2026 SURVEYORS' Conference

Response to Resilience

Unlocking the Power of Imagery, AI, and GeoAI for Operational and Mitigation Strategies

Scott R. Zubek, GISP/MGIS

JANUARY 11-14,2026 | HERSHEY, PA

Presentation Disclaimer

This presentation is provided for informational and educational purposes only and reflects the views of the presenter at the time of delivery. References to artificial intelligence (AI), generative AI (GAI), geospatial AI (GeoAI), and related geospatial technologies are intended to discuss general concepts, emerging trends, and potential applications.

Nothing in this presentation should be construed as professional surveying advice, legal guidance, regulatory interpretation, or a substitute for professional judgment. The use of AI-enabled or geospatial technologies does not replace the responsibility of a licensed professional land surveyor to exercise independent judgment, comply with applicable laws, standards, and regulations, and verify the accuracy and reliability of all data and outputs.

The presenter and affiliated organizations make no warranties or guarantees, express or implied, regarding the accuracy, completeness, or suitability of any information or technology discussed.

SESSION EVALUATION

HTTPS://WWW.SURVEYMONKEY.COM/R/PSLS2026EVAL

The Future of Geospatial Technology

Exploring the Impact of Emerging AI Innovations

Table of contents

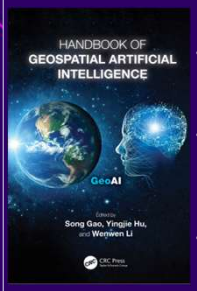
01 Introduction

Artificial Intelligence (AI) is rapidly transforming industries and has the potential to drive what is often called the Fourth Industrial Revolution (Industry 4.0). As AI advances, Geospatial Artificial Intelligence (GeoAI) is poised to redefine how geospatial professionals serve both public and private sectors.

Introduction

This presentation examines a consortium-driven approach to exploring emerging AI technologies within the geospatial domain. It highlights key developments, potential applications, and the evolving role of AI in spatial analysis, decision-making, and innovation.

Introduction



- **Opening Credits: Note that much of the general resource information comes from this text.**
- **The PA Geoboard's Emerging Tech Subcommittee research has found this to be a gold-standard as far as resourcing.**
- ***Citation: Gao, S., Hu, Y., & Li, W. (2024). Handbook of Artificial Intelligence. CRC Press.***

Introduction

Defined: GeoAI is the fusion of GIS (Geospatial Sciences), remote sensing, and Artificial Intelligence (AI).

Emphasis on:

Machine Learning (ML): Utilizing algorithms that can learn patterns from spatial, temporal, and environmental data to make predictions, detect anomalies, classify features (like land cover), and support decision-making in mapping, modeling, and analyzing Earth systems.

Introduction

Defined: GeoAI is the fusion of GIS (Geospatial Sciences), remote sensing, and Artificial Intelligence (AI).

Emphasis on:

Deep Learning (DL): Application of artificial neural networks—especially deep architectures like convolutional neural networks (CNNs) and recurrent neural networks (RNNs)—to analyze large and complex geospatial datasets.

Introduction

Defined: GeoAI is the fusion of GIS (Geospatial Sciences), remote sensing, and Artificial Intelligence (AI).

Emphasis on:

Deep Learning (DL): Models automatically learn hierarchical features from spatial, temporal, and environmental data, enabling advanced tasks such as high-resolution image classification, object detection, change detection, feature extraction, and predictive modeling.

Introduction

Defined: GeoAI is the fusion of GIS (Geospatial Sciences), remote sensing, and Artificial Intelligence (AI).

Emphasis on:

Deep Learning (DL): Deep learning is particularly ***powerful for handling unstructured data like satellite imagery, UAV data, and sensor streams, often outperforming traditional machine learning in accuracy and scalability***.

Introduction

- Example from my previous presentation today on UAV data; developing a **DEEP LEARNING** Geospatial AI approach:

1. **Study ESRI Living Atlas Deep Learning Packages.**
2. **Use ESRI's Deep Learning Tools to Prepare Your Dataset.**
3. **Label Objects in Your Imagery for Model Training.**
4. **Train a New Model or Fine-Tune an Existing DLPK.**

Introduction

- Example from my previous presentation today, on developing a **DEEP LEARNING** Geospatial AI approach:

5. **Use Geoprocessing Tools to Apply the Model at Scale Apply.**

- Detect Objects Using Deep Learning.
- Classify Pixels Using Deep Learning This enables you to run inference on large volumes of UAV, satellite, or aerial imagery for automated feature extraction.

Introduction

Utilize Large Language Models (LLMs) to ***REFINE*** Workflows.

I developed this workflow, and used ChatGPT (Gpt-40 paid subscription Model) to refine my steps as shown here.

Independible tool

Refined GeoAI Workflow with Esri Deep Learning Packages

1. **Study ESRI Living Atlas Deep Learning Packages (DLPKs)**
   Begin by exploring available pretrained models to understand what's already been developed (e.g., building footprints, tree canopy, land cover). Review the model types, label schemas, and input requirements.
2. **Use ESRI's Deep Learning Tools to Prepare Your Data**
   Set up your imagery environment in ArcGIS Pro or ArcGIS Enterprise. Ensure you have georeferenced imagery or a mosaic dataset ready to support object detection or classification.
3. **Label Objects in Your Imagery for Model Training**
   Use the **Label Objects for Deep Learning** or **Training Samples Manager** tool to digitize features of interest (e.g., buildings, debris, water). This forms the foundation of your custom training dataset.
4. **Train a New Model or Fine-Tune an Existing DLPK**
   Based on your labeled training data, either:
   - Train a brand-new model from scratch using the **Train Deep Learning Model** tool, or
   - Fine-tune an existing DLPK model to adapt it to your specific imagery style or content.
   This is where studying existing DLPKs helps you align formats, classes, and expectations.
5. **Use Geoprocessing Tools to Apply the Model at Scale**
   Apply the model to your imagery using tools like:
   - **Detect Objects Using Deep Learning**
   - **Classify Pixels Using Deep Learning** This enables you to run inference on large volumes of UAV, satellite, or aerial imagery for automated feature extraction.

Introduction

More to follow into the Geo-AI (and general or generative AI) in daily operations section...

Refined GeoAI Workflow with Esri Deep Learning Packages

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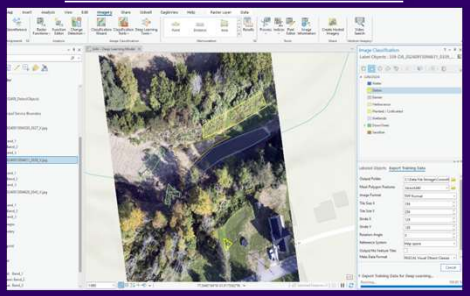
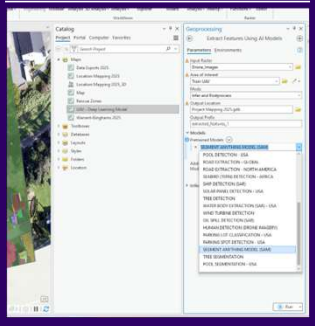
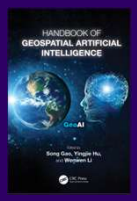
Introduction: Pretrained Models



ESRI DLPK Pretrained Models



02 Geo-AI Handbook



Strategic insights from trusted sources

Insights from Trusted Sources

- Historical Evolution: GeoAI evolving from spatial statistics and geospatial data mining to spatial deep learning.
- Founded on Theories and Principles…
- **Spatial Autocorrelation**: nearby things are more likely to be similar than distant things.(e.g., temperatures in nearby towns tend to be close in value)
- **Heterogeneity**: spatial data varies across space; no uniform pattern applies everywhere.

Insights from Trusted Sources

- Why now?
- ***Big spatial data + cloud computing + deep learning = real-time spatial insight.***
- What's unique?
- Models must honor spatial dependence, heterogeneity, and topology.
- Future Direction: Toward real-time, explainable, multimodal GeoAI with ethical safeguards.

Imagery Analysis: Game Changer

- Deep learning became a game-changer for image analysis.
- **Convolutional Neural Networks (CNNs)** – well-suited for image feature extraction (e.g. recognizing spatial patterns like building shapes or crop textures).
- Using GeoAI to process satellite, aerial, and ***street-view imagery***. Deep learning enables automated land cover mapping and object extraction. (Urban Analysis Studies).
- Public datasets (SpaceNet, xView) catalyzed development.

Imagery Analysis: Game Changer

- Convolutional Neural Networks (CNNs), the workhorse of image recognition. Learn features from multi-band imagery.
- Vision Transformers emerging for geospatial analysis.
- Tools: TensorFlow, PyTorch, Raster Vision, TorchGeo.
- Pixel-level classification using U-Net, DeepLab, etc.
- Used for building footprint extraction, land cover mapping
  Outputs converted to vector data for GIS integration.

Imagery Analysis: Game Changer

- Multi-source input: imagery + DEM, radar, LiDAR, or vector layers.
- AI outputs used in ArcGIS, QGIS for downstream spatial analysis.
- Example: AI-detected floods intersected with population maps.
- Applications: disaster response, urban growth, agriculture, conservation.

Insights from Trusted Sources

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Ethical Considerations

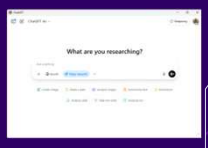
- Risks associated with geolocation data, including unauthorized tracking and profiling.
- Bias in AI algorithms leading to unfair outcomes.
- Surveillance implications and the balance between security and individual rights.
- Implementation of data anonymization and differential privacy techniques.

Ethical Considerations

- Development of transparent and explainable AI models.
- Establishment of ethical guidelines and regulatory frameworks.
- Design GeoAI systems that augment human decision-making rather than replace it.
- Incorporating user feedback into AI model development.

Ethical Considerations

- Assessing how GeoAI affects communities, particularly marginalized groups.
- Promoting inclusivity and accessibility in GeoAI applications.
- Recognize and respect cultural differences in geospatial data interpretation and usage.
- Take a humanistic approach: serve societal interests, contribute positively to human well-being.



