history has been dominated or captured by outsiders. The domination has resulted in epistemic theft and injustice because the actors, both human and non-human, marginalized the Khmer, as the extraneous foreign, with its technology used to dominate and dictate the space from their lenses, and the Khmer people and temple were viewed as merely one of the data sets mentioned above (Falser, 2013). It is only perceived as another space to be captured, considering the US satellite, whereas the French can be considered one of the colonies that they colonized and now own. In other words, the camera, plane, and photo, as well as the dominant narrative and the French narrative, are all embedded with prejudice, and Khmer is not linked or visible in these frames. These colonial precedents normalized a view-from-above in which outsiders plan the mission, classify the ground, and curate the archive. The next section will examine further in today's defaults of how aerial archaeology works.

THE CONTINUITY OF EPISTEMIC INEQUALITY IN THE LIDAR ERA

In this section, the article will look at a new type of aerial archaeological survey that uses Lidar (Light Detection and Ranging) and can be equipped with a drone. This technology, through the emission and reception of a laser pulse wave, can scan the terrain and understand the landscape without the need to remove dense forest cover, which is non-destructive (Mlekuž, 2015). While it is understandable that Lidar has made significant contributions to landscape mapping and archaeology, research into how Lidar can lead to epistemic uncertainties, particularly when used for archaeology to interpret history for a group, has been far less extensive (Ros, 2025).

To begin with, if not used carefully, archaeological research can be dominated by technology rather than attempting to understand the local context or identify cultural gaps and questions (Lock & Pouncett, 2017). Lidar technology can be used for specific functions but cannot provide an answer or a complete picture of history. It is important to note that Lidar is an expensive and sophisticated methodology that Cambodian researchers may not have the opportunity to fully train or use properly. This is not only the case in Cambodia; even in leading nations, Lidar or GIS is a separate field and discipline, and archaeologists are not always the ones who operate the tool or

know how to use it, and only receive the data later (Poehler, 2023). That being said, Lidar is not neutral in the sense that the technology embedded in it already frames what questions should be asked, what area or location to work on, and not to mention that the project is designed and funded by an institution outside of the country, for example, to focus on only survey water networks but not on the cultural ontology (Lozny, 2011). Moreover, once again, this may call into question the Khmer's understanding of space and time, as well as their disregard for traditional knowledge (Piphal et al., 2023). That being said, the technology comes with a preconceived notion of what research is possible and what is not possible, neglected, or worthy of the tool to be used, which shapes how knowledge is created (Ros, 2025).

Furthermore, as technology advances, the way lidar works and its dataset will become less accessible to the local community and scholars. It is because the data will be stored in the cloud and controlled by a foreign team, which adds barriers and red tape to participation and involvement (A. S. Cohen et al., 2022). Data sets received or permission to use and reuse them independently could also be an issue, as they may necessitate screening (Düring, 2025). However, the problem with data collection is that it is not meaningful and does not capture the host's complete ontologies and epistemologies. For example, the flight path for the drone and lidar is determined not by cultural geography, but by scientific feasibility (Jameson, 2020). Furthermore, a potential issue is that the lidar algorithm may remove what it considers to be noise, such as vegetation, small huts, or offerings, or does not fit the targeted massive structure or mound or the preset terrain model intended for, resulting in the omission of living religious sites or sights (Moullou et al., 2024). Within that, in terms of data classification, the GIS software, for example, can categorize it as simply temple, canal, residence, and so on, but this can reclassify the meaning and spiritual landscape, with local meaning not embedded, resulting in the loss of local knowledge (Moullou et al., 2024). It does not acknowledge and appreciate the integration of local meaning, and the knowledge or outcome created is still filtered by external lessons, particularly through technology, resulting in the prioritization of objective narrative while ignoring Khmer perspectives.

