PE&RS
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PHOTOGRAMMETRIC ENGINEERING & REMOTE SENSING
The official journal for imaging and geospatial information science and technology

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MAPPS

USIBD U.S. Institute of BUILDING DOCUMENTATION

WGIC World Geospatial Industry Council

ANNOUNCEMENTS

Pixxel, announced a partnership with Sanborn, a leading geospatial solutions company at the forefront of spatial data collection.

Using Pixxel's hyperspectral dataset, **Sanborn**, www.sanborn.com, will equip their customers with advanced insights to solve problems as varied as agriculture crop and forestry health monitoring, exploration for minerals and mining, natural resource management, monitoring the impacts of extreme events – flood, storm, wildfire – and much more.

The new partnership will allow Pixxel to further its vision to build a health monitor for the planet. With three pathfinders already in space, Pixxel has signed up 45+ direct early adopters and over 60 resellers around the world. Most recently, Pixxel announced a $36 Million Series B funding round and a 5-year contract with the NRO Commercial Systems Program Office (CSPO) for the Strategic Commercial Enhancements for Commercial Hyperspectral Capabilities program. For more information visit www.pixxel.space.

Pickett, www.pickettusa.com, is pleased to announce the purchase of a new SkyFish M4 RTK aircraft! This USA-made system is an innovative addition to our existing Unmanned Aerial System (UAS) fleet. The M4 system was designed using USA made components and assembled in the USA, complying with NDAA Sec. 848 (Federal Department of Defense) regulations and Florida Administrative Code 60GG-2.0075 (State of Florida) for use by municipal agencies.

The high-resolution custom integrated Sony a7R IVA camera on this platform provides 61 MP full frame images for aerial inspection, mapping, reality modeling, and public relations presentations. The real time display is also the "eyes in the sky" for emergency response scouting and disaster response planning. Using the onboard Skymind edge computing system, this platform can be integrated with AI applications to rapidly plan complex missions, identify maintenance concerns, and assess storm damage to utility infrastructure. We are confident that this system will help us respond more effectively to *solve the problems that matter* to our clients.

TECHNOLOGY

Merrick & Company, www.merrick.com, is pleased to announce the latest release of our lidar processing software solution, MARS® 2023.1.

Highlights include:

- A new raster option for the 'Flightline Separation – Tiled GeoTIFF' export type that uses a hybrid of TIN and GRID to produce rasters with better useability while maintaining good throughput times.
- Enhancements to the Raster QC tool that include better identification of NODATA cells, improved handling of irregular project boundaries, and automatic correction of cell elevation values when testing for hydro-flattening.
- A new 'TIFF Origin Rounding' tool that produces better edge-matching results between adjacent raster tiles.
- The lidar point cloud statistics created by several tools and stored in tile-based polygon shapefiles have been cleaned up to remove many unnecessary fields, and now include Withheld point counts per classification.

In addition to these quality and compliance enhancements, several other improvements and bug fixes are included in this latest MARS® release, as detailed in the Release Notes, www.merrick.com/site/static/mars/documentation/MARS_v2023.1_Release_Notes.pdf.

Nearmap, www.nearmap.com, announced new advancements in its effort to make accurate, up-to-date property information more accessible to all insurers through the launch of its new product, Nearmap PropertyVision, www.nearmap.com/us/en/property-data-for-insurance.

With Nearmap PropertyVision, physical property reviews are transformed into an easy-to-use web application, delivering extensive analytics data all in one place. The online platform marks a shift from physical to virtual— augmenting market-leading APIs for data scientists and automated pre-fill applications. This innovation allows carriers to engage in detailed property reviews through sharp aerial imagery and AI-derived property insights, making it possible for carriers to make more timely, educated decisions about the properties they insure.

This new interface makes data more accessible to underwriters and adjustors, not just the data science department—ensuring access to key data points including current and historical aerial imagery, roof condition scores, industry-leading post-catastrophe aerial imagery and AI data.

The release of PropertyVision comes on the heels of several insurance-focused property innovations from Nearmap, allowing for greater accessibility to the most up-to-date property intelligence insights for insurers. These innovations include:

- Nearmap Fire Risk AI helps insurers rapidly assess and understand the fire vulnerability of a given property. Carriers can rely on Nearmap Fire Risk AI to understand property vulnerability and inform wildfire risk assessments. Powered by Nearmap imagery, the solution provides insurers with information on the defensible space related to 15+ property attributes—including vegetation, bodies of water, wooden decking, 3D data and third-party data from the USDA and USGS.
- ImpactAssessment AI facilitates detailed examinations of property conditions post-disaster by providing insurers with a robust collection of AI-derived condition and damage data attributes on specified properties. Insurers can use the data—including roof damage, temporary and permanent repairs, structural damage, debris, wreckage, and more—to analyze and assess vast amounts of incoming post-catastrophe claims more quickly and accurately.
- With Advance AI Viewer, users can now utilize Nearmap MapBrowser to view AI features as raster and vector layers, enabling them to experience the full power of the 500+ AI attributes without IT support or API integration.

To learn more, visit https://www.nearmap.com/us/en/property-data-for-insurance.

ACCOMPLISHMENTS

URISA is pleased to announce the newest members of its Vanguard Cabinet. The Vanguard Cabinet (VC) is a URISA initiative (which debuted in 2011) to engage young GIS practitioners, increase their numbers in the organization, and better understand the concerns facing these future leaders of the GIS community. The VC is an advisory board who represent the young membership of the organization. The Cabinet's mission is to collaborate with URISA's Board of Directors and Committees in creating and promoting programs and policies of benefit to young professionals.

Comprised entirely of passionate young members selected from different geospatial disciplines, the Cabinet aims to position URISA as the center of opportunities for ambitious young professionals who are committed to improving URISA and the geospatial profession via innovation, collaboration, networking, and professional development. Each will serve a three-year term.

2024-2026 URISA Vanguard Cabinet Members:

- Rachel Byrd, GISP, Geographer & GIS Subject Matter Expert (SME), Infrastructure, Land, & Water Resource Management, New York, New York
- Rasha Elnimeiry, MPH, MAS, CPH, Geospatial Epidemiologist, Washington State Department of Health, Rochester, Minnesota
- Sydney Fuhrig, Planning Specialist, Tennessee Department of Transportation, Nashville, Tennessee
- Johnny Harley, GIS Analyst, TREKK Design Group, Kansas City, Missouri
- Julie Lazor, Technical Advisor, SoCalGas, Long Beach, California
- Jacob McDaniel, GIS Manager, Washington County Assessor's Office, Fayetteville, Arkansas
- Ludo Nthoiwa, MSc Environment Science Student, Botswana International University of Science and Technology, Palapye, Botswana
- Olga Tambazidis, GIS Technician II, Los Angeles County Department of Mental Health, Los Angeles, California
- Hannah Walters, GIS Analyst, Denver Water, Denver, Colorado

For more information, visit https://bit.ly/46GdMh5.

CALENDAR

- 11-13, February 2024, **Geo Week**, Denver, Colorado; https://www.geo-week.com.
- 2-4 May 2024, **GISTAM 2024**, Angers, France; https://gistam.scitevents.org.
- 13-16 May 2024, **Geospatial World Forum**, Rotterdam, The Netherlands; https://geospatialworldforum.org..
- 11-14 June 2024, **ISPRS Technical Commission II Symposium — The Role of Photogrammetry for a Sustainable World**, Las Vegas, Nevada; www.isprs.org/tc2-symposium2024.

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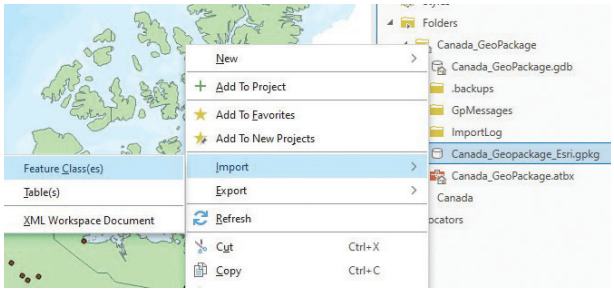

725 GIS Tips & Tricks — Tired of Distributing Multiple "shapefiles"? Try a GeoPackage

729 ASPRS Announces Workshops for Geo Week

733 Introduction for Innovative Methods for Geospatial Data using Remote Sensing and GIS — Part II

By Tolga Bakırman and George Arampatzis

735 IMU and Bluetooth Data Fusion to Achieve Submeter Position Accuracy in Indoor Positioning

Ugur Acar

With the ability of mobile phones to determine position, indoor navigation applications have become widespread in recent years. Due to the inefficiency of global positioning system (GPS) indoors, other positioning methods have been developed based on local networks using technologies such as Bluetooth, wireless networks, ultra-wideband signals, ultrasonic signals, and radio frequency identification modules. Various technologies yield high or medium accuracy. Combining data from multiple sources via fusion enhances location precision. In this study, indoor positions were estimated using trilateration with Bluetooth devices, and the accuracy was improved by applying filters to the data from inertial measurement unit (IMU) sensors on the phone. As a result of combining Bluetooth and IMU data with data fusion, submeter accuracy was achieved.

741 Rice Identification Under Complex Surface Conditions with CNN and Integrated Remote Sensing Spectral-Temporal-Spatial Features

Tianjiao Liu, Jiankui Chen, Li Zhang, and *Dong Li*

Accurate and effective rice identification has great significance for the sustainable development of agricultural management and food security. This article proposes an accurate rice identification method that can solve the confused problem between fragmented rice fields and the surroundings in complex surface areas. The spectral, temporal, and spatial features extracted from the created Sentinel-2 time series were integrated and collaboratively displayed in the form of visual images, and a convolutional neural network model embedded with integrated information was established to further mine the key information that distinguishes rice from other types.

753 Combination of Terrestrial Laser Scanning and Unmanned Aerial Vehicle Photogrammetry for Heritage Building Information Modeling: A Case Study of Tarsus St. Paul Church

Şafak Fidan, Ali Ulvi, Abdurahman Yasin Yiğit, Seda Nur Gamze Hamal, and *Murat Yakar*

Cultural heritage building information modeling (HBIM) is an emerging process allowing us to reconstruct built heritage virtually. The data of a digitally documented cultural heritage building offers significant advantages as it is accessible and modifiable by all professionals involved in the same or different projects. The most important factor affecting the accuracy and precision of the HBIM model is the ability to collect complete and accurate information about the physical structure. Combining terrestrial laser scanning (TLS) and unmanned aerial vehicle (UAV) photogrammetry point clouds is one of the most efficient ways to capture accurate digital data on the building. This study provides the foundation for creating an HBIM model for cultural heritage buildings using combined spatial data from TLS and UAV. This article aims to generate synergy between TLS and UAV point cloud data and ensure that the spatial database contains sufficient data to model historical objects with HBIM tendencies.

761 Quantifying Impacts of Regional Multiple Factors on Spatiotemporal the Mechanisms for Spatio-temporal changes of Net Primary Vegetation Productivity and Net Ecosystem Productivity: An Example in the Jianghuai River Basin, China

Huimin Chen, Benlin Wang, Liangfeng Zheng, and *AmirReza Shahtahmassebi*

Despite much valuable research on the mechanisms for spatiotemporal changes of net primary vegetation productivity (NPP) and net ecosystem productivity (NEP), there is a paucity of information on assessing impacts of regional multiple factors on spatiotemporal research of NPP and NEP in the complex environment. Using the Jianghuai Basin in China as a case study, this article attempts to bridge this information gap. Using a field campaign, remotely sensed imagery, socioeconomic data, and meteorological parameters, we developed a framework based on the Carnegie–Ames–Stanford Approach (CASA) model, correlation technique, trend analysis, and landscape metrics to measure spatiotemporal changes in NPP and NEP from 2001 to 2018.