03 Geo-AI & Operations

Geo-AI already being used in daily GIS operations.

Geo-AI in Daily Operations

- **Generative AI Defined**: specific type of artificial intelligence that creates new & original content—like text, images, music, code, etc. based on patterns it has learned from existing data.
- Very different from earlier types of AI, including voice assistants like Alexa.
- Alexa voice assistants are a narrower and more limited in scope; a more primitive form of commonly used AI.

Geo-AI in Daily Operations

- **Examples:**
- **ChatGPT** (text generation)
- **DALL·E** (image generation)
- **GitHub Copilot** (code generation)
- **Suno** (music generation)

Geo-AI in Daily Operations

- **Key Capabilities:**
- Writes essays, poems, or reports
- Creates photorealistic images from text
- Composes music or soundtracks
- **Generates new software code – e.g. Python**
- **Tech Behind It:** Often uses transformer-based models (like GPT, LLaMA, etc.) trained on massive, diverse datasets Uses probabilistic reasoning to "imagine" new outputs.

Geo-AI in Daily Operations

- **Defined**: **Large Language Model (LLM):** An artificial intelligence model trained on vast amounts of text data to understand, generate, and interact using human language.
- **LLMs** use deep learning—typically transformer architectures—to perform tasks such as text generation, summarization, question answering, translation, and more.
- **LLMs** work by predicting the most likely next word in a sentence, based on the context of the words that came before.

Geo-AI in Daily Operations

- Many nuances to the AI tools available, too many nuances, too many to cover here.
- For example, there is a key difference between a standalone LLM and an AI application or assistant that integrates LLM capabilities.
- Microsoft products like Word, Excel, Outlook, and Teams ***integrate*** LLMs or LLM-powered tools.

My LLM "Power Tools"

Examples of LLMs

LLM Name	Developer / Organization	Notable Use Case
GPT-4 / GPT-3.5	OpenAI	General-purpose language modeling (core of ChatGPT)
Claude	Anthropic	Safe and ethical conversational AI
Gemini (formerly Bard)	Google DeepMind	Web-connected chatbot and assistant
LLaMA (1, 2, 3)	Meta (Facebook)	Research-grade, open-weight LLMs
Mistral / Mixtral	Mistral	High-performance open models with mixture of experts
Falcon	Technology Innovation Institute (UAE)	Open-source LLMs for research
Command R	Cohere	Enterprise-focused LLM optimized for RAG
ERNIE	Baidu	Chinese-language and multilingual LLM
Grok	xAI (Elon Musk)	Conversational LLM integrated with X (Twitter)

LLM "Power Tools"

Applications Powered by LLMs

AI Tool / Application	Developer	Built On / Powered By	Use Case
ChatGPT	OpenAI	GPT-3.5 / GPT-4	Conversational AI, content generation
Microsoft Copilot	Microsoft	GPT-4 (via Azure/OpenAI)	AI assistant in Office apps (Word, Excel, etc.)
Gemini Assistant	Google	Gemini LLM	AI assistant for Docs, Gmail, Search, etc.
Claude Assistant	Anthropic	Claude LLM	Ethical AI assistant for writing and Q&A
Grok	xAI	Grok LLM	Social media–integrated chatbot on X (Twitter)

Geo-AI in Daily Operations

I have used most of these workflows, or some version thereof, in my day-to-day workflows. I was even shocked, putting this slide together, how much I now rely on it.

- **Data Preparation and Management**
- Automated Metadata Generation. ***DOCUMENTATION, DOCUMENTATION, DOCUMENTATION!***
- Schema Mapping and Attribute Harmonization.
- Geocoding & Named Entity Recognition (NER).

Geo-AI in Daily Operations

- **Spatial Analysis & Modeling:**
- Land Use & Land Cover Classification.
- Object Detection from UAV or Satellite Imagery.
- Anomaly Detection in Geospatial Time Series.

Geo-AI in Daily Operations

- **Mapping & Visualization:**
- Automated Map Captioning & Summaries.
- Map Style Recommendations – working with map product exports (PDF, JPEG, etc. for optimization).
- Web-App Builder and now Experience Bulder design strategies.

Geo-AI in Daily Operations

- **Mapping & Visualization:**
- Web Application (Story Maps) design strategies.

  This is a good example, because Story Maps, though useful, can be difficult to organize.

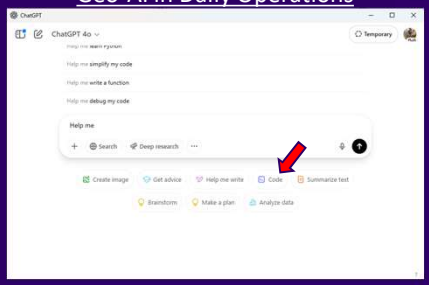
Geo-AI in Daily Operations

- **Mapping & Visualization:**
- Automated Situation Reports (SitReps).
- Translating Technical Jargon into Plain Language.
- Suggestions for industry standard symbology, rendering, scale dependency, etc. settings for various themes.

Geo-AI in Daily Operations

- **Workflow Automation:**
- ***Generate Python/ArcPy/ModelBuilder Scripts with LLMs***
  Code support is built into ChatGPT (GPT-40 model).
- AI-Powered Task Assistants in GIS Software (Microsoft 356).
- **Data Cleaning Scripts for Tabular/Spatial Data.**

Geo-AI in Daily Operations



Geo-AI in Daily Operations

- **Workflow Automation:**
- Data Cleaning Scripts for Tabular/Spatial Data.
- ***Geocoding.*** Tabular data used in an ArcGIS Pro geocoding process can be messy.
- Using Generative AI to just clean up a CSV or customizing a script can drastically improve tabular data quality for higher match rates/scoring in geocoding.

Geo-AI in Daily Operations

Predictive modeling design recommendations and analysis.

- Identify patterns and trends from historical and streaming data (e.g., flood risks, infrastructure failures, disease outbreaks).
- Simulate outcomes under various scenarios using deep learning, spatial-temporal models, or ensemble techniques.
- Recommend optimized strategies for risk mitigation, resource allocation, or infrastructure development.

Geo-AI in Daily Operations

- **Random Ideas**:
- LLM-Powered chatbots for GIS portals
- Explain errors in geoprocessing tools
- Train GeoAI models with custom imagery
- Storytelling with catching geospatial narratives

04
Power Tools

Geo-AI tools in the modern geospatial ecosystem

AI Power Tools

- **ArcGIS Pro (Esri)**
- 70+ pretrained deep learning models (Living Atlas)
- Tools for object detection, classification, change detection
- arcgis.learn with PyTorch/fast.ai integration
- ModelBuilder + ArcPy + Jupyter for automation
- Scalable via ArcGIS Image Server & cloud compute

AI Power Tools

- **GeoMedia Pro (Hexagon)**

- AI via integration with Spatial Modeler & ERDAS Imagine
- ML tools: decision trees, SVM, object-based classification
- GUI-based automation with Spatial Modeler
- Cloud deployment via M.App Enterprise/M.App X

AI Power Tools

- **AutoCAD / Autodesk**

- Smart Blocks (object recognition in CAD)
- InfraWorks
- AI for terrain & flood modelingAI from integration with ArcGIS or cloud tools
- Python/.NET APIs enable external ML integration
- Cloud AI via Autodesk Forge, Forma, Info360

AI Power Tools

- **QGIS (Open Source)**

- AI via plugins: Dzetsaka, Deepness, SCP
- Supports TensorFlow, PyTorch through Python API
- Modeler + PyQGIS for automation
- No native cloud, but integrates with GEE, APIs

AI Power Tools

- **TerrSet / IDRISI (Clark Labs)**

- Built-in ML: SVM, RF, neural networks, fuzzy logic
- Strong for land change modeling, suitability analysis
- Automation via IML scripting
- No native cloud; limited external integration

AI Power Tools

- **Google Earth Engine**

- Native ML: RF, SVM, CART, k-means
- API-based scripting in JS & Python
- Integrates with TensorFlow for training off-platform
- Fully cloud-native, scales to global datasets

AI Power Tools

- **MapInfo Pro (Precisely)**

- No native AI tools
- Python & MapBasic enable ML integration
- Used with external AI tools or cloud services
- Consumer of AI results, not generator

AI Power Tools

- **ENVI (NV5 Geospatial)**
- ML toolkit + Deep Learning Module
- Supports SVM, RF, anomaly detection, object detection
- Python & IDL scripting
- Cloud deployment via VMs; integrates with ArcGIS

AI Power Tools

- **RDAS Imagine (Hexagon)**
- Built-in ML & deep learning in Spatial Modeler
- TensorFlow integration for CNNs
- OBIA + ML for segmentation/classification
- Server/cloud deployment via Apollo, M.App X

AI Power Tools

- **eCognition (Trimble)**
- OBIA with SVM, RF, deep learning (TensorFlow/ONNX)
- Rule sets for automation + deep model import
- eCognition Server for batch/cloud workflows
- Fits into cloud pipelines

AI Power Tools: Quick Summary

- **ArcGIS Pro, ERDAS, ENVI**: Full-stack GeoAI.
- **QGIS:** Flexible via Python & plugins.
- **Google Earth Engine:** Best for cloud-native ML.
- **MapInfo:** Needs external AI tools.
- **Autodesk:** AI for design; integrates well with GIS.

Imagery Vendors: Quick Summary

- **EagleView:** Uses AI to extract roofs, buildings, and property features from high-res oblique imagery for insurance and assessment.
- **Near Map:** Offers 70+ AI-derived geospatial layers (e.g., pools, solar panels, vegetation) from aerial imagery with seamless GIS integration.

Imagery Vendors: Quick Summary

- **Maxar:** Delivers satellite-based object detection and change monitoring powered by deep learning and integrated GEOINT services.
- **Planet Labs:** Combines daily Earth imagery with AI to monitor agriculture, forests, and urban development in near real-time.

