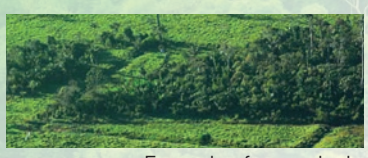
Lidar: Uncovering Lost Cities

Archaelogical evidence suggests that the Amazon Rainforest may once have been home to numerous complex societies. With the aid of lidar (light detection and ranging) equipped drones and technology, what's left of these ancient civilizations is now re-emerging.

Lidar is capable of penetrating the thick jungle vegetation at a rate of **560,000 dots/sec**

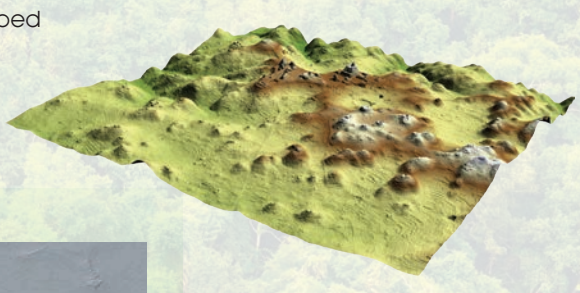
The Amazon today

- The Amazon Basin stretches **7,500,000 km²** across Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela
- The Amazon is covered by **5,500,000 km²** of dense tropical forest
- Archaeologists have identified **>450** geoglyphs in deforested areas and uncovered urban centers that were home to up to **10,000** inhabitants



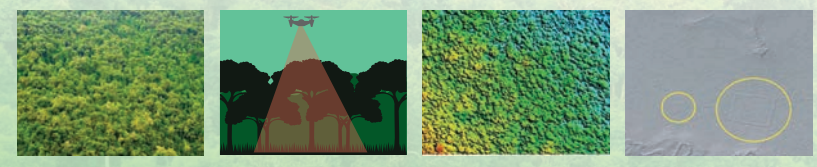
Example of a geoglyph.

Using lidar, **1000s** of acres of dense jungle can be finely mapped in just a few hours.

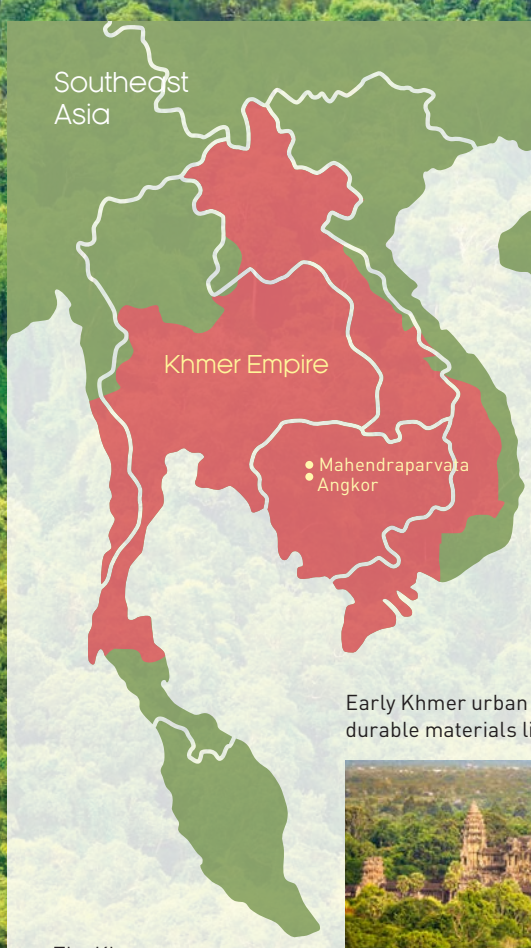


Lidar 2.5-D detail of the ancient Mayan city of Caracol, Belize. In 2009, airborne lidar was used to penetrate the dense forest canopy, revealing a large, sprawling urban center with religious temples and terraces.

