



U.S. ARMY



DIGITAL GRAIN-SIZE IMAGERY ANALYSIS AND CITIZEN SCIENCE INLET GEOMORPHOLOGY

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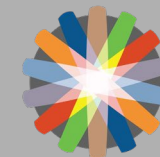
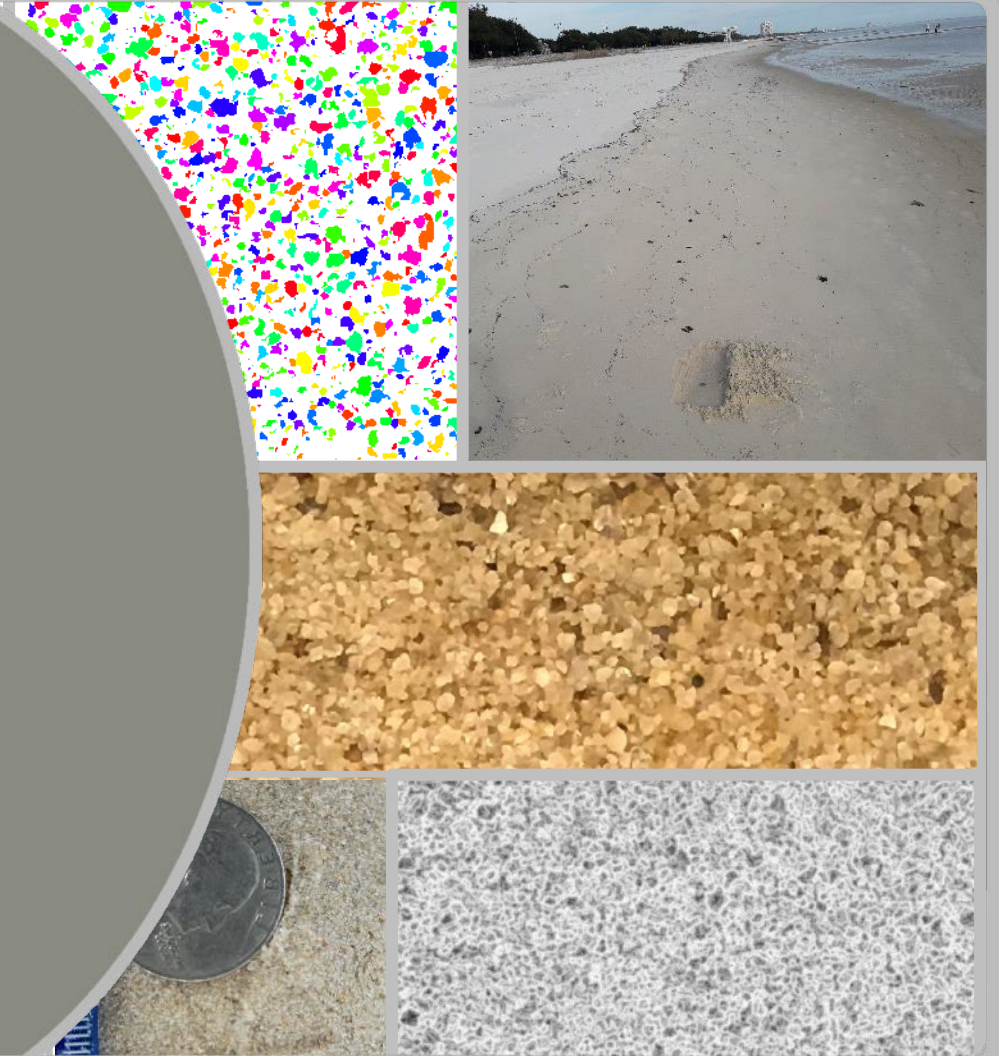