Imagery Vendors: Quick Summary

- **Hexagon (HxGN):** Leverages AI in aerial imagery and LiDAR to support 3D modeling, infrastructure planning, and land classification.
- **Airbus (OneAtlas):** Provides AI-ready satellite analytics for land use classification, infrastructure, and emergency response via cloud APIs.

Imagery Vendors: Quick Summary

- **Fugro:** Applies AI to seabed mapping, infrastructure inspection, and environmental monitoring using remote and autonomous platforms.

Power Tools: Quick Summary

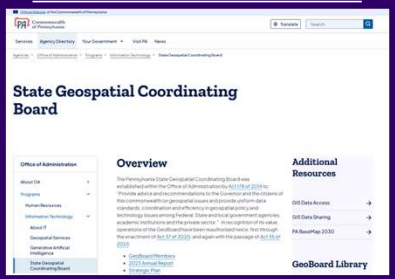
Please be aware that the previous research is a cursory review of commonly used software programs & packages.

Be sure to do your own research.

05 Leading Innovation

The PA-Geoboard's Emerging Technology Subcommittee

PA Geoboard ET Subcommittee



PA Geoboard ET Subcommittee

- **Background:**

✓ PA Geoboard started a drone/UAV subcommittee (volunteer group).

✓ Members realized that the UAV topic was a duplication of efforts.

✓ The PA Geoboard's Governance Task Force reorganized the UAV subcommittee into the ***Emerging Technology Subcommittee.***

PA Geoboard ET Subcommittee

- **Background**:

✓ Scott R. Zubek, GISP/MGIS (Director of Tioga County PA GIS Department/) named Chairperson.
    Legislative appointee and voting member of the Geoboard.

✓ Kevin Eaton, Chairperson of the Governance Taks Force, oversee and approves subcommittee action items.

PA Geoboard ET Subcommittee

- **Organizational Context**:

✓ First meetings held in September of 2024.

✓ The group meets bi-weekly via Zoom at 1:00pm on Fridays.

✓ Started with 7 members, now up to about 12 members invited to attend the biweekly meetings.

✓ The group generates an agenda and minutes per each meeting. Stored on the Geoboard's SharePoint.

PA Geoboard ET Subcommittee

- **Achievements**:

✓ We decided to set up a quarterly panel discussion series.

✓ Collaborative effort with Pennsylvania Spatial Data Access (PASDA) and the Geoboard's Service Delivery Task Force.

✓ First seminar held on January 30, 2025 (Friday) which was a success – above expected attendance.

✓ Let us know if you have a topic or know someone who'd like to present!

PA Geoboard ET Subcommittee

Achievements:

Q1: *Digital Twins and Quality of Life Innovations. (1/17/2025)*

Q2: GNSS Receiver Technology for Field Data Collection. (5/2/2025).

Q3: Open Spot (If anyone is interested, contact us!).

Q4: Clark University to present a topic - November of 2025.

Join Us for an Exciting Panel Discussion on Emerging Geospatial Technology

Presented By:

PA GeoBoard Governance Task Force – Emerging Technology Subcommittee | PASDA | PA GeoBoard Service Delivery Task Force

A Future Powered by GeoAI: Digital Twins and Quality of Life Innovations

Moderated Panel Discussion

Date: Friday, January 17th
Time: 10:00 AM - 11:00 AM
Location: Zoom Virtual Meeting

Explore how Artificial Intelligence (AI), Machine Learning (ML), and 3D technologies are revolutionizing Geographic Information Systems (GIS) and geospatial analysis. Learn from leading experts about innovative applications shaping urban development, environmental resilience, and public well-being. Discover how advancements in AI and digital twinning are transforming geospatial practices and unlocking new possibilities for urban and environmental resilience.

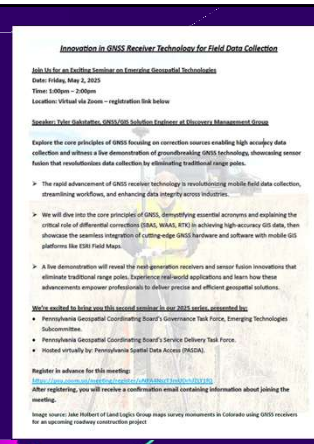
Speakers:

- Kristen Kurland | Professor, Carnegie Mellon University
  Using 3D GIS, Machine Learning, and AI for a Quality-of-Life Project
  Kristen's expertise spans health, urban design, and sustainability. She will share insights on AI-driven tools improving quality of life in Pittsburgh and beyond.
- Kat Kraft | Vice President, Teren4D Inc.
  The Evolution and Applications of Environmental Twin Technology
  With a decade of experience in geospatial technologies, Kat specializes in creating long-term solutions for environmental and economic challenges.

About the Series:
This panel discussion is the first in a series of events focused on the exploration and application of emerging technologies in the geospatial community within Pennsylvania and beyond.

Register as an attendee for this panel discussion:

After registering, you will receive a confirmation email containing the virtual meeting access information.



Innovation in GNSS Receiver Technology for Field Data Collection

Join Us for an Exciting Seminar on Emerging Geospatial Technologies
Date: Friday, May 2, 2025
Time: 1:00pm – 2:00pm
Location: Virtual via Zoom – registration link below

Speaker: Tyler Gakstatter, GNSS/GIS Solution Engineer at Discovery Management Group

Explore the core principles of GNSS focusing on correction sources enabling high accuracy data collection and witness a live demonstration of groundbreaking GNSS technology, showcasing sensor fusion that revolutionizes data collection by eliminating traditional range poles.

➢ The rapid advancement of GNSS receiver technology is revolutionizing mobile field data collection, streamlining workflows, and enhancing data integrity across industries.

➢ We will dive into the core principles of GNSS, demystifying essential acronyms and explaining the critical role of differential corrections (SBAS, WAAS, RTK) in achieving high-accuracy GIS data, then showcase the seamless integration of cutting-edge GNSS hardware and software with mobile GIS platforms like ESRI Field Maps.

➢ A live demonstration will reveal the next-generation receivers and sensor fusion innovations that eliminate traditional range poles. Experience real-world applications and learn how these advancements empower professionals to deliver precise and efficient geospatial solutions.

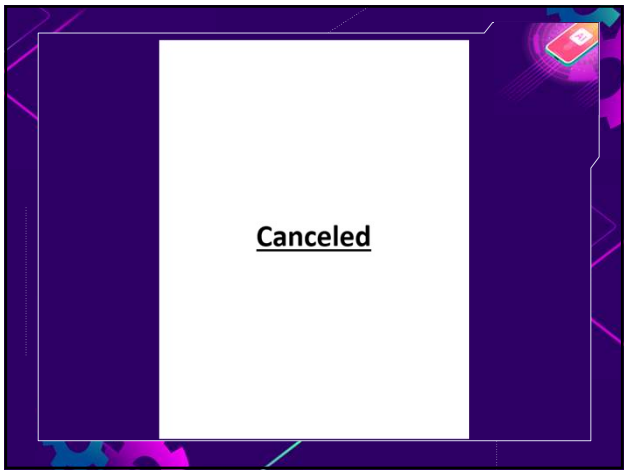
We're excited to bring you this second seminar in our 2025 series, presented by:

- Pennsylvania Geospatial Coordinating Board's Governance Task Force, Emerging Technologies Subcommittee.
- Pennsylvania Geospatial Coordinating Board's Service Delivery Task Force.
- Hosted virtually by: Pennsylvania Spatial Data Access (PASDA).

Register in advance for this meeting:

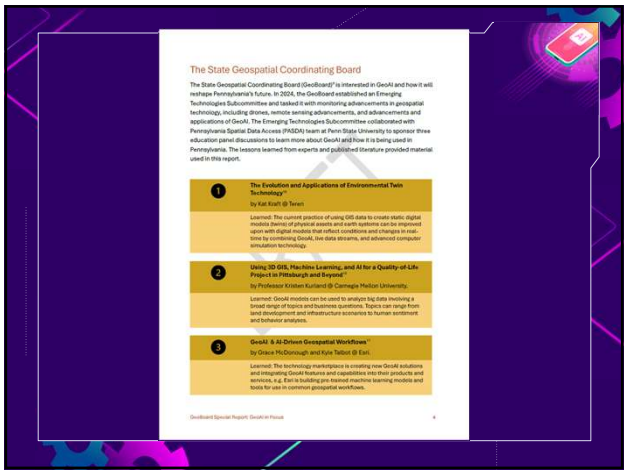
After registering, you will receive a confirmation email containing information about joining the meeting.

Image source: Jake Holbert of Land Logics Group maps survey monuments in Colorado using GNSS receivers for an upcoming roadway construction project



PA Geoboard ET Subcommittee

- **Upcoming Initiatives**:
- Drafting of a Special Report.
- Focus on Commonwealth Case Studies of ET, AI or Geo-AI in particular.
- Follow the professional format of the “Basemap” and “Data Sharing” special reports.
- ***Not limited to AI or Geo-AI, all emerging tech is fair game.***



PA Geoboard ET Subcommittee

Thanks to Members!

Damon Anderson / Shanthi Mahesh – PA, PUC
Scott Drzyzga – Geoboard Executive Director
Kevin Eaton (GovTF Chair) – OA, C & E Delivery Center
Sally Holbert – Land Logics Group
Maurie Kelly – Director of PASDA
Steve Kocis – Cambria County, PA, GIS
Joe Livoti II – Union County, PA, GIS
Harrison McCrae – PA Governor's Office AI Pilot Program
Grace McDonough – ESRI
Keith Swavely – ESRI
Scottie Wall – OA, State GIS Coordinator
Scott Zubek (ET Chair/GovTF Vice Chair) – Tioga County, PA GIS

**** ETS will resume in the future, focusing on a new emerging technology ****

06 Conclusion

Closing thoughts and recommendations

Recommendations

- Start using AI for small tasks in your professional space – get used to using it literally as a "Copilot." Start with assistance with writing emails.
- Decided if you want your prompts to train the AI models, and other security considerations. Follow "Use as Directed" guidelines as you would with any other online tool.
- ChatGPT and other LLMs have an option for "Temporary" which is perfect for small research, refinement, etc.

