Lidar in Mesoamerica since 2016: Acquisition, Ownership, and Accessibility

Kathryn Reese-Taylor and **Arlen Chase**

In 2016, we were privileged to edit a special section in *Advances in Archaeological Practices* on lidar in Mesoamerica and are delighted that the editors of AAP have invited us to provide an update to that special section in this blog. At that time, lidar acquisition was still uncommon, with only a handful of projects being fortunate enough to acquire the data that was revolutionizing settlement studies in tropical areas like Mesoamerica. Since 2016, many studies covering large areas in excess of 100 km2 have followed (Golden et al. 2021; Inomata et al. 2018; Ringle et al. 2021; Šprajc et al. 2021; Stanton et al. 2020; Sugiyama et al. 2021), including the major lidar acquisition funded by Pacunam in Guatemala, with phase one covering 2144 km2 in 2016 (Canuto et al. 2018). To alleviate a bias in lidar collection due to the prohibitively high cost of flying small scale surveys, NCALM (National Center for American Laser Mapping), funded by NSF (National Science Foundation), initiated a small project grant program, which allowed seven research projects to acquire smaller areas of coverage ranging in area from 10-30 km2: three in Belize, two in Guatemala, one in Mexico, and one in El Salvador. Several recent studies also have made use of publicly available data from INEGI and Nasa's G-LGHT (Inomata et al. 2021; Kokalj and Mast 2021; Ruhl et al. 2018; Schroder et al. 2020).

However, despite the increase in coverage, equity in acquisition, ownership, and accessibility of lidar have not become easier since 2016 in Mesoamerica. We have recently participated in two forums that focused on these issues, Chase in the special collection of papers in the *Journal of Computer Applications in Archaeology* (2020) and Reese-Taylor in an ethics forum in the Earth Archive Congress (2021). We represent just two of the voices that have grown exponentially to call for more ethics and oversight in archaeological lidar prospection.

While many issues have been raised, ownership may be one of the most imperative. Ownership refers to people or institutions that, first, hold a special interest in lidar and data derived from the lidar, and second, the ownership of the land, resources, and elements captured in lidar data. Given that the vast majority of lidar for archaeological purposes is acquired by researchers from the global north, a digital elitism has emerged (Cohen et al. 2020). Adding to this issue is the fact that to date, no government agencies in Mexico, Guatemala, or Belize have formal written policies that clearly articulate ownership rights and accessibility privileges. Given that lidar data does not only reveal heritage features, but also private homes and businesses, public facilities and infrastructure, along with geographic and environmental data, creating these policies would, no doubt, involve multiple agencies. Yet, government agencies can develop such policies and best practices, this would ignore two significant problems.

One concerns the rights of local residents, including many indigenous communities. Do individuals that live and work on the lands captured by lidar prospection have "moral"

rights to own and control the data? Should local residents have the ability to stop lidar prospection due to privacy concerns? Given that lidar collection can take place from far above the earth's surface, any proscriptions become problematic (similar to "google earth" or "street view").

Another involves collaboration with colleagues in countries lacking large funding agencies and technological support. How can the playing field be leveled so that these researchers have the same opportunities to acquire and use lidar in their studies? Is open access the answer and who decides? Because of computer and software costs, open access still privileges use by the global north and is not currently the policy in Belize or, apparently, in Guatemala. Some countries, like Belize, prohibit open access because of concerns about heritage preservation.