COLUMNS

725 GIS Tips & Tricks — Tired of Distributing Multiple "shapefiles"? Try a GeoPackage

ANNOUNCEMENTS

728 ASPRS Certifications

729 Headquarters News — ASPRS Announces Workshops at Geo Week

732 New ASPRS Members
Join us in welcoming our newest members to ASPRS.

734 Call for *PE&RS* Special Issue Submissions — Ushering a New Era of Hyperspectral Remote Sensing to Advance Remote Sensing Science in the Twenty- first Century

DEPARTMENTS

721 Industry News

722 Calendar

771 In-Press *PE&RS* Articles

772 Who's Who in ASPRS

773 ASPRS Media Kit

780 ASPRS Sustaining Members

See the Cover Description on Page 724

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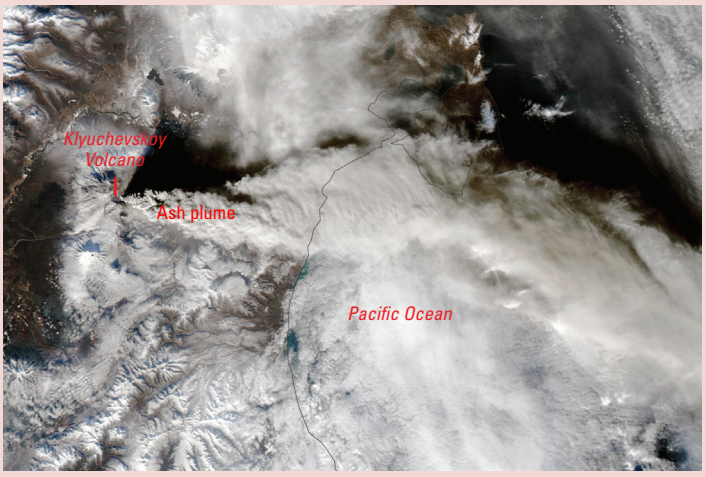

Eruption activity escalated at the Klyuchevskoy volcano on Russia's Kamchatka Peninsula in autumn 2023. When the MODIS (Moderate Resolution Imaging Spectroradiometer) sensor on NASA's Aqua satellite acquired this image (above) on November 1, 2023, the ash plume from Klyuchevskoy (also Kliuchevskoi) rose as high as 12 kilometers (40,000 feet) above sea level. The plume extended 1,600 kilometers (1,000 miles) to the east-southeast, reported the Kamchatka Volcanic Eruption Response Team (KVERT).

The false-color image on the cover offers a detailed look at the lava flows and ash plume emanating from the volcano. It was acquired by the OLI (Operational Land Imager) on Landsat 8 on November 1, 2023. The hot lava gives off a shortwave infrared signal that makes it appear red in this band combination (6-5-3). Clouds appear blue, contrasting with the gray, roiling plume.

As a precaution, authorities ordered the closure of schools in two nearby towns, according to news reports. The aviation color code was elevated to red, the highest warning level, due to the significant emissions of ash into the atmosphere.

Located along the Pacific Ring of Fire, the Kamchatka Peninsula is home to more than 300 volcanoes, including several that are frequently active. The current eruption at Klyuchevskoy, Eurasia's tallest active volcano, has been ongoing since June 2023, when KVERT noted the start of Strombolian eruptions. Explosive eruptions and lava flows continued in the ensuing months. Landsat 8 captured an image of a tamer eruptive phase, along with activity at neighboring volcano Bezymianny, in mid-October 2023.

NASA Earth Observatory images by Wanmei Liang and Lauren Dauphin, using MODIS data from NASA EOSDIS LANCE and GIBS/Worldview, and Landsat data from the U.S. Geological Survey. Story by Lindsey Doermann. The image images can be viewed online by visiting the Landsat Image Gallery, https://landsat.gsfc.nasa.gov/, image id 152037.

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GIS Tips & Tricks

By Al Karlin, Ph.D. CMS-L, GISP

Tired of Distributing Multiple "shapefiles"? Try a GeoPackage

When Esri introduced the "shapefile" with ArcView 2.0 in the early 1990s, the idea was revolutionary. The "shapefile" represented an open, non-proprietary, 8-bit transportable format for shape geometry (the .shp file), tabular-like attributes (the .dbf file) and a spatial index (the .shx file) that could be easily ingested into GIS software, both Esri and portable to other platforms. The shapefile quickly replaced the older Esri GIS "coverage" format, and it persists today coexisting with 32-bit feature classes in Esri file-geodatabases.

For beginning and some intermediate GIS students and particularly for students not familiar with Microsoft file structures, the "shapefile" is a source of never-ending confusion. First of all, the "shapefile" actually consists of three required computer files. The file that holds the geometry is called the shapefile and has the .shp extension; a major point of confusion. The attribute file is a holdover from those early 1990s and a database product, dBase™, with a .dbf extension. The third file is the index, the .shx file, to connect the .shp with the .dbf file. It would be great if that were all the individual files comprising the "shapefile", but there are more, optional but very important files. For the "shapefile" to be projected and rendered in the correct geographic space, it must have an accompanying projection, a .prj file, and to include metadata, a .xml file is needed. If you want to include legend symbology with the "shapefile" an .avl file is added to the list. As if this were not enough, to assist in rendering speed, additional index files are needed. So… it is not uncommon for a "shapefile" to contain 8 or more individual files! Try explaining that to students only familiar with iOS and MacBooks! Then, there are the limitations of the "shapefile" format. "Shapefiles" (1) can only contain vector-based shapes, (2) are limited to 2GB is size, (3) field names are limited to 10 characters, (4) can only store one geometry type, and the list goes on.

By the early 2000s, other "GIS" file formats were constructed to imitate the portability of the Esri "shapefiles". GeoJSON was constructed to be an open-source portable GIS format, more compact than "shapefiles". Other open-source formats, such as Keyhole Markup Language (.kml) and Extensible Markup Language (.xml) appeared about the same time. The newest GIS open-source file format, the "GeoPackage" emerged in the mid-2010s and is supported by most popular GIS packages (Esri Desktop and Pro, QGIS, and others), as well as Python and R. For details and comparisons between shapefiles and GeoPackages, see: https://www.geopackage.org/ or watch the many videos on YouTube. Although this month's Tips & Tricks focus on making GeoPackages in QGIS and ArcGIS Pro, you can also make GeoPackages using Python and/or R as the container is an opensource SQLite database.

Tip #1 — Creating a GeoPackage in QGIS

For this tip, I am creating a GeoPackage from existing Esri shapefiles using QGIS "Lima"; one (Canadian Provinces) file has polygon- geometry and the other (Canadian Cities) has point-geometry, Figure 1, but Esri Feature Classes residing

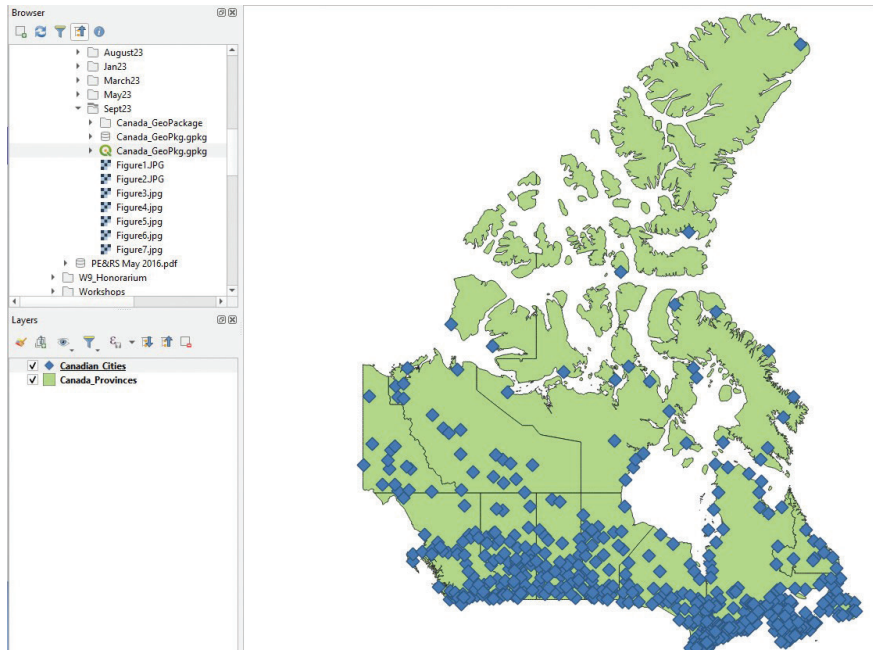

Figure1. QGIS Lima displaying two Esri shapefiles; a point feature (the Canadian Cities) and a polygon feature (the Canadian Provinces.)

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in a file-Geodatabase could just as easily be integrated into GeoPackages (see later example). Both shapefiles will be exported into a single GeoPackage.

Step 1 — Open QGIS and import the shapefiles from the Browser window into the Layers.

Step 2 — Right-click on the polygon shapefile in the Layers Window and choose "export | save features as" and choose GeoPackage, Figure 2.

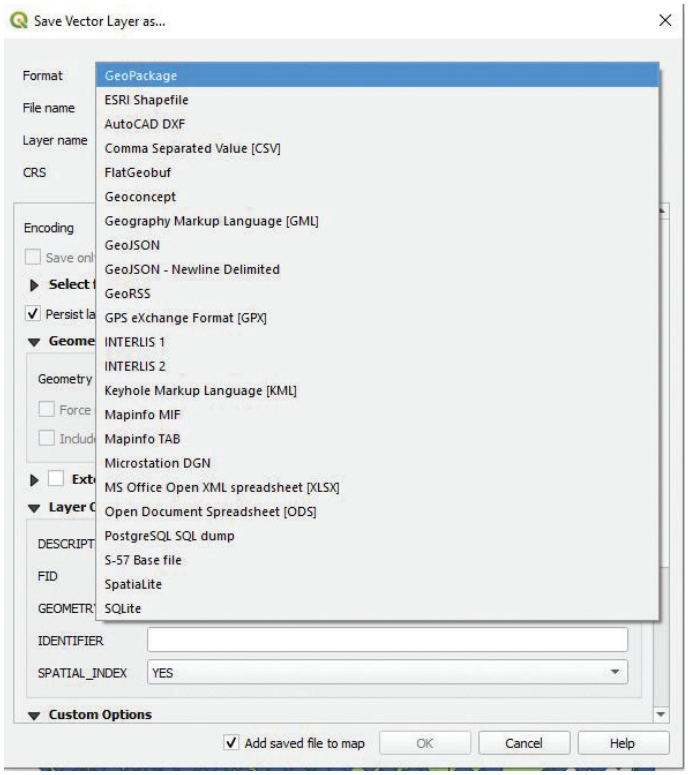

Figure 2. Saving an Esri shapefile to a GeoPackage.

Step 3 — Use the ellipses by the File name fill-in to navigate to a folder and provide a name for the GeoPackage, Figure 3.

Step 4 — Define any Layer Options (Description, etc.) and Custom Options.

Step 5 — Press Save to construct the GeoPackage containing the shapefile.

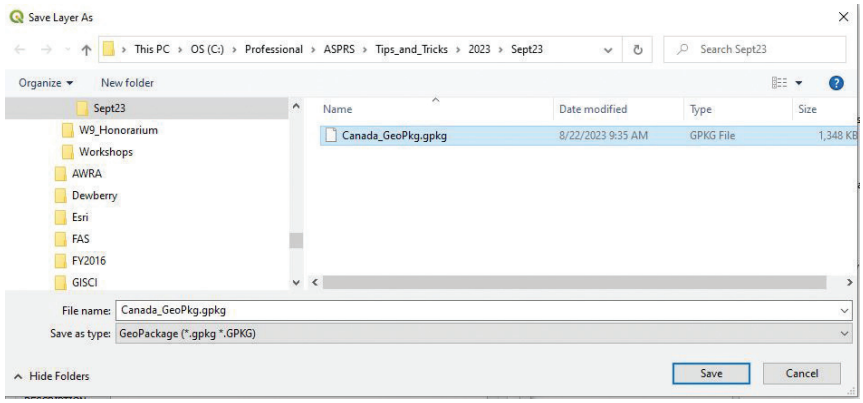

Figure 3. Saving a QGIS layer into a GeoPackage.