Furthermore, when the technology is expensive, it is treated with caution. This mentality is also linked to a capitalist phenomenon, in which lidar projections may require the involvement of an international team, as well as a grant and the need for publication, potentially leaving the drop-in, drop-out mode of research (Shanks & Tilley, 1987). Because part of the project requires publication due to the grant condition, the strategy is to extract data while limiting cost and time, reflecting the capitalist logics of productivity rather than long-term study, and ethically engage with the community (Düring, 2025; Shanks & Tilley, 1987). Furthermore, the way archaeology is done now, particularly with the inclusion of aerial tools, means that it is no longer land-based and traditional; the work to be done could be half on the spot but still with digital devices, and the other half is with data cleaning, categorization, running the simulation or modelling, and interpretation, which again takes one out of context and instead works with technology (Sylaiou et al., 2025). The problem here is that the importance of skill transfer and co-creation of research agendas has been downgraded. In other words, research is a transaction in which efficacy is prioritized over relationship to understand and build epistemic justice (Lock & Pouncett, 2017). Without a proper monitoring system in place to ensure that there are emic and etic interpretation of data or curating data, as well as emic and etic data retrieval methods and accessibility, Cambodian may also face the issue of parachute scientists and over-reliance on technology (Ros, 2025).

On the other hand, it is also important to acknowledge that lidar comes with unequal labor. This is because the project design so that local labor, in this case Cambodians, is mostly contributed as drivers, security, field assistants, or cultural translators instead of the capacity or role that the foreign expert holds, which are those who operate the technology, do the analysis, share the final analyze output or data that is sorted from their epistemology, and also monitoring authors (Heffron & Tütüncü Çağlar, 2025; Heng, Phon, & Heng, 2020). It is also worth noting that local experts are sometimes assigned multiple tasks beyond the core architectural work that must be completed. It is because doing archaeological work is not merely going and doing the digging for a survey (Poehler, 2023). However, this is reflects the Cambodian case where it also holds an amount of task in the logistical arrangement, clearing of the space, doing the translation and coordination work, doing the report for its institution, all of which piles up and also lead to the reason of being able to add much added value to the external counter parts or participate in a way that the network is symmetrical, sometimes even the data set give afterward or being completely left out (Heffron & Tütüncü Çağlar, 2025, Heng, Phon, & Heng, 2020). Such practices closely resemble what occurred in the past here, but they are neither acknowledged nor sanctioned. This phenomenon is yet another example of a network of indigenous actors who are underappreciated, even when the knowledge they produce is about their own homeland and heritage.

In conclusion, the lidar is more than just a neutral tool because it is used in a network of humans and non-humans, and as a result, it may gatekeep data or renarrative data from an etic perspective rather than an emic perspective, reinforcing systemic injustice and marginalizing the Khmer way of understanding knowledge.

DATA ETHICS AND ETHICAL REFORM IN THE AGE OF LIDAR ARCHAEOLOGY

Within the STS context, approaching Lidar and its data sets requires caution to avoid being blinded by the visualized output it provides, while also understanding the constraints of narrative and how they are presented to the general public. The restructuring of the narrative, as well as the introduction of this technology into the field, necessitates the reconfiguration of human and non-human actors' roles and activities, which is not simply considered a normal technological addition. This technology alone has the potential to reshape and impact research ethics, data ownership, and, ultimately, empirical quality. In other words, in addition to the lavish new content generated and used by lidar, what has been left in the black box, hidden, or ignored is data justice, consent, and epistemic knowledge ownership (A. Cohen et al., 2020). That being the case, it is also critical to provide solutions in addition to pointing out potential issues.

First, in terms of data ownership and access, Cambodians are primarily viewed as subjects rather than owners because they cannot share and participate in the technical aspects of the project (Ros, 2024). To reconfigure such as asymmetrical relations or hidden networks, it may be best to include data sovereignty clauses in MoUs or research codes of conduct that require not only the sharing of raw and processed data, but also the translation of it into Khmer (Ros, 2025). Furthermore, having the data and having it translated does not equate to being able to use it properly; therefore, it is critical for the research design at the outset to consider and take action to support local development and infrastructure, as well as training in Cambodia for lidar and its system (Ros, 2025). This also helps with the issue of drop-in and out of the program, as well as Cambodian labour inequality.

