



AAAS NEWS & NOTES

AAAS analyst assists a human rights organization in gathering data during an exhumation.

Emerging scientific technologies help defend human rights

Scientists leverage advancing tools to gather evidence and expand the capacity of human rights groups

By Anne Q. Hoy

Against a backdrop of summer heat and a constant roar of distant howler monkeys, a scientific analyst piloted a drone to collect data from a hillside in northern Guatemala. At his side, anthropologists affiliated with a regional human rights group painstakingly cleared soil and roots from human remains in a mass grave.

"Remains contorted, overlapping, interlaced, a cruel, tragic mashup of Hieronymus Bosch and H.R. Giger," noted Jonathan Drake, senior program associate of the American Association for the Advancement of Science's Geospatial Technologies Project, summoning images from 15th- and 20th-century artists to describe the nightmarish remnants of an atrocity estimated to have occurred sometime after 1980, during Guatemala's lengthy civil war.

Multiple skeletons were exhumed. Clothing with burnt edges stuck to the bones of some. A blindfold encircled a skull. Leg bones bore evidence of a child. Those were among the observations Drake shared after maneuvering a commercial-grade drone at specific angles for optimal data collection and documentation.

Drake and the representatives of the Guatemalan Forensic Anthropology Foundation (FAFG) each used drones to collect several hundred overlapping photographs documenting the location of the mass grave and to record each step of the exhumation process.

AAAS and FAFG have worked together on six projects since AAAS

first offered its scientific expertise and technical and analytical skills to assist in the search and exhumation of mass graves in Guatemala. The collaborations went from "proof of concept, to training on data processing, to capacity building, to implementation in a real-world context," said Drake.

AAAS's use of drones for geospatial documentation in Guatemala grew out of an earlier alliance with EQUITAS, an independent, nonprofit organization of scientific investigators of human rights violations in Bogotá, Colombia. The organization sought help locating remains of victims of forced disappearances during Colombia's decades-long war.

EQUITAS asked for help with a suspected mass grave in a cloud-covered, mountainous region likely inaccessible to remote sensing satellites. While remote sensing collects data without requiring a visit and some types can penetrate cloud cover, high-resolution optical imagery offers better chances of capturing data from locations blanketed by clouds.

It was in Colombia where AAAS first used and tested a drone to collect data from the suspected mass grave

site. The site turned out to have no graves, but the data gathered allowed AAAS to produce a comprehensive map of the canopied jungle, providing EQUITAS with its first detailed survey of the region and a tool for planning future digs, Drake said.

The AAAS geospatial project has evolved since its establishment in 2005 by putting technologies to work as they emerge. Drake and

"All of these technologies are sort of converging in a way that is really very effective..."

Jonathan Drake, AAAS

earlier project participants have incorporated emerging technological advances into scientific collaborations with human rights practitioners around the globe.

Lars Bromley, a former AAAS staff member and participant in the geospatial project's collaborations with human rights organizations, took on one of AAAS's initial initiatives. In an alliance with Amnesty International, Bromley used available technology and applied his background in geospatial analysis to scrutinize satellite imagery of four communities in Zimbabwe.

The government asserted that homes in the communities were illegal and launched a demolition campaign that organizations considered to be human rights violations. AAAS analyzed the destruction and removal of more than 5000 homes captured by data that were provided to human rights lawyers in Zimbabwe.

Leveraging drones to gather evidence that can later be used in courts is just one of the emerging technologies AAAS is now testing and using in its alliances with human rights organizations, particularly those that lack significant resources.

Scientific advances in machine learning and artificial intelligence are being studied and, in some cases, tested for their ability to capture and analyze copious amounts of data. More recently, blockchain, microdrones, and nanodrones are being recognized as technologies that could assist in human rights investigations.

Blockchain technology, Drake noted, could be useful in establishing a chain of custody for scientific evidence, as well as providing verifiable provenance of digital data necessary in human rights cases.

"They all fit together. Artificial intelligence fits with satellite imagery in terms of classifying images, and it is also critical in linking hundreds and hundreds of images collected by a drone into a 3-D model," Drake explained. "You can't do that sort of thing without machine learning."