Step 6 — To ADD additional layers into the GeoPackage:

1. In the Layers panel, click the "Create a new layer" button to create a new vector layer, or right-click on an existing layer and choose "Export" to export it to a new GeoPackage file.
2. In the "Create a Layer" or "Export" dialog box, choose "GeoPackage" as the file format.
3. Choose the GeoPackage file created previously,
4. Choose the type of data you want to store in the GeoPackage, such as point, line, or polygon data.
5. Define the properties of the new layer, such as the name, attributes, and coordinate system.
6. Add data to the new layer by importing or creating new features, or by loading data from other sources.
7. Save the changes to the GeoPackage by choosing the option to save or export the layer to the GeoPackage format.

Tip #2 — Creating a GeoPackage in ArcGIS Pro

Constructing a GeoPackage in ArcGIS Pro 3.13 is a two-step process; (1) first you create a SQLite database (.gpkg) as a container, and then (2) use the Catalog pane to load/import feature classes or shapefiles into the database container. (Esri provides a special tool for loading rasters into the GeoPackage, see Tip #3.)

Step 1— Make the SQLite database: In the Data Management | Workspace toolset, select the Create SQLite Database script, Figure 4.

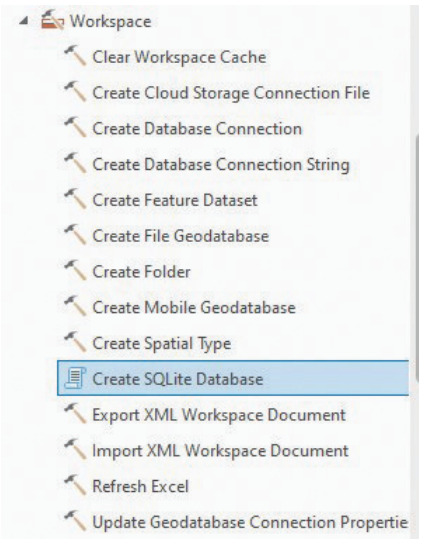

Figure 4. The Create SQLite Database script in the Data Management | Workspace Geoprocessing Toolset

Step 2 — Use the Folder icon to navigate to a file folder and provide a name for you GeoPackage, and be sure to change the Spatial Type to GeoPackage (equivalent to GeoPackage 1.3) as below (there are no Environment variables to set) and press "Run", Figure 5.

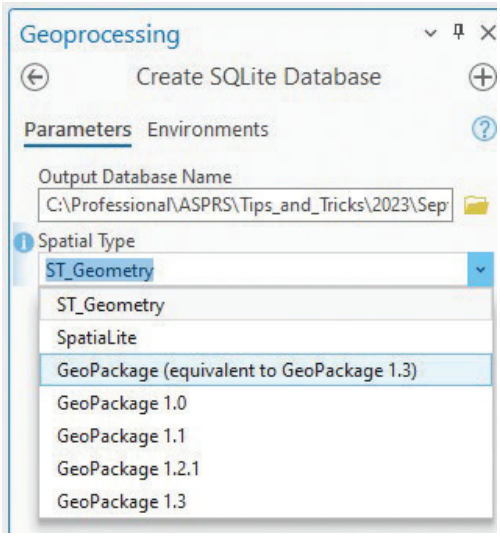

Figure 5. The Create SQLite Database dialog box.

Step 3 — Open a Catalog pane, use the "Folder" tab to navigate to your GeoPackage container (the .gpkg file), right-click on the GeoPackage contained and select "Import", Figure 6.

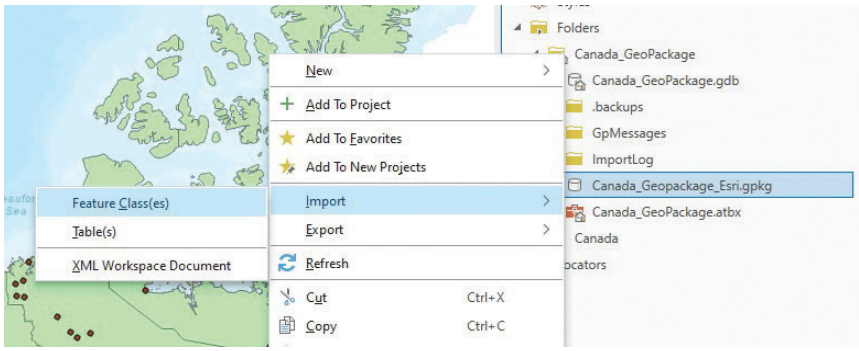

Figure 6. The Catalog Pane showing Importing Feature Class(es) or shapefiles into the GeoPackage.

Step 4 — The Feature Class to Geodatabase script will open and on the dialog menu select (or navigate) to as many shapefiles or feature classes that you want to add to the GeoPackage. Check that the correct GeoPackage is loaded into the "Output Geodatabase" line, and press "Run", Figure 7. (NOTE: You can specify Environment Variables on the Environments tab).

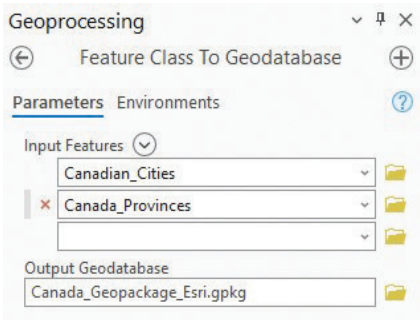

Figure 7. The Geoprocessing dialog box showing importing multiple shapefiles into the GeoPackage.

Step 4 — In the Catalog pane, opening the GeoPackage will display the features added. You can drag & drop these into your map or navigate to the features through the standard Esri ArcGIS Pro interface, Figure 8.

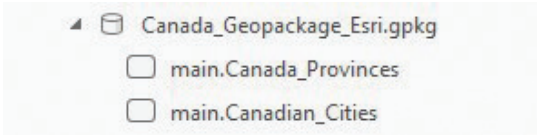

Figure 8. The Catalog Pane view of the GeoPackage populated with the two shapefiles.

Tip #3: Adding a Raster to a Geopackage

ArcGIS Pro provides a separate tool to add a raster to an existing GeoPackage. The Geoprocessing Tool is located in the "Data Conversion | To GeoPackage" toolset. Fill-in the required fields (Input Raster, Target GeoPackage, and Raster Name) and the raster file be added to the GeoPackage.

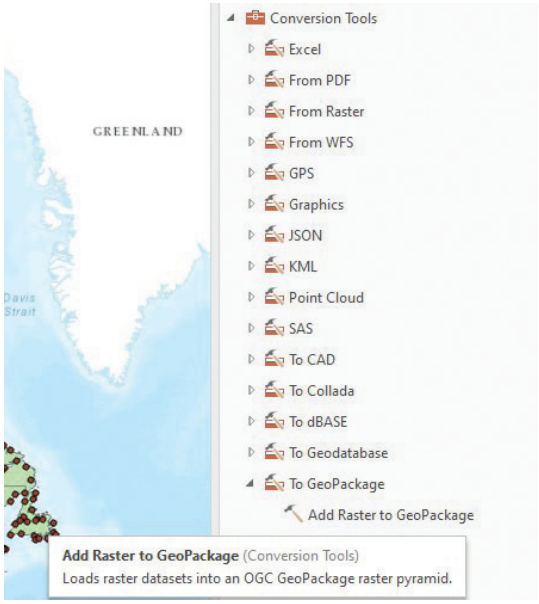

Figure 9. Adding a raster to the GeoPackage from the Conversion Tools | To GeoPackage toolset.

"...it is not uncommon for a "shapefile" to contain 8 or more individual files! Try explaining that to students only familiar with iOS and MacBooks!"

Tip #4 — Creating a GeoPackage in ArcGIS Desktop

Creating a GeoPackage in ArcGIS Desktop uses the same workflow and identical tools as were used in ArcGIS Pro, i.e. use the Geoprocessing tool: Data Conversion | Workspace | Create SQLite Database script to create the .gpgk file, and then use Catalog to import shapefiles and/or feature classes into the GeoPackage, Figure 10.

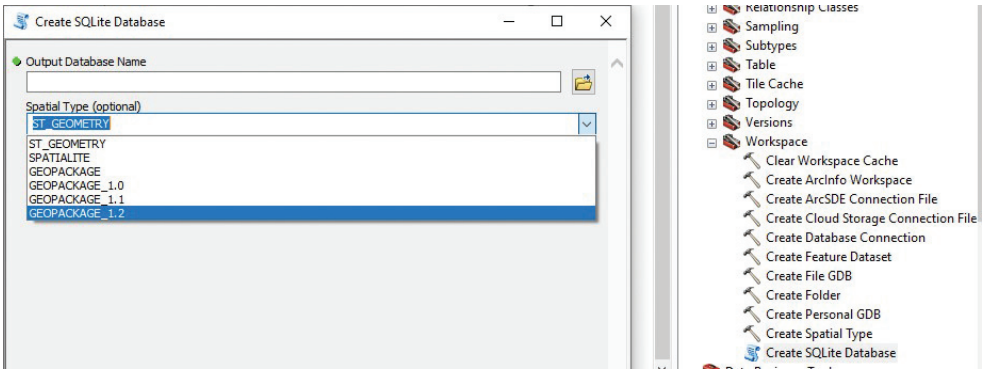

Figure 10. The Create SQLite Database tool in ArcGIS Desktop.

Also, as in ArcGIS Pro, to add a raster to the GeoPackage, use the Data Conversion | To GeoPackage | Add Raster to GeoPackage tool.

It is that easy to make GeoPackages that can be sent to other users and imported into multiple GIS software packages.

Send your questions, comments, and tips to GISTT@ASPRS.org.

Al Karlin, Ph.D., CMS-L, GISP is with Dewberry's Geospatial and Technology Services group in Tampa, FL. As a senior geospatial scientist, Al works with all aspects of Lidar, remote sensing, photogrammetry, and GIS-related projects.

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Introduction to Geographic Object Based Object Analysis (GEOBIA) Utilizing eCognition Developer
February 11, 2024, 8 AM to 12 NOON

Presenters
Dr. JB Sharma, *University of North Georgia*, Department of Physics and Astronomy, Emeritus Retiree; Penn State University, Dutton Adjunct Professor and

John McCombs, *Lynker* for *NOAA Office of Coastal Management*, GIS Team Lead

High spatial resolution remotely sensed data streams from multiple sensors present an increasing challenge and opportunity for mapping applications. eCognition Developer software is a leader in GEOBIA based automated feature extraction capability for high spatial resolution multi-sensor based mapping. This workshop will introduce the participants to the fundamental concepts of GEOBIA mapping workflows and provide a hands-on exploration of eCognition Developer software. This includes an overview of the eCognition interface, exploration of segmentation algorithms, creating workspaces and projects, object exploration, interpretation keys, ruleset development and a simple classification. The fusion of spectral and spatial Remotely Sensing (RS) data in mapping applications will be emphasized. There are several resources available for learning about additional capabilities of eCognition which will be discussed. GEOBIA workflows replicate human visual cognition which are based not just on spectral information, but include object attributes like geometry, location, size, texture, pattern, context, shadows and relations to neighbors. Traditional RS image classification approaches are solely based on the spectral properties of pixels of moderate resolution (>10 m) multispectral (MSI) satellite data. In the past two decades there has been a proliferation of MSI from satellite and aerial platforms at a high spatial resolution (<1 m). Lidar collects are increasing nationwide where the point clouds can be processed to <1 m rasterized elevation models. Unmanned Aerial Systems (UAS) are data collection platforms at an ultra-high spatial resolution to the order of centimeters. Pixel based spectral classification approaches do not work for high and ultra-high spatial resolution data. These high spatial resolution and exponentially increasing RS data streams give a particular contemporary importance to the multi-sensor mapping capabilities of the eCognition Developer software. This workshop will introduce GEOBIA principles and ruleset development in an interactive and hands-on manner. Participants will be provided with instructions for installing the eCognition Developer software and the provided RS data on their laptops, prior to the workshop.

