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the study is important. When comparing before and after optical imagery, even with high resolution, it's difficult to detect a damaged building that dropped down the height of a story with only minimal horizontal change.

When Moya's team evaluated aerial lidar's success at collapsed building detection, it determined that the technique achieved its greatest accuracy (93%) for structures that had lost 0.5 meter or more in height. To come up with that accuracy, the researchers compared their lidar results with the findings from a field assessment of damage conducted by another research group (that included one of Moya's coauthors) in Japan that was studying the impacts of the same pair of quakes, Moya said.

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The Future of Damage Assessment

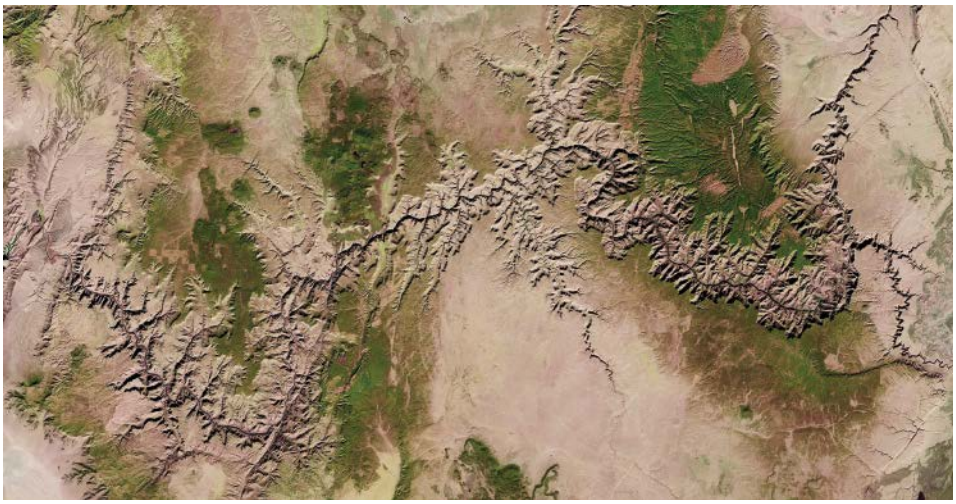
Rapid response to an extreme event is possible if accurate information is continuously gathered before the event occurs and can be followed by collecting the same kind of data after the event for quick comparisons, according to Renschler. "What is often forgotten is that emergency managers may not have the opportunity of gathering such data, but once something happens, they are really in need of that information," he said.

Decision makers in earthquake-prone communities should take note of the potential of the lidar methods demonstrated in this study, he added. "With the technology getting cheaper, communities may want to do this assessment on a continuous basis so that they are updated," he said.

In the meantime, Moya isn't waiting for decision makers. His next step is to try to combine lidar data with data from other sources to explore the possibility of identifying damaged structures with only postevent information.

By **Laura G. Shields** (email: lgshields@gmail.com; @LauraGShields), Science Communication Program Graduate Student, University of California, Santa Cruz

Report Recommends Priorities for Earth Observations from Space



A mosaic of two Landsat 8 satellite images taken in 2009 shows the Grand Canyon in the southwestern United States. A new report by the National Academies of Sciences, Engineering, and Medicine offers a 10-year plan for making the most-needed observations of our planet by U.S. spacecraft. The Landsat program has carried out space-based imaging of Earth for decades. Credit: Smith Collection/Gado/Archive Photos/Getty Images (image courtesy USGS 2009)

Nearly 60 years after the launch of Explorer 1, the United States' first satellite, a new decadal strategy for Earth observations from space calls for U.S. federal civilian agencies to coordinate and advance a U.S. program of Earth observations from space "that is robust, resilient, and appropriately balanced."

"Earth science and applications are a key part of the nation's information infrastructure," according to the National Academies of Sciences, Engineering, and Medicine (NASEM) report *Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space* (http://bit.ly/NASEM-Decadal). It calls for the primary U.S. civilian agencies involved with Earth observations from space—NASA; the National Oceanic and Atmospheric Administration (NOAA); and the U.S. Geological Survey (USGS), with its long-standing Landsat program—to work toward this goal in collaboration with other interested U.S. agencies.

The report, issued on 5 January and sponsored by NASA, NOAA, and USGS, identifies top science priorities for the next decade, along with observational needs and programmatic support. Together, those make up a strategy for initiating observations to study aspects of Earth that the committee believes require far more scrutiny and to achieve breakthroughs on major scientific questions, all while increasing program cost-effectiveness.

"The science alone is inspiring and compelling, but understanding and reliably predicting the Earth system is a vital economic, societal, and national security need as well," the report notes.