How airborne lidar can reveal lost cities



1. With traditional aerial imagery, only the treetops are visible above dense jungle.
2. Lidar bounces hundreds of thousands of infrared laser pulses off the landscape below.
3. A digital map of the canopy is created (here colored by height), which can then be removed.
4. The remaining image is composed only of pulses from the previously hidden, underlying terrain.



The 2015 Cambodian Archaeological Lidar Initiative (CALI) airborne lidar study covered **1,901 sq km²** of terrain over **90 hours**.

The Khmer Empire

Recent aerial lidar surveys have shown that the Khmer empire, which ruled much of southeast Asia between the 9th and 15th centuries C.E., was made up of more densley populated and expansive cities, temples and canals than previously thought.

Early Khmer urban and agricultural networks were almost entirely made of earth and non-durable materials like wood and thatch that disappeared into jungle over the centuries.

The Khmer network of densley populated cities formed the **largest urban settlements** of pre-industrial times.

Expansive Angkor

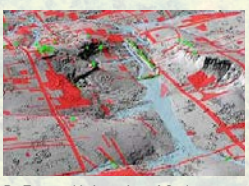
Lidar scans showed that the Angkor-era city surrounding the famous Angkor Tom temple, previously thought to be 9 km², actually covered an area of **40–50 km²**.

Ancient Mahendraparvata

Lidar scans helped uncover the ancient city of Mahendraparvata at Phnom Kulen dating to **~800 C.E.** when the first Khmer King Jayavarman II's reign was consecrated.

Reconstruction image of Angkor Wat based on lidar images and fieldwork.

T. Chandler, Monash University



An airborne lidar map reveals an urban landscape with an elaborate network of roads, dikes and ponds.

D. Evans, University of Sydney

La Mosquitia is a **83,000 km²** stretch of dense forest spanning the Honduras-Nicaragua border.

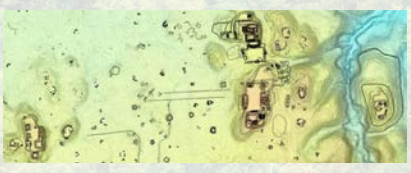
Maya civilization dominated much of Mesoamerica from **~250 B.C.E.** to the **10th century C.E.**

The **~200** known archeological sites in Mosquitia may have been part of a single political system.

Mayan cities and lidar

Lidar has revealed new details and provded a better understanding of how the Maya lived.

- Lidar mapping of Caracol, Belize showed that **~90%** of the site's remains had not been identified by conventional ground survey and revealed large structures, roads and reservoirs.



- Lidar revealed a complex at the Citadel of El Pilar that differs from classic Maya centers—it spreads across **10,000 m²** and is perched atop a ridge with the appearance of fortifications, consisting of concentric terracing and six structures.

La Mosquitia and "La Ciudad Blanca"

Until recently, archaelolgical signs of complex Mesoamerican societies seemed to end in Honduras, but rumors of a lost city "La Ciudad Blanca" in the jungles of Mosquitia persisted. Thanks to lidar data, it's now beginning to reappear.

- The Mosquitia of today looks inhospitable, but lidar data show that pre-Columbian Mosquitia was made up of completely modified human environments with clear division of space, social stratification, and had roads leading to farms and outskirt settlements.
- Compared with what is known about the Maya, little is understood about the ancient peoples who lived in Mosquitia. Like the Maya, they built temples, pyramids, ball courts, and plazas; however, they used non-durable materials that have long since been reclaimed by the jungle.
- Lidar data from Mosquitia have identified at least two large cities that appear to be as large as or larger than anything previously found in Mosquitia. The data have also uncovered **~200** smaller sites, connected by **1000s** of canals and roads, with signs of farming, large structures and terraced landscapes.

Sources: Int'l J. Remote Sensing **38**(8-10); Opt. Photon. News **25**(1); http://angkorlidar.org; www.joseiriartearchaeology.net; http://anthropology.colostate.edu; www.caracol.org; Wikipedia; Getty Images / Infographic by Alessia Kirkland