Practical Approach to Using the ASPRS Positional Accuracy Standards for Digital Geospatial Data
February 11, 2024, 8 AM to 12 NOON

Presenter
Dr. Qassim Abdullah, *Woolpert*, Vice-President and Chief Scientist; ASPRS Positional Accuracy Standards Working Group, Chair

This workshop provides an in-depth look at the ASPRS Positional Accuracy Standards to categorize positional accuracy of products derived from digital aerial cameras, manned and unmanned aerial systems, and all types of lidar including terrestrial, mobile, and airborne. The workshop will explain the basis for each accuracy measure adopted in the standards. Instructors will demonstrate practical application of these standards using a web-based application deployed by Esri.

Remote Sensing Data for Climate Change Analysis
February 11, 2024, 8 AM to 10 am

Presenter
Dr. Indu Jeyachandran, *San Jose State University*, Department of Civil and Environmental Engineering, Assistant Professor

This workshop will focus on applications of remote sensing for climate change analysis. A case study of Land Surface Temperature(LST) variation across a decade using Landsat LST data will be demonstrated during the workshop. Participants will learn to analyze LST data and study the variation of LST across various years.

Geospatial Deep Learning with ArcGIS
February 11, 2024, 10 AM to 12 NOON

Presenters
Vinay Viswambharan, *Esri*, Imagery and Remote Sensing, Principal Product Manager

Canserina Kurnia, *Esri*, Senior Solution Engineer

Deep Learning is an AI technique that uses deep neural networks to solve complex problems. One area of AI where Deep Learning has done exceedingly well is computer vision, or the ability for computers to see. This makes it especially suitable for imagery tasks such as pixel classification, object detection, and categorizing features. ArcGIS provides a rich suite of tools and APIs to perform end-to-end deep learning workflows with a variety of data types. In this session users will learn how deep learning can be applied to perform feature extraction and classification in the ArcGIS Platform. You will see how Deep Learning tools, Pre-trained deep learning models and AI-infused apps make deep learning easier to use – within ArcGIS Pro, the online Map Viewer and ArcGIS Notebooks designed for the data scientists and developers.

Professional Mapping Using Drones
February 11, 2024, 1 PM to 3 PM

Presenter
Dr. Qassim Abdullah, *Woolpert*, Vice-President and Chief Scientist; ASPRS Positional Accuracy Standards Working Group, Chair

The use of small drones is becoming an integral part of the daily activities for construction sites monitoring and project planning and design. As the market flooded with different types of drones and the sensors it can carry, many surveyors and mappers are confused about the right path to follow acquire drones and sensors for their operations. The proposed training and education session focus on providing the participants with the foundational knowledge on important topics such as licensing, airframes, sensors, planning, processing software, data accuracy, etc.

Preparation for ASPRS Certification
February 11, 2024, 1 PM to 5 PM

Presenter
Harold Rempel, *ESP Associates, Inc.*, Senior Geospatial Manager

This workshop covers the common knowledge areas comprising a large portion of exam content for ASPRS Certification. It is valuable preparation for those who have never taken an ASPRS exam, as well as for those who have expertise in a particular specialty, such as lidar or UAS, but feel less prepared for the general knowledge component of the exam. This workshop will also explain the certification application process and the importance of certification in career development.

Advanced Remote Sensing Data Processing and Deep Learning with PyTorch
February 11, 2024, 1 PM to 5 PM

Presenter
Dr. Tao Liu, *Michigan Technological University*, College of Forest Resources and Environmental Engineering, Assistant Professor in Remote Sensing and GIS

Attendees will learn how to utilize deep learning techniques to process remote sensing (RS) data in a 4-hour workshop. The first three hours will be dedicated to learning PyTorch (and other Python tools), an open-source deep learning development platform. Participants will be introduced to the fundamentals of deep learning, learn how to create deep learning models from scratch, and explore customized applications such as image classification using PyTorch Image Models (TIMM) and image segmentation with Segmentation Models PyTorch (SMP). The final hour will focus on 3D RS data generation and processing. Using PyTorch3D, we will introduce the implementation of the structure-from-motion (SfM) algorithm based on 2D images to generate georeferenced point clouds. With brief exposure to digital surface and terrain model generation using point cloud or LiDAR data, advanced semantic 3D classification and segmentation models will be introduced. Upon completion of the workshop, attendees will possess the necessary skills to develop customized applications using Python tools for advanced RS data processing.

Airborne Bathymetric Lidar
February 11, 2024, 3 PM to 5 PM

Presenters
Chris Parrish, *Oregon State University,* Department of Civil and Construction Engineering, Associate Research Professor; ASPRS, Immediate Past President

Amar Nayegandhi, *Dewberry*, Senior Vice President

Airborne bathymetric lidar is one of the most exciting and rapidly-advancing technologies in the geospatial sector. Its uses range from safety of marine navigation (i.e., hydrographic surveying and nautical charting), to sediment transport modeling, benthic habitat mapping and monitoring, marine ecological assessments, flood inundation modeling, river morphology, coastal engineering, and more. This workshop is designed for geospatial professionals, students, and even those new to the field who are interested in learning more about lidar bathymetry. We will start with a brief history and theory of bathymetric lidar, including terminology, system components, and acquisition principles. We will then cover operational concepts, including mission planning, data processing and workflows, calibration, QA/QC, and accuracy assessment. We will conclude with a view of the future of airborne bathymetric lidar, including emerging trends and anticipated advances over the next decade.

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Go to our Community page at https://community.asprs.org/ecpc/home and click on Council - Early Career Professionals - Public to join our community!

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During the months of May, June, July, August, and September *PE&RS* has ranked in the top 20 for downloads on IngentaConnect. *PE&RS* ranked 6th for the month of August with 3,055 downloads and 7th for September with over 2,700 downloads.

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Introduction for Innovative Methods for Geospatial Data using Remote Sensing and GIS — Part II

Tolga Bakırman, Yildiz Technical University, bakirman@yildiz.edu.tr
George Arampatzis, Technical University Crete, garampatzis@pem.tuc.gr

Internationally comparable data is a global need for managing resources, monitoring current trends and taking actions for sustainable living. Even though there has been a significant progress on geospatial data availability, extensive data gaps are still a major problem for general assessment and supervise the progress through the years. According to United Nations 2022 The Sustainable Development Goals Report, while health and energy sectors have the highest data available, limited data available for climate action.

The COVID-19 crisis has also shown that there are innovative data collection methods utilizing information and computer technologies. However, only 5% of the countries have benefit from remote sensing technologies to measure the impact of COVID-19. Additionally, novel approaches such as artificial intelligence should be used in conjunction with assessments to make sure they are put to use for critical situations. The recent developments in remote sensing, geographic information systems and ICT have provided a wide accessibility to create geospatial data for various purposes.

The second part of this special issue in *Photogrammetric Engineering and Remote Sensing* (*PE&RS*) gathers peer-reviewed papers that advance state-of-the-art in Innovative Methods for Geospatial Data using Remote Sensing and GIS. The papers focus on geospatial data in terms of rice identification using under complex surface conditions, analysis of net primary vegetation productivity and net ecosystem productivity, use of TLS and UAV for cultural heritage building information modelling and integration of IMU and Bluetooth for indoor positioning.

Rice is an essential staple food for more than half of the world's population. In order to monitor and manage the agricultural production process of this valuable resource, rice planting areas must be precisely and efficiently identified. In this regard, Liu et al. focuses on rice identification using temporal and spatial features extracted from Sentinel-2 with convolutional neural networks.

Net primary vegetation productivity and net ecosystem productivity has key impacts in ecological processed, climate production capacity of vegetation quality of ecosystem and the balance of global carbon. Chen et al. presents a case study in Jianghuai watershed in which a CASA model-based framework is developed to assess spatio-temporal changes in net primary vegetation productivity and net ecosystem productivity from 2001 to 2018.

Cultural heritage building information modelling allows to digitize, monitor and manage historical objects and monuments. Additionally, it creates opportunity and infrastructure to create virtual or augmented environments. Fidan et al. investigates combining terrestrial laser scanning and unmanned aerial vehicle data to generate precise heritage building information model for Tarsus St. Paul's Church in Mersin, Türkiye.

Most of the mobile or web-based applications requires personal location data in order to function properly. In recent years, indoor positioning has also become a hot topic since global navigation satellite systems can only provide precise position outdoors. Acar proposed to integrate inertial measuremut unit and Bluetooth data to obtain indoor position with sub-meter accuracy.

We believe the topics that the papers have focused on in the second part of this Special Issue will have a wider impact for geo-scientist and researchers. We would like to express our gratitude to the authors, who contributed to this Special Issue of the *PE&RS* for sharing their scientific results. We would also like to acknowledge the voluntary reviewers, whose professional reviews contributed to the further improvement of the submitted papers. We are also thankful to Prof. Dr. Bülent Bayram from Yildiz Technical University, Istanbul, Türkiye for organizing the International Symposium on Geoinformatics 2022 (https://www.isagsymposium.org/isag2022/). Finally, we are grateful to *PE&RS* Editor Prof. Dr. Alper Yılmaz for his support and guidance in assembling this Special Issue.

Call for *PE&RS* Special Issue Submissions

Ushering a New Era of Hyperspectral Remote Sensing to Advance Remote Sensing Science in the Twenty-first Century

Great advances are taking place in remote sensing with the advent of new generation of hyperspectral sensors. These include data from, already in orbit sensors such as: 1. Germany's Deutsches Zentrum fur Luftund Raumfahrt (DLR's) Earth Sensing Imaging Spectrometer (DESIS) sensor onboard the International Space Station (ISS), 2. Italian Space Agency's (ASI's) PRISMA (Hyperspectral Precursor of the Application Mission), and 3. Germany's DLR's Environmental Mapping and Analysis Program (EnMAP). Further, Planet Labs PBC recently announced the launch of two hyperspectral sensors called Tanager in 2023. NASA is planning for the hyperspectral sensor Surface Biology and Geology (SBG) to be launched in the coming years. Further, we already have over 70,000 hyperspectral images of the world acquired from NASA's Earth Observing-1 (EO-1) Hyperion that are freely available to anyone from the U.S. Geological Survey's data archives.

These suites of sensors acquire data in 200 plus hyperspectral narrowbands (HNBs) in 2.55 to 12 nm bandwidth, either in 400-1000 or 400-2500 nm spectral range with SBG also acquiring data in the thermal range. In addition, Landsat-NEXT is planning a constellation of 3 satellites each carrying 26 bands in the 400-12,000 nm wavelength range. HNBs provide data as "spectral signatures" in stark contrast to "a few data points along the spectrum" provided by multispectral broadbands (MBBs) such as the Landsat satellite series.

The goal of this special issue is to seek scientific papers that perform research utilizing data from these new generation hyperspectral narrowband (HNB) sensors for a wide array of science applications and compare them with the performance of the multispectral broadband (MBB) sensors such as Landsat, Sentinels, MODIS, IRS, SPOT, and a host of others.

Papers on the following topics are of particular interest:

1. Methods and techniques of understanding, processing, and computing hyperspectral data with specific emphasis on machine learning, deep learning, artificial intelligence (ML/DL/AI), and cloud computing.
2. Issues of hyperspectral data volumes, data redundancy, and overcoming Hughes' phenomenon.
3. Building hyperspectral libraries for purposes of creating reference training, testing, and validation data.
4. Utilizing time-series multispectral data and hyperspectral data over many years to build data cubes and apply advanced computational methods of ML/DL/AI methods and approaches on the cloud.
5. Discussions of hyperspectral data analysis techniques like full spectral analysis versus optimal band analysis.
6. Developing hyperspectral vegetation indices (HVIs) for targeted applications to model and map plant biophysical (e.g., Yield, biomass, leaf area index), biochemical (e.g., Nitrogen, anthocyanins, carotenoids), plant health/stress, and plant structural quantities.
7. Classification of complex vegetation and crop types/species using HNBs and HVIs and comparing them with the performance of multispectral broadband data.

