AirSpace Season 6 Episode 6 - Journey to the Past

Matt: Yeah. You know, I was up there last weekend digging around the Apollo 11 landing site and just, you know, pouring a little bit of plaster of Paris into the Neil Armstrong footprint so that we could bring that back.

Music up and under

Matt: Welcome to AirSpace from the Smithsonian's National Air and Space Museum. I'm Matt.

Emily: I'm Emily.

Nick: And I'm Nick.

Emily: There are more than 4,500 satellites orbiting Earth, and some of them are taking pictures. They're used for a lot of things like intelligence, weather prediction, climate change research, and our topic today, archeology.

Matt: Archeologists use satellite imagery and other aerial imagery to find new sites. Track changes on already found ones and to detect and hopefully stop or prevent things like looting.

Nick: This imagery is also used in cultural preservation to protect or track changes to sites that are in vulnerable locations like inside countries at war. We're taking images in the sky to dig in the dirt. Today on AirSpace, presented by Olay

Music up and out

Nick: So space archeology is not archeology in space. Space archeology is archeology on Earth, supported by things in space. Is that the simplest way to put it?

Matt: Yeah. So I mean, one of the really like the the reason I was really interested in this topic and really wanted us to do an episode about it was that, you know, we think of space technologies as being these very futuristic, future looking building futures for humans in space but you know, one of the things that operating in space has allowed us to do is not just understand like the geologic history of our planet or of planets like Mars but to start to understand better the human history on Earth. And, you know, how people have moved, how, you know, they adapted to new environments over time and to you know, find things that we weren't otherwise able to find just from doing regular, you know, still very sophisticated, scientific, ground based archeology. But adding that space component and, you know, increasing the amount we could learn about archeological sites.

Emily: Well, and taking pictures of Earth from space or from airplanes is not brand new technology. I mean, it's not like deep time, ancient civilizations kind of technology. But we've been using satellites or airplanes to look at Earth for a really long time. And we did an episode a long time ago about U-2 spy planes, and it turns out that a lot of that imagery has been declassified in 1997 and can be used for archeology today. It's a bit of a mess because it wasn't well archived. But, you know, there's a big effort right now to continue to sort and digitize all of that imagery because it's so good and if you talk about things like doing change detection, monitoring changes in landscapes over time, U-2 spy plane pictures are perfect. So there's a lot of good stuff out there. And so I think it's important to remember that when we talk about space archeology, we do kind of lump in aerial photography and aerial remote sensing, kind of under that umbrella because it it's observing Earth and it's doing archeology with pictures of the Earth.

Nick: In the early aughts as more and more satellites went up and more and more images became available, archeologists started to use them for kind of off-book projects where they would just get whatever images had been taken for a different purpose and apply them to their research. There are satellites up there now doing specific archeological work, but none of them are exclusively dedicated to it. So archeologists can say, we really need to take a look at this place, and there are ways to do that. But there's still no constellation of Indiana Jones satellites orbiting the Earth…yet.

Emily: Yeah, and I think if if this feels a little confusing, think of it like the Hubble Space Telescope. Nobody owns the Hubble Space Telescope, but scientists, astronomers, planetary scientist, planetary geologists, even, everybody who can use Hubble can submit a proposal to say, 'Hey, NASA, I really need you to take this picture for me.' And so it's leveraging satellites that already exist rather than creating a dedicated satellite to do archeology. But as we'll talk about a lot later in the episode, it's more than just archeology. There's a lot of really awesome stuff that you can do from space when it comes to observing the Earth.

Matt: Right. But there is an actual NASA program now, right? There's a program called SERVIR, which is not an acronym. It's S-E-R-V-I-R. But, you know, it's actually a Spanish word, which means 'to serve.' Right. Servir. It's an infinitive. If you ever took Spanish as a language you know, and and it's really a project that's meant to collect data, and not just archeological satellite data, but that's a big part of it to serve the global community with the information that those satellites can provide. So we talked to a few people who are working in space based archeology and one of those superstars was Kelsey Herndon.

Kelsey Herndon: So my name is Kelsey Herndon, and I am a research associate at the University of Alabama in Huntsville. And I'm also a researcher with the NASA SERVIR Program, which is a joint program between NASA and the United States Agency for

International Development, where basically we use remote sensing to help countries around the world address different environmental issues. So things like drought monitoring, or ag yield predictions, flooding, all sorts of different topics like that.