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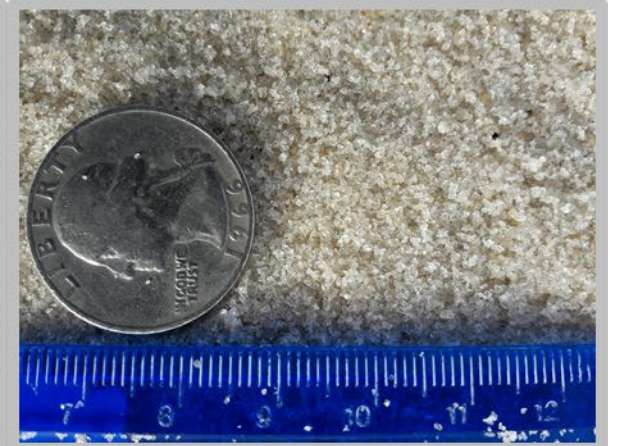
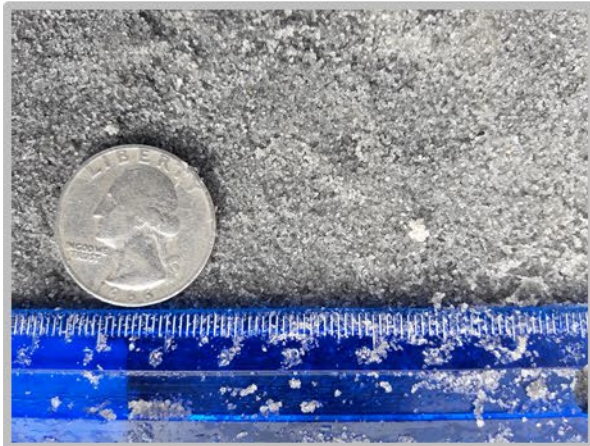
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BLUF



National citizen scientist collected grain size data could enhance regional predictive capabilities and improve public engagement. Techniques were collaboratively investigated and appear promising, but need further refinement.



Background and Inspiration



Southern Ocean



CoastSnap

December 5 at 1:28 AM · 🌐

Our CoastSnap shoreline analysis at Manly Beach indicates that there was minor erosion of up to 10m due to last week's storm. The red line shows the location of the shoreline as it was before the storm hit and the blue line shows the shoreline just two days ago (after the storm). Both shorelines are at the same tide level.

Thanks to frannyfish and Jenny Harley for the two CoastSnaps!
#CoastSnapManly



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es



observations with iNaturalist.

Methodology and Methods Investigated



- **Concept Methodology:**

The screenshot displays the 'Beach Data' application interface. The main window shows a map of Shearwater Beach with a location pin. The 'Beach Data' panel includes a description field, a location map, and a 'Sand Picture' section. The 'Sand Picture' section shows a sequence of three images: a grayscale image of sand, a binary image of sand grains, and a color-coded image of sand grains. The 'Tools' panel includes options for 'Set Resolution (meters)', 'Filter Options', and 'Calculate Size Distribution'. The 'Calculate Size Distribution' panel shows a histogram and statistical data.

Beach Data

Description content for the survey

Location*

To automatically collect your location using your device's GPS tap the circle on the map.

Find address or place

Lat: 30.39221 Lon: -88.8020

Sand Picture*

Take a picture of the sand with a coin.

