

Use of Drones and Bathymetry to Assist with Decision Making by a State Dam Safety Program

National Dam Safety Program Technical Seminar | Feb 2024



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Presentation Outline

- Overview of SC Dam Safety Program
- Current Practice
- A Better Way
- Equipment
- Methodology & Refinement
- Grant Funding



SC Dam Safety Program

- A dam in South Carolina is regulated if it meets at least one of the following:
 - Measures 25 feet or more in height
 - Impounds 50 acre-feet or more of water
 - Failure of dam results in loss of human life, regardless of size



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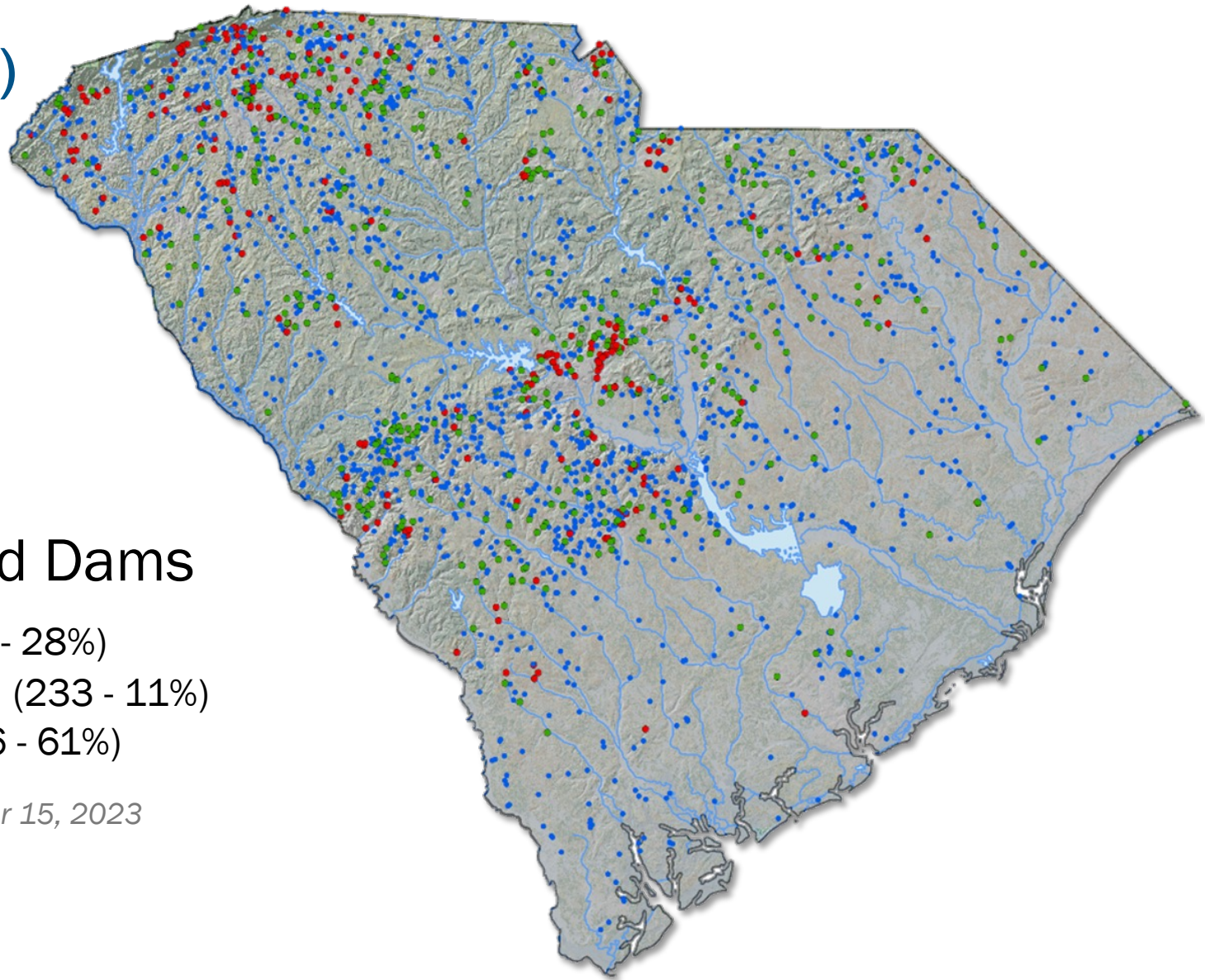


