SandSnap - *Amassing A Nationwide Beach Grain Size Database*

Brian McFall, David Young,
Brooke Walker, Shannon Stever
U.S. Army ERDC Coastal and Hydraulics Laboratory

Shelley Whitmeyer
James Madison University

Daniel Buscombe
MARDA Science, LLC

AAPA Harbors and Nav Committee
10 November 2022

US Army Corps of Engineers

CHL COASTAL & HYDRAULICS LABORATORY

Objective: Amass a National Beach Sand Grain Size Database

Why: - To Increase BU Opportunities
- Improve Coastal Resilience Quantification

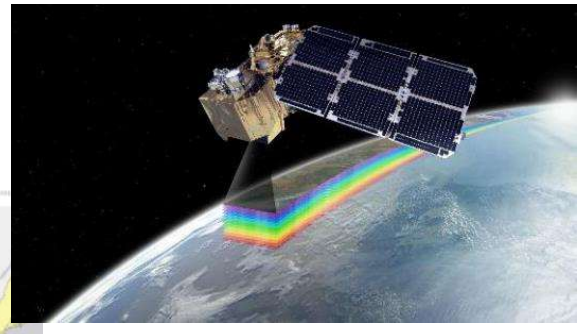
sandsnap-erdcchl.hub.arcgis.com

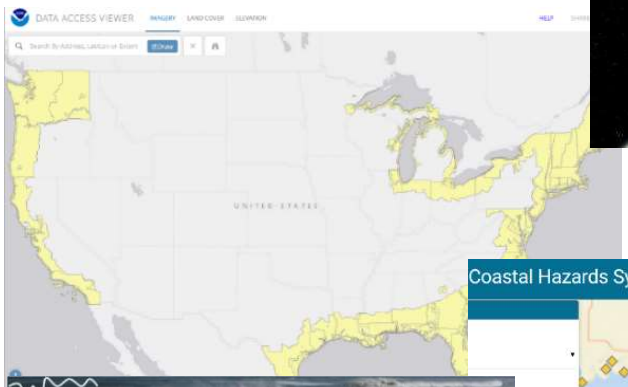
Motivation

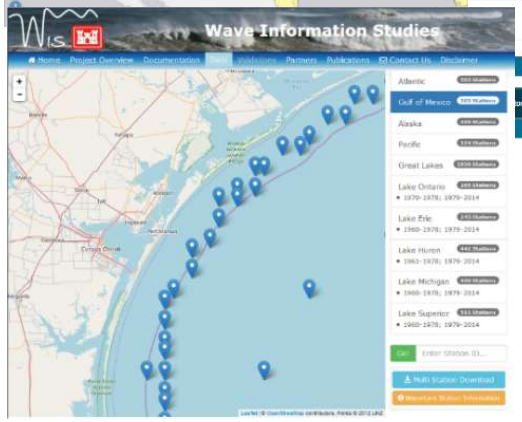
Coasts are a Data Rich Environment

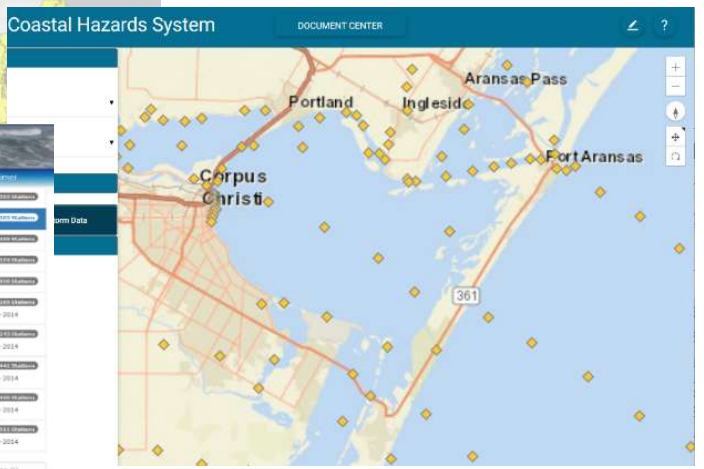
- Topo & Bathymetric
  - LiDAR
  - Photogrammetry
- Shoreline Position
  - Satellite and Aerial Imagery
- Wave Information
  - Buoys
  - WIS
  - Coastal Hazard System

But what's the beach made of?



