NO PREP

LiDAR and the Maya

Finding Hidden Cities from the Sky

Includes: Student reading, case study, differentiated questions, teacher key

Name: Period: Date:

LiDAR and the Maya: Finding Hidden Cities from the Sky

The Technology That Changed Everything

In February 2018, a team of archaeologists announced results from a LiDAR survey of northern Guatemala that rewrote what anyone thought they knew about the ancient Maya. The survey covered approximately 2,100 square kilometers of jungle — an area about one-fifth the size of Los Angeles County — and revealed more than 61,000 previously unknown structures. These were not isolated ruins hidden under vines. They were cities, towns, roads, agricultural fields, defensive walls, and water management systems — the physical infrastructure of a civilization that archaeologists had been studying for over a century without seeing most of it. LiDAR — Light Detection and Ranging — works by firing laser pulses from an aircraft and measuring

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What the 2018 Guatemala Survey Revealed

The scale of the 2018 PACUNAM LiDAR Initiative survey results was genuinely shocking even to experienced Maya archaeologists. The survey covered areas that had been walked by researchers for decades, areas where people knew there were ruins and had mapped what they could find. What LiDAR revealed was that what had been found was a tiny fraction of what was actually there. Among the discoveries:

massive defensive earthworks (walls, ditches, and ramparts) surrounding major cities and stretching for kilometers into the countryside. These defensive systems, some over a hundred meters wide, indicated a level of organized military threat and response that completely changed understanding of Classic Maya conflict. The Maya world, previously thought to have experienced warfare primarily as elite raiding for captives, was revealed as a landscape of fortified cities prepared for siege warfare on a scale approaching ancient Rome or medieval Europe. The survey also revealed the connections between cities: wide, straight causeways, called sacbeob in Maya, running through the jungle between major centers. Some of these causeways were raised above the surrounding terrain, paved with lime plaster, and wide enough for multiple people to walk abreast. They connected cities into a network, facilitating trade, communication, and military movement. The Maya were not isolated city-states connected by forest paths. They were linked by an engineered road system.

The Population Question Revisited

Before LiDAR, estimates of the total population of the Classic Maya lowlands during the peak of the Classic period ranged widely but generally fell in the range of five to ten million people. The 2018 survey results required revising these estimates dramatically upward. By counting the number of structures revealed by LiDAR and applying reasonable estimates for occupancy, researchers concluded that the Maya lowlands may have supported 10 to 15 million people (or possibly more) during the Classic period peak. This population figure has enormous implications. It means the Maya lowlands were one of the most densely populated regions on earth in the 7th and 8th centuries CE, comparable in density to medieval Europe or the Nile Valley. It means Maya agriculture had to be extraordinarily productive to feed this many people, which in turn requires rethinking assumptions about the efficiency of tropical farming. And it means the 9th-century regional decline involved the migration or death of enormous numbers of people, on a scale comparable to the Black Death in Europe.

LiDAR Beyond Guatemala: A Revolution in Progress

The 2018 survey was transformative, but it covered only a portion of the Maya world. LiDAR surveys have since been conducted at additional Maya sites, each yielding comparable surprises. The 2016 survey of Tikal revealed that the city was more than twice its previously mapped size. A survey of the area around Caracol in

Belize revealed a city of extraordinary extent with dense settlement extending far into the surrounding jungle. Surveys in the Yucatan are ongoing. The technology is also being applied elsewhere in the world. LiDAR surveys have revealed previously unknown cities beneath the forests of Cambodia (Angkor Wat and surrounding regions), the Amazon basin, and other tropical regions. The common pattern is consistent: forest environments are not barriers to archaeological discovery — they have simply required the right technology to see through. LiDAR is providing that technology, and the result is a fundamental revision of human prehistory in forested regions worldwide.

The Limits of LiDAR

LiDAR is revolutionary but not omniscient. It reveals the shape of the terrain — which structures exist — but not what is inside them, when they were built, who used them, or what they meant. Ground-truth excavation remains essential: every LiDAR-identified feature needs to be visited, documented, and ideally excavated by archaeologists working on the ground. The 61,000 structures identified in the 2018 survey represent centuries of potential fieldwork — far more than any current generation of archaeologists can excavate. LiDAR has created an extraordinary map, but the task of reading that map through excavation has barely begun.