Insights gleaned from the drone test in Colombia were put to work in Guatemala. The drone's effectiveness in data gathering opened the door to AAAS's eventual ability to produce 3-D models from high-resolution images, assign global coordinates, map large areas, and conduct such analyses relatively quickly.

During AAAS's first collaboration with FAFG in Guatemala, Drake used a drone to collect extensive photographic data and later transformed the photographs into a 3-D representation using a computer-assisted process known as photogrammetry. The process permits photographs of a single skeleton to be merged with images of subsequent exhumations, producing a dynamic model of a mass grave's human remains and contents. The model offers an integrated 3-D image of all or any part of the scene.

Data collection by drones can show the precise orientation of one skeleton in relation to another—such as one facing another—a heartbreaking and rarely noticed view at a site during an exhumation since skeletons are most often removed separately.

Removal is a laborious process that can consume a day for a single extraction. Precise documentation of each exhumation is required. The scientific methods employed to collect data also must be described.

"All of these technologies are sort of converging in a way that is really very effective and has the potential of being really effective in promoting human rights around the world," noted Drake.

The AAAS Scientific Responsibility, Human Rights and Law Program released a report in July examining the lessons learned by the organization in providing "geospatial analysis in a human rights context."

The report includes reviews of dozens of legal cases in which geospatial technology provided evidence used in international criminal

prosecutions brought before the International Criminal Court; conflict-specific courts in Yugoslavia, Sierra Leone, and Cambodia; and human rights courts in Europe and Central and South America.

Among its recommendations, the report calls on the judicial branch to appoint independent scientific advisers for cases that involve highly technical or specialized research; geospatial analysts to document where and how their findings were collected and explain the scientific methods used; and human rights groups to use independent, experienced analysts. It urges government agencies to safeguard metadata and preserve the chain of custody of data, which are vital to the legal community. It also advises private-sector satellite data providers to protect their images from manipulation.

Bromley, who now serves as a principal analyst and research adviser for a United Nations institute and a satellite operations program, expressed surprise about how often fundamental education about geospatial technologies continues to be required by human rights organizations. Over time, Bromley said, he has "come to accept that capacity building is a slow and never-ending process." AAAS integrates extensive training in the collection of evidence from emerging technologies in its work with human rights groups.

"Now, 10 years later, these technologies are firmly embedded in the human rights landscape and are in relatively common use," said Bromley, referring to the geospatial technologies that were actively used when the program began and the pathway AAAS continues to pursue with emerging technologies.

"We really did manage to take these from an infant technology to something useful and valued," he added.

AAAS annual election: Preliminary announcement

The 2018 AAAS election of general and section officers is scheduled to begin in October. All members will receive a ballot for election of the president-elect, members of the Board of Directors, and members of the Committee on Nominations. Additionally, members registered in sections (up to three) will receive ballots for the specified section elections. Biographical information for the candidates will be provided along with ballots. The general election slate is listed below. The list of section candidates can be viewed at www.aaas.org/annual-election.

Notice to our international members:

In an effort to conserve resources, AAAS will be sending electronic election ballots to our non-U.S.-based members. In order to ensure you receive your ballot, please make sure your email is up-to-date with AAAS by logging on to www.aaas.org. 1) Click on "Member Login" (if you have not yet created an account, you will be prompted to do so); 2) After you log in, click on the red "My Profile" button in the upper right-hand corner of the page; 3) Click on "Edit My Contact Information" in the left-hand side bar; 4) Update your email and click on the "Save" button.

If you would like to request a special paper ballot, please send an email with your name and address with your request to elections@aaas.org.

General Election Slate President-Elect:

Jared L. Cohon, Carnegie Mellon University; Claire M. Fraser, University of Maryland School of Medicine

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Federal research funding aims to ease societal challenges

A key goal is to spread access to scientific excellence and federal research funding nationwide

By Anne Q. Hoy

Half of all federal research funding in the United States goes to recipients based in six states and the District of Columbia, leaving the other 50% of funding split among those in the remaining 44 states, the National Science Foundation's annual Survey of Federal Funds for Research and Development shows.

The concentration of geographic funding to primary recipients in California, Maryland, Massachusetts, New York, Texas, Virginia, and the District of Columbia was cited by Kei Koizumi, a senior science policy adviser for the American Association for the Advancement of Science, during a panel presentation exploring the evolution of federal research funding in the United States, France, Japan, and other Organization for Economic Co-operation and Development member countries.