Press here to choose image

Tools

Set Resolution (meters): 0.1123

Filter Options: Boost, Cutoff, Order

Calculate Size Distribution: This Image, All Images

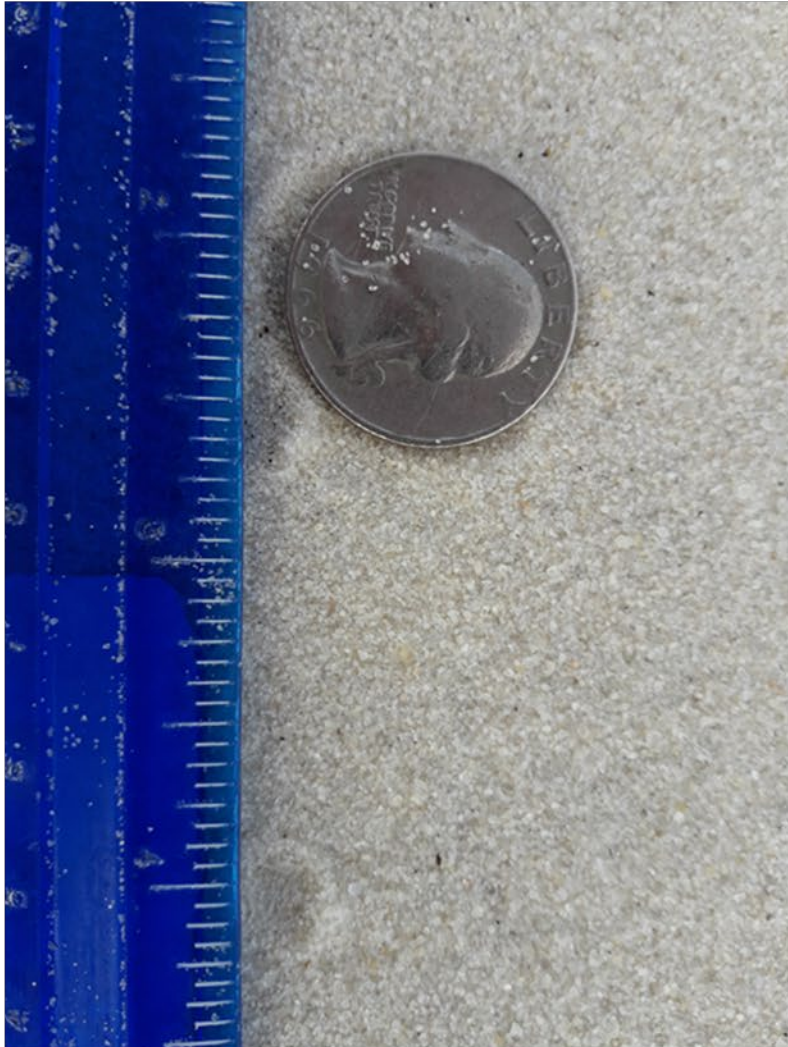
Save results: Save Data, Save Graphs

Statistical Data:

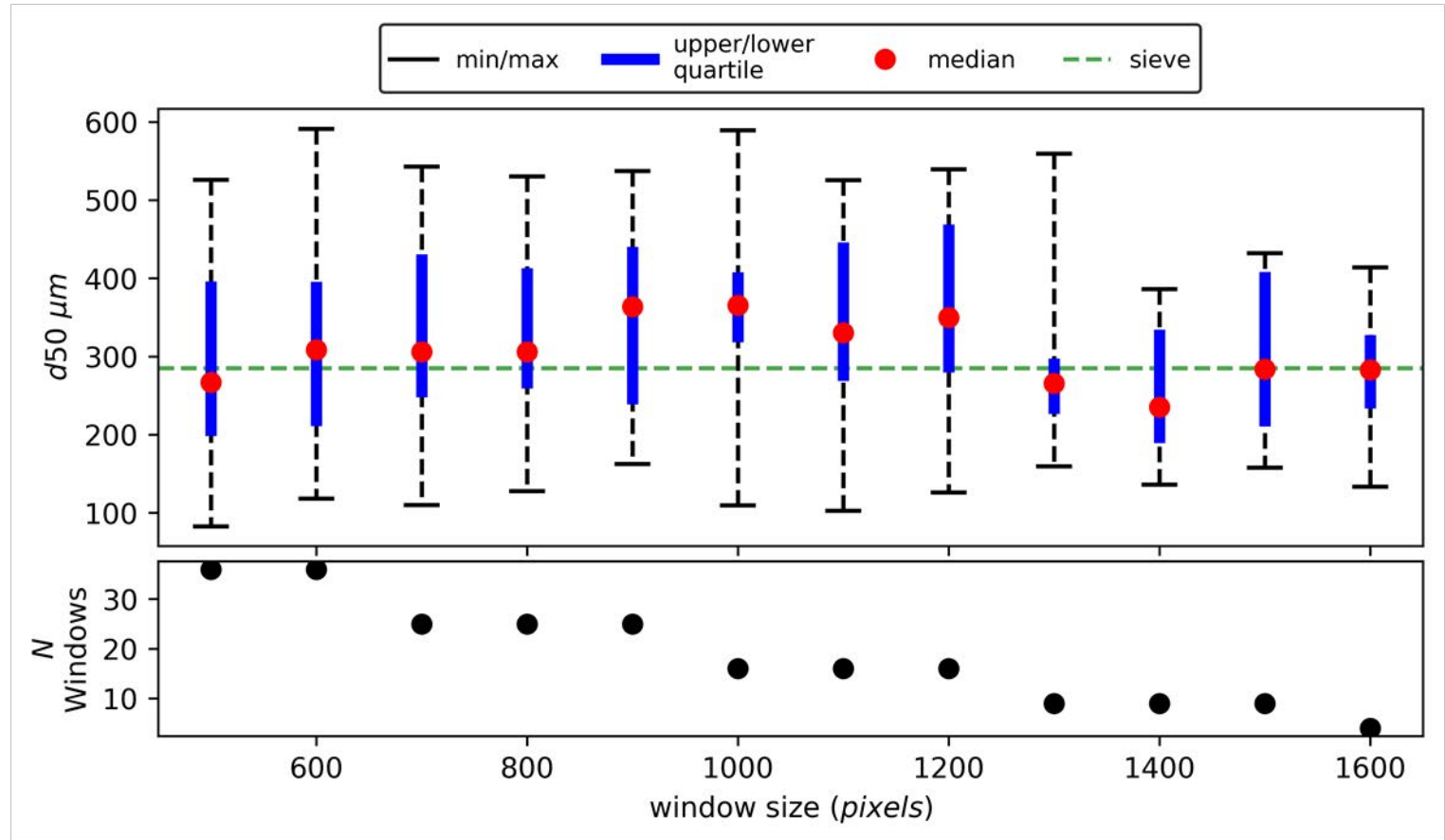
- Mean = 0.534
- Sorting = 0.208
- Skewness = 0.0192
- $D_{10} = 0.333$
- $D_{50} = 0.451$
- $D_{90} = 0.769$

