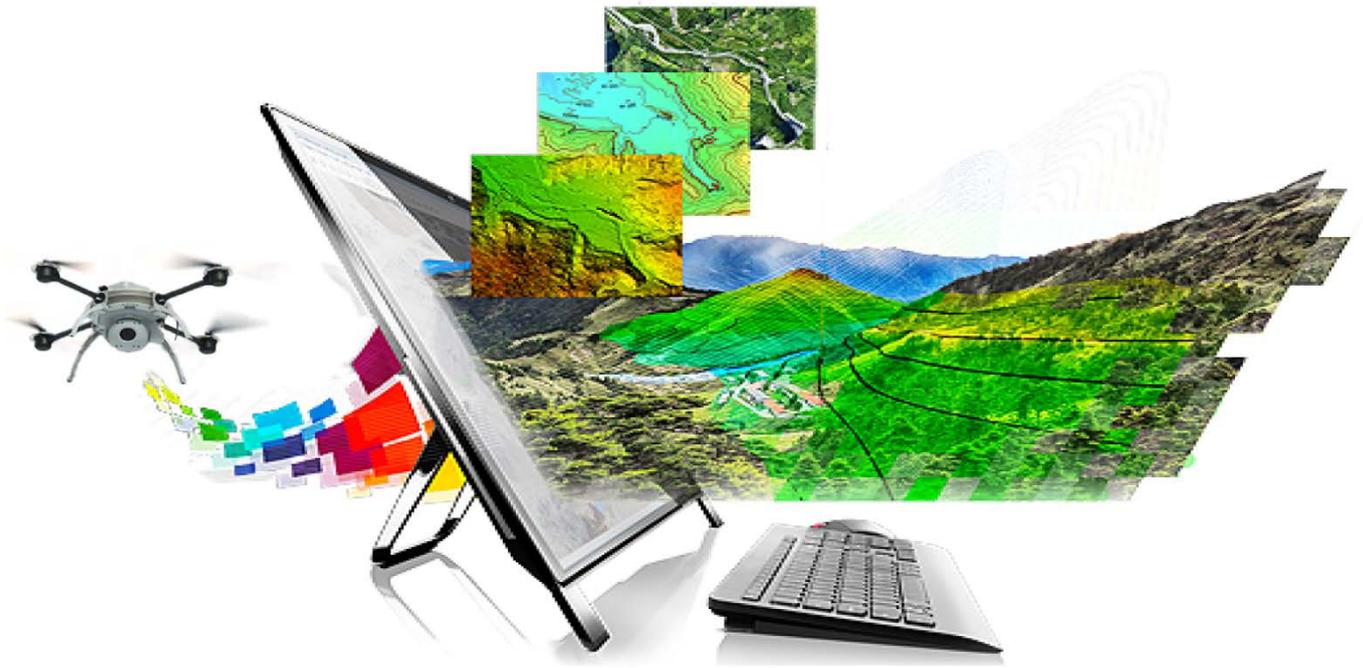


# CGA Conference 2017



## The Drone Revolution in Spatial Analysis

April 27th - 28th, 2017

1730 Cambridge St., Cambridge, MA 02138



### Co-organizers:

Center for Geographic Analysis  
Signal Program, Harvard Humanitarian Initiative



### Co-sponsors:

BCN Drone Center  
Esri



# Introduction

Unarmed Aerial Systems (UAS), Unmanned Aerial Vehicles (UAVs), or simply “Drones”, represent a new type of remote sensing platform that is inexpensive, easy to use, and provides users with many new options regarding where, when, and how geospatial imagery and data is collected. As the technology proliferates, it is revolutionizing both spatial data collection and geographic analysis. This paradigm shift brings new perspectives to a wide range of application fields, and calls for new skills, best practices, regulations, policies, ethics, and more.

This conference aims at illuminating the profound changes drones have brought to mapping practice, from platform and sensor selection, flight path planning, field operations, data processing, image analysis, feature extraction, 3-D model construction, and visualization. Experts will share their experiences with application cases and first-hand operational logistics.

The event will start with a half-day hands-on demo and training workshop Thursday afternoon, followed by a full day of plenary sessions on Friday, which will include a keynote address, presentation sessions, panel discussions, and closing remarks. Invited speakers will engage with the audience in discussions on the status, achievements, lessons learned, unmet needs, challenges, potentials, and perspectives of drones in spatial data collection and analysis, particularly as it relates to academic research and learning.

# Program

**DAY 1 - Thursday, April 27, 2017 1:00-6:00PM**

**Room CGIS S020**

**1:00PM**      *Registration*

**1:30PM**      **Welcome & Orientation**

*Jason Ur*

*Moderator: Matthew Wilson*

**1:40PM**      **Drones for Demining (BCN Drone Center)**

*Marc Beltran*

*Moderator: Dave Strohschein*

**2:25PM**      **Computer Vision & Drones (BCN Drone Center)**

*Jordi Salvador*

*Moderator: Dave Strohschein*

**3:10PM**      *Coffee Break*

**3:20PM**      **Drone imagery in ArcGIS (Esri)**

*Cody Benkelman*

*Moderator: Wendy Guan*

**4:05PM**      **OpenDroneMap - Free and Open Source Toolkit for Creating Aerial Orthomosaics (MIT Urban Risk Lab)**

*Tomas Holderness*

*Moderator: Ben Lewis*

**4:35PM**      **Drone applications at the Harvard Humanitarian Initiative**

*Faine Greenwood*

*Moderator: Ben Lewis*

**5:00PM**      *Light Reception - CGIS South Concourse*

# Program

DAY 2 - Friday, April 28, 2017 8:30 - 5:10PM

Room CGIS S010

8:30AM *Registration*

9:00AM **Introduction and Overview**

*Jason Ur*

*Moderator: Matthew Wilson*

9:10AM **Panel I: Ethics and Legal Issues**

*Matthew Fox (9:15), Faine Greenwood (9:25), Jamon Van Den Hoek (9:35),  
Kevin Pomfret (9:45), Jeff Sloan (9:55)*

*Moderator: Matthew Wilson*

10:30AM *Coffee Break*

10:40AM **Panel II: Hardware: platforms and sensors**

*Austin (Chad) Hill (10:45), Ben Kreimer (10:55), Nadeem Mazen (11:05),  
Brandon Montellato (11:15), Jeffrey Warren (11:25)*