Recommendations

- Integration will improve across the boards and across products.
- Microsoft Word products have Copilot built-in, it's great, but I'm not a huge fan of how it integrates.
- Microsoft 365 subscriptions integrate with ArcGIS Pro features – not necessary but there are some advantages.
- Azure services and product integration.

Closing Remarsk

- **Recommendations**:
- Read some books and articles on drafting "prompts" which basically tell an AI what to do. Very important, get a "knack" for it.
- Draft your prompts both literally and professionally, always be polite as you would with a formal email.
- Get detailed, pretend like you are working with a real-life assistant or co-worker.

Closing Remarsk

- **Recommendations**:
- Work with someone or shadow someone who uses AI in their daily workflows, try and get some ideas (especially Geo-AI.
- Collaboration is key – this is an evolving science, and we can all learn from each other.

Closing Remarsk

- **Recommendations**:
- For GeoAI operations:
- ***Documentation, documentation, documentation – whether writing it, drafting it, or researching it. Does the "boiler plate" work that is so time consuming.***
- Ask your AI literally what it can and can't do. If it can't do something, then ask for suggestions!

Closing Remarsk

- **Recommendations**:
- ***Be careful in uploading data products & outputs to the AI for processing… being mindful of what you are uploading; e.g. privacy, security, sensitivity, etc. is key.***

AI in GeoAI Presentations

🔍 Research & Content Development

1. **Finding Documentation & Resources**
   - Search for official documentation on GIS tools (e.g., ArcGIS Pro, QGIS).
   - Retrieve academic papers, case studies, and datasets relevant to your topic.
   - Summarize chapters from technical books (e.g., *Handbook of Geospatial AI*).
2. **Clarifying Definitions & Terminology**
   - Explain terms like "semantic segmentation" or "object detection in imagery."
   - Translate technical jargon into plain English (or vice versa).
3. **Workflow Explanations**
   - Generate step-by-step guides for GIS tasks (e.g., training a deep learning model on land cover classification).
   - Visualize and narrate processes like spatial analysis, UAV data processing, or map publishing.
4. **Use Case Identification**
   - Suggest real-world applications of your topic (e.g., flood prediction with AI).
   - Provide industry-specific examples (emergency management, environmental planning, etc.).

AI in GeoAI Presentations

🧠 Content Creation & Writing

5. **Slide Drafting**
   - Generate structured slide outlines (intro, body, conclusion).
   - Create titles, bullet points, and speaker notes.
6. **Script & Narrative Support**
   - Write talking points or a full speech to accompany slides.
   - Suggest quotes, statistics, or anecdotes to add depth.
7. **Q&A Prep**
   - Anticipate audience questions and provide answers.
   - Create flashcards for practicing key responses.

AI in GeoAI Presentations

🎨 Design & Aesthetic Assistance

8. **Template Recommendations**
   - Find or suggest PowerPoint templates matching your theme (e.g., tech, emergency response, AI).
   - Customize layouts (e.g., title slides, section headers, charts).
9. **Visual Enhancements**
   - Generate AI graphics, diagrams, or infographics.
   - Suggest icon sets, GIS symbols, or color palettes.
   - Recommend image sources (e.g., public domain satellite images).
10. **Slide Layout Optimization**
    - Help with content density: when to split slides, what to highlight.
    - Improve visual hierarchy and user attention flow.

AI in GeoAI Presentations

🧑‍💻 Technical Integration

11. **Live Demos & GIFs**
    - Provide code snippets or walkthroughs of GIS/AI workflows.
    - Convert steps into GIFs or video clips for the presentation.
12. **Model Output Summarization**
    - Interpret results from AI models (e.g., classify imagery, confusion matrices).
    - Turn tables or graphs into key messages for your audience.
13. **Data Visualization**
    - Suggest or generate charts, heat maps, or 3D scenes.
    - Translate CSV or GIS data into readable visuals for PowerPoint.

AI in GeoAI Presentations

Polishing & Final Touches

14. **Proofreading & Editing**
    - Check for grammar, clarity, tone consistency.
    - Adjust slide text for better flow and impact.
15. **Time Estimation**
    - Estimate how long your talk will take based on word count per slide.
    - Recommend trimming or expanding content to meet time goals.
16. **Accessibility Checks**
    - Ensure readability (color contrast, font size).
    - Recommend alt-text for images and consistent formatting.

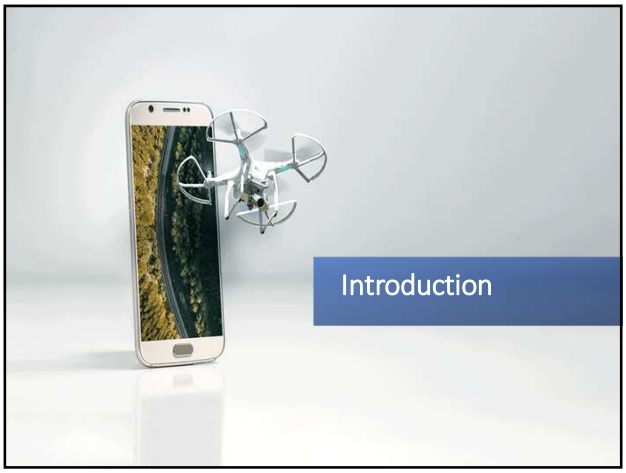
"GeoAI is not just about mapping the world—it's now about understanding it at scale, and in context."

—Song Gao, Geospatial AI researcher and co-author of the *Handbook of Geospatial Artificial Intelligence*

Leveraging Drone Inspection Data for Debris Removal and Erosion Analysis

Presentation Courtesy of the Tioga County, PA GIS Department

Enhancing Disaster Response



Introduction

Introduction

Introduction

- In the wake of **Tropical Storm Debby (August 9, 2024)** Tioga County faced tight deadlines and limited resources while assessing the storm's impact along the Cowanesque River.
- To support ***relief funding applications for debris removal and erosion mitigation efforts***, the county utilized a sequential catalog of drone (UAV) flight imagery several separate missions.
- Successfully provided critical visual documentation and basic analysis.

Introduction

- As the project progressed, concepts of Geospatial Artificial Intelligence (GeoAI) were explored to further enhance the data's utility.
  - ✓ Enabling more efficient assessment via both remote and field methods; along with critical decision-making for ongoing debris removal and erosion analysis.
- This presentation evaluates methods, challenges, and potential of integrating drone-based geospatial data and AI-driven insights for disaster recovery efforts.

Background

- **Wellsboro Stakeholder Meeting (Dec 6, 2021)**
- High-Level Discussion: **State Rep. Clint Owlett** hosted a House Policy Committee hearing at the Wellsboro, Pennsylvania Fire Department Annex.
- Local officials, conservation leaders, and landowners gathered to address severe creek and stream erosion issues.
- **Focus on Flooding & Debris:** ***The meeting highlighted how gravel bars and debris buildup in Tioga County streams were worsening flood risks.***

Background


Local Leaders, Landowners Tell Lawmakers Streamlined Permitting, Funding Necessary to Protect Against Flooding

Owlett, Causer co-host Policy Committee hearing in Wellsboro

WELLSBORO – Government officials, conservation leaders and area landowners must work together to properly maintain creeks and streams to prevent devastating floods like the ones seen in the region this summer, members of the House Majority Policy Committee heard Monday.

The hearing was co-hosted by Rep. Clint Owlett (R-Tioga/Bradford/Potter) and Policy Committee Chairman Martin Causer (R-Cameron/McKean/Potter) at the Wellsboro Fire Department Annex. It was preceded by a tour to several problem areas, including Knox Road, Grubb Road Bridge, Seeley Street in Knoxville, and RJ Wood Family Farm.

"The extreme flooding we've seen in some of our communities presents a major threat to the lives and livelihoods of our citizens – and in so many cases it's preventable," Owlett said. "We need to be able to properly maintain our creeks and streams, and I'm grateful to members of the Policy Committee for coming to our area to learn more about the problem and work toward potential solutions."

Background

- **Wellsboro Stakeholder Meeting (Dec 6, 2021)**
- Testimony underscored the need for proactive stream maintenance to prevent disasters – clogged streams and erosion were contributing to dangerous floods.
- Lawmakers heard calls for streamlined permits and funding to clear obstructions.
  - ✓ ***Tioga County Commissioner Erick Coolidge urged enabling boroughs/townships to act before the next storm strikes.***

Background

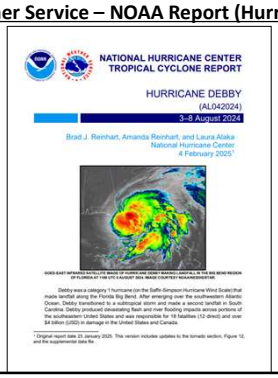
Consensus among municipal officials, state agencies, and landowners was that current regulations made it hard to clear debris like gravel bars from rivers, which worsened flooding.

- ✓ Participants stressed a proactive approach.
- ✓ Stream maintenance and debris removal ahead of storms, rather than reacting afterward.

Meeting set the stage for policy proposals to better manage waterways and reduce erosion damage in places like Tioga County.