Digital Grain Size Wavelet Analysis

Pixel intensity wavelet grain size estimations



- Some success determining spatial frequencies in rows of pixel intensities
- pyDGS – Buscombe (2013): <https://github.com/dbuscombe-usgs/pyDGS>
- Window size can alter results in spectral approaches, including pyDGS



Grain Size Distribution with Image Processing

Original Image

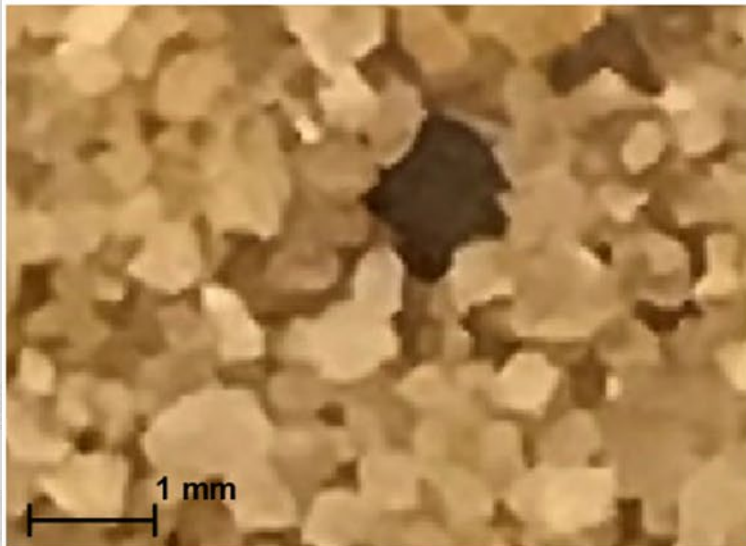


Image Analysis (IA) Results

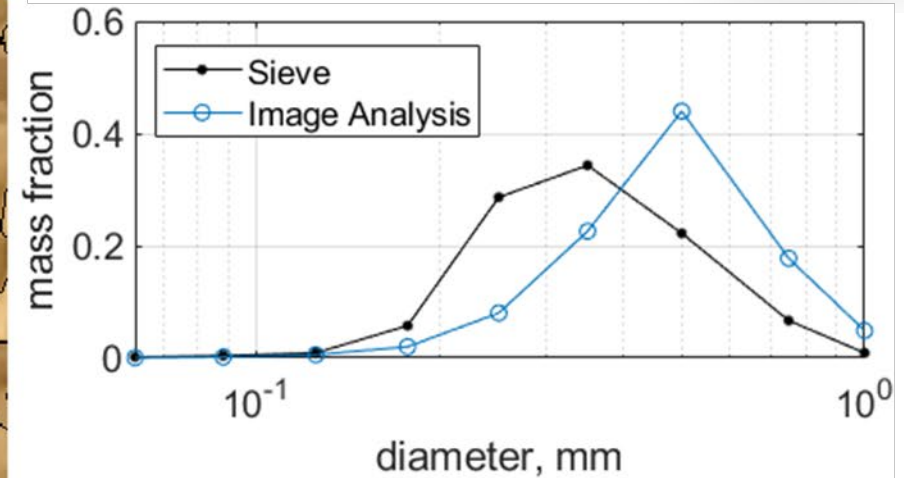
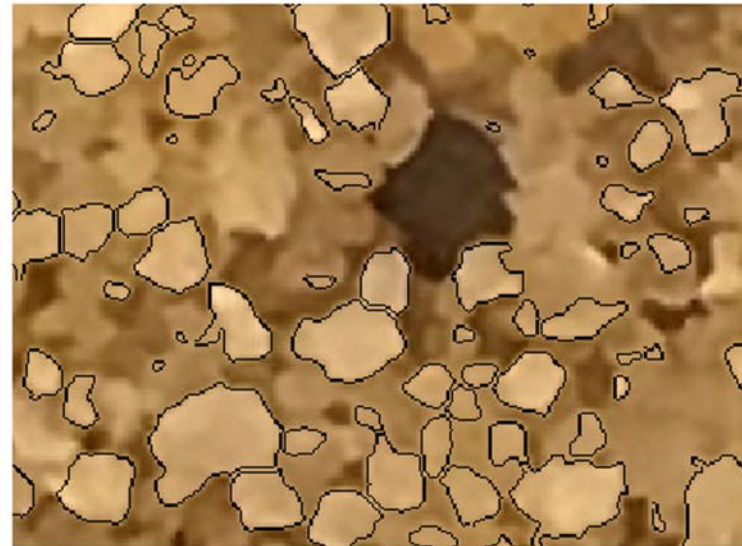