*Moderator: Dave Strohschein*

12:00PM *Lunch Break & Poster Session- CGIS South Concourse*

1:30PM **KeyNote Address: Drone for Community Resilience**

*Jarlath O'Neil-Dunne*

*Moderator: Jason Ur*

2:00PM **Panel III: Software: data processing and analysis**

*Luis Jaime Castillo Butters (2:05), Donna Delparte (2:15),  
Robert Homsher (2:25), Lawrie Jordan (2:35), Walter Volkmann (2:45)*

*Moderator: Josh Lieberman*

3:20PM *Coffee Break*

3:30PM **Panel IV: Applications Across Disciplines**

*Mike Foster & Daniel Sheehan (3:35), Scot Martin (3:45),  
Everette Newton (3:55pm), Nathaniel Raymond (4:05), Jason Ur (4:15)*

*Moderator: Faine Greenwood*

4:50PM **Closing Remarks**

*Faine Greenwood*

*Moderator: Matthew Wilson*

5:00PM **Poster Awards**

*Jason Ur*

*Moderator: Jeff Blossom*

# Abstract and Biography

Day 1 April 27, 2017

## Welcome & Orientation

Jason Ur

Jason Ur is Professor of Anthropology in the Department of Anthropology at Harvard University, and director of its Center for Geographic Analysis.



He specializes in early urbanism, landscape archaeology, and remote sensing, particularly the use of declassified US intelligence imagery. He has directed field surveys in Syria, Iraq, Turkey, and Iran. He is the author of *Urbanism and Cultural Landscapes in Northeastern Syria: The Tell Hamoukar Survey, 1999-2001* (2010). Since 2012, he has directed the Erbil Plain Archaeological Survey, an archaeological survey in the Kurdistan Region of northern Iraq. He is also preparing a history of Mesopotamian cities.

## Drones for Demining

Marc Beltran

*Abstract: I will talk about the benefits of using drones for landmine detection. I will bring signs, 3D-printed landmines (obviously with no explosives) and some datasets that we took in Bosnia & Herzegovina to play with.*

Marc Beltran is a Partner and COO at the BCN Drone Center. He holds a BSc and MSc in Aerospace Engineering. He has worked at the Canadian Center for Aerospace Research in Vancouver and at the German Aerospace Center (DLR) in a project in cooperation with NASA.



## Computer Vision & Drones

Jordi Salvador

*Abstract: Jordi will talk about how computer vision techniques are clue for the use of drones for photogrammetry and remote sensing applications. He will also present which kind of drone applications can be unleashed in the near future thanks to Computer Vision.*

Jordi Salvador is the CTO at BCN Drone Center and is performing his PhD research in multimodal UAV imagery registration at the Computer Vision Center (Barcelona Autonomous University).



His professional experience in aerial robotics starts in 2008 and since then he has worked in different projects, such as a solar powered UAV, fixed-wing and multirotor operation automation, image analysis software development or TCAS for mini UAVs implementation. He holds a MSc in Aerospace Engineering and a MSc in Computer Vision and Artificial Intelligence.

## Drone imagery in ArcGIS Platform

Cody Benkelman

***Abstract:** With the explosive growth of drones around the world, imaging sensors are being applied to many new applications and industries. The low cost and high mobility of drones enables acquisition of massive data volumes, but also presents new challenges for processing and effective exploitation of the data. This presentation will provide an overview of the many ways that ArcGIS is being used to support drone operations and drone data management. ArcGIS has specific tools for working with drone imagery – e.g. ingesting & processing video using the full motion video (FMV) add-in; building orthorectified mosaics from still frame images using the standalone Drone2Map application; or processing large projects with the Ortho Mapping tools added into the latest version of ArcGIS Desktop. In addition, ArcGIS Online provides important support for project planning through easy access to ancillary geospatial data such as elevation, weather, property and political boundaries, etc. We will also discuss a robust, automated data management solution with proven scalability, including support for direct access to imagery stored in the cloud.*

Cody Benkelman has worked in the remote sensing and GIS industry since 1990. He is currently serving as a Technical Product Manager on the Esri imagery team, working to improve customer workflows with regard to using lidar, imagery, and raster data in ArcGIS, with a recent focus on UAV (drone) sensor data. His technical background includes algorithm and software development for image processing and analysis, including one patent, and



he served as a principal investigator on three NASA contracts. Benkelman received an undergraduate degree in Physics from Montana State University, and a master's degree in Applied Physics from the University of Colorado.

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## OpenDroneMap - Free and Open Source Toolkit for Creating Aerial Orthomosaics

Tomas Holderness

***Abstract:** OpenDroneMap (ODM) is a free and open source toolkit for photogrammetric processing of aerial imagery captured by unmanned aircraft. With support from the Humanitarian Innovation Fund, and in collaboration with the American Red Cross, Cleveland Metroparks and the University of Wollongong, OpenDroneMap is currently being extended to support a client-server architecture. The aim of this work is to improve the accessibility of the software by providing both a web-facing interface for image upload and processing requests, and harness cloud-based services for computation. In conjunction, OpenDroneMap's processing engine now includes robust methods for image matching, digital surface modelling, and image mosaicking. Building on contributions from the wider open source community, we anticipate reaching feature parity with commercial-grade photogrammetric software in 2017. This presentation will discuss the current state of development and proposed new features of the OpenDroneMap toolkit.*

Tomas Holderness is a research scientist at the MIT Urban Risk Lab, where he co-directs Indonesia's disaster map project 'PetaBencana.id', and develops geospatial



solutions for analysis of extreme weather events. He holds a PhD in Geomatics and is professionally accredited by the Royal Geographical Society.