Emily: And it's worth saying that Kelsey Herndon works for the SERVIR Project, which is a joint project with the U.S. Agency for International Development, U.S. AID, and has regional partners across the globe.

Matt: So Kelsey's main area of research is the territory formerly occupied by the ancient Mayan civilization in and around present day Guatemala and the Yucatan Peninsula.

Kelsey: So remote sensing within archeology is really, really broad. And I think probably most people, when they think about remote sensing and archeology, they're hearing news stories about like, oh, we discovered a new site, or a new pyramid, or a new you know, I think you probably hear a lot about ancient Egypt discovering new pyramids. You hear a lot about Angkor Wat seeing kind of like structures across the surface. And so some of that can be done with really high resolution satellite imagery, optical satellite imagery, which is like taking a photo. The problem is that in most areas, you can't see through trees. So in forested areas, we can't use high resolution imagery to pick out individual features, usually. So in like the Maya region where I work LIDAR has been really revolutionary because we can actually remove that layer of trees to get down to the structures beneath the Earth's surface.

Nick: If you've ever been to Guatemala, you know that it is largely covered in dense forest, which should be really hard to see through from space. So she uses a combination of satellite imagery and LIDAR, which is light detection and ranging. That's a system that uses lasers to measure distances and map features so that she can see deeper into the jungle through the trees canopies. And that's often based on an aircraft, not necessarily based in space.

Kelsey: In terms of satellite, but probably the most common one that that you've heard of is these high resolution like 50 centimeter resolution, optical satellites, LIDAR is typically airborne LIDAR. So that's where they put a LIDAR sensor on a plane and fly it over strips of Earth's surface. There is a LIDAR sensor on the International Space Station right now called GEDI, but it's significantly lower resolution, so it's about 30 meter resolution. So it hasn't been used as much for archeological applications. I think part of that's because it's so new and part of that's because the resolution is so low.
So in addition to airborne LIDAR I also really like to use Landsat imagery. So Landsat imagery is a 30 meter resolution kind of optical sensor that's flown by NASA and USGS. And basically we use this to answer a different kind of question. So LIDAR and the high resolution imagery we might use to identify specific structures, specific features on the landscape. But we can look at kind of landscape scale changes using lower resolution imagery. So I can model, you know, how

land cover has changed over time in an area to give me more information about maybe like the modern impacts of of ancient landscape change or land use.

Matt: So what's really cool about that too is that, you know, for a long time we've known about Mayan structures that are in this area. Right? We've known about certain ruins that have been studied by archeologists on the ground. But until you can really get that, that view from above and erase the trees, so to speak, you know, you don't really get a sense of the scale of their agricultural practices or of, you know, all of the very sophisticated things the Maya were doing with their land and the extent of that. That's why this stuff is really so cool and gives you such a better understanding of the history of that empire.

Emily: But the other thing Kelsey and other archeologists are using are all these other wavelengths in the electromagnetic spectrum. So we all see stuff in the electromagnetic spectrum, but in a pretty narrow band of wavelengths. And so they you can use all other kinds of wavelengths like microwaves and radar and x-rays, probably not a lot of x-ray usage, but the point being there's all these other wavelengths and those can tell you different things about that part of the earth that you're studying, like the health of that forest or the depth of the roots in that area or what the soil is made up of, or maybe there's some ancient structures under the surface of the very top layer of the Earth.

Nick: So when we say archeology, people often think Egypt, ancient Egypt, and they think that, you know, the satellites are discovering new pyramids or something like that. It turns out yeah.

Emily: So if you've ever heard of space archeology or you sort of have the little gray cells in the back of your brain are kind of itching because you're like, I feel like I've heard of this, but I'm not really sure if I've heard of this. You probably have heard of this and you probably heard it from a TED Talk from 2016 by Dr Sarah Parcak who is pretty well known for the space archeology that she does in Egypt.

Dr. Sarah Parcak (from TED): This is a site located in the eastern Egyptian delta called Mendes, and the site visibly appears brown. But when we use the infrared and we process it, all of a sudden, using false color, the site appears as bright pink. What you are seeing are the actual chemical changes to the landscape caused by the building materials and activities of the ancient Egyptians.

Nick: Dr. Parcak runs an open source project where satellite images can be accessed by the regular public and after some initial training, you can use your eyes to help her brain find new discoveries out there in the wild.