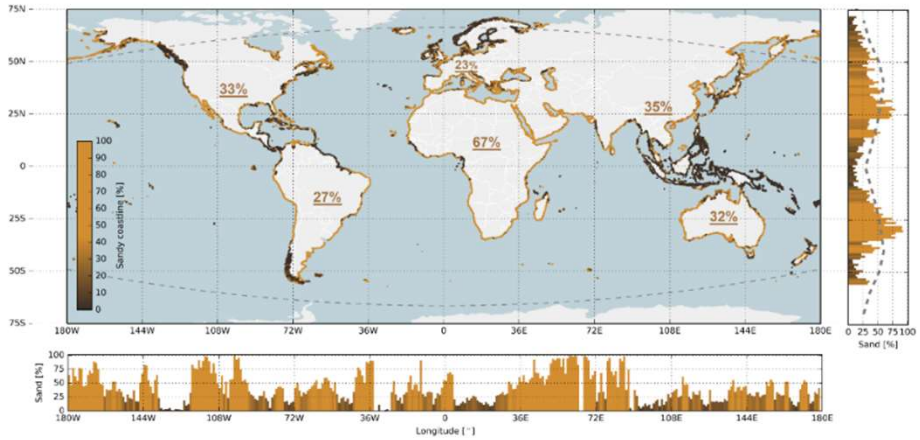




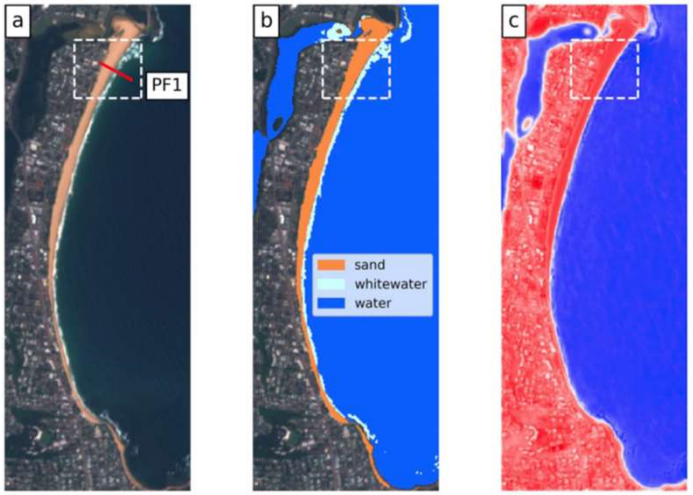


Beach Sand Grain Size Database Uses

- Large-scale Preliminary Studies
- Depth of Closure Studies
- Analysis of Spatial and Temporal Gradation Variation
  - Improved Life Cycle Analysis and Uncertainty
  - Beach Compatibility
  - Increase BU opportunities



Luijendijk et al. (2018)



Vos et al. (2019)