All submissions will be peer-reviewed in line with *PE&RS* policy. Because of page limits, not all submissions recommended for acceptance by the review panel may be included in the special issue. Under this circumstance, the guest editors will select the most relevant papers for inclusion in the special issue. Authors must prepare manuscripts according to the *PE&RS* Instructions to Authors, published in each issue of *PE&RS* and also available on the ASPRS website, https://www.asprs.org/asprs-publications/pers/manuscript-submission.

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Important Dates

Manuscripts Due — December 15, 2023

Final Papers Due — May 1, 2024

Tentative Publication Date — 2024

Please submit your manuscript — www.editorialmanager.com/asprs-pers/ select "Hyperspectral Remote Sensing"

IMU and Bluetooth Data Fusion to Achieve Submeter Position Accuracy in Indoor Positioning

Ugur Acar

Abstract

Indoor navigation applications have become widespread in recent years with the ability of mobile phones which determine the position. Due to the inefficiency of global positioning system (GPS) indoors, other positioning methods have been developed based on local networks using technologies such as Bluetooth, wireless networks, ultra-wideband signals, ultrasonic signals, and radio frequency identification modules. Various technologies yield high or medium accuracy. Combining data from multiple sources via fusion enhances location precision. In this study, indoor positions were estimated using trilateration with Bluetooth devices, and the accuracy was improved by applying filters to the data from inertial measurement unit (IMU) sensors on the phone. As a result of combining Bluetooth and IMU data with data fusion, submeter accuracy was achieved. The results obtained were tested at Yildiz Technical University-Istanbul Türkiye. It was determined that 92% of the data was obtained with submeter accuracy.

Introduction

Human location, navigation, obtaining location-based density information, advertising, artificial reality, and many other applications rely on the foundation of location. The amount of location accuracy varies according to the needs of the applications. However, in recent years, the expectation for location accuracy has been set as submeter in many applications. The Global Navigation Satellite System (GNSS) is commonly used to determine human location. However, GNSS can only produce satisfactory results in open areas. GNSS receivers with L1 band, which are widely used, provide a location accuracy of three to five meters. Although this accuracy level may seem generally sufficient, person location cannot be determined with GNSS in indoor environments. Therefore, various systems have been developed.

One of the technologies used for person location determination is systems that use Radio Frequency Identification (RFID). This system stands out with its very cost-effective structure. However, it has disadvantages related to range. The location determination system is based on the Received Signal Strength Indication (RSSI), which determines the distance based on the strength of the signal transmitted from the transmitters to the receivers (Hightower *et al.* 2000; Ni *et al.* 2003). "Spot-On" and "LANDMARC" are the two most important methods used in RFID-based location determination systems. The biggest problem with both methods is that they have location accuracy issues above one meter (Jin *et al.* 2006).

Another system based on radio frequency is the use of RADAR. The location accuracy of this system is at the level of two to three meters, which is insufficient for many systems (Bahl and Padmanabhan 2000). Another radio frequency-based system is the ultra-wideband (UWB) system. This system, which has very high location accuracy developed in recent years, differs from other radio frequency-based systems in that it uses ultra-wide frequencies of 3.1 GHz to 5.15 GHz, which are used very little. Thus, it is not affected by many devices operating on other frequencies. The location accuracy of the system can drop to 10 cm, making it a solution for many applications. The system has very low power consumption, and the sensors are relatively cheap (Ingram *et al.* 2014; Jiang *et al.* 2010; Gigl *et al.* 2007; Ni *et al.*. 2003). However, it is a technology that is still being developed, so its applications have not yet become widespread enough. In addition, due to the frequency used, the signals cannot pass through objects such as humans and walls. On the other hand, the signal range is around 15 meters, which means that the system requires a lot of receivers. Therefore, there is a need to place many receivers inside the area to obtain good coverage.

Another system is the system that uses ultrasonic receiver technology. In these systems, unlike the previously described systems, the transmitter that produces the active signal is on the object to be tracked. This situation leads to the placement of more expensive transmitters that consume more batteries on every object and the need to install many receivers (Hazas and Hopper 2006).

The most commonly used system is the Wireless Local Area Network (WLAN), also known as Wi-Fi (IEEE 802.11 (a, b, and c)) (Bahl and Padmanabhan 2000; Roos *et al.* 2002), which uses WLAN signals. The reason for its widespread use is the low cost of the system, as WLAN networks are already widely established. Additionally, many devices that need to be tracked already have WLAN hardware. Another advantage of the system is that WLAN signals can be transmitted over long distances (Xiang *et al.* 2004).

Similarly, systems that use Bluetooth technology also have the same advantages as those that use WLAN. Both systems also consume low power. Although Bluetooth technology is commonly used at short ranges, products are available that can transmit signals up to 500 meters (Feldmann *et al.* 2003). Both systems use RSSI, which is the same method as RFID, for location tracking. Despite the mentioned advantages, these systems have low location accuracy. Nevertheless, this system, which is compatible with hybrid systems and open, remains one of the most common systems.

Another system is an optical indoor positioning system that uses a technology that is very different from all the previously mentioned systems, where a camera is installed on the tracked person to determine their location within the indoor environment. The system works based on detecting objects with predetermined locations in the camera image (Tilch and Mautz 2010). Because of its high cost, this system can only be used in special projects. The characteristics of indoor positioning systems are presented in Table 1.

The systems described above use various technologies to determine location. Some systems convert the received signal strength to distance, some measure the difference in time of flight of the signal (Time of Arrival (TOA)) (Nguyen and Dogancay 2016; He *et al.* 2014), some systems directly measure the distance, while others measure the angle of arrival (Angle of Arrival (AOA)) (Malajner *et al.* 2015; Griepentrog *et al.* 2006) The distances and angles obtained are then converted into a location using calculations such as trilateration or triangulation.

Even if sensors and receivers are placed with high frequency and accurate geometry, there are "blind spots" where tracking is not

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Rice Identification Under Complex Surface Conditions with CNN and Integrated Remote Sensing Spectral-Temporal-Spatial Features

Tianjiao Liu, Sibo Duan, Jiankui Chen, Li Zhang, Dong Li, and Xuqing Li

Abstract

Accurate and effective rice identification has great significance for the sustainable development of agricultural management and food security. This paper proposes an accurate rice identification method that can solve the confused problem between fragmented rice fields and the surroundings in complex surface areas. The spectral, temporal, and spatial features extracted from the created Sentinel-2 *time series were integrated and collaboratively displayed in the form of visual images, and a convolutional neural network model embedded with integrated information was established to further mine the key information that distinguishes rice from other types. The results showed that the overall accuracy, precision, recall, and F1-score of the proposed method for rice identification reached 99.4%, 99.5%, 99.5%, and 99.5%, respectively, achieving a better performance than the support vector machine classifier. Therefore, the proposed method can effectively reduce the confusion between rice and other types and accurately extract rice distribution information under complex surface conditions.*

Introduction

Rice, an important food crop widely cultivated around the world, provides staple food for over 50% of the global population (Zhao *et al.* 2017; Bouvet and Toan 2011; Guan *et al.* 2018). Especially in China, about 65% of Chinese people rely on rice as their staple food (Peng *et al.* 2009). With the acceleration of nationwide urbanization, the conversion of rice fields into non-cultivated land has increased in recent years. Meanwhile, due to various human factors, plenty of abandoned land and cropping system changes have emerged in parts of southern China, such as Hunan province, severely disrupting grain production and having a great impact on sustainable agricultural development (Rosada 2016). In addition, rice is the largest water-consuming crop, accounting for 34%–43% of the total water consumption of agricultural irrigation (Bouman *et al.* 2007). Rice planting areas are closely related to water resource distribution and water security. Therefore, a timely, accurate, and large-scale rice classification map is significant for adjusting and optimizing the agricultural production structure, rationally using water resources, and ensuring food security.

Compared with traditional land resource survey methods, remote sensing techniques, with their good characteristics of wide observation range, high cost-effectiveness, and non-destruction, have become a timely and efficient means for rice monitoring (Mosleh *et al.* 2015; Zhao *et al.* 2021). And with this, remote sensing data, especially free public data acquired by orbital sensors, has been more and more widely used in rice classification (Dong and Xiao 2016; Qin *et al.* 2015; Chaves *et al.* 2020). Methods for mapping rice distribution using remote sensing data can generally be classified into two types: methods based on identification features and those based on algorithm learning. The feature identification method is based on remote sensing information that can efficiently reflect rice properties and growth status. The identification features mainly include multispectral, microwave, hyperspectral, and spatial features, and among them, multi-spectrum is the most widely used and fundamental feature in remote sensing classification (Dong *et al.* 2016; Zwiggelaar 1998). The multispectral features involved in rice identification can be grouped into two categories. The first category is the original spectral bands collected by multispectral sensors, including blue, green, red, near infrared, shortwave infrared, and red edge bands. In particular, the red edge band is very helpful for monitoring vegetation health information and has been extensively used in crop monitoring (Zhang *et al.* 2019; Elvidge and Chen 1995; Li *et al.* 2017). The second category is the spectral indices obtained by specific mathematical transformations of two or more original spectral bands (Xue and Su 2017). The morphology, canopy structure, and physiological parameters of rice exhibit different trends at different growth stages, while the spectral data from a single image only reflect the growth state of a certain growth stage, which may lead to low identification accuracy (Conese and Maselli 1991). So how to use the abundant seasonal variation information in time series images for rice identification has become a hot research topic. Recently, a number of studies have demonstrated the potential of vegetation index time series for rice classification (Tornos *et al.* 2021; Jiang *et al.* 2021; Zhang *et al.* 2020; Son *et al.* 2020; Dou *et al.* 2019). Some time series similarity methods that are based on temporal vegetation index profiles, such as dynamic time warping (DTW), were used to describe the characteristics of data changes over time (Guan *et al.* 2014; Guan *et al.* 2016). Some researchers have also introduced phenological characteristics, on the grounds that the land surface during rice flooding and transplanting is covered with a mixture of water, rice, and soil, whereas other crops and dry land are usually not covered with water (Dong and Xiao 2016; Guo *et al.* 2019; Zhan *et al.* 2021; Shao *et al.* 2023; Dong *et al.* 2016). Two representative vegetation indices, the Normalized Difference Vegetation Index (NDVI) and the Normalized Difference Water Index (NDWI), are often selected for this purpose. It is believed that for rice, the NDWI value will be close to or greater than the NDVI value during

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Combination of Terrestrial Laser Scanning and Unmanned Aerial Vehicle Photogrammetry for Heritage Building Information Modeling: A Case Study of Tarsus St. Paul Church

Şafak Fidan, Ali Ulvi, Abdurahman Yasin Yiğit, Seda Nur Gamze Hamal, and Murat Yakar

Abstract

Cultural heritage building information modeling (HBIM) is an emerging process allowing us to reconstruct built heritage virtually. The data of a digitally documented cultural heritage building offers significant advantages as it is accessible and modifiable by all professionals involved in the same or different projects. The most important factor affecting the accuracy and precision of the HBIM model is the ability to collect complete and accurate information about the physical structure. Combining terrestrial laser scanning (TLS) and unmanned aerial vehicle (UAV) photogrammetry point clouds is one of the most efficient ways to capture accurate digital data on the building. This study provides the foundation for creating an HBIM model for cultural heritage the coupling of spatial data with TLS and UAV. This paper aims to generate synergy between TLS and UAV point cloud data and ensure that the spatial database contains sufficient data to model historical objects with HBIM tendencies.

Introduction

Acquiring accurate data in three dimensions (3D) is the part of developing the heritage building ınformation modeling (HBIM) model that is the most important. Not only does the faithfulness of the reproduction of the historical item in the model space in the context of building modeling serve to illustrate the quality of the geometric foundation, but it also commonly serves as the basis for the expert judgment about the degree to which the structure has been damaged and degraded. Murphy et al. (2012) suggest using remote sensing methods to collect data in this setting. This strategy would make producing accurate digital copies of the building's age-related properties easier if implemented. Exploring technical solutions that complement one another while collecting 3D data is vital instead of duplicating the object's acquired geometry. This is because duplicating the object's geometry might lead to inaccurate results. Bruno and Roncella (2018) observed and reported the potential synergistic link between terrestrial and aerial measuring methods to accomplish the proposed solution.

