Question 1-11 are based on the following passage.

This passage is excerpted from Joseph Mascaro, Gregory P Asner, Stuart Davies, Alex Dehgan, and Sassan Saatchi, "These Are the Days of Lasers in the Jungle," ©2014 by Joseph Mascaro, et al.

Just as the Moon's history was disrobed by laser ranging 50 years ago, Earth's tropical forests are giving up their secrets to the light. Airborne light detection and ranging-called LiDAR-has over the last ten years become a key tool that ecologists use to understand physical variation in tropical forests across space and time. Like an MRI of the human brain, LiDAR probes the intricate three-dimensional architecture of the forest canopy, unveiling carbon that forests keep out of the atmosphere, and also the mounting threats to that carbon storehouse: drought, fire, clandestine logging and brash gold-mining operations. Even the quintessential natural disturbance of the sun-filled light gap —long thought to enhance the incredibly high species diversity of tropical forests—has been deconstructed by laser technology.

Laser ranging in tropical forests is such a game-changing technology that science results can scarcely get through peer-review before they are dwarfed by still larger-scale studies. In a decade, laser power on commercial-grade LiDARs has skyrocketed and costs have plummeted. These improvements in LiDAR technology allow airplanes to fly faster, higher and farther, covering more forest area in a single day than every ground-based survey that has ever been collected in the history of tropical ecology. To estimate the amount of carbon stored in a 50-hectare tropical forest monitoring plot on the ground—the largest field plot in the world—takes a team of 12 people about eight months: a slog of rain and mud and snakes with tape measures and data log books. Today's airborne LiDARs can get you to within about 10% of the same carbon estimate in eight seconds.

It is this staggering contrast in scale between LiDAR and fieldwork that led us here: Before this decade is out, we could directly assess the carbon stock of every single square hectare of tropical forest on Earth.We could do it just as well as if we were standing there in the flesh with tape measures in hand. And we could do it for far less than what we have already spent to offset carbon emissions from forests. . . .

It is easy in principle, though logistically nightmarish, to measure carbon in tropical forests. A strict constructionist would cut, dry and weigh the biomass of the world's forests. But this is a self-defeating enterprise. As a result, it is likely that no one has measured carbon over a single hectare of tropical forest, even with the most detailed field surveys. For a century ecologists and foresters have relied on allometric[1] estimation in lieu of carbon measurements to translate field surveys of tree diameters, heights and wood densities into whole-forest carbon estimates. Given a volume with known dimensions and density, one would estimate its mass in a similar fashion.

As the new kid on the block, LiDAR has been tacked onto the back end—initially thought of as kind of large-scale helper to field surveys. Carbon estimates from the field have been treated as something inherently closer to the real thing than measurements made by LiDAR—ground "Truth" with a capital "T". This is perhaps understandable historically, but vis-à-vis actual carbon, there is no such thing as ground truth: both field and LiDAR efforts rely on allometry to convert measurements into carbon estimates. Prior to using these measurements for carbon estimation, they exist as standardized, spatially explicit, archivable and verifiable data -the needed substrate for a REDD[2] -type accounting program.

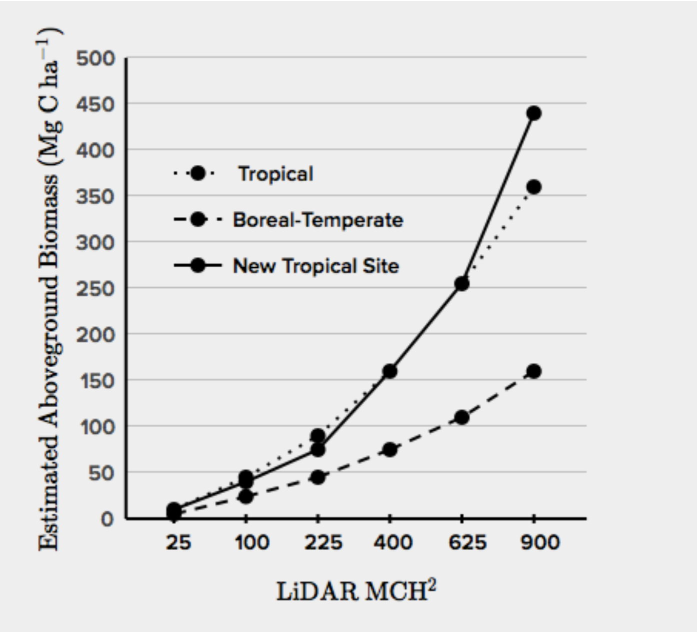
Due to the constancy of the underlying measurements, both field and LiDAR data could provide the needed information if they covered every hectare on Earth. But, in the case of field surveys, this is impossible. The surveys that do exist measure a tiny amount of actual forest, and so what might be verified is widely spaced. And to avoid fraud and protect landowners, many governments keep their plot locations secret. Satellite LiDAR data remain sparse, providing only extrapolated, coarse-resolution carbon estimates with very high uncertainties, and there is no prospect of wall-to-wall coverage in the near future. By 2020, airborne LiDAR could give us a direct measurement of 3-D forest structure for every hectare in the tropics: a standardized database from which to build a carbon economy.