Matt: Well, what's really cool about that technique, I think, is that, you know, you can put satellites in orbit and you can take thousands, millions of images. But unless you actually put eyes on those images and get people to actually start interpreting them with their powerful human brains, then, you know, those images can't really help you do anything. Planetary scientist face that problem all the time with all of the imagery returned from Mars, for example. How do you actually look at all of the thousands of images that are returned? But, you know, with Earth orbiting satellites, it's the exact same problem. How do you actually look at all of the images of the Earth, even if you have 100% coverage of the Earth, you know, hundreds of times a day? What does it mean unless you're looking at it?

Emily: Well, and as scientists have really improved their data collection strategies, they've started to realize that there's a huge amount of buy in from the general public. Right. I mean, a lot of these programs are being funded by taxpayer dollars. Scientists have really started to recognize the desire of people in the general public who want to participate in this kind of work. And so, you know, there's this whole new world of citizen science or community science projects that get developed so that people like Sarah can then take their data or take open source data, provide it to the community and say, hey, here are the things that I'm looking for. Here's how you can help. And it really helps us do our science better. It helps us do more science. I mean, this is how you know, new Kuiper Belt objects are discovered. This is how new asteroids are discovered. I mean, the commitment and the curiosity of the general public is something that scientists are recognizing can really help them advance their work and help deal with these huge volumes of data that sometimes we're getting and we don't necessarily have the best tools to maximize the utility of it.

Nick: It turns out that space archeology is something we do here at the Smithsonian. So we reached out to Dr. Katharyn Hanson who uses satellite data to track sites around the world, monitoring them for cultural preservation.

Dr Katharyn Hanson: Sure. I'm Katharyn Hanson. I'm a secretary scholar here at the Smithsonian. I work as a cultural heritage preservation scholar at the Museum Conservation Institute.

Matt: So back in 2017, Katharyn and others from the cultural heritage preservation community were watching a site in Syria that had been in the hands of ISIS and the military was fighting ISIS to take it back.

Katharyn: Raqqa is a city in Syria. And this was what had been what up until through the summer of 2017 had been the capital of sort-of ISIS's domain. And when that offensive began there was a big push and a big effort from academics and nonprofits to make sure that those who

were in charge of the no strike lists understood that there was a tentative World Heritage Site in the middle of Raqqa, and it was a medieval era, 800 AD era mud brick, adobe city wall.
And it's large, right? Very large. Really, really elaborate. I have a bunch of dorky tourist pictures of myself in front of it, you know from back in 2009.
And when that offensive began, we had some serious concerns about what was going to happen. And one of the things that we were able to do with the satellite imagery was track what had happened to it under ISIS's control and there had been some damage done to it at that point. A chunk of it had been hacked out. And then as the offensive progressed for about two weeks, the way the offensive happened, we were able to basically compare before and after and see what damage had occurred. And one of the things that was really striking was it was the first time I've ever seen, and working on this for a while now, that the airstrikes made a deliberate targeting choice and only bombed the areas where the roadway had already cut through this mud brick wall. It didn't damage new areas, with the exception of two areas which DOD cited a press release for stating that they had done this.

Nick: The sophisticated network of communication between cultural preservation organizations and the militaries that are carrying out things like airstrikes are made possible by groups whose purpose is to communicate, monitor and protect sites like this wall in Raqqa.

Katharyn: There's a large group of there's a couple of NGOs and academic organizations who work to basically create that bridge between academics and military. So the US Committee of the Blue Shield, is the NGO that that does that, and they're the ones who have really spearheaded this, making sure that cultural heritage sites are included in the inventories, right, is what they're called, but they're really no strike lists to protect things like museums, schools, universities, all that stuff gets wrapped up together.

Matt: Like Raqqa in 2017, the cultural protectors have turned their eyes to Europe and to the war that began in Ukraine in February. The Smithsonian and others have worked with people on the ground and in the region to do what can be done to protect sites within that active war zone. Obviously, there's only so much that can be done when a cultural site is under active attack but the people are trained and global resources are brought to bear to try and preserve what can be preserved.

Emily: Well, and as a historian, Matt, I'm sure you can appreciate sometimes simply documenting changes is also a really valuable record, even if you're not able to actually preserve sites in these situations.