The standardization of terrestrial laser scanning (TLS) for cultural heritage (CH) 3D data results from the expanding accessibility of scanning technologies and thorough models of cloud object outcomes. (Shanoer and Abed 2018). The actual mapping of a monument in virtual space, made possible by a high-resolution and topologically accurate point cloud, has become the standard technique for documenting architectural details, historic structures (Ullah *et al.* 2022), and their complexities. In addition to documenting cultural heritage, TLS data enable the investigation of monuments' technical conditions (Alshawabkeh *et al.* 2021) and serve as the foundation for their administration and propagation in the global network through virtual and augmented reality development (Bayram *et al.* 2015). There are frequent zones that cannot be accessed or observed via TLS. However, more 3D data are needed for spaces that cannot be seen on the roof of the building. Due to the aero solution, these gaps enhance the unmanned aerial vehicle (UAV) data, providing a more accurate imaging geometry than close-range photogrammetry (Bruno and Roncella 2018). When equipped with high-resolution cameras, UAVs can perform structure-from-motion (SfM)–based photogrammetry to monitor and manage protected cultural properties in areas with limited public access.

CH preservation measures a country's economic and intellectual growth (Bozdoğan *et al.* 2022). By 2030, the European Commission recommends digitizing at least 50% of the most visited and endangered sites and monuments in 3D (Guzmán *et al.* 2017). Building information modeling (BIM) and 3D measuring tools provide CH buildings with great virtual preservation potential. While BIM for new investments has reached a level of operationalization in many countries (Ullah *et al.* 2022), its use for historic buildings remains inconsistent, making it a topic of current academic research (Rodrigues *et al.* 2019).

Heritage building ınformation modeling, or HBIM or H-BIM, is a way of building intelligent BIM that includes, manages, and analyzes data on built heritage (Moyano *et al.* 2022). This method makes use of 3D modeling and information management. HBIM has become indispensable for exhibiting and safeguarding cultural assets (Pepe *et al.* 2021). A typical HBIM implementation technique consists of an introductory phase establishing the objective and level of development (LOD). This process phase involves collecting geographical and semantic data, followed by a phase of data processing. These phases take place prior to the phase in which the model is developed (Currà *et al*. 2021). Both historical and up-to-date information on the heritage structure is compiled during the data-collecting phase of the HBIM technique. The historical data consist of various items, such as the original blueprints and building papers, historical records and pictures, reports on maintenance and renovation, bibliographic references, and information on key historical events related to the structure. Data on the built heritage's extant (as-built) condition is collected using field survey methodologies. This includes collecting geometrical data, structural details, material data, faults, and degradation. The subsequent phase analyzes the acquired geometric and descriptive data to generate

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Quantifying Impacts of Regional Multiple Factors on Spatiotemporal the Mechanisms for Spatio-temporal changes of Net Primary Vegetation Productivity and Net Ecosystem Productivity: An Example in the Jianghuai River Basin, China

Huimin Chen, Benlin Wang, Liangfeng Zheng, and AmirReza Shahtahmassebi

Abstract

Despite much valuable research on the mechanisms for spatio-temporal changesof net primary vegetation productivity (NPP) and net ecosystem productivity (NEP), there is a paucity of information on assessing impacts of regional multiple factors on spatiotemporal researchs of NPP and NEP in the complex environment. This study attempts to bridge this information gap using the Jianghuai Basin in China as a case study. Using a field campaign, remotely sensed imagery, socioeconomic data, and meteorological parameters, we developed a framework based on the Carnegie–Ames–Stanford Approach (CASA) model, correlation technique, trend analysis, and landscape metrics to measure spatiotemporal changes in NPP and NEP from 2001 to 2018. The derived changes were then linked to regional multiple factors including climate, landscape factors, human activity, and land use change. The results of the research can provide a scientific basis for vegetation evaluation, ecosystem assessment, and other aspects of the region.

Introduction

Net primary vegetation productivity (NPP) and net ecosystem productivity (NEP) play significant roles in the ecological process, the climate production capacity of vegetation, the quality of ecosystems, and the balance of global carbon (Cao and Woodward 1998; Minvielle and Garreaud 2011). Both NPP and NEP rely on transpiration, photosynthesis, and respiration processes, and thereby they can link vegetation communities to the climate and carbon cycle (Field *et al.* 1998; Hicke *et al.* 2002; Guo *et al.* 2008). Tremendous research efforts have been devoted to understanding the interaction between NPP, NEP, carbon cycle, and climate change. Gao *et al.* (2009) showed impacts of climate change on grassland NPP in northern Tibet during 1981–2004 successfully. McGuire *et al.* (1992) quantified the effects of carbon and nitrogen cycles on increasing NPP in North America. Moreover, Wang *et al.* (2022) highlighted that natural environmental and climate factors were the dominant factors that determine the distribution of NEP.

NPP can be generally estimated through two methods: field measurements and remote sensing data models. Field measurements consist of several methods such as direct harvesting, photosynthesis, CO_2, pH, chlorophyll, and radiolabeling (Clark *et al.* 2001; Li *et al.* 2003). However, due to its large workload and other factors, it is not conducive to large-scale implementation. (Liu *et al.* 2020). Considering this limitation, many studies have been devoted to estimating NPP using modeling-based approaches as they can measure NPP at the regional and global scales (Alexandrov *et al.* 2022; Zhu 2005). Modeling approaches are divided into three categories: climate productivity models, ecological physiological process models, and light energy use utilization models (Zhu *et al.* 2005). Climate productivity models mainly include the Miami model, the Thornthwaite Memorial model, and the Chikugo model, etc. However, these models are simpler in form and do not fully consider the physiological and ecological processes of vegetation, and the estimation results are less accurate (Lieth 1973; Uchijima and Seino 1985). Based on the above knowledge, scholars have developed ecological physiological process models, such as the BIOME-BGC model, the CENTURY model, the TEM model, and the SILVAN model, etc. Although the accuracy of these models is high for the estimation of NPP, they are more complicated and difficult to generalize (Running and Hunt 1993; Kaduk and Heimann 1996). Compared with the above two types of models, a light utilization model such as the Carnegie–Ames–Stanford Approach (CASA) has been used widely in the simulation and estimation of NPP. Such models are based on the photosynthetic process of plants. Therefore, they have high calculation accuracy and easy access to data (Yang *et al.* 2020). For instance, the CASA model has been used to quantify the spatiotemporal changes of NPP under different land cover types. In terms of NEP, field survey and modeling are the common methods for gauging this parameter. Large-scale NEP measurement is difficult to achieve using field measurements; thus, modeling techniques have been suggested (Piao *et al.* 2022) . Estimating NEP using modeling approaches includes two steps: (1) NPP can be calculated by using a model or existing NPP products and (2) a NEP can be then calculated (Dai *et al.* 2016; Zhang *et al.* 2021; Wang *et al.* 2022).

With increased availability of current and historical archives of remotely sensed data, it is now possible to monitor NPP and NEP with large geographic coverage, at a fine spatial scale and a high temporal resolution, and in a cost-effective way (Cao *et al.* 2003). Having these advantages, a considerable number of studies have used integration of remotely sensed data with modeling approaches to analyze spatiotemporal patterns of NPP and NEP (Cao *et al.* 2003; Hashimoto *et al.* 2015; Dai *et al.* 2016).

Various remotely sensed data have been used for analyzing NEP and NPP. One of the various methods, moderate resolution imaging spectroradiometry (MODIS) has been implemented extensively in much NEP and NPP research. This is because MODIS possesses three advantages: large coverage, high spectral resolution, and high temporal resolution. The wide coverage of MODIS facilitates monitoring

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ASPRS is in the Top 10!

In July, August, and September 2023, *PE&RS* ranked 8th, 6th, and 7th, respectively, out of over 11,000 journals for full-text downloads with Ingenta Connect.

Circulation: 2,500

Total audience: 5,000*

Digital Edition Monthly Unique Views: 2,000+

Professional Demographics

	% Composition
Work Setting	
Corporate	30%
Academia	30%
Government	26%
Sole Proprietor	13%

Education	
Doctorate degree	32%
Post graduate degree	45%
4-year college degree	19%
2-year college degree	4%

ASPRS Certifications	**Amount**
ASPRS Certified Photogrammetrists	290+
ASPRS Certified Mapping Scientists†	130+
ASPRS Certified Technologists	40+

†Includes our new and fast-growing Lidar certification

asprs THE IMAGING & GEOSPATIAL INFORMATION SOCIETY

Founded in 1934, the American Society for Photogrammetry and Remote Sensing (ASPRS) is a scientific association serving professional members throughout the world. Our mission is to advance knowledge and improve understanding of mapping sciences to promote the responsible applications of photogrammetry, remote sensing, geographic information systems (GIS), and supporting technologies.

Our members are analysts/specialists, educators, engineers, managers/administrators, manufacturers/ product developers, operators, technicians, trainees, marketers, and scientists/ researchers. Employed in the disciplines of the mapping sciences, they work in the fields of Agriculture/Soils, Archeology, Biology, Cartography, Ecology, Environment, Forestry/ Range, Geodesy, Geography, Geology, Hydrology/Water Resources, Land Appraisal/ Real Estate, Medicine, Transportation, and Urban Planning/Development.

*Based on 2 readers per copy as well as online views| Source: *PE&RS* Readership Survey, Summer 2023

For more information, contact Bill Spilman at bill@innovativemediasolutions.com | (877) 878-3260 toll-free | (309) 483-6467 direct | (309) 483-2371 fax

Readership Habits

90%
of PE&RS readers have
10+ years experience
in their profession

89% of our readers agree that *PE&RS* is their
TRUSTED SOURCE
of information about their profession

3 out of **4**
PE&RS readers save their issues for future reference

70% of *PE&RS* readers select, authorize or approve the products of products and services

Time spent reading *PE&RS* (average)
45
minutes

Our readers are regular attendees of the ASPRS Annual Conference as well as:
ILMF, Esri, URISA, SPAR/AEC, GEOINT, Commercial UAV Expo, AUVSI

	% Composition
Read regularly (at least 3 out of 4 monthly issues)	54%

Products and services used or purchased in past 12 months	
GPS	92%
Computer Workstations	52%
Lidar	50%
Unmanned Aerial Systems	45%
GIS	45%
Data Storage Devices	42%
Aerial Photography	35%
Cameras	35%
Terrain Modeling	30%

30%
of *PE&RS* readers have a geospatial information technology budget of
$1 million or greater
for the current fiscal year.

Source: *PE&RS* Readership Survey, Summer 2023

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PE&RS 2024 Advertising Rates & Specs

THE MORE YOU ADVERTISE THE MORE YOU SAVE! PE&RS offers frequency discounts. Invest in a three-times per year advertising package and receive a 5% discount, six-times per year and receive a 10% discount, 12-times per year and receive a 15% discount off the cost of the package.