None of these questions have easy answers and many obstacles exist in our current institutional and funding models that undercut potential solutions. However, a fresh generation of archaeologists are pushing the ethical boundaries of lidar acquisition/ownership, just as they are the analytical boundaries of remote sensing (see Chase 2021). They are challenging all of us to be active allies and enter dialogues, not only with governments and academic institutions, but also with local communities. Realistically, such issues are beyond the scope of researchers alone; they need to be discussed and promulgated by the countries in which the lidar is being used and placed within broader policy contexts. We are optimistic that these conversations and their ensuing actions can help us achieve the equity and inclusion that is the future of our discipline.
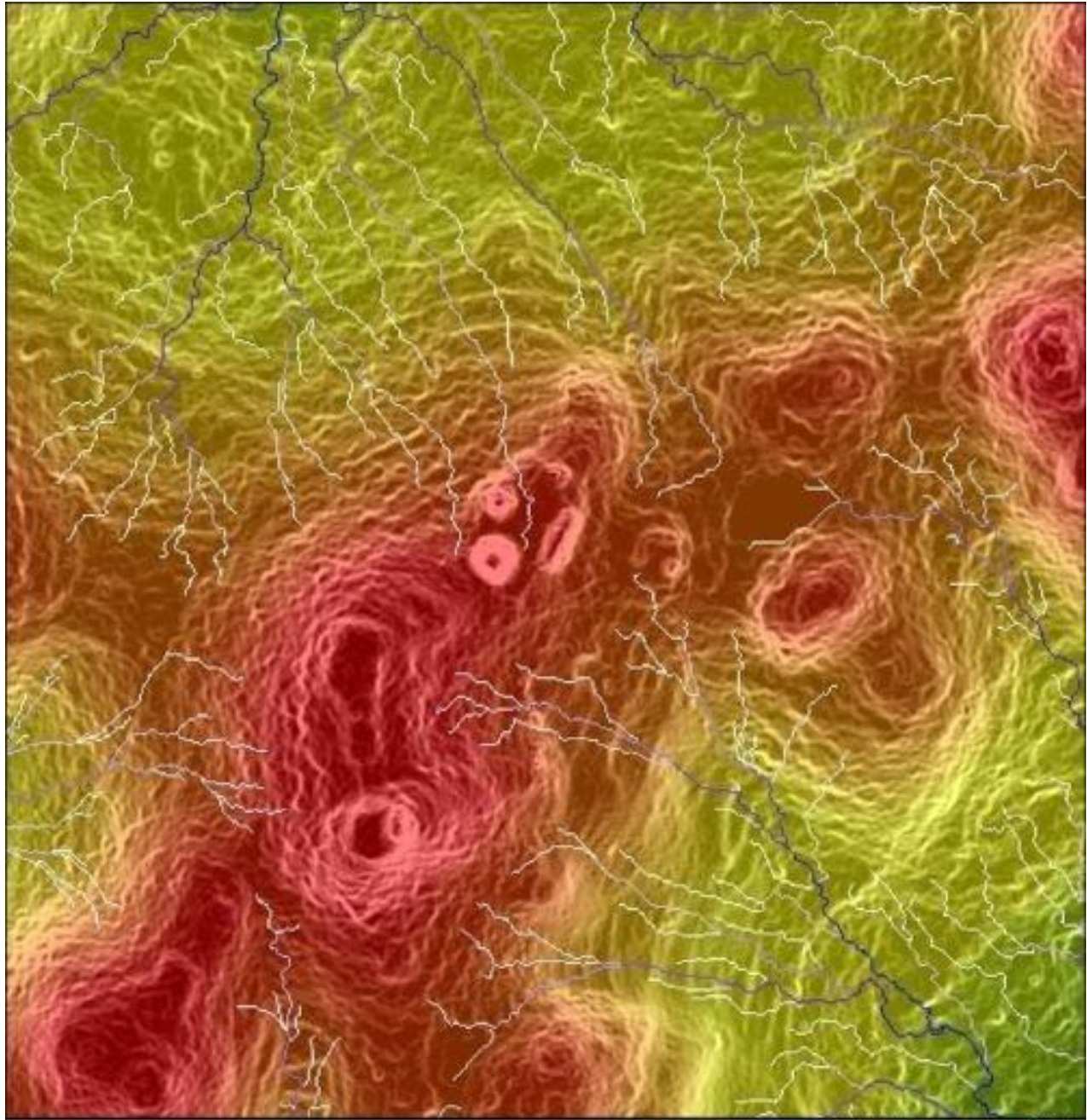
Access to associated research Progression and Issues in the Mesoamerican Geospatial Revolution (by *Arlen F. Chase, Kathryn Reese-Taylor, Juan C. Fernandez-Diaz* and *Diane Z. Chase*) is free until the end of June 2022.

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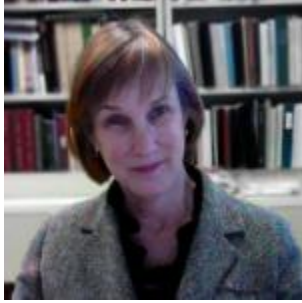
Kathryn Reese-Taylor has taught archaeology in the Department of Anthropology and Archaeology at the University of Calgary since 2000. Although she maintains broad interests in early complex societies, her principal research focuses on landscape archaeology, urbanism, and the development of complexity in the Maya lowlands. Reese-Taylor has directed archaeological projects in the Belize, Guatemala, and Mexico and published published numerous articles, chapters, and reports, often with collaborators and students. Her current project is a multidisciplinary program of research located in southern Campeche centered in the region surrounding an extensive wetland, the Bajo Laberinto. Since 2014, she has analyzed remote sensing imagery, including lidar, to assess landscape modification, urban development, and population dynamics in the Central Karstic Uplands.

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References cited

Canuto, Marcello A., Francisco Estrada-Belli, Thomas G. Garrison, Stephen D. Houston, Mary Jane Acuña, Milan Kovác̆, Damien Marken, Philippe Nondédéo, Luke Auld-Thomas, Cyril Castanet, David Chatelain, Carlos R. Chiriboga, Tomáš Drápela, Tibor Lieskovský, Alexandre Tokovinine, Antolín Velasquez, Juan C. Fernández-Díaz and Ramesh Shrestha
2018 Ancient Lowland Maya Complexity as Revealed by Airborne Laser Scanning of Northern Guatemala. Science 361(6409).
http://science.sciencemag.org/content/sci/361/6409/eaau0137.full.pdf

Chase, Adrian S.Z.
2021 Urban Life at Caracol, Belize: Neighborhoods, Inequality, Infrastructure, and Governance. Ph.D. dissertation. School of Human Evolution and Social Change, Arizona State University, Tempe.