Matt: Yeah. Historically, keeping track of changes is important just for the record. But in some of these situations, keeping track of what's been destroyed can also be important information used to hold perpetrators accountable at a later date.

Katharyn: It speaks to the potential for researchers to, I mean, as we're seeing with Ukraine right now, for research to be able to keep up with and account for what's happening within sort of the umbrella of international law and international war crime law.

Nick: Yeah, and holding perpetrators accountable at a later date is also sometimes the best you can do, but can be critically important. Even when sites are damaged, if the satellites are able to ID who did it, that's something that we can use to protect future sites by holding perpetrators accountable for past crimes.

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Matt: So we've talked a lot about what can be done from space, but of course, that doesn't mean that you don't still have to go out and put your boots in the dirt, right? And actually get your hands dirty. Looking at these archeological sites, you know, there's a real importance to something that's called groundtruthing. And I know we've maybe mentioned that before on this show when we've talked about why we send rovers to the surface of Mars as opposed to just studying them with, with satellites from above. But, you know, groundtruthing in this sense, means putting an actual human in these spaces and actually checking to see if the thing is on the ground, what it seems to be from space.

Katharyn: Groundtruthing is what you want to do with any imagery. You want to make sure that what you're seeing from above matches what you're seeing on the ground. A really great example of this is there's a site in Syria that was getting heavily looted and people were saying the damage wasn't all that bad. And so we went back to colleagues who were in Syria at the time and said, 'hey, we're not seeing that looting you guys say it's happening.' And they said, 'well, that's because you're looking from above and it's all tunnels coming in from the side.'

Emily: And maybe we never use the word groundtruthing, but we've definitely talked about this before. You know, everybody's like, well, how do you know that that squiggle means water at Enceladus or how do you know that that squiggle means this at Titan? Like, we know that because we made those measurements in a laboratory and we learned that those squiggles that you see in a plot full of data means water, or means methane, or mean something else. Right? Or going back to Sarah Parcak and the Egyptian desert they know that a certain color, maybe pink and certain wavelengths show chemical changes because they've done the field work that tells them that these chemicals are these colors in this wavelength. And those chemicals come from ancient building techniques. Scientists do this all the time. We've been doing this for a very long time. You do something in the laboratory, you compare it to what you're seeing in nature. And you, you rinse and repeat until you have a really good understanding of what you're actually looking at, what you're detecting.

Same thing with space archeology. The reason archeologists understand what they're seeing from space-based satellite imagery or from aerial imagery is that they've been down on the ground and they know that this blue pixel correlates to this kind of structure or this kind of feature. They've built up this body of knowledge that tells them what they're seeing in these aerial images or these satellite images. But groundtruthing is the linchpin in making that connection.

Katharyn: For instance, when I wrote this Raqqa article, right, I ended I say like, this is what we can see from space, but it hasn't been ground truthed. And I would not expect any of my colleagues in Raqqa, Syria, to be wasting their time to ground truth, a cultural heritage that right now when, you know, there's there's a lot more infrastructure that's more vital, that needs to be dealt with first.

Nick: Katharyn also teaches classes mainly in Iraq and Syria so that those communities know how to take imagery, G.P.S. data, and just good old fashioned map making skills and create detailed site plans and data sets that complement one another for preservation and monitoring purposes on the ground.

Matt: And that really turns them into active participants and collaborators in this work.

Nick: Having electronic data and sites accessible to the archeologists and others on the ground is really important. People who have cultural ties to these sites should be part of the work. However, access to information and sites can also pose a problem. Not everyone wants to study and preserve the sites. Looting is a real problem at sites all around the world. Not only looting, though. As much as we love the enthusiastic public, sightseers at unprotected sites can also be a problem. Even if nobody is coming to an ancient site to rob it, a million people traipsing through will cause a lot of damage on its own. If any of our listeners to the museum are out there listening, we do love you. We're not talking about you. Please come wear out our carpet, but don't touch our objects. That's how it works.

Matt: Right, you know, if everybody threw a rock into the Grand Canyon, what would happen? Right.

Nick: I've heard that it is big, though. Maybe it would survive.

Emily: I’m pretty sure the Colorado would take that.

Matt: All right, all right. *Laughs*

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Nick: AirSpace is from the Smithsonian's National Air and Space Museum. It is produced by Katie Moyer and Jennifer Weingart. Mix by Tarek Fouda.

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