The Storm

Nation Weather Service – NOAA Report (Hurricane Center)


NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

HURRICANE DEBBY
(AL042024)
3–8 August 2024

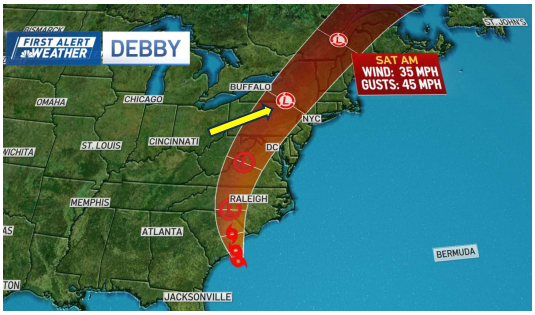
Brad J. Reinhart, Amanda Reinhart, and Laura Alaka
National Hurricane Center
4 February 2025*

Debby was a category 1 hurricane (on the Saffir-Simpson Hurricane Wind Scale) that made landfall along the Florida Big Bend. After emerging over the southwestern Atlantic Ocean, Debby transitioned to a subtropical storm and made a second landfall in South Carolina. Debby produced devastating flash and river flooding impacts across portions of the southeastern United States and was responsible for 18 fatalities (12 direct) and over $4 billion (USD) in damage in the United States and Canada.

* Original report date 23 January 2025. This version includes updates to the tornado section, Figure 12, and the supplemental data file.

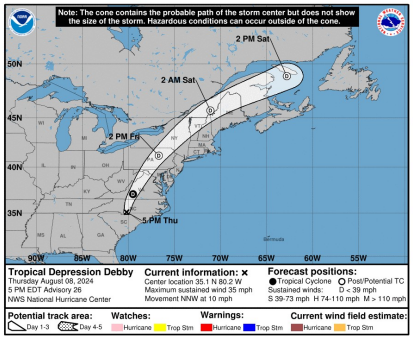
The Storm

- **Nation Weather Service – NOAA Report**

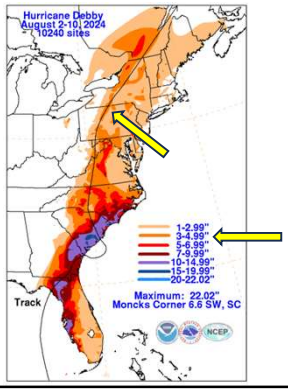


The Storm

- **Nation Weather Service – NOAA Report**



The Storm



The Storm

- **Tropical Storm Debby Strikes (August 9, 2024)**
- Record Rainfall: Much of the north-central Pennsylvania region saw 1 to 4 or more inches of rain in under 24 hours.
- Parts of nearby Potter County recorded over 4 inches, triggering flash floods.
- Emergency Response: In Tioga and Potter counties, 911 centers were inundated with calls.
- First responders performed many water rescues.

The Storm

- **<u>Tropical Storm Debby Strikes (August 9, 2024)</u>**
- Cowanesque Valley Flooding:
- The Cowanesque River at Westfield (Tioga County) shattered its record crest – rising to just over 13.5 feet (previous record 11.1 ft from 1996).
- Water quickly overwhelmed roads, swept away cars, and even knocked houses off foundations.
- **One fatality from the flash-flooding.**

The Storm

Westfield, Pennsylvania under water during the flood. The local gas station and streets were submerged, and a fire truck had to navigate what looked like a river.

The Storm

Westfield, Pennsylvania under water during the flood.

FEMA-DR-4815-PA

- **<u>Federal Aid</u>:** On Sept. 11, 2024, a **Presidential Major Disaster Declaration (FEMA-DR-4815-PA)** was approved for Tropical Storm Debby.
- Tioga, Potter, Lycoming, and Union counties were designated for federal disaster assistance.
- **<u>Individual Assistance</u>:** FEMA's Individual Assistance allowed homeowners and renters in Tioga & neighboring counties could apply for aid to cover uninsured losses, repairs, temporary housing, etc.

FEMA-DR-4815-PA

- **<u>Timeline – Summarizing Federal & State Aid:</u>**
- Governor Josh Shapiro issued a Proclamation of Disaster Emergency for 21 counties on August 9, 2024, later amending it to include 28 counties as further assessments revealed extensive damages.
- By late 2024, FEMA had approved over $12 million in relief for victims in the four hardest-hit counties.
- Disaster Recovery Coordination Centers were set up in the affected region to assist victims file and track claims.

FEMA-DR-4815-PA

- **Federal Aid:**
- **Mitigation Assistance:** The declaration activated the Hazard Mitigation Grant Program (HMGP), a post-disaster funding mechanism under Section 404 of the Stafford Act.
- HMGP is designed to support long-term, cost-effective mitigation efforts aimed at reducing the impact of future natural disasters.
- Individual Assistance made available to residents in the declared counties – HMGP is available statewide.

FEMA-DR-4815-PA

Mitigation Assistance

Eligible Mitigation Projects Relevant to our Topic:

- Streambank Stabilization.
- Installation of riprap, gabions, and vegetative buffers to prevent erosion.
- Stormwater Infrastructure Improvements: Enlarging culverts, improving drainage capacity, or rerouting high-risk flows.

UAV Ops

- Public meeting of October 8, 2024: The Tioga County Board of Commissioners approved allocation for damage assessment and debris identification UAV/drone missions.
- Conducted by the North Central Pennsylvania Unmanned Emergency Services (Department 50), aka **Unmanned-50**.
- Subject area for this talk: aerial inspection along the Route 49/Cowanesque River corridor (and select tributaries).
- Also limited missions in the Liberty Borough area.

UAV Ops

- Background: North Central Pennsylvania Unmanned Emergency Services (Department 50), aka **Unmanned-50**.
- Founded in 2021, based in Tioga County, PAA 501(c)(3) non-profit emergency services unit.
- Entirely focused on unmanned systems (drones, ROVs) Volunteer-based, integrated into the 911 dispatch.
- Mission & Motto: “Novus Optios” – “New Options” with the mission of supporting incident commanders using drones for ISR – Bridging the tech gap for rural emergency.

UAV Imagery Missions

Drone-50.com

OUR MISSION IS TO ENHANCE THE SAFETY AND EFFECTIVENESS OF EMERGENCY RESPONSE AND PUBLIC SAFETY OPERATIONS THROUGH UNMANNED SYSTEMS AND ADVANCED TECHNOLOGY.

UAV Imagery Missions

Drone-50.com

UAV Ops

- FAA-certified drone pilots and underwater ROV operators.
- Drones equipped with thermal cameras, sensors, and mapping tools.
  - Deployable for:
    - ✓ Structure fires.
    - ✓ Wildfires.
    - ✓ Flood response.
    - ✓ Water rescues.
    - ✓ Missing persons/rope rescues.
    - ✓ Law enforcement reconnaissance.
    - ✓ Damage assessment.

UAV Ops

- **Immediate Aftermath of Storm – Unmanned-50**
- **Rapid Deployment:** Drones launched mid-storm on Aug. 9, 2024, giving incident command real-time aerial visibility while roads were flooded.
- **Search & Rescue Support:** Enabled location of stranded victims during active flood conditions – enhancing responder safety and efficiency.
- **Public Safety Integration:** Operates through 911 dispatch like any fire/rescue unit, deploying UAVs and ROVs for real-time intel.

UAV Ops

- **Immediate Aftermath of Storm – Unmanned-50**
- **8,000+ Geo-Tagged Images:** Captured high-resolution drone imagery across Tioga and Potter Counties within days, including **washed-out bridges, landslides, and debris dams**.
- **Prioritizing Hazards:** Drone maps allowed officials to **target creek blockages, unstable slopes**, and eroded banks for urgent mitigation.

UAV Ops

- **Immediate Aftermath of Storm – Unmanned-50**
- **Equipment Specs**
  - **DJI M3T UAVs** utilized for our most operations and for the flood work completed in August through October of 2024
- **Credit: Ron Warren, Chief 50**
- **North Central Pennsylvania Unmanned Emergency Services (Tioga County Department 50)**

UAV Ops

- **Immediate Aftermath of Storm – Unmanned-50**
  - **DJI M3T UAVs**

Specs

Aircraft

Weight (with propellers, without accessories) [1]	DJI Mavic 3E: 915 g DJI Mavic 3T: 920 g
Max Takeoff Weight	DJI Mavic 3E/3T: 1050 g With DJI Mavic 3 Enterprise Series Battery (EU C1 Version) and DJI Mavic 3 Enterprise Series Low-Noise Propellers, the max takeoff weight of DJI Mavic 3T and DJI Mavic 3E is 899 g.
Dimensions	Folded (without propellers): 221×96.3×90.3 mm (L×W×H) Unfolded (without propellers): 347.5×283×107.7 mm (L×W×H)
Diagonal Distance	380.1 mm
Max Ascent Speed	6 m/s (Normal Mode) 8 m/s (Sport Mode)
Max Descent Speed	6 m/s (Normal Mode) 6 m/s (Sport Mode)
Max Flight Speed (at sea level, no wind)	15 m/s (Normal Mode) Forward: 21 m/s, Side: 20 m/s, Backward: 19 m/s (Sport Mode) [2]

UAV Ops

- **Immediate Aftermath of Storm – Unmanned-50**
  - **DJI M3T UAVs**

Wide Camera

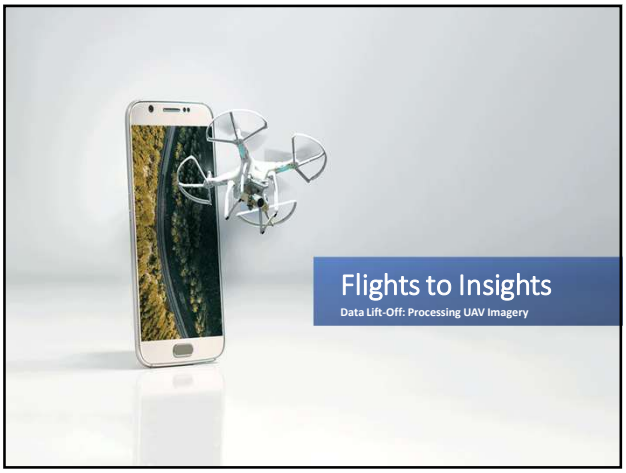
Sensor	DJI Mavic 3E: 4/3 CMOS, Effective pixels: 20 MP DJI Mavic 3T: 1/2-inch CMOS, Effective pixels: 48 MP
Lens	DJI Mavic 3E: FOV: 84° Format Equivalent: 24 mm Aperture: f/2.8-f/11 Focus: 1 m to ∞ DJI Mavic 3T: FOV: 84° Format Equivalent: 24 mm Aperture: f/2.8 Focus: 1 m to ∞
ISO Range	DJI Mavic 3E: 100-6400 DJI Mavic 3T: 100-25600
Shutter Speed	DJI Mavic 3E: Electronic Shutter: 8-1/8000 s Mechanical Shutter: 8-1/2000 s DJI Mavic 3T: Electronic Shutter: 8-1/8000 s
Max Image Size	DJI Mavic 3E: 5280×3956 DJI Mavic 3T: 8000×6000