## Drone applications at the Harvard Humanitarian Initiative

Faine Greenwood

*Abstract: Greenwood will provide an overview of how drones are being used in the humanitarian and development sectors, with a broad international scope and a particular emphasis on ethical issues. Greenwood will also describe the Harvard Humanitarian Initiative’s remote sensing and UAV work, as well as its educational offerings. Key questions include: What are key trends in humanitarian drone tech, and what can we expect in the near future? What are the primary challenges to the wider use of drones in the humanitarian sector, and what can academics contribute to overcoming them?*

Faine Greenwood (@faineg) is a Researcher at the Harvard Humanitarian Initiative focusing on how UAV and satellite technology can be used in humanitarian contexts. Greenwood is an instructor in the Signal Program’s Remote Sensing for Humanitarian Programs workshop, and is particularly interested in developing ethical and technical standards for integrating drone technology into disaster response. Greenwood is a regular contributor to Slate.com’s Future Tense blog, and has also written freelance for Drone360, Make, Time, the San Francisco Chronicle, World Politics Review, GlobalPost, the Southeast Asia Globe, the



Cambodia Daily, and many other publications. Prior to joining the Signal Program, Greenwood co-authored “Drones and Aerial Observation” for the New America Foundation, the first primer on civilian drone technology. Greenwood worked as a reporter, freelance writer, and photographer in Southeast Asia, with a particular focus on the impact of social media and technology on political change. Greenwood holds a master’s degree in journalism from Stanford University, and a bachelor’s degree in English from Tulane University.

Day 2 April 28, 2017

## Introduction and Overview

Jason Ur

Jason Ur - see page 4

## Panel I: Ethics and Legal Issues

Matthew Fox, Faine Greenwood, Jamon Van Den Hoek, Kevin Pomfret, Jeff Sloan

*This session will place drones in disciplinary context and overview the range of ethical and legal issues that condition the use of drones/UAVs for spatial analysis.*

## Universities and the New FAA Regulations

*Abstract: The past several years have seen dramatic developments in UAV technology, which have in turn given rise to a new set of rules governing their operation. Universities have been largely overlooked in this rulemaking: the regulators have focused their attention primarily on commercial use, and recreational use is exempt from most FAA regulation by an old federal law. Universities have*

*argued that a third category is needed because teachers and researchers are neither hobbyists nor commercial operators, but to no avail. We will discuss the ways that universities have worked to shape the new regulatory regime – including comments on proposed rules, direct lobbying, litigation, and proposed statutory language -- and how they fit into the rules as they have developed.*

Matthew Fox serves as a Senior Research Compliance Officer within the Office of the Vice Provost for Research. In this capacity, Matt works to support and facilitate the conduct of research through the review, development and implementation of rational University-wide research policies. He supports and manages several University-wide committees on research policy, including the Research Compliance subcommittee of the Sponsored Administration Leadership Committee. Additionally, Matt advises researchers and department administrators on compliance issues across the University. Prior to joining the Office of the Vice Provost for Research, Matt was an Associate Attorney in the Office of the General Counsel at Harvard, where his practice focused on litigation and dispute resolution as well as advising clients through the university on regulatory compliance both within and outside of the research context.



*drones make it easier than ever for non-specialists to make maps and to collect aerial imagery. With this ease of use comes new ethical challenges: how can the privacy of people affected by disaster be preserved? How should humanitarians protect the data they collect, and who should be able to see it? Are humanitarians involving local people in humanitarian drone projects? These and other questions will be addressed in this presentation.*

Faine Greenwood – see page 6

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**Place-based relationships linking drone warfare and agricultural land cover and livelihood dynamics in northwest Pakistan**

***Abstract:** In Pakistan, Afghanistan, Yemen, and Somalia, American drone warfare has been a campaign of slow violence punctuated by Hellfire missiles that fly faster than the speed of sound. In northwest Pakistan, there have been over 400 drone strikes since 2004 and untold hours of surveillance; here, drones have earned the nickname of 'mosquitoes' by surveilled communities. The persistence and pervasiveness of the drone campaign have fueled anti-American sentiment within the region, and the loss of life from strikes has been packaged as recruitment fodder by extremist militant groups. Though the CIA does not know the identities of most of those killed by drones, we do know that almost two thirds (63%) of drone strikes in Pakistan have targeted domestic dwellings within socio-spatially marginalized agricultural communities where 2/3 of people live in multidimensional poverty. In examining the potential recursive relationships between drone warfare and livelihood dynamics, I map place-based linkages between drone strike incidence/recurrence and seasonal agricultural land cover changes in northwest Pakistan using satellite time series and open/declassified strike data,*

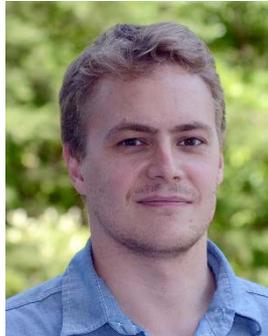
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**Eye in the Sky - Ethical Issues and Humanitarian Drones**

***Abstract:** Humanitarians are increasingly using drones to gather geospatial information post-disaster. Inexpensive and easy to use,*

*spatial modeling, and clustering techniques. Results spatialize the livelihood conditions of the drone campaign in northwest Pakistan and illuminate unintended and unaccounted for consequences of drone warfare on highly vulnerable land use systems.*

**Jamon Van Den Hoek**

is a geographer and remote sensing scientist. He pursues satellite imagery and machine learning approaches to document social-environmental consequences of armed violent conflict, and uses novel assemblages of geospatial datasets to counter dominant statist perspectives of human and environmental security. His current conflict ecology research examines the effects of the American drone campaign on agrarian livelihoods in Pakistan, the manifestation of damage in Aleppo over the course of the Syrian civil war, and spatially explicit relationships linking violent extremism and food security in Nigeria. Van Den Hoek is an Assistant Professor of Geography and Geospatial Science at Oregon State University and was previously a NASA Postdoctoral Fellow at NASA Goddard Space Flight Center from 2012-2015. He completed his PhD in Geography at the University of Wisconsin-Madison where he was a National Science Foundation IGERT Fellow from 2007-2010.



*from the ground up. However, the rapid growth in small, unmanned aircraft systems (UAS), commonly referred to as drones, for commercial and recreational purposes has challenged the status quo. The FAA does not have the resources to monitor drone use across the nation, but is concerned about ceding too much authority to local authorities as it might result in unintended consequences for the broader aviation community. At the same time, state and local authorities are getting tremendous pressure from their citizens to restrict the use of drones due to concerns over privacy, trespass and nuisance. This presentation will describe some of the ways in which states and localities are trying to address their citizens concerns and the potential federal preemption issues.*

**Kevin D. Pomfret** is a corporate partner at the Williams Mullen law firm and co-chair of the firm's Unmanned Systems practice group and the Data Protection and Cybersecurity practice group.