[1] Pertaining to the study of changing proportions in part of an organism or body resulting from growth.

[2] Reduced Emissions from Deforestation and Degradation, a program implemented by the United Nations Framework Convention on Climate Change.

CONTINUE

Carbon Biomass and Mean Canopy Height (MCH) in Different Types of Forests



The graph illustrates the relationship in different types of forests between mean canopy vertical height profiles (MCH), as measured by LiDAR, and field-based estimates of carbon biomass.

Adapted from Gregory P. Asner, "Tropical Forest Carbon Assessment: Integrating Satellite and Airborne Mapping Approaches." ©2010 Institute of Physics and IOP Publishing.

1

The authors' central claim in the passage is that

A) LiDAR's opponents have prevented the technology from advancing to a point where it might be scientifically useful, favoring traditional methods.
B) Fieldwork and LiDAR are best used in combination when mapping carbon in tropical forests, in order to avoid human error while maintaining accuracy.
C) LiDAR is as important a technology as MRI scanning or the scientific study of the moon with lasers.
D) LiDAR technology is faster, cheaper, and nearly as accurate as traditional field methods for measuring the carbon biomass on Earth.

2

In the first paragraph, the words "disrobed," "unveiling" and "deconstructed" primarily serve to

A) highlight the negative connotations that laser technology currently has.
B) emphasize the extensive reach of laser technology.
C) demonstrate the inherently unknowable characteristics of objects, even with laser technology.
D) implicitly compare lasers to other forms of technology.

3

The authors imply that the main benefit of using LiDAR, as opposed to fieldwork, for measuring carbon in tropical forests is the

A) scale and rapidity with which LiDAR can be used.
B) expense of hiring scientists to carry out fieldwork.
C) rapid changes and improvements in LiDAR technology.
D) precision of LiDAR, which eliminates human error.

4

Which choice provides the best evidence for the answer to the previous question?

A) lines 19–20 ("In . . . plummeted")
B) lines 20–22 ("These . . . farther")
C) lines 32–34 ("Before . . . Earth")
D) lines 34–36 ("We could . . . hand")

5

As used in line 45, "translate" most nearly means

A) convert.
B) move.
C) transform.
D) express.

6

The authors use the phrase "ground "Truth" with a capital "T" (lines 54–55) in order to

A) argue that field measurements should be given up in order to focus exclusively on LiDAR measurements.
B) illustrate the impossibility of ever gaining accurate and usable measurements from either fieldwork or LiDAR.
C) defend the idea that LiDAR measurements are inherently more accurate than measurements obtained via fieldwork.
D) note the excessive faith scientists have put in the accuracy of field-survey estimates.

7

The authors imply that the response of various officials to attempts to measure their countries' carbon stock through field surveys has been

A) unhelpful, because they fear that jobs for their countries' scientists will be lost.
B) helpful, because their countries have invested significantly in technology to allow studies to expand.
C) helpful, because their countries stand to benefit from universal carbon data that the studies will uncover.
D) unhelpful, because they do not make their countries' land holdings readily available for study.

8

Which choice provides the best evidence for the answer to the previous question?

A) lines 63–65 ("Due . . . Earth")
B) lines 66–68 ("The surveys . . . spaced")
C) lines 68–70 ("And . . . secret")
D) lines 70–73 ("Satellite . . . future")

9

The data in the graph support the authors' point in paragraph five (lines 50–62) about the uses of LiDAR by

A) providing an example of the use of information from LiDAR in conjunction with traditional field-based estimates.
B) comparing data gathered by LiDAR technology from three separate forest sites.
C) showing LiDAR's superior accuracy compared to data gathered through fieldwork, even though the graph uses estimated figures.
D) presenting an example of the use of LiDAR in a tropical forest, which until this study was purely hypothetical.

10

It can reasonably be inferred from the graph that

A) for the same mean canopy height (above 25 MCH^2), tropical forests have more carbon biomass than temperate forests.
B) there is an inverse relationship between mean canopy vertical height and aboveground carbon biomass.
C) at a mean canopy height of 625 MCH^2, all three types of forests depicted will have approximately the same aboveground carbon biomass.
D) on average, the new tropical forest has less aboveground carbon biomass at a given canopy height than the boreal-temperate forest depicted.

11

The information from the graph best supports the claim that the carbon biomass of the three forests depicted is most disparate at

A) 25 MCH^2
B) 225 MCH^2
C) 400 MCH^2
D) 900 MCH^2