UAV Ops

- **Immediate Aftermath of Storm – Unmanned-50**
  - **DJI M3T UAVs**

Tele Camera

Sensor	1/2-inch CMOS, Effective pixels: 12 MP
Lens	FOV: 15° Format Equivalent: 162 mm Aperture: f/4.4 Focus: 3 m to ∞
ISO Range	DJI Mavic 3E: 100-6400 DJI Mavic 3T: 100-25600
Shutter Speed	Electronic Shutter: 8-1/8000 s
Max Image Size	4000×3000
Photo Format	JPEG
Video Format	MP4 (MPEG-4 AVC/H.264)
Still Photography Modes	DJI Mavic 3E: Single: 12 MP Timed: 12 MP JPEG: 0.7/1/2/3/5/7/10/15/20/30/60 s Smart Low-light Shooting: 12 MP DJI Mavic 3T: Single: 12 MP Timed: 12 MP JPEG: 2/3/5/7/10/15/20/30/60 s Smart Low-light Shooting: 12 MP



Flights to Insights

UAV Imagery Integration for Post-Flood Assessment:
Tioga County – Cowanesque River & Route 49 Corridor

Fall of 2024 UAV Mission
- 4,316 total UAV images collected
- **2,576** images selected for viewing and analysis

Objective: Rapid assessment of debris and erosion post-flood

🗣 ***"We had to act fast to get something usable in front of key stakeholders—this was about speed, clarity, and actionable data."***

Flights to Insights

GIS Processing Workflow Summary

- Create the entirety of the Flight Path with ESRI's ArcGIS Pro Geoprocessing tools.
- Plotted x/y as vector points to form UAV flight line.
- Images attached to points using built-in attachment tools.

🗣 ***"ESRI Desktop came through for us here, ArcGIS Pro provided a straightforward processing workflow with satisfactory results."***

Flights to Insights

Extracting Value from Metadata

- **Situational Overview Imagery**: broad overview shots or to assess the overall scene. Large areas shown with moderate detail.
- Each image contained x/y coordinate metadata.
- Coordinates represent drone location (camera angle origin). Enabled accurate spatial plotting of images.

🗣 ***"Rather than reinvent the wheel, we let the image metadata guide us—every image already knew where it came from."***

Flights to Insights

Publishing and Sharing Results as Web Services

- Hosted the vector/image layer as a web service on ArcGIS Online.
- Integrated with Tioga County's modular GIS web layers.
- Enabled easy stakeholder access.

🗣 ***"This wasn't just a one-off—it became part of our broader web GIS ecosystem."***

Flights to Insights

Choosing the Right Web Application

- Tested: Web App Builder, Experience Builder, & Others.
- Time of the essence. Final Choice: **Attachment Viewer.**
- Sequential display of UAV images along flight path.
- Very focused user experience.

🗣 ***"In a sea of powerful tools, this one turned out to be the best, especially considering user feedback."***

Flights to Insights

The Final Result of this Phase

- Erosion, debris, and damage visualized.
- Clean, interactive image viewer for stakeholders
- Clear depiction of short-term and long-term impacts on the riverway
- **Shared with:**
  - ✓ County Personnel.
  - ✓ DES Staff in particular.
  - ✓ PEMA Decision Makers.

🗣 ***"The imagery spoke volumes. What might've taken pages of explanation became instantly clear with a single click."***

Flights to Insights

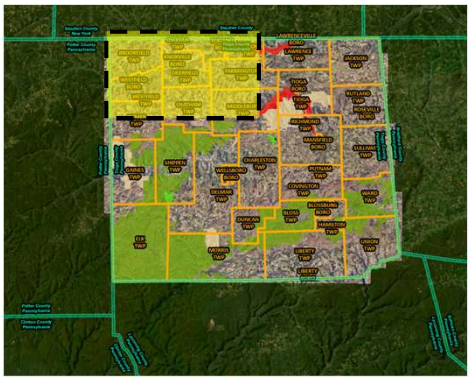
Praise from Representative Owlett's Office.

Acknowledgment for Key stakeholders.

🗣 ***"The imagery spoke volumes. What might've taken pages of explanation were instantly clear with a single click."***

Flights to Insights

Flight Area



Flights to Insights

Flight Area

Flights to Insights

Flight Area

Flights to Insights

Flight Area

Flights to Insights

Pre-built GIS web services, always a major asset!

Flights to Insights

Broad area sweeps – maximizing situational overviews!

Flights to Insights

Broad area sweeps – maximizing situational overviews!

Flights to Insights

The river behind the gas station, badly flooded area.

Flights to Insights

Parcel/ownership labels integrated with UAV/Ortho images.

Flights to Insights

The river behind the gas station, badly flooded area.

Flights to Insights

The river behind the gas station, badly flooded area.

Flights to Insights

In-house damage assessment points Included.

Flights to Insights

Aerial photo catalogs – historic to present (2015 Catalog).

Flights to Insights

Comparison

2015

2024

Field Inspections

- **Tioga County Commissioners asked the Mitigation Advisory Committee (MAC) – sanctioned by the County's All-Hazard Mitigation Plan to form a Task Force.**
- **Come up with a system to identify sites along the river for funding and mitigation through channel stabilization.**
- **Draft a legislative master document so that legislators, funding decision makers, local officials, and concerned citizens could track project locations and mitigation progress.**

Field Inspections

Tioga County Mitigation Advisory Committee

MAC

Scott Zubek, GISP / MGIS
(Chairperson)

99 William Farrell Drive
Wellsboro, PA 16901

Phone: (570) 723-8253
Email: szubek@tiogacountypa.us

MAC Meeting Agenda: (Monday) June 30, 2025 – Starting @ 11:00am
Special Session – Stream Bank Stabilization (5-7 Year Plan)
Meeting #2

1 Agenda – Action Items Review

- Develop a comprehensive 5-year stream maintenance plan aimed at mitigating flood risks, improving streambank stability, and enhancing long-term watershed resilience.
- Emphasis was placed on prioritizing high-risk and high-impact areas along the Cowanesque River (not a creek), Troops Creek, and Potter Brook—areas significantly affected by past flood events and erosion.
- Begin assessments at the Harrison Township boundary along the Potter–Tioga County line and move eastward, systematically evaluating and prioritizing intervention sites along each waterway.

High-order Goals
- Identifying immediate and long-term maintenance needs
- Mapping and documenting stream conditions
- Coordinating debris removal and stabilization efforts
- Establishing a phased project timeline with achievable milestones
- Pursuing sustainable funding sources and leveraging interagency support

- **Representative Owlett:**
  - The need for a long-term, phased roadmap with specific projects and timeframes.
  - A public-facing product that shows the community tangible progress and intent.
  - ***Strategic funding pursuit, drawing on models from PennDOT and Fish & Boat Commission along with practical aids such as mapping tools and imagery products.***
  - Coordinating local leadership with state-level advocacy for permits and resources.
- ***Rep. Owlett had previously suggested using PennDOT's project planning model as a framework, providing a visual map and timeline of planned projects to the public and stakeholders. (Scott Zubek)***

Field Inspections

- **Previous attempts at collecting necessary data for funding applications were problematic.**
- **Sites needed to be tied to specific location with approximate classifications and calculations of area and volume – *mismatches*.**

There is also another large gravel deposit approximately 50' upstream of the existing culvert that carries SR 349 over Wattles Run. The sediment has the potential to be further washed downstream and into the structure, causing the hydraulic opening of the structure to become smaller; therefore, decreasing the volume of water that the structure could pass without overtopping and increasing the chances of flooding. There is also a gravel deposit located and a small accumulation of tree debris downstream of the structure. The purpose of the project is to remove approximately 2750 cubic yards of sediment and 80 cubic yards of woody material from the site as well as provide approximately 60 cubic yards of rock protection for the upstream stream bank that has become unstable. Access for the upstream removal would be from the private drive that is near the unstable streambank and the downstream access would be through an existing field access adjacent to the sediment build up. The total anticipated area of disturbance for this site is 41,600 SF (0.96 acres).