"We have abundant research that shows the majority of U.S. students go to school in their home states," said Koizumi during the presentation on 13 July. "So, if research funding is not happening in their state, then they are missing out on an opportunity to participate in our science and technology enterprise."

Concentrated research funding distribution levels, he added, deny states economic development, growth, and jobs that the system develops.

The presentation was held at the biennial EuroScience Open Forum 2018 in Toulouse, France, a gathering of more than 3000 scientists, innovators, policy-makers, and business representatives 9–14 July to discuss scientific research, innovation, and science policy issues. AAAS CEO Rush Holt moderated a session on science diplomacy and AAAS staff highlighted activities of AAAS's Cambridge, U.K., office and the online, global news service EurekAlert!

In recent years, geographic funding concentration levels in the United States have remained fairly consistent.

Yet the country's leading federal research funding institutions have been testing experimental programs to spread federal research funding more equally across the country to address economic and social inequities.

Science and engineering research funding programs are searching for ways to provide university students in every state an opportunity to search for knowledge, extend scientific excellence, and, in so doing, ensure that the system tackles larger societal issues, said Koizumi.

"It is important, both politically and socially, to address inequalities on multiple dimensions, and science funding is not exempt from that imperative," Koizumi said. "We have seen that competitive research funding mechanisms, left to their own devices, can result in inequalities. They can perpetuate other inequalities that exist in society."

Adjusting the funding system to support multiple societal objectives as it also seeks to produce scientific excellence is not easy, noted Koizumi in his session on "Supporting long-term research in a world of sudden change: The evolution of research and funding in current financial and political contexts."

"It is, of course, a common insight now to see that the U.S. scientific workforce does not look like the U.S. population, and so diversity

and inclusion are important considerations for how we support the U.S. scientific enterprise," added Koizumi.

To overcome impediments, the National Science Foundation, the Departments of Energy and Agriculture, and NASA have established programs under the Established Program to Stimulate Competitive Research, or EPSCoR, which was established in 1978 to enable universities across the country to compete for federal research funding. The National Institutes of Health began a similar program 25 years ago known as Institutional Development Awards, or IDeA. Both programs continue to grow.

For two decades, AAAS has supported more than 30 states by providing 151 assessments of more than \$1.2 billion in research projects funded by NSF's EPSCoR and NIH's biomedical research IDeA programs. AAAS's Research Competitiveness Program, or RCP, conducts the work and provides peer-to-peer insights from independent U.S. experts and, more recently, quantitative evaluations of projects. In addition, RCP is now working on a NSF study to devise a framework for measuring academic research excellence

and competitiveness for EPSCoR and potentially other NSF programs.

"Our programs strengthening STEM ecosystems within the U.S. have parallels to national STEM initiatives in other countries," said Charles Dunlap, RCP's program director. "While we continue to support institutions in the U.S., institutions abroad are increasingly contacting AAAS for support as well."

A range of other collaboration models also have emerged. One is organized around national objectives such as improving health care, addressing climate change, or expanding manufacturing opportunities. Other competitive funding initiatives promote cross-sector collaborations that align private businesses with research universities and federal research laboratories and international

collaborations that match scientific research groups with global partners to pursue shared scientific goals.

Competitive research funding endeavors also focus on "high-risk, high-reward research, or potentially transformative research," said Koizumi, in a drive to offset the tendency among experienced researchers in a highly competitive funding arena to pitch less risky and shorter-term proposals.

Since World War II, the federal research funding system has helped the United States become the world's leader in science and engineering innovation. With time, though, system flaws have emerged, including stress on success rates due to the growing number of research proposals that fall short of funding, a development that raises the cost of the scientific review process. The system also has failed to expand the ranks of underrepresented minorities and women in the scientific enterprise.

In addressing the state of today's competitive research funding system, Koizumi said, "With careful attention we can use competitive research funding to attempt to address the challenges of inequalities both inside the scientific enterprise but also with our society at large."



Kei Koizumi (right) fields questions about scientific research funding mechanisms during a break at biennial ESO in Toulouse, France.

Science

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