He is also the founder and Executive Director of the Centre for Spatial Law and Policy. He counsels businesses and government agencies on the policy and legal issues that impact the collection, use, storage and distribution of geospatial information, such as licensing, privacy and data protection, data quality and liability and regulatory matters. Mr. Pomfret regularly speaks on around the globe on these issues and has presented to committees of the United Nations and the U.S. House of Representatives. He began his career as a satellite imagery analyst where he helped to develop imagery

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**Drones and Federal Preemption:  
Who Controls the Airspace over Your  
Backyard**

***Abstract:*** *Historically the Federal Aviation Administration has had the exclusive authority to regulate the national airspace*

collection strategies and identify requirements for future collection systems. He is a member of the U.S. National Geospatial Advisory Committee. Mr. Pomfret is a graduate of Bates College and Washington & Lee School of Law.

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**Implementing UAS for Scientific Research in the Department of the Interior**

*Abstract: The U.S. Geological Survey (USGS) National Unmanned Aircraft Systems (UAS) Project Office leads the implementation of UAS technology in the Department of the Interior (DOI). Our mission is to support the transition of UAS into DOI as a new cost-effective tool for collecting highly accurate remote-sensing data to monitor environmental conditions, respond to natural hazards, recognize the consequences and benefits of land and climate change and conduct wildlife inventories. The USGS is teaming with all DOI agencies and academia as well as local, State, and Tribal governments with guidance from the Federal Aviation Administration and the DOI Office of Aviation Services (OAS) to lead the safe, efficient, cost-effective and leading-edge adoption of UAS technology into the scientific research and operational activities of the DOI. Website: <http://uas.usgs.gov/>.*

Jeff Sloan is Project Leader in the USGS National Unmanned Aircraft Systems Project Office. He holds a Bachelor of Science Degree in Geography from the University of Northern Iowa (1981-85) and Master's Degree in Geographic Information Systems at the University of



Denver in Denver, Colorado (1991-92). He has worked as a Cartographer in the U.S. Federal Government for 32 years beginning with the U.S Dept. of Defense - Defense Mapping Agency, with U.S. Dept. of Homeland Security - Operations Center and the Customs and Border Protection in Washington D.C, and a majority of his career with the Dept. of the Interior - U.S. Geological Survey in Denver, Colorado. His background is primarily in the areas of cartography, photogrammetry, and remote sensing pertaining to domestic and international mapping and monitoring. He has been involved with UAS operations since 2008 and in 2014, he took over as the Project Leader for the USGS National Unmanned Aircraft Systems Project Office in Lakewood, Colorado.

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**Panel II: Hardware: platforms and sensors**

Austin (Chad) Hill, Ben Kreimer, Nadeem Mazen, Brandon Montellato, Jeffrey Warren

*This session will present an overview of the existing hardware, including both flying platforms and mapping sensors, a brief history of their evolution, and diverse research application examples on how to evaluate and select among the available hardware options for achieving research goals.*

**Low Cost Drones and Archaeology: Evolving Methods, Hardware, and Capabilities**

*Abstract: Unpiloted Aerial Vehicles (UAVs), or "drones", have rapidly become an important tool for site monitoring, landscape mapping, and archaeological documentation. Drones can be deployed in remote locations, can operate in a wide range of conditions, and can provide higher resolution imagery than*

satellite images or traditional aerial photography. Over the course of the last decade, drone hardware has become increasingly more powerful, simpler to use, and affordable. It is now possible to perform rapid, high resolution, and accurate mapping at a scale that would previously have been impossible. In this presentation, I will discuss some of the ways low cost drones have been improving, and talk about a variety of archaeological drone survey projects from around the world.

Austin (Chad) Hill is a post-doctoral research associate and lecturer in the Department of Anthropology at Dartmouth College. Austin has worked at the forefront of drone-based low-elevation aerial remote sensing for archaeology for the last several years, and has worked on drone mapping projects in Jordan, Israel, Qatar, Kenya, and the United States. He is a co-director of the Landscapes of the Dead Project, Jordan and field director of the Galilee Prehistory Project, Israel. His current position at Dartmouth is focused on developing new methods to improve drone mapping efficiency, as well as expanding the functionality of and defining applications for drone-based aerial thermography.



and virtual reality, allow people anywhere to access and explore stories and otherwise inaccessible spaces. This presentation will include content examples and the hardware and software used to create them.

Ben Kreimer is a journalism technologist who specializes in storytelling with drones, virtual reality, 360° video, 3D reconstructions, and open source hardware sensor platforms. He helps storytellers, researchers, and mission-driven organizations leverage these emerging communications tools for amplifying their work, sharing knowledge, telling immersive stories, and encouraging positive change. Ben introduced 360° video to BuzzFeed as the first fellow in their San Francisco based Open Lab, a media R&D space. He co-produced many of BuzzFeed's 360° videos, including their first, which has received over six million views. He is also an adviser for the Drone Journalism Lab, and has worked with academic institutions and organizations including Columbia's Tow Center for Digital Journalism, Times of India, CCTV Africa, VICE News, Australian Aid, SecondMuse and LAUNCH, the African Wildlife Foundation, M.S. University of Baroda, and Antiochia ad Cragum Archaeological Research Project in Turkey.



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**Drones for Spatial Storytelling**

**Abstract:** As a spatial storytelling platform, consumer drones are not only for producing captivating aerial video and photographs, but also 360-degree videos, three-dimensional reconstructions, and virtual reality environments. This enables storytellers to expose and tell stories, especially those with a strong spatial element, through the creation of immersive content. Drones, 3D reconstructions,

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**Amateur Drone-Building and its Positive Effects on the Community**

**Abstract:** Although many perceive drones to be solely used by Big Brother, amateur, non-violent drone-making can have a positive community impact. In 2014, Danger!Awesome, a makerspace in Central Square, hosted

*a drone-building workshop to teach community members how to create their own drones for personal learning and growth.*

Nadeem Mazen is an educator, entrepreneur, and community organizer. He has been elected to Cambridge City Council for two terms since 2013. Nadeem first arrived in Cambridge to study Engineering at MIT. After graduation, he founded two community-oriented businesses in Central Square: Nimblebot, a creative agency, and danger! awesome, a makerspace that brings creative expression and tools to the masses. In 2014, he and a local artist Simon Remiszewski jointly organized a workshop in Boston for the public to design and build drones.