Field Inspections

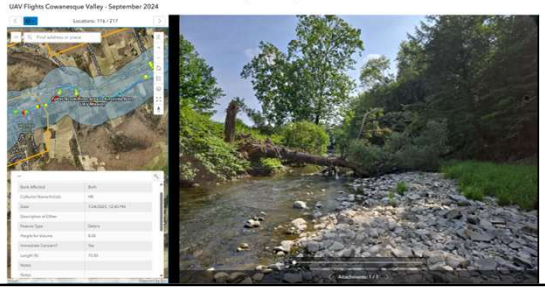
- **3 teams performed two-days of field work with mapping/inspection grade GPS equipment hardware, paired with antennas and the ArcGIS Online platform.**

Field Inspections

- **Simple, cost-effective, and accurate system using equipment and platforms that we already were using.**

Field Inspections

- **Integrated field-captured points (about 3 meters steady accuracy) with PICTURES along with basic info entered into survey (ESRI's Survey 123).**



Field Inspections

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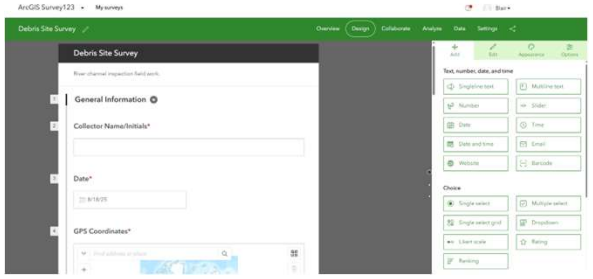
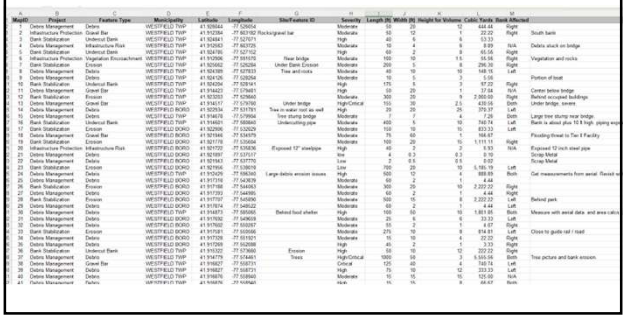


Field Inspections

- **Drone shots and field-work all in one web based app.**

Field Inspections

- **Process the field-work points data, create tabular data for funding applications. 217 locations processed.**



Field Inspections

- **<u>Recommendations for setting up successful field work.</u>**
  - ✓ **Inspection grade does not require expensive or complex setups. Galaxy/Apple phones and tablets should be utilized.**
  - ✓ **Precision not necessary, but accuracy is important. Pair gadgets GPS/Bluetooth antennas.**
  - ✓ **Think about an appropriate field/survey design.**
  - ✓ **Create a field map or ESRI ArcGIS Online dashboard so the team can track progress.**

Field Inspections

- **<u>Recommendations for setting up successful field work.</u>**
  - ✓ **Create at least one field, in the field design, for general comments (but not too many).**
  - ✓ **Deciding on your field app for data collection.**
    - ❖ **Survey 123 more friendly for general users. Limitations with photo attachments (workaround: create several photo fields).**
    - ❖ **ArcGIS Field Maps not as user friendly, better for image attachment capture.**

Field Inspections

- **Recommendations for setting up successful field work.**

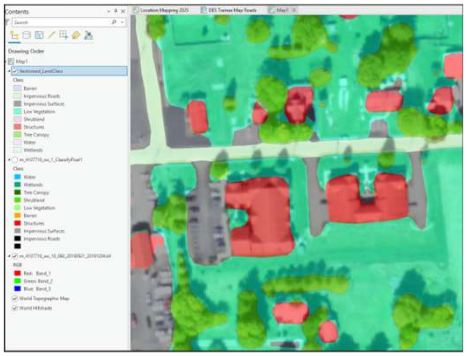
  ✓ **IMPORTANT: Download points from ArcGIS Online into a file-geodatabase for desktop mapping and other derivative uses – *this preserves the links to the images by way of a relationship class.***

  ❖ **A significant component of the project is lost when images are not directly attached 1:1 with the points.**

  ❖ **File-geodatabase can be shared with the images included and lines to the points preserved.**

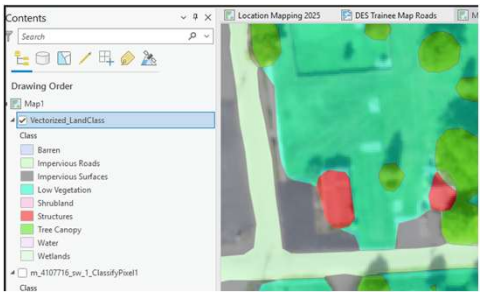
GeoAI Solutions

ESRI Deep Learning Packages – imagery processing



GeoAI Solutions

ESRI Deep Learning Packages – imagery processing



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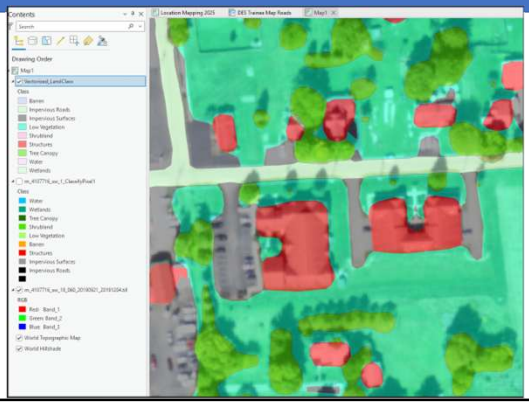

GeoAI Solutions

GeoAI: Geospatial Artificial Intelligence.

What is it?

GeoAI: The integration of geospatial data science with artificial intelligence (AI), especially machine learning (ML) and deep learning (DL), to solve spatial problems.

Remote Sensing: Imagery and sensors:
AI/ML: Automated learning from data, creating new models.

Handbook of Artificial Intelligence (2024) by Gao, Hu, and Li.

GeoAI Solutions

GeoAI: Geospatial Artificial Intelligence.

So, how can we use GeoAI to enhance our results? Ideas?

1. Pictures only geotagged, so how can I still get detailed geospatial information about the images?
2. Consistently identify and classify pixels in the vast catalog of images.
3. Quantify the data in the image. Percentage of pixels are water, trees, debris, etc.

GeoAI Solutions

GeoAI: Geospatial Artificial Intelligence.

So, how can we use GeoAI to enhance our results? Ideas?

1. Geo-reference UAV images with reasonable accuracy (or find a way to use geotagged images).
2. ***Use a custom-trained model to identify different types of erosion and debris from vast amounts of consistently collected imagery.***
3. Getting a volume calculation for certain features shown on the image (3D Solution).

GeoAI Solutions

GeoAI: Geospatial Artificial Intelligence.

GeoAI workflows and tools to consider:

1. **Scene-Level Classification & Tagging**
2. ***Object Detection / Semantic Segmentation***
3. **Probabilistic Geo-registration Using AI**
4. ***3D Reconstruction & AI-Based Feature Recognition***

GeoAI Solutions

GeoAI: Geospatial Artificial Intelligence.

So, how can we use GeoAI to enhance our results? Ideas?

5. ***Change Detection Over Time***
6. **GeoAI-Enhanced Index Calculation**
7. **Embedding into GIS Workflows with AI-Driven Insights**
8. **Federated or Edge-Based AI**

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GeoAI workflows
Object Detection / Semantic Segmentation

Objective: Identify and extract specific features (e.g., roads, buildings, vegetation, flooding) from within each UAV image using AI.

Expanded Description:
This workflow involves training AI models to locate and classify individual objects or land cover types within each UAV image.

GeoAI Solutions

GeoAI Workflows
Object Detection / Semantic Segmentation

- Training can be done using manually ***labeled*** UAV images or transfer learning from existing datasets.
  - ✓ Output formats include shapefiles (vectors) or classified rasters that can be imported directly into a GIS environment, such as ArcGIS Pro and then published as a shared service, etc.

GeoAI Solutions

GeoAI Workflows
Object Detection / Semantic Segmentation

- Tools like ArcGIS Pro's **"Train Deep Learning Model"** and **"Detect Objects Using Deep Learning"** can help create an end-to-end workflow.
- Ideal method for creating up-to-date maps of damaged infrastructure, invasive species, flood extents, or post-disaster debris.

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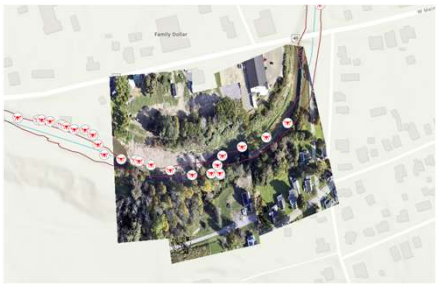
GeoAI Workflows

1. Get imagery in a format that can be used.



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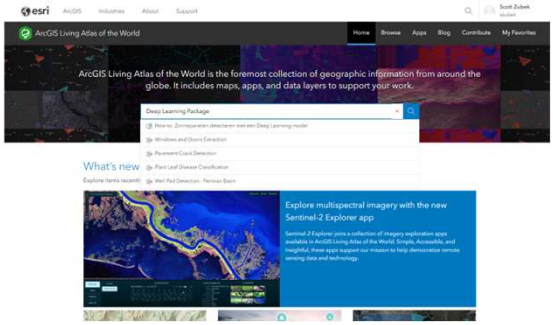
GeoAI Workflows

2. Study ESRI Living Atlas Deep Learning Packages (DLPKs)



GeoAI Solutions

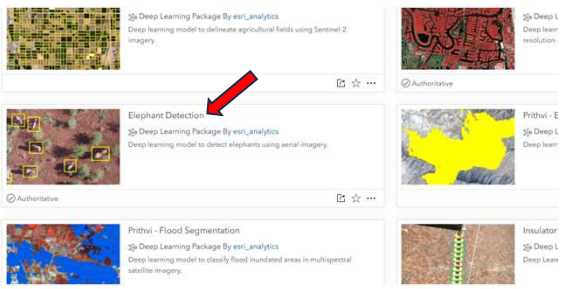
GeoAI Workflows

2. Study ESRI Living Atlas Deep Learning Packages (DLPKs)
Explore available pretrained models to understand what's already been developed (e.g., building footprints, tree canopy, land cover). Review the model types, label schemas, and input requirements.

GeoAI Solutions

GeoAI Workflows

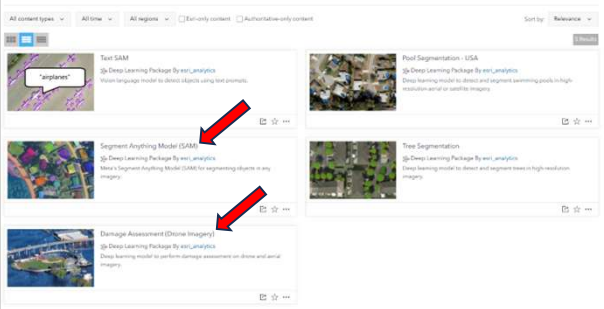
Want to find elephants in the Safari? There's a DLPK for that…



GeoAI Solutions

GeoAI Workflows

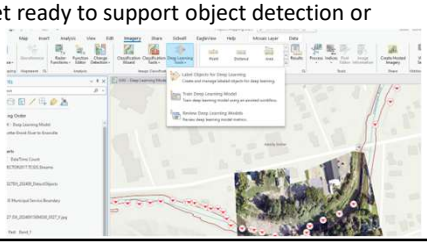
Damage Assessment and SAM DLPK.