Chase, Adrian S.Z., Diane Z. Chase, and Arlen F. Chase.
2020 Ethics, New Colonialism, and Lidar Data: A Decade of Lidar in Maya Archaeology. Journal of Computer Applications in Archaeology 3 (1):51-62. 10.5334/jcaa.43. hal-02567666

Cohen, Anna, Sarah Klassen, and Damien Evans
2020 Ethics in Archaeological Lidar. Journal of Computer Applications in Archaeology 3(1): 76-91.

Golden, Charles, Andrew K. Scherer, Whittaker Schroder, Timothy Murtha, Shanti Morell-Hart, Juan Carlos Fernandez Diaz, Socorro del Pilar Jiménez Álvarez, Omar Alcover Firpi, Mark Agostini, Alexandra Bazarsky, Morgan Clark, G. Van Kollias III, Mallory Matsumoto, Alejandra Roche Recinos, Joshua Schnell, and Bethany Whitlock
2021 Airborne Lidar Survey, Density-Based Clustering, and Ancient Maya Settlement in the Upper Usumacinta River Region of Mexico and Guatemala. Remote Sensing 13, 4109. ttps://doi.org/10.3390/ rs13204109
Inomata, Takeshi, Juan Carlos Fernandez-Diaz, Daniela Triadan, Miguel García Mollinedo, Flory Pinzón, Melina García Hernández, Atasta Flores, Ashley Sharpe, Timothy Beach, Gregory W. L. Hodgins, Juan Javier Durón Díaz, Antonio Guerra Luna, Luis Guerrero Chávez, María de Lourdes Hernández Jiménez, and Manuel Moreno Díaz
2021 Origins and spread of formal ceremonial complexes in the Olmec and Maya regions revealed by airborne lidar. Nature: Human Behavior 5:1487–1501. https://doi.org/10.1038/s41562-021-01218-1.

Inomata, Takeshi, Daniela Triadan, Flory Pinzón, Melissa Burham, José Luis Ranchos, Kazuo Aoyama, Tsuyoshi Haraguchi
2018 Archaeological application of airborne LiDAR to examine social changes in the Ceibal region of the Maya lowlands. PLoS ONE 13(2): e0191619. https://doi.org/10.1371/journal.pone.0191619

Kokalj, Žiga and Johannes Mast.
2021 Space lidar for archaeology? Reanalyzing GEDI data for detection of ancient Maya buildings. Journal of Archaeological Science: Reports 36:102811.

Reese-Taylor, Kathryn
2021 Digital Elitism or Digital Democratization: Accessibility and decolonization of lidar. Invited talk given at the Earth Archive Virtual Conference, June 16.

Ringle, William M., Tomás Gallareta Negrón, Rossana May Ciau, Kenneth E. Seligson, Juan C. Fernandez-Diaz, David Ortegón Zapata
2021 Lidar survey of ancient Maya settlement in the Puuc region of Yucatan, Mexico. PLoS ONE 16(4): e0249314. https://doi.org/10.1371/journal.pone.0249314

Ruhl, Thomas, Nicholas P. Dunning, and Chris Carr.
2018 Lidar Reveals Possible Network of Ancient Maya Marketplaces in Southern Campeche, Mexico. Mexicon 40(3): 83-91.

Schroder, Whittaker, Timothy Murtha, Charles Golden, Armando Anaya Hernández, Andrew Scherer, Shanti Morell-Hart, Angélica Almeyda Zambrano, Eben Broadbent, Madeline Brown,
2020 The lowland Maya settlement landscape: Environmental LiDAR and ecology. Journal of Archaeological Science: Reports 33:102543.
https://doi.org/10.1016/j.jasrep.2020.102543.

Šprajc, Ivan, Nicholas P. Dunning, Jasmina Štajdohar, Quintin Hernández Gómez, Israel Chato López, Aleš Marsetič, Joseph W. Ball, Sara Dzul Góngora, Octavio Q. Esparza Olguín, Atasta Flores Esquivel, Žiga Kokalj
2021 Ancient Maya water management, agriculture, and society in the area of Chactún, Campeche, Mexico. Journal of Anthropological Archaeology 61:101261.
https://doi.org/10.1016/j.jaa.2020.101261

Stanton. Travis W., Traci Ardren, Nicolas C. Barth, Juan C. Fernandez-Diaz, Patrick Rohrer, Dominique Meyer, Stephanie J. Miller, Aline Magnoni, Manuel Pérez
2020 'Structure' density, area, and volume as complementary tools to understand Maya Settlement: An analysis of lidar data along the great road between Coba and Yaxuna. Journal of Archaeological Science: Reports 29:102178.
https://doi.org/10.1016/j.jasrep.2019.102178.

Sugiyama, Nawa, Saburo Sugiyama, Tanya Catignani, Adrian S. Z. Chase, Juan C. Fernandez-Diaz
2021 Humans as geomorphic agents: Lidar detection of the past, present and future of the Teotihuacan Valley, Mexico. PLoS ONE 16(9): e0257550.
https://doi.org/10.1371/journal.pone.0257550