Sampling Methodology

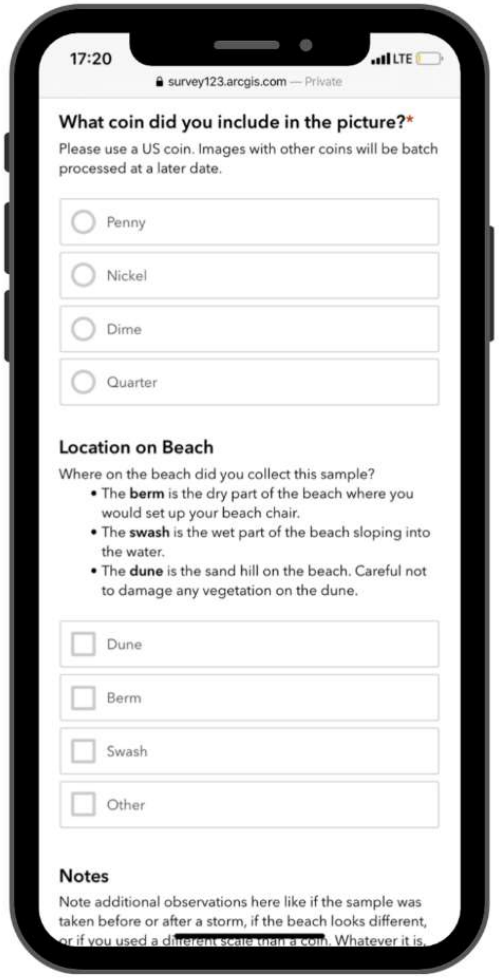
1.

2.

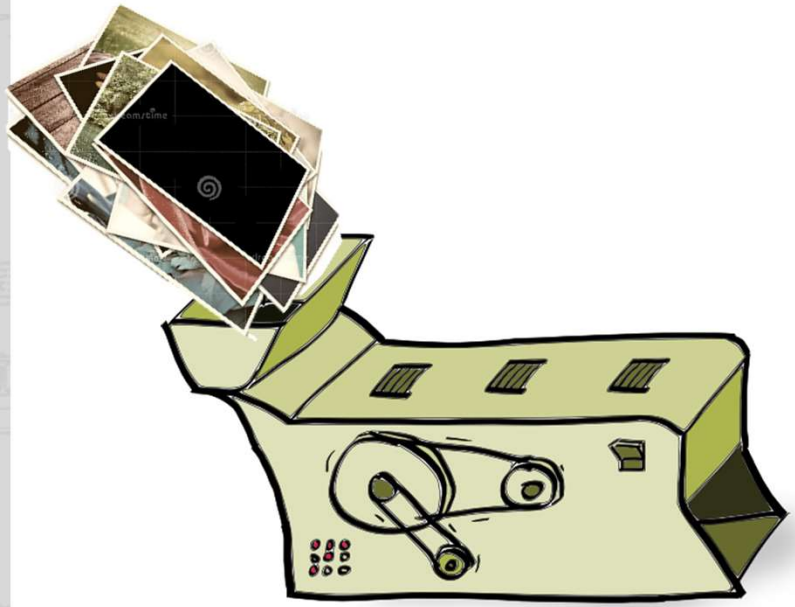
Scan Me!

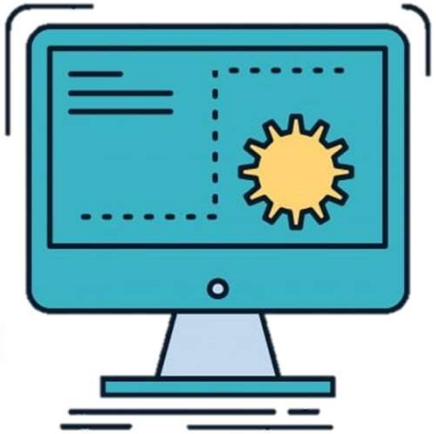
sandsnap-erdcchl.hub.arcgis.com

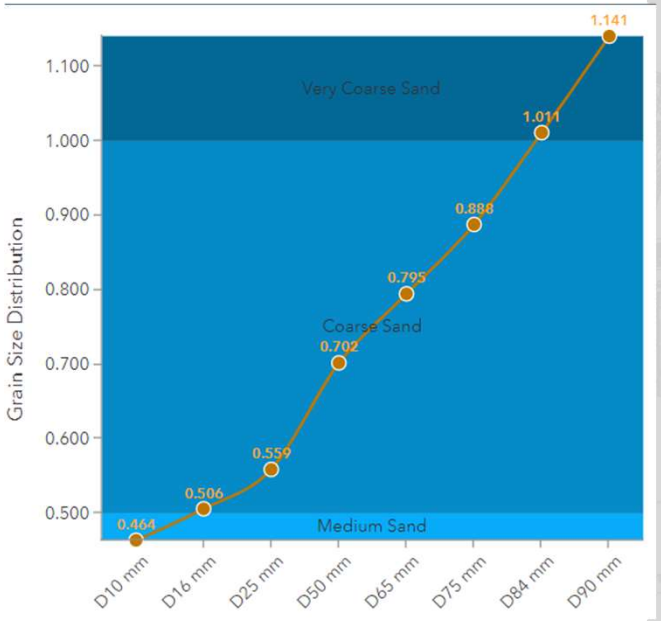
3.