SC Dam Safety Program (2)

2,193 State Regulated Dams

- Class 1 – High Hazard (614 - 28%)
- Class 2 – Significant Hazard (233 - 11%)
- Class 3 – Low Hazard (1346 - 61%)

**as of September 15, 2023*



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SC Dam Safety Program (3)

- In 1978, the General Assembly established a regulatory framework for dam safety in the state. A large percentage (~77%) of our existing inventory of dams were already constructed by this time.
 - Thus, virtually no construction drawings or pre-dam topography available
 - Struggled with obtaining reliable estimates of impoundment volume

Current Practice

- Each dam's volume has been calculated by multiplying surface area by depth and the factor of 0.4
 - We suspect this age-old method was standard but is often challenged by dam owners
- Elevation data collected with leveling rod and optical level



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A Better Way

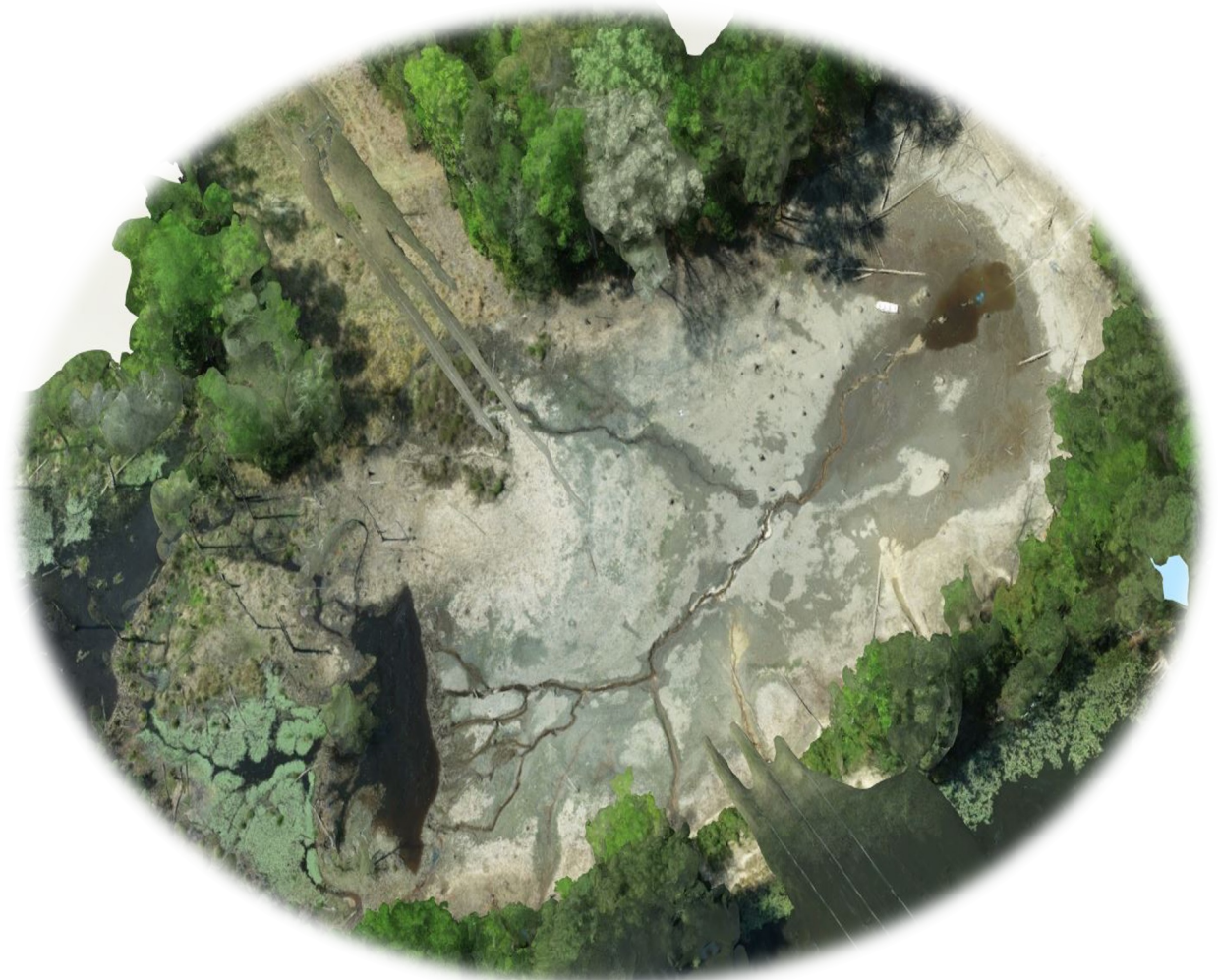
- Came to a decision to turn to new technologies to provide a more exact and defensible method
- New technologies include:
 - 3D photogrammetry by Unmanned Aerial Vehicle (UAV) or drone
 - Depth sonar
 - Bathymetry is the techniques of mapping the bottoms of ponds, lakes, rivers, and the ocean.
 - Hydrone
 - Carlson GPS unit
- Focus on dams that are on edge of regulation or that may have some concerns