Image Analysis (IA): Matlab Image Processing toolbox

Thresholding (based on intensity/brightness) + Separate touching

- Resolve “top” layer of grains
- Resolves particle shape
- Better resolution of larger grains
- Not resolving “dark” grains
- Some grains hard to separate
- Some grains partly identified

Reasonable agreement with sieve: IA slightly coarser

(expected, e.g. Sime and Ferguson, 2003; Graham et al., 2005)

Particle Size Distribution by Mass

	Sieve	Image Analysis
D ₁₀ [mm]	0.26	0.34
D ₅₀ [mm]	0.41	0.58
D ₉₀ [mm]	0.72	0.92

***(IA D₁₀, D₅₀, D₉₀ ~ 1.4x higher)**

Future Work

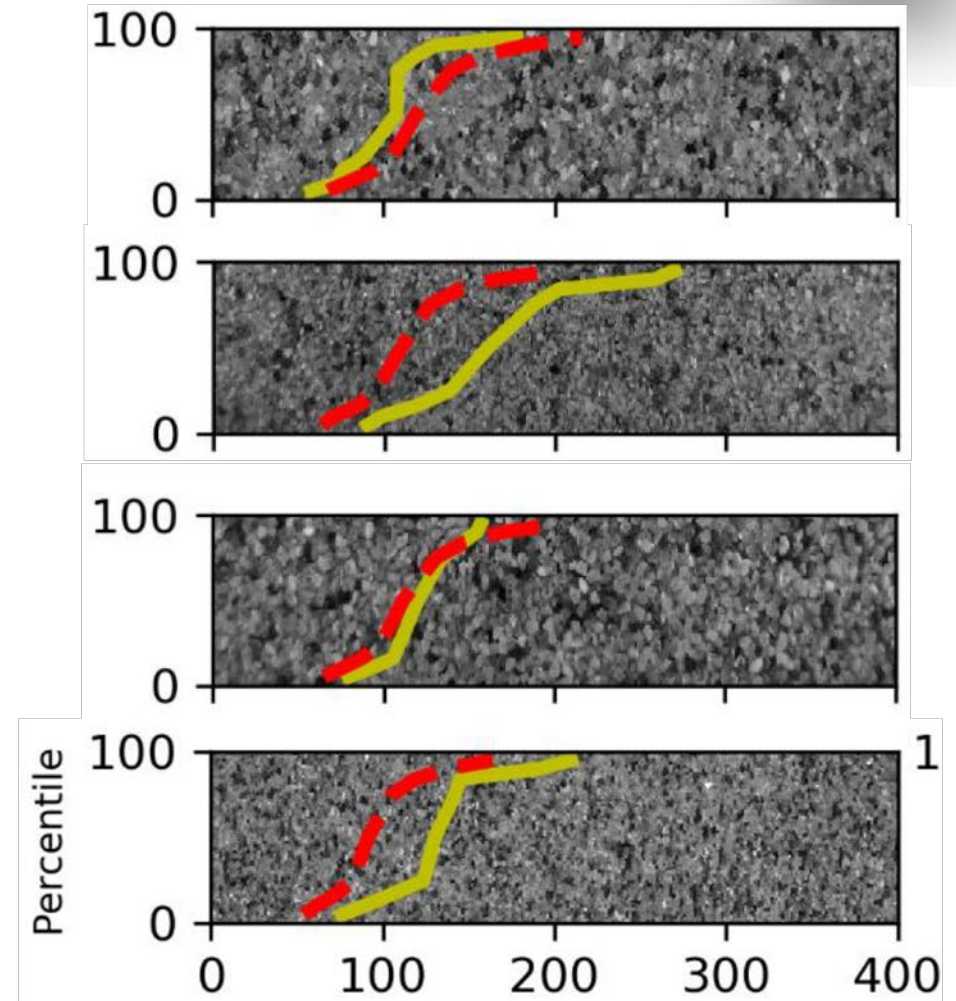


SediNet: deep learning optical granulometry

- configurable deep learning framework to estimate sedimentological variables from imagery
- “Off-the-shelf”, alternate models, or user training sets
- Potential for citizen-scientist based sediment imagery
- Model accuracy (Buscombe, 2019):
 - Full training set: 24 - 45%
 - Sieved beach sand training set: 16 - 29%
 - Without image scale: 22%
- Encourages user data submission to improve models

<https://github.com/MARDAScience/SediNet>

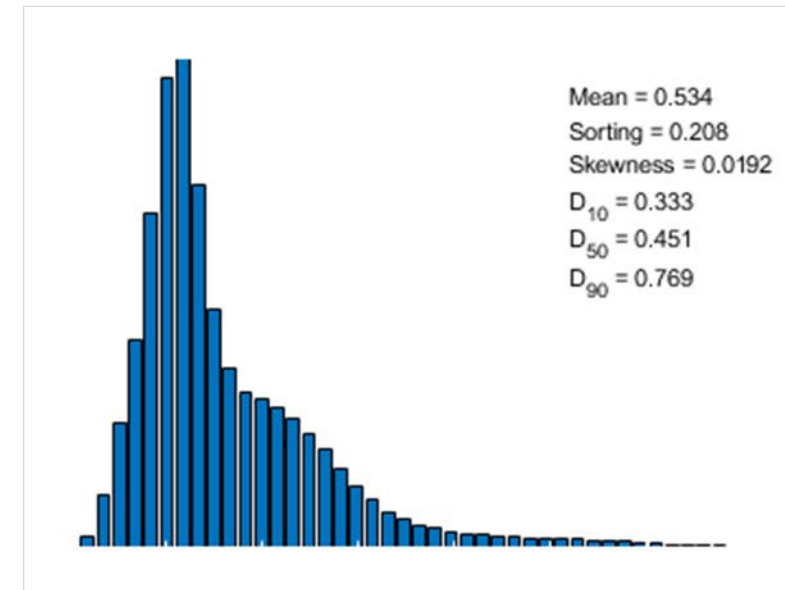
Buscombe, D. (2019, in review). SediNet: a configurable deep learning model for mixed qualitative and quantitative optical granulometry. Submitted to Earth Surface Processes and Landforms



Future Work



- **IF TECHNICALLY FEASIBLE – NEXT STEPS**
- **School and Community Engagement**
 - Phase 1: University students, Identified State Parks, Coastal Districts
 - Phase 2: Promote at conferences: ASBPA, GSA, etc. and promote with nature-centric groups: Master Naturalist Association, Audubon Society, Coastal State Parks
- **App or Website Creation**
- **Identify Storage Location and Data Access (Link with SAGA?)**
- **Identify Best Ways to Keep Citizens Engaged:**
 - Reply Email with Results from Photo
 - Online Scoreboard for Most Submissions



Summary



FY19 major advances

- Collaboration begun with Shelley Whitmeyer and Celes Woodruff at James Madison University and Daniel Buscombe at Northern Arizona University.
- Wavelet and thresholding/watershed analysis of citizen scientist imagery investigated.
 - Promising results, but refinement is likely required.

FY20 key products/advances (next steps)

- Machine learning optical granulometry
- Expansion from Technical Note summarizing FY19 findings to Technical Report summarizing FY19 and FY20 findings