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**Next generation sensors and software integration**

*Abstract: The integration of UAV hardware and software has led to rapid advancements in the way geospatial data is collected and analyzed. By incorporating multiple sensors such as LiDAR, multispectral and thermal imagery, researchers are able to glean more meaningful information from aerial data. This combination of sensors and onboard computation, open SDK, enables algorithms to run in real-time, providing live feedback, data processing and analytics.*

Brandon Montellato is the University Relations Manager at DJI, serving as the lead liaison for university research. He also supports DJI STEAM academic partnerships to



develop certification programs, curriculum, and education applications. Prior to joining DJI, Brandon led strategic accounts and engineering services for Sky-catch, where he was deployed with major mining and construction clients, such as DPR, Skanska, and Rio Tinto. He holds a B.A. in Corporate Communications from San Francisco State University.

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**Balloons and Kites in the age of Autonomous Flight**

*Abstract: Thoughts on cost, accessibility, authorship, accountability and the authoritative view across different methodologies; photography as journalism, investigation, evidence, and protest with Public Lab and others.*

Jeffrey Warren The creator of Grassroots-Mapping.org and co-founder and Research Director for Public Lab, Jeffrey Warren designs mapping and civic science tools and



professionally flies balloons and kites. Notable software he has created include the vector-mapping framework Cartagen and orthorectification tool MapKnitter, as well as open spectral database and toolkit Spectral Workbench. He is Vice President of the board of the Open Source Hardware Association, on the board of alternative education program Parts and Crafts in Somerville MA, on the advisory board of Personal Democracy Media's WeGov and an advocate of open source software, hardware, and data. He co-founded Vestal Design, a graphic/interaction design firm in 2004, and directed the Cut&Paste Labs project, a year-long series of workshops on open source tools and web design in 2006-7 with Lima designer Diego Rotalde. Jeff

holds an MS from MIT and a BA in Architecture from Yale University, and spent much of that time working with artist/technologist Natalie Jeremijenko, building robotic dogs and stuff. To find out more, visit [Unterbahn.com](http://Unterbahn.com).

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**Keynote address:**  
**Drone for Community Resilience**

Jarlath O'Neil-Dunne

***Abstract:** Despite decades of advances in remote sensing, the technology has often passed by smaller communities who lack the resources and technical expertise to make use of these robust datasets. Drones are changing this, providing low-cost, rapid response approaches that help communities build resilience in the face of climate change. Drawing from case studies throughout the United States we will look at how the drone data is spurring a revolution in community-based spatial analysis.*

Jarlath O'Neil-Dunne

is the Director of the University of Vermont Spatial Analysis Laboratory where he leads the Unmanned Aircraft Systems Team. He holds a faculty appointment in the Rubenstein School of the Environment & Natural Resources and a joint appointment with the United States Forest Services' Northern Research Station. Prior to joining academia, he served as an officer in the United States Marine Corps.



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**Panel III: Software: data processing and analysis**

Luis Jaime Castillo Butters, Donna Delparte, Robert Homsher, Lawrie Jordan, Walter Volkmann

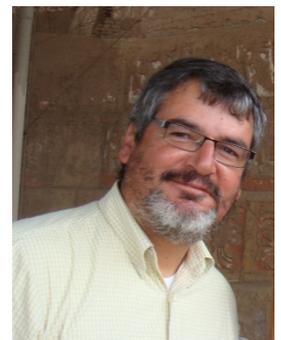
*This session will present use cases for major software options, focus on research application cases, and demonstrate innovative approaches in data post-processing for mapping.*

**Drones and Photogrammetry in Archaeology, Field Challenges and Lab Opportunities**

***Abstract:** Drones and Photogrammetry have proven to be two of the most transforming technologies applied to the archaeological study of the past. From the 3D representation of the smallest artifacts, the modeling of complex archaeological contexts, the creation of digital worlds where space and time are no longer limitations, to the capacity to survey enormous areas in great detail, to the reconstruction of ancient landscapes, these technologies are allowing us to do things we never imagined. But these techniques as surprising as they are, are also new and challenging, and are also in constant change offering us new opportunities. Synchronization of means and ends in the data that is acquired in the field and the data that is process in the lab is essential. In this talk I will try to convey some of the lessons that I have learned in 6 years of continuous dialog between field and lab.*

Luis Jaime Castillo Butters

is Professor of Archaeology, at the Pontificia Universidad Católica del Perú. Luis Jaime got his PhD in Anthropology at UCLA. Since 1991 he has been director of the San Jose de Moro Archaeological Program which conducts research in the Jequetepeque Valley focused on the evolution of complex Pre-Columbian societies, ideology and power, the political and geo political organization of the Moche, the collapse of



the Moche, ritual and funerary practices, etc. He has been member of the SAA Ethics Committee and Co Editor of Latin American Antiquity and visiting professor in several universities in the Americas and Europe. He has published books and articles on the archaeology of northern Peru and particularly about the Moche. He has also been, for 18 months, Vice Minister of Cultural Patrimony and Cultural Industries, in the Ministry of Culture, Peru where he had to deal, on a daily basis with the realities of Heritage Promotion and Preservation.

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### **UAS Hyperspectral Data Processing and Analysis**

*Abstract: The use of drones for agriculture is anticipated to grow into a billion-dollar industry. Drones have been commonly used for assessment of crop health. Our research at Idaho State University is furthering this technology by utilizing cutting-edge hyperspectral sensors to detect individual plants infected with a virus where the plant exhibits no symptoms that are detectable to the human eye, but are detectable by our drones. Additional research applies hyperspectral remote sensing to conservation efforts in a sage brush ecosystem. UAS hyperspectral sensors can be used to differentiate between three species of sagebrush to map vegetation cover, composition, and density. This presentation will highlight software tools and systems for processing hyperspectral data and the unique challenges associated with data analysis and modeling.*

Donna Delparte is a faculty member in the Department of Geosciences at Idaho State University. She has an extensive background in the cross-disciplinary applications of GIS and remote sensing in the fields of precision agriculture, re-

source management, and conservation/environmental planning. As an expert in data analysis and modeling, Dr. Delparte's current research focus relates to using hyperspectral sensor-equipped unmanned aircraft systems (UAS) for data collection and analysis. Dr. Delparte received her PhD from the University of Calgary, Canada. Prior to launching her academic career, she worked in various GIS positions in the private sector and managed GIS teams for governmental operations. Her other areas of interest include using 3D virtual and augmented reality for avalanche flow and hazard modeling, land cover change, and image analysis.