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Drone

- DJI Phantom 4
 - Flown several dams while drained
 - Dams that have issues or in the process of being decommissioned
 - Captures how they have changed over time
- Drone2Map and ArcGIS Pro



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Canoe

- Started in 2019 with a large battery and trolling motor with the help of a licensed surveyor
 - Safety concerns and inefficient



Drone Boat

- The Seafloor Systems HyDrone
 - Is a one-person portable catamaran platform
 - Safer compared to canoe
 - Easier to use
- Recently added Seafloor Systems AutoNav system
 - Completely autonomous
- Two Venom 15C 4S LiPo Drone Batteries



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Other Equipment

- Carlson GPS unit
 - BRx6+ GNSS Receiver
 - Carlson RT3 Tablet
 - Two SurvPC licenses
 - Unable to transfer one license between tablet and AutoNav computer on drone boat
 - SC Real Time Network Subscription



- Seafloor HydroLite
 - Single frequency Echosounder Kit



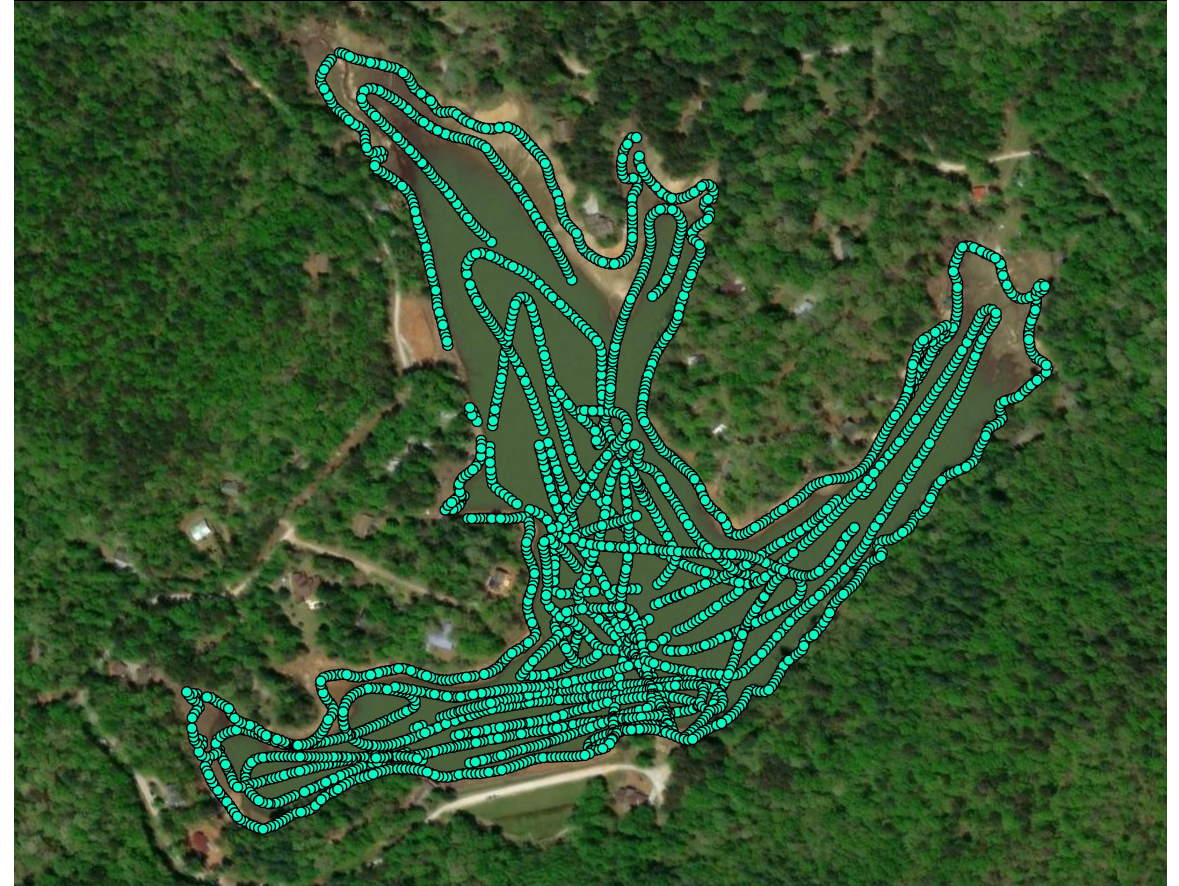
- Plum Case
 - High speed connectivity while on the move
 - Helps with areas within South Carolina with little to no coverage
 - Saves time and keeps GPS continuously connected for corrections