"We focused on the value of Earth information from space-based observations. That value is not limited to the scientific domain or potentially controversial topics," Waleed Abdalati, cochair of the NASEM committee that issued the report, told *Eos*. Abdalati is director of the Cooperative Institute for Research in Environmental Sciences at the University of Colorado Boulder and was NASA chief scientist from 2011 to 2012.

Science Priorities

To address key Earth science and applications questions, the priorities outlined in the report include five targets designated by the committee for observation: aerosols; clouds, convection, and precipitation; mass change; surface biology and geology; and surface deformation and change. The report also specifies competitive selection of three additional targets (a group dubbed "Earth System Explorer") in seven possible areas: greenhouse gases, ice elevation, ocean surface winds and currents,

ozone and trace gases, snow depth and snow water equivalent, terrestrial ecosystem structure, and atmospheric winds. The report calls for development of instruments, instrument suites, or missions to implement observational needs for the five designated targets and three Earth System Explorer targets.

The report also calls for greater attention to potential benefits from domestic and international partnerships and "the growing capability of commercial sources" and for keeping costs within anticipated budget constraints to avoid draining funds from other programs and throwing off "desired programmatic balance." If budgets prove more or less generous than expected, the report includes "rules for altering plans in a manner that seeks to ensure the overall program integrity," the document states.

Building on Earlier Reports

The report builds on earlier strategic overviews put forward by NASEM or federal government entities, including a 2007 NASEM decadal report (http://bit.ly/NAS-2007) and two prior White House studies: the 2013 National Strategy for Civil Earth Observations and the 2014 National Plan for Civil Earth Observations. Although the national strategy and the plan "represent progress toward a strategy for achieving and sustaining Earth observations," the new report states, "the U.S. has not committed the resources to collect the broad range of sustained observations needed to monitor and understand the Earth as a system." Hence, the nation has left "critical gaps in the implementation of this National Plan and a dependency on non-U.S. sources."

Earth Science Community Consensus

The plan for Earth observations provided by the decadal strategy "should keep NASA Earth Science on the right path for the coming decade if funded adequately," Steven Running, retired regents professor of ecology at the University of Montana in Missoula, told *Eos*.

The agency's Earth Science program "is of unparalleled significance to humanity in this age of rapid change," added Running, an expert in global ecosystem monitoring who served on a panel for the 2007 decadal report and is a past chair of the NASA Advisory Council's Earth Science Subcommittee. This new decadal strategy "well documents this urgency and uniqueness of mission, and identified the most critical science questions society needs to answer," and it represents an Earth science community–wide consensus on mission priorities for the coming decade, he said. However, he noted that he was disappointed that the strategy doesn't include more of a full Earth systems science plan. Studying Earth is a "systems problem," he said. So long-term storage, reprocessing, and distribution to the science community of climate data records and integration with Earth systems modeling are needed strategic planning components. "Yet this [strategy], as with the 2007 report, sticks almost entirely to planning and prioritizing flight missions," Running said.

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Who Is Paying Attention?

"The report affirmed the importance of NASA and the other satellite-enabled agencies to keep an eye on planet Earth," Ann Bartuska, vice president for land, water, and nature with Resources for the Future (RFF), an independent nonprofit research institution based in Washington, D. C., told *Eos*. However, she wondered "who is paying attention to these recommendations," because the administration still doesn't have a robust White House science structure in place.

Although Bartuska praised the report overall, she said that it would benefit from a "translation" for policy makers that provides them with a "short list" of its most important points and recommendations. The document's summary and tables, she noted, only partially meet that need. She also said she would have liked to have seen the report focus more on the value of in situ measurements that complement satellite-based systems and on agricultural uses of satellite information to forewarn of crop losses that could destabilize societies.

Bartuska served as deputy undersecretary for research, education, and economics with the U.S. Department of Agriculture from 2010 to 2017. From 2016 to 2017, she chaired the Subcommittee on Global Change Research, which steers the activities of the U.S. Global Change Research Program.

Report "Hopefully" Is Important for Congress As Well

Although important for the scientific community itself, the report "hopefully" will affect members of Congress who set the budget for science agencies, Anne Nolin told *Eos*. She is a professor in the College of Earth, Ocean, and Atmospheric Sciences at Oregon State University in Corvallis and served as vice chair of the panel on water resources and the global hydrologic cycle for the previous decadal survey.

Nolin, whose specialties include mountain hydroclimatology, snow and ice in the climate system, and remote sensing, expressed concern that even members of the public with an interest in science may not immediately recognize what the report is about. "It would be great for the science-literate public to be able to get excited about it [but] I don't think people know what it is," she said.

"We say, 'decadal survey' and they say, 'What?'" she noted. "But if you say, 'road map for next-generation satellites to monitor the Earth, to look at our planet,' people go, 'Oh, that's interesting.'"

By **Randy Showstack** (@RandyShowstack), Staff Writer