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### **Workflow and data optimization using Structure from Motion to process aerial datasets**

*Abstract: Over recent years, the Jezreel Valley Regional Project has developed an efficient and precise method for spatial documentation in archaeological fieldwork from the spatial scale of objects to landscape. The process of innovation evolved from ground-based SLR photogrammetry to 3D Structure from Motion, which we have now adapted for aerial imagery. I will present major practical solutions and key improvements we have discovered over the course of our own problem-solving and in collaboration with others. First are basic observations on flight software and image capturing specifically for SfM processing. Second are quick and effective steps one can take for image pre-processing that may drastically improve models and reduce processing time. I will particularly summarize key tools and processing parameters using Agisoft Photoscan, highlighting the use*

of multiple chunks in recombinant modeling and data output. Finally, I will contrast the resulting SfM datasets (namely orthophotos and DEMs) with others, discuss their potential for generating vector data and conducting spatial analyses, while also emphasizing several advantages throughout the process.

Robert Homsher is an archaeologist specializing in methods used for landscape and environmental archaeology. He received his doctorate from the Institute of Archaeology at University College London, and has taught as College Fellow at Harvard University and Lecturer at San Francisco State University. Robert is presently a Visiting Fellow at the Center for Geographic Analysis at Harvard and a Research Fellow at the W.F. Albright Institute of Archaeological Research, where his research integrates proxy environmental and geospatial data to explore human-environmental dynamics during the Bronze Age. He has conducted archaeological excavation and survey the Middle East for several years, and currently co-directs the Jezreel Valley Regional Project among other collaborations. The JVRP emphasizes interdisciplinary methodological innovation for the advancement of archaeological efficiency and precision.



professionals with backgrounds across several disciplines but they are not experts in Remote Sensing, nor do they want to be. Instead, they desire to solve application-specific problems and make better decisions based upon imagery-derived information products, specifically from UAV / UAS systems, without needing to become domain experts on the detailed science of rigorous photogrammetric methods. Recent examples illustrating several use cases will be presented, along with observations on near-term trends related to drone use within GIS systems.

Lawrie Jordan is Director of Imagery and Remote Sensing for Esri, as well as Special Assistant to Esri founder and President, Jack Dangermond. Mr. Jordan has over 35 years of experience as a leader in the field of image processing and remote sensing. He was co-founder and President of ERDAS, Inc. for more than 20 years and played a key role in evolving a long standing strategic partnership with Esri. He has been an advisor to numerous government organizations on current and future trends involving imagery and earth observation involving all types of sensors and platforms, and he serves on the boards of several influential organizations and foundations. His background education is in Landscape Architecture, with degrees from The University of Georgia and Harvard University. Lawrie is a member of the European Academy of Sciences and Arts, as well as the 2015 recipient of the Geospatial World Leadership Lifetime Achievement Award for his decades of contribution in the field of Image Processing and Earth Observation. He is also grateful to be the recipient of



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**The Illusion of Simplicity and the Arrival of Disappearance**

*Abstract: This presentation will address the notion that the future of Geospatial Information Technology belongs to the simple and the quick. The assertion is that we are witnessing a new normal emerging within the Geospatial community whereby many incoming members of this industry increasingly are*

the U.S Government's medal for Outstanding Support and Patriotism.

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**Opportunity for Future Automation in Personal Mapping Operations, with Particular Reference to Cadastral (Property Boundary) Surveying**

*Abstract: For all practical purposes, the abundance of functionality provided by open source flight planning and flight management capabilities (software and hardware) in their current stage of development is at the threshold of maturity. In other words, not much more development is needed to efficiently and reliably perform small, highly accurate and detailed aerial surveys under small, decentralized enterprise conditions. However, despite the high degree of automation achieved to date, there is still opportunity for further reduction in operational complexity, costs and minimum skills needed in personal mapping enterprises. I will be speaking about the conventional A to Z workflow in small drone supported Structure from Motion mapping techniques and will point out how airborne dual frequency GNSS technology and the technique of linear interpolation of camera events can significantly improve the economics in personal cadastral and topographic aerial mapping operations.*

Walter Volkmann grew up on a cattle farm in Namibia in southern Africa. After graduating at the University of Natal in South Africa in 1980 and registering as a professional land surveyor in South Africa and Namibia he took over his father's family practice and built it into a progressive geo-spatial service provider with clients in southern as



well as western Africa. His classic education in the natural sciences and geo-spatial applications enabled him to quickly seize on cost cutting opportunities offered by personal computers, electromagnetic distance measurement, GPS, computer aided drafting (CAD), geographic information systems (GIS) and, albeit much later, small drone technology and mapping by means of the structure from motion method. His experience as a private sector entrepreneur has provided him with a grass roots level focus on appropriate applications of technology in development. He immigrated to the United States in 2002 from where he has since been engaged as an international consultant in various roles related to geodetic and cadastral surveying. With the purpose of exploring innovative mapping methods with community participation, he founded Micro Aerial Projects LLC in 2008. Walter lives in Gainesville, Florida with his wife Mary Jane, a fine artist, and enjoys working with his son Oliver, who manages the operations at Micro Aerial Projects LLC as well as the jointly owned firm drone2GIS Inc.

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**Panel IV: Applications across Disciplines**  
Mike Foster & Daniel Sheehan, Scot Martin, Everette Newton, Nathaniel Raymond, Jason Ur

*This session will discuss a range of applications of drones, with an eye toward the future of these disciplines including the social sciences, humanities, natural sciences, urban design, and crisis/humanitarian mapping.*

## Building the Foundations for UAV Support and Education in an Academic Research Environment

*Abstract: The MIT Libraries and MIT Department of Urban Studies and Planning are developing a drone program to support classes and research. The program involves a crosscutting array of components, evaluating methods for enabling drone use by students and researchers, and expanding curriculum and assessing best practices and technologies. We will focus on a recent sedimentology field trip to the Death Valley area to supplement field observations, which we supported by drone operations to acquire high resolution orthophotos and create 3D image of the Carrara Formation.*

Mike Foster is a GIS/Data Visualization Specialist and Instructor in the MIT Department of Urban Studies and Planning, where he focuses on urban-oriented geospatial technologies, mapping and data analysis, and visualization and communication. He teaches GIS and develops/manages curriculum for coding, mapping, and data management. Prior to coming to MIT, he worked as a GIS Analyst specializing in large infrastructure projects. He has a Master's Degree in Geographic Information Science from University of Minnesota, with a focus on crowdsourcing, interoperability, and open source GIS, and a B.S. in Geography from University of Wisconsin-Madison with a focus on cartographic design and representation.