	Sustaining Member Exhibiting at a 2024 ASPRS Conference	**Sustaining Member**	**Exhibitor**	**Non Member**
All rates below are for four-color advertisments				
Cover 1	$1,850	$2,000	$2,350	$2,500
In addition to the cover image, the cover sponsor receives a half-page area to include a description of the cover (maximum 500 words). The cover sponsor also has the opportunity to write a highlight article for the journal. Highlight articles are scientific articles designed to appeal to a broad audience and are subject to editorial review before publishing.				
Cover 2	$1,500	$1,850	$2,000	$2,350
Cover 3	$1,500	$1,850	$2,000	$2,350
Cover 4	$1,850	$2,000	$2,350	$2,500
Advertorial	1 Complimentary Per Year	1 Complimentary Per Year	$2,150	$2,500
Full Page	$1,000	$1,175	$2,000	$2,350
2 page spread	$1,500	$1,800	$3,200	$3,600
2/3 Page	$1,100	$1,160	$1,450	$1,450
1/2 Page	$900	$960	$1,200	$1,200
1/3 Page	$800	$800	$1,000	$1,000
1/4 Page	$600	$600	$750	$750
1/6 Page	$400	$400	$500	$500
1/8 Page	$200	$200	$250	$250
Other Advertising Opportunities (see page 5 for full descriptions)				
Employment Promotion	$500 (30 day web + 1 email) $300 (30 day web)	$500 (30 day web + 1 email) $300 (30 day web)	$500 (30 day web + 1 email) $300 (30 day web)	$500 (30 day web + 1 email) $300 (30 day web)
Dedicated Content Email blast	$2,500	$2,500	$2,500	$2,500
Newsletter Display Advertising	1 Complimentary Per Year	1 Complimentary Per Year	$500	$500
PE&RS Announcement E-Mail	$1000	$1000	$1000	$1000

A 15% commission is allowed to recognized advertising agencies

Ad Size	Width	Height
Cover	8.625”	11.25”
Full Page	8.375”	10.875”
2/3 Page Horizontal	7.125”	6.25”
2/3 Page Vertical	4.58”	9.625”
1/2 Page Horizontal	7.125”	4.6875”
1/2 Page Vertical	3.4375”	9.625”
1/3 Page Horizontal	7.125”	3.125”
1/3 Page Vertical	2.29”	9.625”
1/4 Page Horizontal	7.125”	2.34”
1/4 Page Vertical	3.4375”	4.6875”
1/8 Page Horizontal	7.125”	1.17”
1/8 Page Vertical	1.71875”	4.6875”

Send ad materials to:
Rae Kelley
rkelley@asprs.org

- Publication Size: 8.375” × 10.875” (W x H)
- Live area: 1/2” from gutter and 3/8” from all other edges
- Software Used: PC InDesign
- Supported formats: TIFF, EPS, BMP, JPEG, PDF, PNG PC InDesign, Illustrator, and Photoshop

For more information, contact Bill Spilman at bill@innovativemediasolutions.com | (877) 878-3260 toll-free | (309) 483-6467 direct | (309) 483-2371 fax

Special Advertising Opportunities

FRONT COVER SPONSORSHIP

A PE&RS cover sponsorship is a unique opportunity to capture the undivided attention of your target market through three premium points of contact.

1— *PE&RS* FRONT COVER

(Only twelve available, first-come, first-served)
PE&RS is world-renowned for the outstanding imagery displayed monthly on its front cover—and readers have told us they eagerly anticipate every issue. This is a premium opportunity for any company, government agency, university or non-profit organization to provide a strong image that demonstrates their expertise in the geospatial information industry.

2— FREE ACCOMPANYING "HIGHLIGHT" ARTICLE

A detailed article to enhance your cover image is welcome but not a condition of placing an image. Many readers have asked for more information about the covers and your article is a highly visible way to tell your story in more depth for an audience keenly interested in your products and services. No article is guaranteed publication, as it must pass ASPRS editorial review. For more information, contact Rae Kelley at rkelley@asprs.org.

3— FREE TABLE OF CONTENTS COVER DESCRIPTION

Use this highly visible position to showcase your organization by featuring highlights of the technology used in capturing the front cover imagery. Limit 200-word description.

Terms: Fifty percent nonrefundable deposit with space reservation and payment of balance on or before materials closing deadline.

Cover Specifications: 8 3/8" × 10 7/8"

PRICING

	Sustaining Member Exhibiting at a 2024 ASPRS Conference	Sustaining Member	Exhibitor	Non Member
Cover 1	$1,850	$2,000	$2,350	$2,500

VENDOR SEMINARS

ASPRS Sustaining Members now have the opportunity to hold a 1-hour informational session as a Virtual Vendor Seminar that will be free to all ASPRS Members wishing to attend. There will be one opportunity per month to reach out to all ASPRS Members with a demonstration of a new product, service, or other information. ASPRS will promote the Seminar through a blast email to all members, a notice on the ASPRS web site home page, and ads in PE&RS.

The Virtual Seminar will be hosted by ASPRS through its Zoom capability and has the capacity to accommodate 500 attendees.

Vendor Seminars	
Fee	$2,500 (no discounts)

DIGITAL ADVERTISING OPPORTUNITIES

EMPLOYMENT PROMOTION

When you need to fill a position right away, use this direct, right-to-the-desktop approach to announce your employment opportunity. The employment opportunity will be sent once to all ASPRS members in our regular Wednesday email newsletter to members, and will be posted on the ASPRS Web site for one month. This type of advertising gets results when you provide a web link with your text.

Employment Opportunity	Net Rate
30-Day Web + 1 email	$500/opportunity
Web-only (no email)	$300/opportunity

Do you have multiple vacancies that need to be filled? Contact us for pricing details for multiple listings.

NEWSLETTER DISPLAY ADVERTISING

Your vertical ad will show up in the right hand column of our weekly newsletter, which is sent to more than 3,000 people, including our membership and interested parties. **Open Rate: 32.9%**

Newsletter vertical banner ad	Net Rate
180 pixels x 240 pixels max	$500/ opportunity

DEDICATED CONTENT EMAIL BLAST

Send a dedicated email blast to the ASPRS email list. Advertiser supplies HTML (including images). Lead time: 14 days.

Materials	Net Rate
Advertiser supplies HTML, including images.	$3000/ opportunity

Digital Edition Announcement E-Mail: 5,800+

PE&RS is available online in both a public version that is available to anyone but does not include the peer-reviewed articles, and a full version that is available to ASPRS members only upon login.

The enhanced version of PE&RS contains hot links for all ASPRS Sustaining Member Companies, as well as hot links on advertisements, ASPRS Who's Who, and internet references.

Become a sponsor today!

The e-mail blast sponsorship opportunity includes a **180 x 240 pixel ad** in the email announcement that goes out to our membership announcing the availability of the electronic issue.

Digital Edition Opportunities	Net Rate
E-mail Blast Sponsorship*	$1,000

For more information, contact Bill Spilman at bill@innovativemediasolutions.com | (877) 878-3260 toll-free | (309) 483-6467 direct | (309) 483-2371 fax

Conference Advertising Opportunities

Every year ASPRS holds an **Annual Conference** as an in-person event, in addition to a **Virtual Technical Symposium**. There are exciting advertising opportunites available for each.

Our Attendees are people you need to reach! You'll meet face-to-face with decision makers who have budget authority from top organizations utilizing your products and services. Land remote sensing data users, researchers, applications scientists, producers, managers and policymakers participate in this important conference.

Maximize the benefits of your participation by becoming a conference sponsor. Your company can make its mark and gain visibility before, during and after the event. Choose from our list of Unique Sponsorships for the events or items that best showcase your company. If you are interested in a sponsorship not shown here, speak with our sales representative and he will be happy to work with your needs and desires for a mutually beneficial opportunity.

ANNUAL CONFERENCE at GEO WEEK ADVERTISING OPPORTUNITIES

Sponsor an ASPRS Workshop
Sponsoring an ASPRS Workshop is an excellent way to reach a targeted audience of attendees seeking professional development.

Your support for an ASPRS workshop shows your commitment to promote unbiased educational materials to the professional community. Your support also helps ASPRS offset a portion of cost of the A/V equipment for the workshop and provide a small honorarium for the workshop instructors who volunteer their preparation time and travel.

Each workshop sponsor will receive:
1. Recognition on ASPRS website
2. Recognition in ASPRS enewsletter
3. Recognition in ASPRS conference program (printed handout)
4. Session moderator thanks sponsor in introductory remarks with logo on screen
5. Logo and sponsorship noted in workshop handouts
6. Area in workshop classroom for promotional materials

Day Sponsor
Each Day Sponsor opportunity will include
1. Logo on program website
2. eBlast announcement to all conference attendees on sponsored day. Announcement will include a 50-word description and logo.
3. 30-second video at the beginning of sponsored day.
4. Logo on opening slide of all 4-5 sessions throughout the sponsored day and sponsor acknowledgement.

Single Session Sponsor
Each Single Session Sponsor opportunity will include
1. Logo on program website
2. Logo on opening slide of the session and sponsor acknowledgement.

Break Sponsorship
Coffee and sodas will be available for workshop participants. Take this time, as the workshop participants enjoy a break, to promote your company and products.

VIRTUAL TECHNICAL SYMPOSIUM ADVERTISING OPPORTUNITIES

This format is an attractive, convenient presentation venue for remote sensing professionals globally who are unable to travel. This year, ASPRS will be offering a select number of Vendor Spotlight opportunities. "This is an excellent opportunity to reach ASPRS Conference attendees and to invite non-attendees to participate in a vendor product demonstration," said Karen Schuckman, Managing Director, ASPRS.

Vendor Spotlight/Product Demo
Each Vendor Spotlight/Product Demo will include
1. 30-minute time slot available during conference week
2. Vendor Spotlight/Product Demo listed in the conference program
3. Free for conference and non-conference attendees. There will be separate URL for each Vendor Spotlight/Product Demo
4. List of Vendor Spotlight/Product Demo attendees supplied to vendor at the end of the conference.

Day Sponsor
Each Day Sponsor opportunity will include
1. Logo on program website
2. eBlast announcement to all conference attendees on sponsored day. Announcement will include a 50-word description and logo.
3. 30-second video at the beginning of sponsored day.
4. Logo on opening slide of all 4-5 sessions throughout the sponsored day and sponsor acknowledgement.

Single Session Sponsor
Each Single Session Sponsor opportunity will include
1. Logo on program website
2. Logo on opening slide of the session and sponsor acknowledgement.

For more prices & a full list of opportunities,
contact Bill Spilman at bill@innovativemediasolutions.com
(877) 878-3260 toll-free, (309) 483-6467 direct, (309) 483-2371 fax

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2024 PE&RS Advertising Deadlines

	Deadlines	
Issue	Space	Artwork
January	November 17	November 30
February	December 8	December 15
March	January 12	January 19
April	February 9	February 16
May	March 8	March 15
June	April 12	April 19
July	May 10	May 17
August	June 7	June 14
September	July 12	July 19
October	August 9	August 16
November	September 13	September 20
December	October 11	October 18

ASPRS CURRENT SUSTAINING MEMBERS

ACI USA Inc.
acicorporation.com
Member Since: 2/2018

Aerial Services, Inc.
AerialServicesInc.com
Member Since: 5/2001

Airworks Solutions Inc.
airworks.io
Member Since: 5/2022

Applanix
applanix.com
Member Since: 7/1997

Ayres Associates
AyresAssociates.com
Member Since: 1/1953

Cardinal Systems LLC
cardinalsystems.net
Member Since: 1/2001

Dewberry
dewberry.com
Member Since: 1/1985

Digital Mapping, Inc
admap.com
Member Since: 4/2002

Esri
esri.com
Member Since: 1/1987

GeoCue Group
geocue.com
Member Since: 10/2003

Geographic Imperatives LLC
geographicimperativesllc.com
Member Since: 9/2021

GPI Geospatial Inc.
aca-net.com
Member Since: 1/1994

Halff Associates, Inc.
halff.com
Member Since: 8/2020

Keystone Aerial Surveys, Inc.
kasurveys.com
Member Since: 1/1985

Kucera International
kucerainternational.com
Member Since: 1/1992

L3Harris Corporation
harris.com
Member Since: 6/2008

Merrick & Company
merrick.com
Member Since: 4/1995

Miller Creek Associates
mcamaps.com
Member Since: 12/2014

Nearmap
nearmap.com
Member Since: 7/2022

NV5 Geospatial
quantumspatial.com
Member Since: 1/1974

Pickett and Associates, Inc.
pickettusa.com
Member Since: 4/2007

PixElement
pixelement.com
Member Since: 2/2017

Riegl USA, Inc.
rieglusa.com
Member Since: 11/2004

RRC International, LLC
rrccompanies.com
Member Since: 9/2023

Sanborn Map Company
sanborn.com
Member Since: 10/1984

Surdex Corporation
surdex.com
Member Since: 12/2011

Surveying And Mapping, LLC (SAM)
sam.biz
Member Since: 12/2005

T3 Global Strategies, Inc.
https://t3gs.com/
Member Since: 6/2020

Towill, Inc.
towill.com
Member Since: 1/1952

U.S. Census Bureau/ Geography Division
census.gov
Member Since: 6/2023

U.S. Geological Survey
usgs.gov/
Member Since: 4/2002

Woolpert LLP
woolpert.com
Member Since: 1/1985

CONTACT INFORMATION

ASPRS ADVERTISING & EXHIBIT SALES:

Bill Spilman
ASPRS Advertising, Exhibit Sales & Sponsorships
320 W. Chestnut St., P.O. Box 399
Oneida, IL 61467
(877) 878-3260 toll-free
(309) 483-6467 direct
(309) 483-2371 fax
bill@innovativemediasolutions.com

SEND PAYMENT TO:

ASPRS Finance Office
PO Box 14713
Baton Rouge, LA 70898

office@asprs.org

Important: If sending payment via wire transfer, you must add a US $25 wire transfer fee to your total. Contact office@asprs.org for instructions on wire transfers.