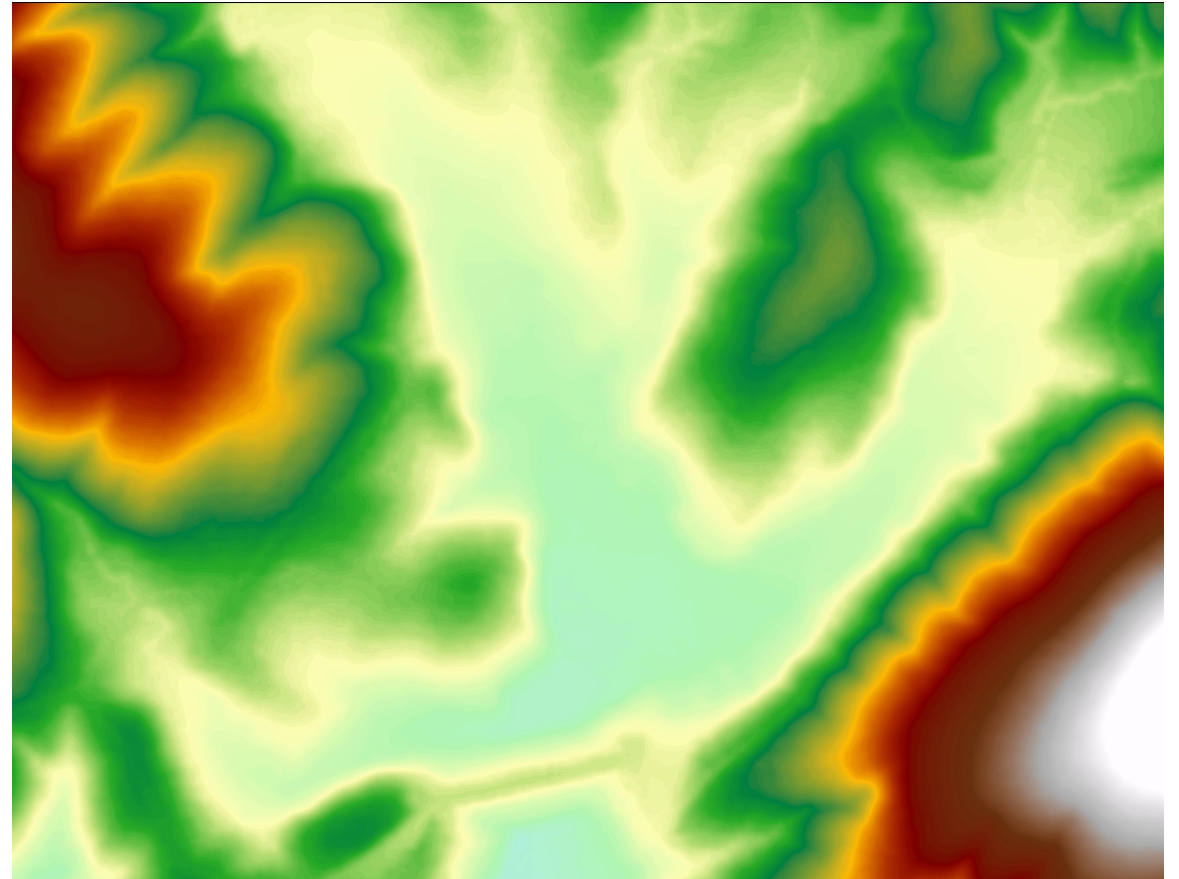
Methodology

- Sonar depth point data
 - Shoreline cruise followed by a N-S or E-W pattern within lake
 - Auto by interval
 - Takes a point every 10 feet
 - Use GIS to combine LiDAR and bathymetry points to create DEM
 - Storage Capacity Tool in ArcMap
- Drone flight photogrammetry
 - Process drone imagery
 - Incorporate control points and check points
 - Create DEM from drone photos in Drone2Map



Methodology (2)

- Sonar depth point data, drone flight photogrammetry, and LiDAR
 - Allows us to create a 3-D model of a dam, reservoir, and surroundings
 - Examples: Jackson Pond and Lake Trotwood
- Enter new volumes into DSS-WISE Lite for a more accurate model of how the dam would fail
- Differences between the two methods
 - So far, this has reduced the overall storage that we originally estimated
 - Previously regulated dams have been exempted because of this new capability





Refinement

- Several different ways to process this data
 - Still learning and each survey presents its own difficulties
- QA/QC protocols
 - Depth sonar does occasionally measure negative values
 - Delete these and any other outliers by using depth quality
 - May cause some holes in data
 - Check points within DEM



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Grant Funding

- Bathymetry drone was not inexpensive
 - Total cost so far = \$37,520
 - Carlson BRx6+ (purchased in 2019): \$9,595
 - Carlson RT3 Tablet (purchased in 2019): \$3,200
 - SurvPCv6 license included
 - Carlson SurvPCv7 (purchased in 2023): \$1,575
 - Seafloor HydroLite (purchased in 2019): \$6,400
 - Seafloor Hydrone (purchased in 2021): \$7,300
 - Drone batteries (purchased in 2021): \$
 - Seafloor Systems AutoNav (purchased in 2023): \$9,450

Prices do not include shipping and taxes
 - Future purchase of a new drone
- Increase in FEMA State Assistance Grant Funding makes the expansion of this capability a real and exciting possibility

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