Daniel Sheehan is a GIS programmer and analyst and leads the MIT GIS Services group in the MIT Libraries. He has

helped people process and visualize spatial and tabular data with GIS in the MIT GIS Lab, in the classroom, and out in the field for the past 18 years. He is currently working with the Department of Urban Studies to promote and enable the use of small UAVs for academic and research use at MIT. He spent the decade prior to coming to MIT helping researchers use GIS at the Woods Hole Lab of the National Marine Fisheries Service and the Geophysical and Polar Research Center at the University of Wisconsin at Madison.



## Drones in Amazonia: Environmental Research

*Abstract: Applications of UAVs equipped with environmental sensing and sampling, with opportunities for studies in Amazonia related to air quality and climate change will be introduced.*

Scot Martin leads a research group at Harvard University that addresses scientific problems, engineering challenges, and technical breakthroughs in the atmospheric sciences, especially as related to the roles of particulate matter in air quality, climate, and atmospheric chemistry. Recent research has taken place both in field work in the Amazon basin and laboratory studies centered at the Harvard Environmental Chamber. Martin served as the Principal Investigator of the Amazonian Aerosol Characterization Experiment (AMAZE-08) and the Observations and



Modeling of the Green Ocean Amazon (GoAmazon2014/5) Experiment. He serves as a Visiting Professor at Amazonas State University, Brazil.

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**Drones in Marine Science...an Amazing Intersection of Science and Technology!**

*Abstract: Two years ago, the Duke Marine Lab in Beaufort, NC designed and developed a facility specifically dedicated to Marine Robotics and Remote Sensing (MaRRS). Since declaring their initial operational capability, the MaRRS team has conducted extensive coastal research in eastern North Carolina, but has also surveyed marine debris in Hawaii, olive ridley sea turtles in Costa Rica, gray seals in Massachusetts and Canada, right whales off the coast of Florida, Etruscan and Roman archeological sites in Italy, WWI shipwrecks along the Potomac River, and (most recently) whales, seals, and penguins in Antarctica. The Duke MaRRS presentation will highlight numerous platforms, sensors, and applications that will inspire the audience to develop their own maritime (or terrestrial) drone projects using rapidly emerging drone technologies and Duke University's lessons learned.*

Everette S. "Rett"

Newton retired as a Colonel from the US Air Force in 2011 following a 28-year career that included leading-edge engineering, F-15E Strike Eagle leadership, and assignments as an Arabic foreign area officer. Rett entered the Air Force in 1982 after earning a Bachelor of Science degree in mathematics at Campbell University. Following Officer Training School, he completed a second Bachelor



of Science degree in the Air Force Institute of Technology electrical engineering program. During his military career, Rett logged approximately 3,500 flight hours in T-41, T-37, T-38, F-4, F-15, and C-12 aircraft. In retirement, he has continued his passion for aviation by designing, building, operating and maintaining unmanned aircraft systems with autopilot, high definition cameras, datalink, and first person view. Rett joined the Duke University Marine Laboratory team in June 2015, serving as initial cadre and Program Manager for the Marine Robotics and Remote Sensing Lab, and he is now a first-year PhD student in Duke's Marine Science and Conservation program.

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**Humanitarian Applications of Unmanned Aerial Systems: Promise and Peril**

*Abstract: The increasing use of unmanned aerial systems in crisis response operations by humanitarian actors and affected communities has provided organizations with improved capacities for situational awareness. However, these technologies challenge available technical expertise, traditional ethical guidance, and accepted operational doctrine currently available to humanitarian actors. Mr. Raymond will discuss how the humanitarian sector is working to navigate these complex issues in an ethical and sustainable way.*

Nathaniel Raymond is Director of the Signal Program on Human Security and Technology at the Harvard Humanitarian Initiative (HHI) of the Harvard T.I. Chan School



of Public Health. He was formerly Director of Operations of the Satellite Sentinel Project at HHI, which was a co-recipient of the 2012 US Geospatial Foundation Industry Intelligence Achievement Award.

**Drones and Historical Landscapes: An Archaeological Case study from the Middle East**

*Abstract: The study of historic landscapes is an undertaking greatly enhanced by a remote perspective. Archaeologists have traditionally approached premodern landscape reconstruction using several sources: historical maps, early aerial and satellite photography, and recent commercial satellite imagery, each with strengths and weaknesses. In the past few years, the availability of commercial UAVs and digital applications for flight planning and image processing have revolutionized landscape research. Much like GIS in the mid-1990s, drones and associated image processing software are poised to transition rapidly from the domain of the specialist to the toolbox of all practicing researchers. This presentation will demonstrate how drone data collection has transformed my own research project, a study of the imperial landscape of the Assyrian Empire (ca. 900-600 BC) in what is today the Kurdistan Region of northern Iraq.*

Jason Ur - see page 4

**Closing Remarks**

Faine Greenwood

*Greenwood will discuss the role of academia and academic research in drone technology. How can academics use drone technology to improve their work - and how can academics have an impact on the regulatory and cultural environment surrounding drone technology?*

Faine Greenwood - see page 6

**Panel Moderators**

Jeff Blossom is the GIS Service Manager of the CGA. He has experience working in the GIS industry as a technician, analyst, developer, manager, and educator. Prior to joining the CGA, Jeff was the GIS Photogrammetry Administrator for the City and County of Denver, and served as Chairman of Denver's GIS Steering Committee. Jeff earned an M.A. in Geography from the University of Denver in 2002, and a B.S. from Willamette University (OR) in 1995. Jeff is especially interested in developing tools, teaching methods, and maps using geographic information that can be used by any student or professional to enhance their work. Related to this effort is the graduate level class he teaches at the Harvard Extension School: Geographic Communication Today. Jeff is also an adjunct faculty member at Salem State University, where he teaches Computer Cartography.



Wendy Guan is the Executive Director who manages daily operations of the CGA. She came to Harvard in 2006 as the Director of GIS Research Services for the newly established Center. Prior to that, she managed professional services at a GIS consulting firm in Washington State; headed a geospatial information technology department for a multinational forestry corporation; and supervised GIS



teams in a Florida government agency. Wendy has a Ph.D. in ecology and GIS; a M.A. and M.S. in geography and natural resource management, and a B.S. in biology. She taught GIS in various universities, including the Harvard Extension School.