GeoAI Solutions

GeoAI Workflows

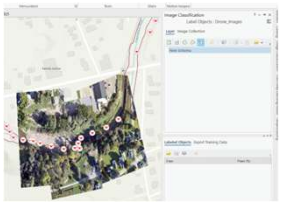
3. **Use ESRI's Deep Learning Tools to Prepare Your Data**
   Set up your imagery environment in ArcGIS Pro or ArcGIS Enterprise. Ensure you have georeferenced imagery or a mosaic dataset ready to support object detection or classification.



GeoAI Solutions

GeoAI Workflows

4. **Label Objects in Your Imagery for Model Training**
   Use the Label Objects for Deep Learning or Training Samples Manager tool to digitize features of interest (e.g., buildings, debris, water). This forms the foundation of your custom training dataset.



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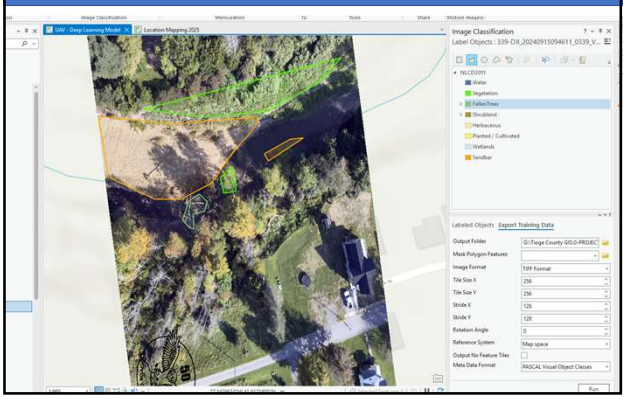

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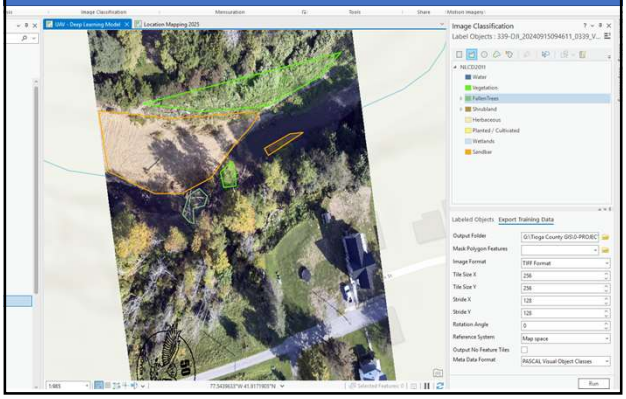

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GeoAI Workflows

5. **Fine-Tune an Existing DLPK (e.g. SAM Segmentation).**
   Based on your labeled training data, either:
   - ✓ Train a brand-new model from scratch using the **Train Deep Learning Model** tool.
   - ✓ Fine-tune an existing DLPK model to adapt it to your specific imagery style or content.

   🔑 *This is where studying existing DLPKs helps you align formats, classes, and expectations.*

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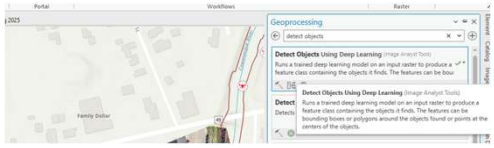
GeoAI Workflows

Use Geoprocessing Tools to Apply the Model at Scale
Apply the model to your imagery using tools like:
- ✓ **Detect Objects Using Deep Learning**
- ✓ **Classify Pixels Using Deep Learning.** *This enables you to run inference on large volumes of UAV, satellite, or aerial imagery for automated feature extraction.*



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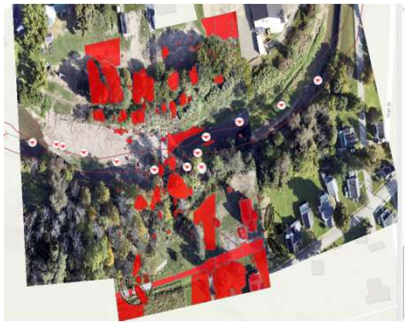
GeoAI Workflows

First execution with the trained model didn't pick up nearly enough, hard to classify…



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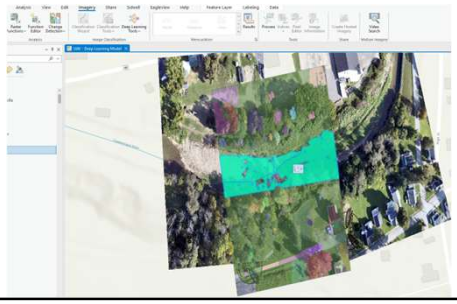
GeoAI Workflows

Continuing to train the SAM and other models, establishing a workflow and quantifiable results. (Recent Updates)



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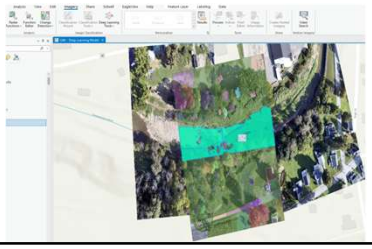
GeoAI Workflows **(Recent Updates)**

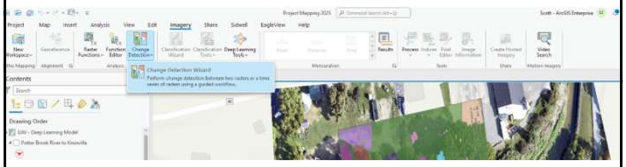
- (See Updates Section) Use this workflow with the NEW 2025 spring (leaf-off) orthorectified imagery.
- Use UAV imagery for DLPK **fine-tuning.**



GeoAI Solutions

GeoAI Workflows: Updated data and workflows.

- Utilize new 2025 orthorectified imagery in the processes.
- Change detection: Updated data and workflows.



GeoAI Solutions

PA Emergency Management Agency (PEMA)
Letter of Intent (LOI)

SUBJECT: Hazard Mitigation Assistance (HMA) Letter of Intent
TO: State Hazard Mitigation Officer (SHMO)
Pennsylvania Emergency Management Agency
1310 Elmerton Avenue
Harrisburg, PA 17110

Dear SHMO:

The purpose of this notice is to inform you of our interest in participating in the Hazard Mitigation Assistance programs(s): Hazard Mitigation Grant Program (HMGP);

Signature | Title

DATE:
APPLICANT COMMUNITY:
COUNTY:

PROJECT CONTACT

NAME:
TITLE:
AGENCY:
ADDRESS:
TEL:
PHONE:
E-Mail:

TYPE OF ORGANIZATION

Municipal Government ☐ Private ☐ Nonprofit ☐
County Government ☐ State ☐ Agency ☐

LOCATION OF PROJECT:

BRIEF DESCRIPTION OF PROJECT:

BRIEF DESCRIPTION OF PROBLEM TO BE SOLVED:

TOTAL ESTIMATED COST:

SOURCE OF FUNDING FOR NON-FEDERAL SHARE:

Email completed form to: ra-nhazmitoff@pa.gov.
FAX to PEMA at 717-651-2150 or mail to:

PA Emergency Management Agency
State Hazard Mitigation Officer
1310 Elmerton Avenue
Harrisburg, Pennsylvania 17110

PRE-APPLICATION MUST BE SUBMITTED BEFORE AN APPLICATION PACKET WILL BE SENT TO YOU.

GeoAI Solutions

Field work 2025

- The above detailed attachment viewer will be relied upon heavily to pick out debris areas. These photos will still be very valuable.

GeoAI Solutions

Recent Updates as of 4/16/2025

- Knoxville Boro requested images of the WTP recently.

GeoAI Solutions

Recent Updates as of 4/16/2025

1. 2025 Images deliverable ***orthorectified***. This is ***key*** for executing the segmentation AI models, object training and detection, etc.

2. We will attempt to use the AI model workflow outlined prior for **object detection** and **change detection.**

3. ***Ultimately, we would like to utilize 3D methods for accurate area & volume calculations. Stay tuned.***

GeoAI Solutions

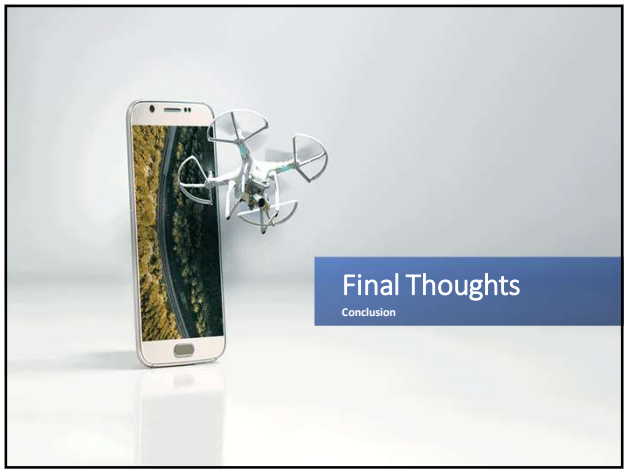
Some things to keep in mind…

1. In working with imagery data, you will almost assuredly need ESRI extensions such as Image Analyst and Spatial Analyst. *Check you license availability.*
   Use ESRI World Atlas > DLPK packages as templates > train those models.

3. Georeferenced/orthorectified data is key. ***Disaster Response Programs (DRPs) in the wake of a disaster may become more valuable than ever because of. Leveraging value…***

4. Workflow has ***quirks and bugs***… evolving technology. Work with ESRI.

5. Memory issues – consider CPU versus GPU processing options.



Questions / Answers?

Thank you for attending!

SESSION EVALUATION

HTTPS://WWW.SURVEYMONKEY.COM/R/PSLS2026EVAL