Key Information: LiDAR and Maya Archaeology

Detail	Information
Technology	LiDAR: laser pulses from aircraft; measures return time to map ground surface
2018 Survey Area	~2,100 sq km in northern Guatemala (PACUNAM LiDAR Initiative)
Structures Found	61,000+ previously unknown structures revealed in 2018 survey
Defensive Walls	Massive earthworks surrounding cities — evidence of siege warfare
Causeways	Sacbeob: wide, straight, plaster-paved roads connecting Maya cities

Detail	Information
Population Revision	Estimates revised to 10-15 million+ in the Classic Maya lowlands
Tikal Revision	2016 survey showed Tikal was more than twice previously mapped size
LiDAR Limits	Reveals shapes, not contents, chronology, or meaning; excavation still required

Case Study: Marcello's Screen

Marcello Guerra had been staring at LiDAR data for six hours when he found the city. He was a remote sensing specialist working for the PACUNAM survey team, his job to process raw point cloud data into interpretable images. He had done this hundreds of times. He knew what natural terrain looked like, knew what previously documented ruins looked like. This was neither. He was looking at an area tagged as 'secondary jungle, no known features' in the project database. The processed image showed something that looked like a grid. Not random mounds — a planned, organized layout of platforms, a central plaza, what appeared to be at least three large structures of pyramid scale, surrounded by smaller platforms in a dense residential pattern. And connecting to it, running northeast: a causeway. A straight line through the jungle, raised above the terrain. Marcello sat back. The nearest documented site was twelve kilometers away. 'Hey,' he called to his colleague across the room. 'Come look at this.' His colleague leaned over his shoulder. Silence for a moment. 'How big?' she asked. Marcello ran the measurements. 'Central area is about two square kilometers. But the residential spread' — he traced it on the screen — 'goes at least this far. Could be a secondary city. Could be something bigger.' 'Has anyone ever walked that area?' 'Not in the database.' Marcello paused. 'We just found it.'

1. Marcello discovers a previously unknown city from satellite data without ever leaving his office. How does this change what fieldwork means for modern archaeologists, and what advantages and limitations does this kind of discovery have?

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2. The reading states that LiDAR creates an 'extraordinary map, but the task of reading that map through excavation has barely begun.' Using Marcello's discovery as an example, explain what excavation would be needed to understand the city he found, and why the map alone is not enough.

Multiple Choice

1. How does LiDAR technology reveal buried structures that are invisible to conventional aerial photography?

a) Sound waves are reflected differently from stone than from natural soil

b) Laser pulses penetrate gaps in the jungle canopy and return data from the ground surface

c) Satellite images at certain wavelengths can show chemical differences in soil above ruins

d) Infrared cameras detect heat signatures from ancient stone structures

2. What did the discovery of massive defensive walls around Maya cities in the 2018 survey reveal about Classic Maya conflict?

a) That the Maya built walls primarily to control trade rather than for military defense

b) That Maya warfare was limited to small raiding parties and never threatened cities directly

c) That Maya cities never engaged in warfare with each other during the Classic period

d) That Maya cities were defended against siege warfare on a scale comparable to ancient Rome

3. Why do archaeologists say that LiDAR surveys still require traditional excavation to be scientifically useful?

a) LiDAR cannot penetrate more than a few centimeters of vegetation and misses most structures

b) LiDAR data is too imprecise to locate individual structures accurately without ground surveys

c) LiDAR shows structure shapes but not contents, chronology, or cultural meaning

d) Ground excavation is needed to confirm the structures are Maya rather than natural features

Matching

Write the letter of the correct definition on the line next to each term.

Term	Definition
1. ___ LiDAR	A) The raw dataset of millions of laser return measurements before processing into a terrain map
2. ___ Sacbe	B) A raised road or bridge providing direct passage between two locations, often through difficult terrain
3. ___ Point cloud	C) A Maya term for a raised, plastered road connecting cities; plural is sacbeob
4. ___ Causeway	D) The organization behind the 2018 Guatemala LiDAR survey that found 61,000+ structures
5. ___ PACUNAM	E) Light Detection and Ranging; aerial laser scanning used to map terrain beneath forest canopy

Fill-in-the-Blank

1. The 2018 PACUNAM LiDAR survey covered approximately 2,100 square kilometers and revealed more than _____ previously unknown structures.

2. LiDAR population estimates revised Classic Maya lowland population upward to a possible _____ to 15 million people.

3. Wide, straight, lime-plaster paved roads called _____ connected Maya cities across the jungle.

Short Answer

Answer each question in 2-4 complete sentences.

1. How did the 2018 LiDAR survey results change archaeologists' understanding of the scale and density of Classic Maya civilization? What specific findings required the most significant revisions?

2. What does the discovery of interconnected causeways between Maya cities tell us about Classic Maya political and economic organization? How does this challenge earlier assumptions about city-state isolation?

3. LiDAR has revealed that forests have been hiding enormous amounts of archaeological information for centuries. What does this suggest about what we might still not know about ancient civilizations in forested regions worldwide, and how might this change archaeological priorities in the future?