For more information, contact Bill Spilman at bill@innovativemediasolutions.com | (877) 878-3260 toll-free | (309) 483-6467 direct | (309) 483-2371 fax

SUSTAININGMEMBERS

ACI USA Inc.
Weston, Florida
https://acicorporation.com/
Member Since: 2/2018

Aerial Services, Inc.
Cedar Falls, Iowa
www.AerialServicesInc.com
Member Since: 5/2001

Airworks Solutions Inc.
Boston, Massachusetts
Member Since: 5/2022

Applanix
Richmond Hill, Ontario, Canada
http://www.applanix.com
Member Since: 7/1997

Ayres Associates
Madison, Wisconsin
www.AyresAssociates.com
Member Since: 1/1953

Cardinal Systems, LLC
Flagler Beach, Florida
www.cardinalsystems.net
Member Since: 1/2001

Dewberry
Fairfax, Virginia
www.dewberry.com
Member Since: 1/1985

Esri
Redlands, California
www.esri.com
Member Since: 1/1987

GeoCue Group
Madison, Alabama
http://www.geocue.com
Member Since: 10/2003

Geographic Imperatives LLC
Centennial, Colorado
Member Since: 12/2020

GPI Geospatial Inc.
Orlando, Florida
www.aca-net.com
Member Since: 1/1994

Halff Associates, Inc.
Richardson, Texas
www.halff.com
Member Since: 8/2021

Keystone Aerial Surveys, Inc.
Philadelphia, Pennsylvania
www.kasurveys.com
Member Since: 1/1985

Kucera International
Willoughby, Ohio
www.kucerainternational.com
Member Since: 1/1992

L3Harris Technologies
Broomfield, Colorado
www.l3harris.com
Member Since: 6/2008

Merrick & Company
Greenwood Village, Colorado
www.merrick.com
Member Since: 4/1995

Miller Creek Associates
SeaTac Washington
www.mcamaps.com
Member Since: 12/2014

Nearmap
South Jordan, Utah
www.nearmap.com
Member Since: 6/2023

NV5 Geospatial
Sheboygan Falls, Wisconsin
www.quantumspatial.com
Member Since: 1/1974

Pickett and Associates, Inc.
Bartow, Florida
www.pickettusa.com
Member Since: 4/2007

PixElement
Belmont, Michigan
https://pixelement.com
Member Since: 2/2017

Riegl USA, Inc.
Orlando, Florida
www.rieglusa.com
Member Since: 11/2004

Sanborn Map Company
Colorado Springs, Colorado
www.sanborn.com
Member Since: 10/1984

Surdex Corporation
Chesterfield, Missouri
www.surdex.com
Member Since: 12/2011

Surveying And Mapping, LLC (SAM)
Austin, Texas
www.sam.biz
Member Since: 12/2005

T3 Global Strategies, Inc.
Bridgeville, Pennsylvania
https://t3gs.com/
Member Since: 6/2020

Towill, Inc.
San Francisco, California
www.towill.com
Member Since: 1/1952

Woolpert LLP
Dayton, Ohio
www.woolpert.com
Member Since: 1/1985

SUSTAININGMEMBER**BENEFITS**

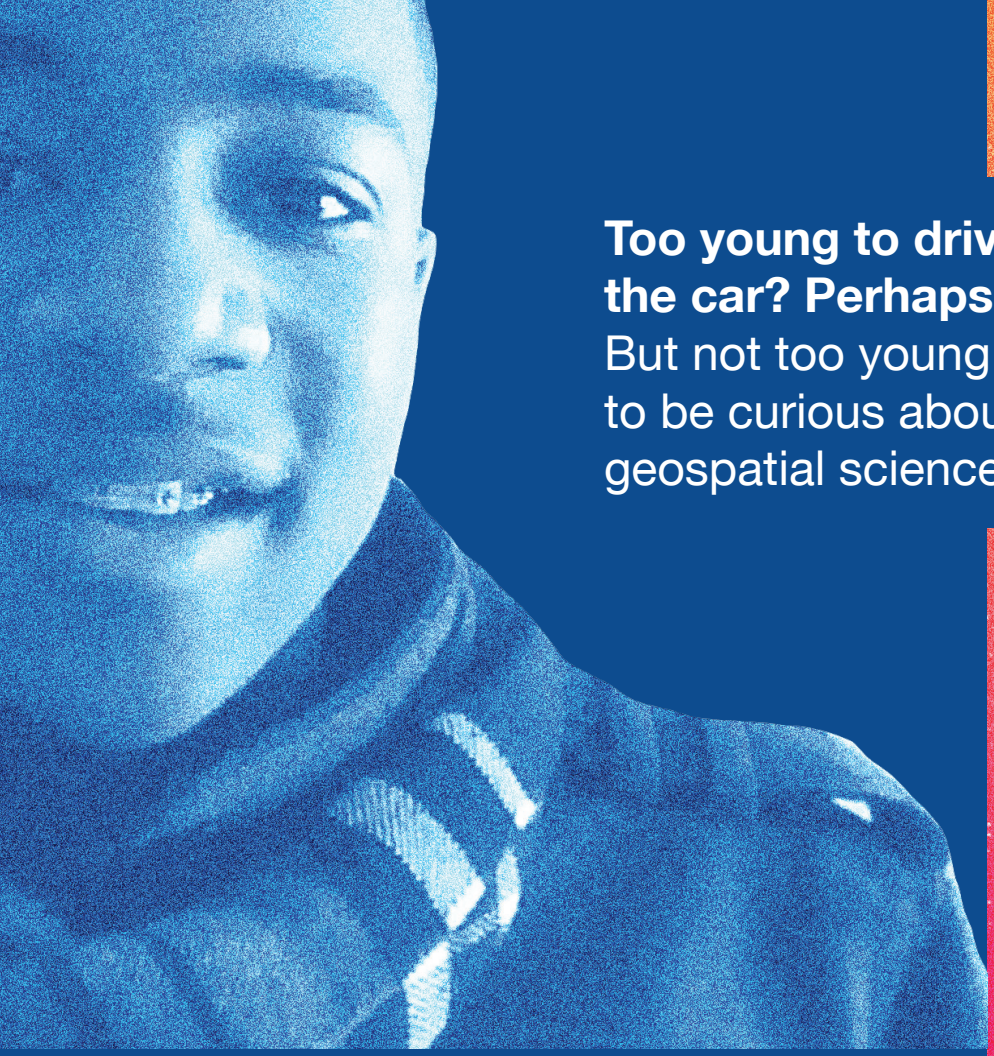
Membership

- ✓ Provides a means for dissemination of new information
- ✓ Encourages an exchange of ideas and communication
- ✓ Offers prime exposure for companies

Benefits of an ASPRS Membership

- Complimentary and discounted Employee Membership*
- E-mail blast to full ASPRS membership*
- Professional Certification Application fee discount for any employee
- Member price for ASPRS publications
- Discount on group registration to ASPRS virtual conferences
- Sustaining Member company listing in ASPRS directory/website
- Hot link to company website from Sustaining Member company listing page on ASPRS website
- Press Release Priority Listing in *PE&RS* Industry News
- Priority publishing of Highlight Articles in *PE&RS* plus, 20% discount off cover fee
- Discount on *PE&RS* advertising
- Exhibit discounts at ASPRS sponsored conferences (exception ASPRS/ILMF)
- Free training webinar registrations per year*
- Discount on additional training webinar registrations for employees
- Discount for each new SMC member brought on board (Discount for first year only)

*quantity depends on membership level



Too young to drive the car? Perhaps!
But not too young to be curious about geospatial sciences.

asprs FOUNDATION

The ASPRS Foundation was established to advance the understanding and use of spatial data for the betterment of humankind.

The Foundation provides grants, scholarships, loans and other forms of aid to individuals or organizations pursuing knowledge of imaging and geospatial information science and technology, and their applications across the scientific, governmental, and commercial sectors.

Support the foundation, so when they are ready, we are too.

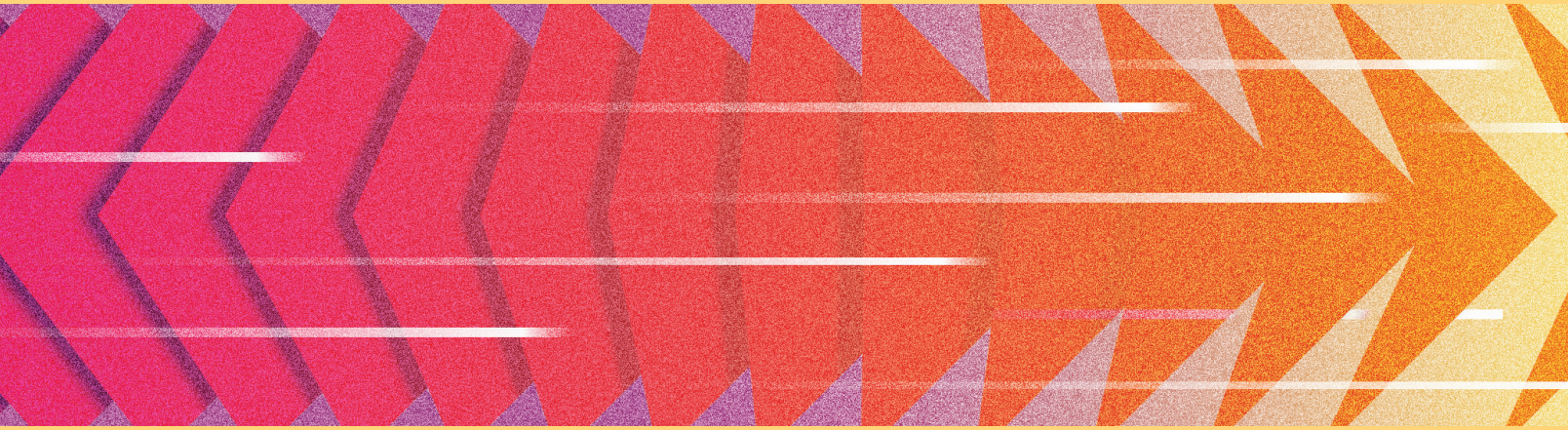
asprsfoundation.org/donate

JOIN ASPRS TODAY!

asprs THE IMAGING & GEOSPATIAL INFORMATION SOCIETY

ACCELERATE YOUR CAREER!

PHOTOGRAMMETRY · REMOTE SENSING · GIS · LIDAR · UAS …and more!



LEARN

- Read our journal, *PE&RS*
- Attend professional development workshops, GeoBytes, and online courses through the ASPRS ProLearn platform
- Earn professional development hours (PDH)
- Attend our national & regional meetings and conferences

DO

- Write for *PE&RS*
- Innovate to create new geospatial technologies
- Present at our national & regional meetings and conferences
- Engage & network

GIVE

- Participate in the development of standards & best practices
- Influence state licensure through our NCEES affiliation
- Mentor colleagues & support students
- Educate others about geospatial science & technology

BELONG

- Establish yourself as a geospatial expert
- Grow business relationships
- Brand yourself and your company as geospatial leaders
- Connect to the world via our affiliation with ISPRS

Don’t delay, join today at **asprs.org**