Second, downplaying the importance of the local is a primary ethical concern. Although lidar is flying above, the data being captured is unknown to the locals, who are unaware that their sacred space has been digitized and what the outcome and interpretation will be (Simbolon & Comer, 2023). In this case, it is critical to have a proper protocol and guidelines for technology use in archaeology, particularly for ethical remote sensing, which requires community notice, dialogue, and benefit-sharing, as well as details about flight paths, mapping, types of technology, and actors involved to ensure that the findings are accessible while also culturally relevant (Kemarau et al., 2024).

Third, the issue of exclusion of data interpretation leads to the epistemological inequality, which states that only what can be measured is knowable (Wylie, 2011). Other ways to deal with this include having emic-etic interpretation layers, rather than the foreign team doing its interpretation and then sharing the results. The data should not be interpreted or relied on solely, but should be supplemented with ethnographic and oral history perspectives (Huggett, 2022).

Overall, as discussed by Ros (2025), in Cambodia's context, the main actor that could re-configure the network is the Minister of Culture and Fine Arts, as well as the specific authority such as the Apasara National Authority, with the former overseeing all cultural heritage matters and the latter focusing specifically on a specific region, Siem Reap Province. These two institutions, for example, serve as gatekeepers for research projects by issuing and approving permits, as well as monitoring and evaluating the project (Piphal et al., 2023). As a result, it is ideal that the initiative come from these authoritarian institutions, but also a proper governance framework, guidelines, and work processes to ensure epistemologies (Ros, 2025). Other actor to check and verify epistemologies, such as the Royal University of Fine Arts, or the establishment of an ethical board to review projects, again under the supervision of the ministry of the specific institution to deal with digital anthropology and aerial anthropology, may also be required (Ros, 2025).

That being said, while lidar has been seen and praised for its accuracy or new angle of arachnology, as well as its ability to democratize knowledge, this will only be true if it is reconfigured to be ethically and epistemically just. The reconfiguration entails strengthening and amplifying the emic voices, redistributing technological access, and locating the core of the archaeological research using lidar on the historical and local value and memory rather than the data sets. In other words, data justice cannot be achieved solely through technical means, but also through political, epistemological, and ethical transformations that are hidden and embedded within the system.

CONCLUSION

Overall, looking at historical trajectories, it is clear that aerial surveying for archaeological purposes was dominated by external experts who had already painted the Cambodian story from their perspective, from French colonial photogrammetry in the 1920s to U.S. Cold War satellite reconnaissance in the 1960s and 1970s. In today's

world, LiDAR mapping and other forms of aerial surveillance reveal a concerning pattern that contains the risk of epistemic inequality embedded in the hidden network and black box of the arachnological proactive.

Through ANT, it can be seen that the expensive technological device has been centered with the external experts, and this also dictates the research design and agenda, while also through the technology-centered may led to prejudice of assuming of what data to collect and which not to collect, leading to the exclusion of local epistemology and idea of knowledge that is rooted in other forms other than liner scientific rigorous as presumed by the external view, for example. With ANT, the relationships between humans and non-humans, such as external institutions, local experts, plans, satellites, lidars, algorithms, GIS systems, and so on, are linked and networked in a way that prioritizes efficiency, cost-saving, and rapid dissemination of results over long-term engagement with local or so-interpretation and the creation of a balanced and symmetrical understanding of knowledge. The network also leads to unequal labor realities, where local experts are often entangled in other arrangements but lack epistemic engagement or are unaware of the epistemic justice issue after working under the dominance of external experts for so long.

It is also important to note that in order to address this epistemic inequality, it is necessary to consider not only training but also the overall reconfiguration of the network, a structural revision. It is here that the research agenda should be co-created and identified, and technology is used to serve the community rather than prioritizing the data set, technology, or external academic and economic interests. Furthermore, the obligation to share data from raw to processed, as well as to collaborate and interpret, is critical to ensuring that humans, algorithms, or technology do not undermine local epistemologies. By revealing the network, Cambodian archaeology can move forward to decolonize the context and meaning of prejudice, thereby sustaining the knowledge system with Khmer heritage for centuries. To decolonize aerial digital archaeology, specifically in Cambodia, it is necessary to reconfigure the network, specifically from flight plans to file permissions, in order to help take more precautions and consideration of Khmer epistemologies, shared authorship, and enforceable data sovereignty into every project.

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