You take the photo, the machines do the work



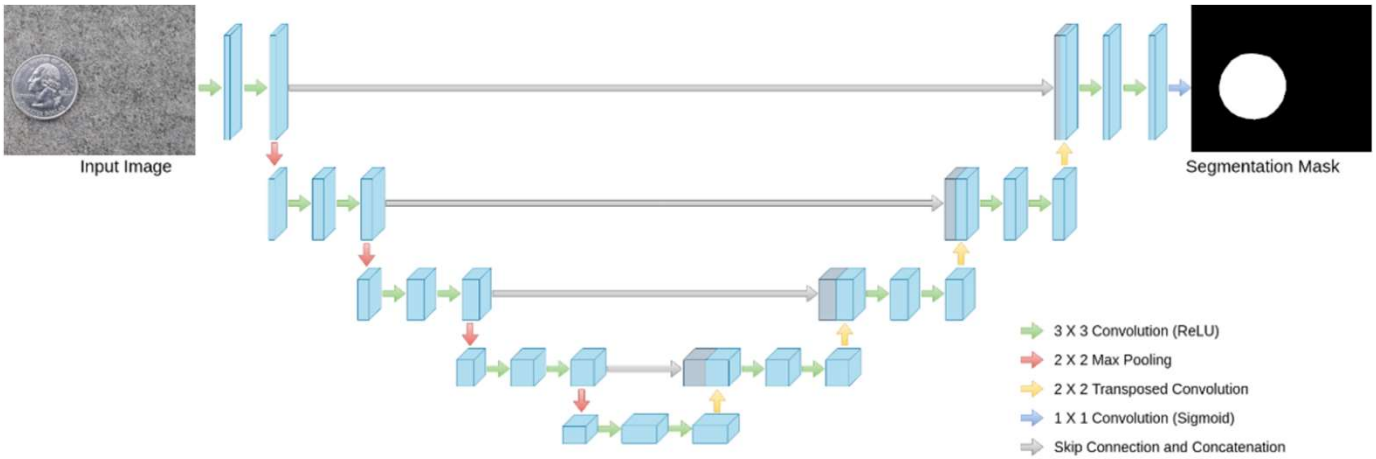


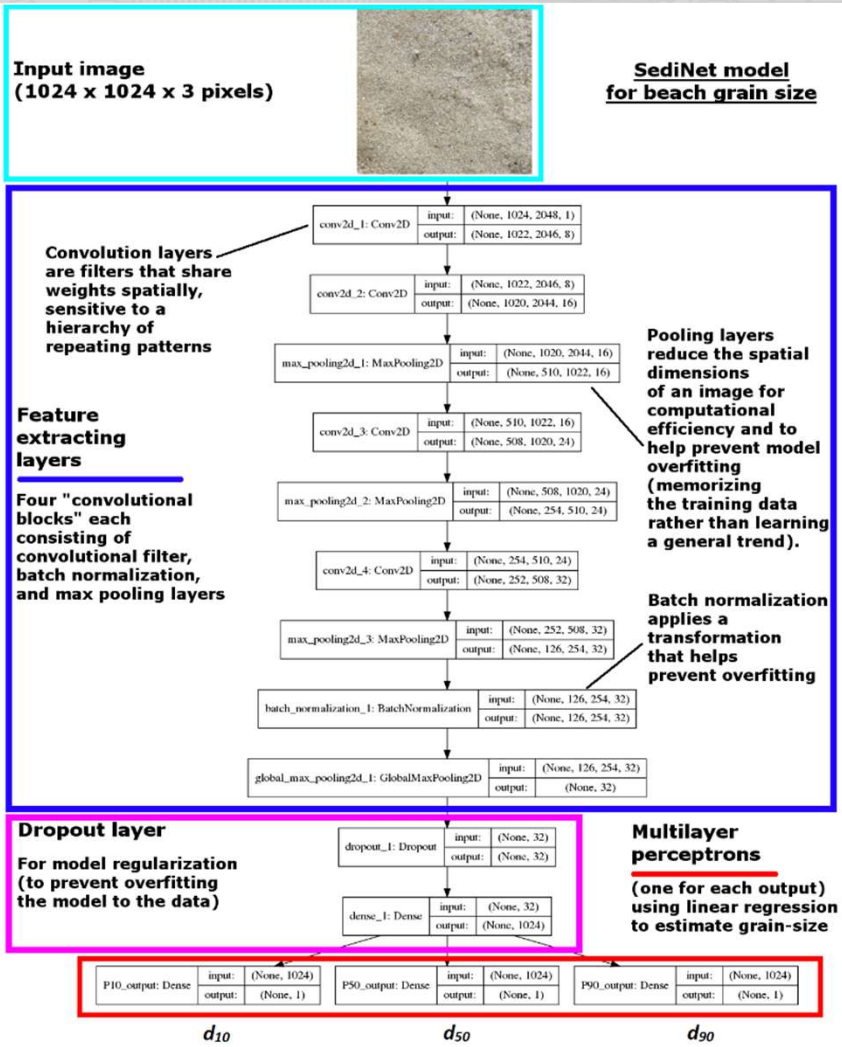


Good vs. Bad “SandSnaps”

Machine Learning: Coin Detection

- **Detect coin pixels versus sand pixels.**
  - **U-Net (Ronneberger et al. 2015).**
  - **Fully convolution neural network.**
- **Individual models tended to underestimate portions of coins.**
  - **Combination of results from 5 distinct models.**
- **RANSAC model on "coin pixels" to estimate diameter/centroid.**
- **Functions:**
  - **Where is the coin.**
  - **How large is it in pixels – for mm/px.**
  - **Divide parent images up into 1024 x 1024 pixel coinless sub-images.**





Machine Learning: SediNet

- **SediNet (Buscombe 2019):**
  - **Deep Learning Model**
  - **Convolutional Neural Network with multiple processing layers**
  - **Estimates grain size information from imagery**
  - **https://github.com/MARDAScience/SediNet**
  - **Can estimate up to 9 numeric grain size metrics**
  - **Can also calculate categorical variables (grain shape, population, color)**
  - **Uses GPU for computations with tensorflow package in Python**
- **<12% d_{50} error from *in situ* test images**
- **Can be trained on a wide range of sediments – applied more generally**

Buscombe 2019

SandSnap Database

= Data point

Collaborations

Outreach Efforts – K-12 Outreach

STEM Activities:

- "Sorting It Out" – Sieve & Sand Castle
- "That Settles It" – Settling Tube
- "Digging In Deeper" – Petri Dish & Hand Lens
- "It's a Snap" – SandSnap

Library Bag Test Locations:

- John Jermain Memorial Library in Sag Harbor, NY
- Thomas B. Norton Library in Gulf Shores, AL

Outreach Efforts – ASBPA Conference

- Booth w/Demo
- Presentation
- SandSnap training on the beach

Outreach Efforts –CSBPA “Snap the Sand”

Sept. 15-30, 2022

Summary & Call to Action

SandSnap Web Application is fully operational

CALL TO ACTION

- **Participation is needed for SUCCESS**
- **Participate by collecting imagery from your favorite beach**

Brian.C.McFall@usace.army.mil