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Ben Lewis is the Geospatial Technology Manager of the CGA.



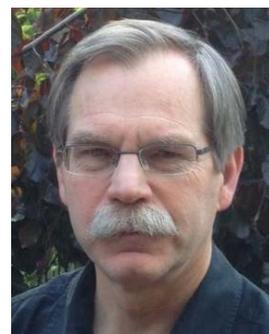
He is the system architect and project manager for WorldMap, an open source infrastructure that supports collaborative research centered around geospatial information. Before joining Harvard, Ben was a project manager with Advanced Technology Solutions of Pennsylvania, where he led the company in adopting platform independent approaches to GIS system development. Ben studied Chinese at the University of Wisconsin and has a Masters in Planning from the University of Pennsylvania. After Penn, Ben worked at the U.C Berkeley GIS Lab, started the GIS group for the transportation engineering firm McCormick Taylor, and coordinated the Land Acquisition Mapping System for the South Florida Water Management District. Ben is especially interested in technologies that lower the barrier to GIS access.

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Josh Lieberman is a senior research scientist at CGA working on hydrographic ontologies and semantic applications for the U.S. National Map as part of the new Spatiotemporal Innovation Center. He also serves as a coordinating



architect and initiative manager for the Open Geospatial Consortium and as a lecturer at the University of Maryland Baltimore County. Josh has a Ph.D. from the University of Washington, M.S. from the University of Oregon, and A.B. from Dartmouth College, as well as many years of experience in earth and environmental sciences and geospatial modeling.

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Dave Strohschein



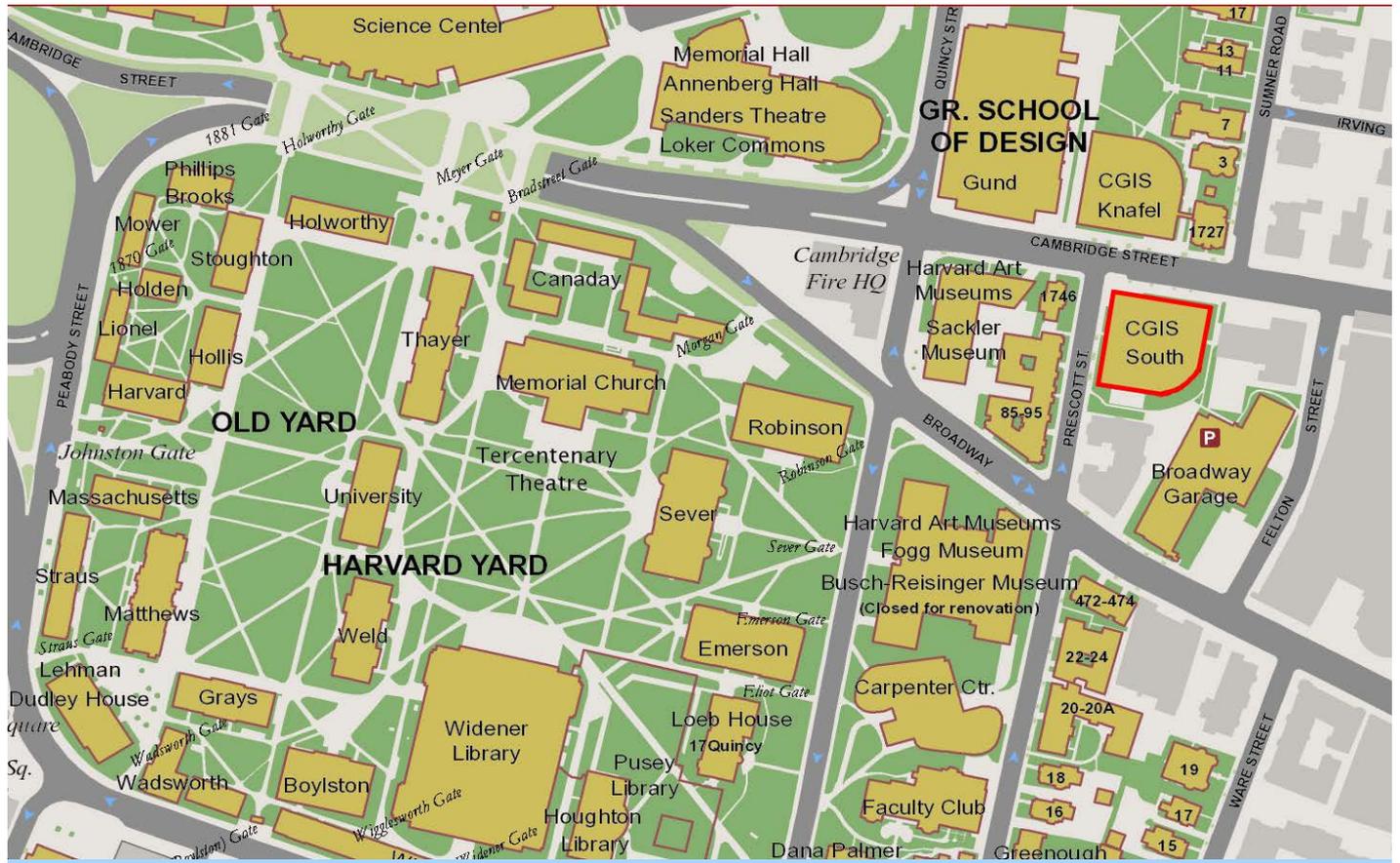
came to Harvard in 2014 as a GIS Fellow. He draws from a multidisciplinary background encompassing engineering, software design, systems analysis, and geo information science. He has applied this experience to such areas as complex systems' performance, GIScience education, and application of GIS to healthcare and municipal planning.

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Matthew W. Wilson,



PhD, is Associate Professor of Geography at the University of Kentucky and Visiting Scholar at the Center for Geographic Analysis at Harvard University. He co-founded and co-directs the New Mappings Collaboratory, which studies and facilitates new engagements with geographic representation. He has previously taught at the Harvard Graduate School of Design, and his current research examines mid-20th century, digital mapping practices. He earned his PhD and MA from the University of Washington and his BS from Northwest Missouri State University.

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