



Overview of Wetland Remote Sensing Technologies

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San Francisco Estuary Institute (SFEI) - Wetland Mapping

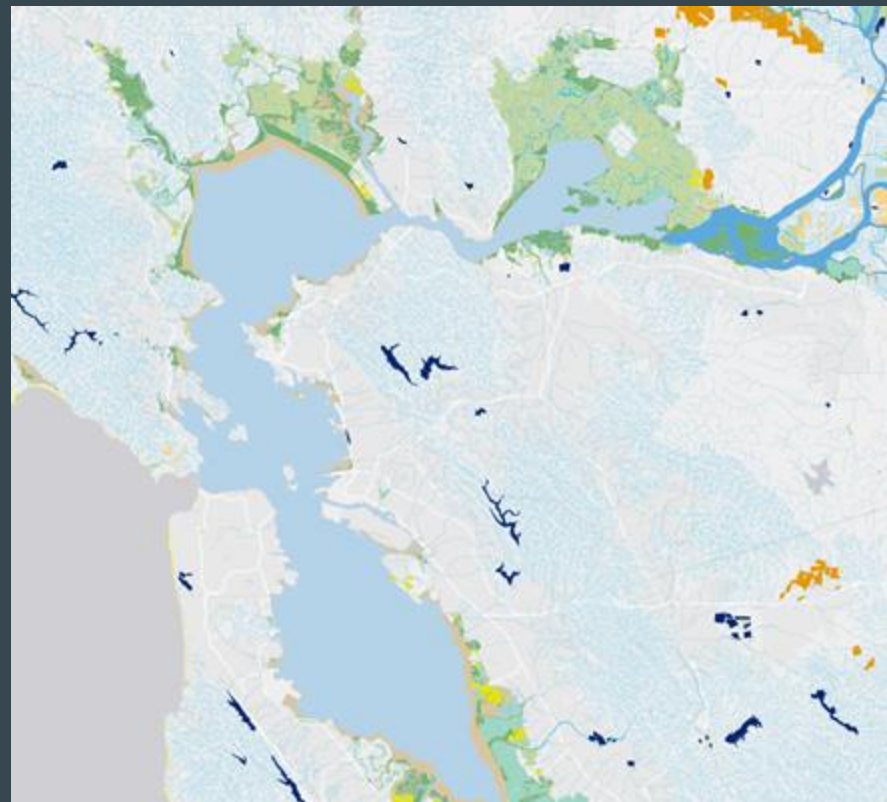
EcoAtlas (EcoAtlas.org)

- California Aquatic Resource Inventory ([CARI](#))
 - Bay Area ([BAARI](#))
 - Delta ([DARI](#))
 - Santa Rosa ([NCARI](#))
 - Tahoe ([TARI](#))

Current Projects

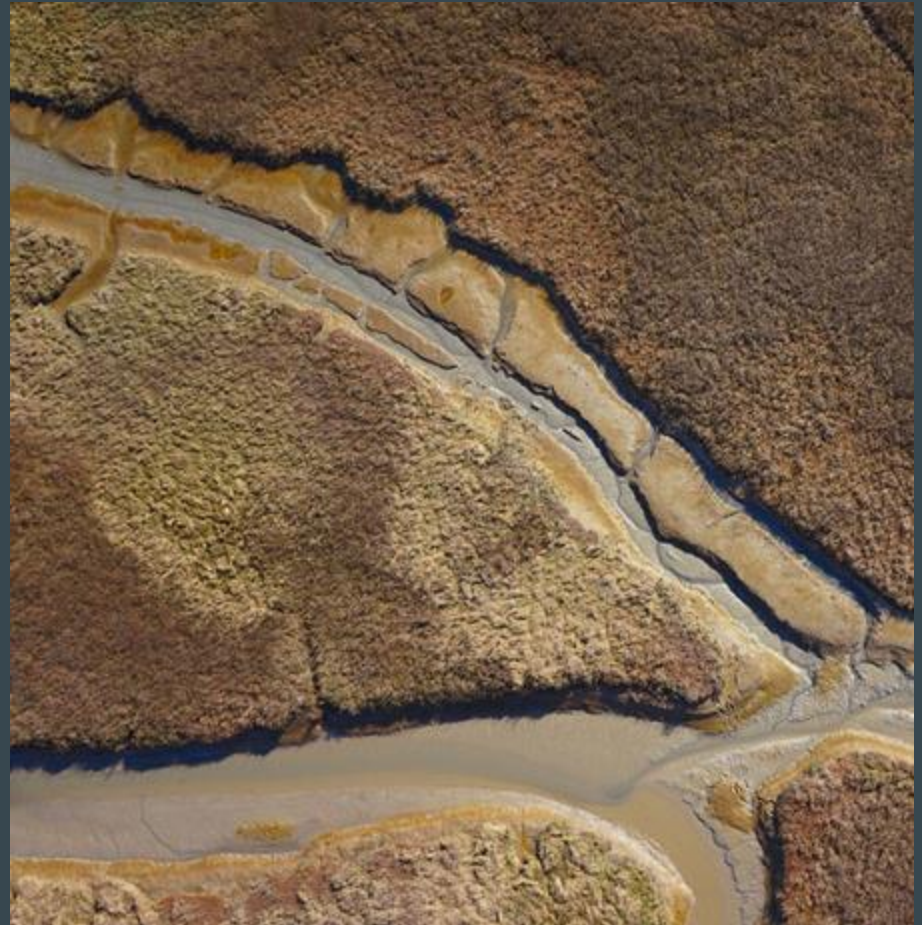
- San Diego (SDARI)
- Russian River (RRARI)
- SF Baylands Mapping Update (BAARI +)

CRAM, other project based work, UAS surveys



Outline

- Remote Sensing Platforms
- Sensor Types
- Mapping Analyses/Products
- Software
- Existing Datasets and Resources



Remote Sensing Platforms: What types of platforms are used for wetland mapping?



Remote Sensing Platforms - relevant to wetlands

Satellites

- Largest spatial coverage (global)
- Lowest spatial resolution (~300m - 3m*)
- Dependable revisits time

Planes

- Medium spatial coverage (state/ county scale)
- High spatial resolution (~1m - 15cm*)
- Some national programs have dependable revisit times

UAS/drones

- Lowest spatial coverage (20 -1000 acres, project footprints)
- Highest spatial resolution (~ 5cm - 0.6cm*)
- More control over timing of collection

*Depends on the sensor and elevation flown

When should/shouldn't you use UAS?

UAS - Unoccupied Aerial Systems

Often there is a tendency to use drones because they are new and exciting!

Considerations:

- Study area size
- Ensure the data you capture can and are needed to address your questions
- Constraints: (e.g. flight restrictions, access, and liability)
- Alternatives
 - Satellite
 - Plane based
 - Stationary cameras
 - Boots on the ground



UAS - Products and Uses

Products:

- Video
- Imagery
- DEMs (photogrammetry)
- Point Clouds
- 3D models

Uses

- Before and after (restoration, disasters etc.)
- Virtual cross sections
- Counts (paired with ML or manual)
- Communication materials
 - 360 Panos, Fly-throughs, Maps



Sensor Types:
What types of sensors are
useful for wetland mapping?



Sensor Types

Passive

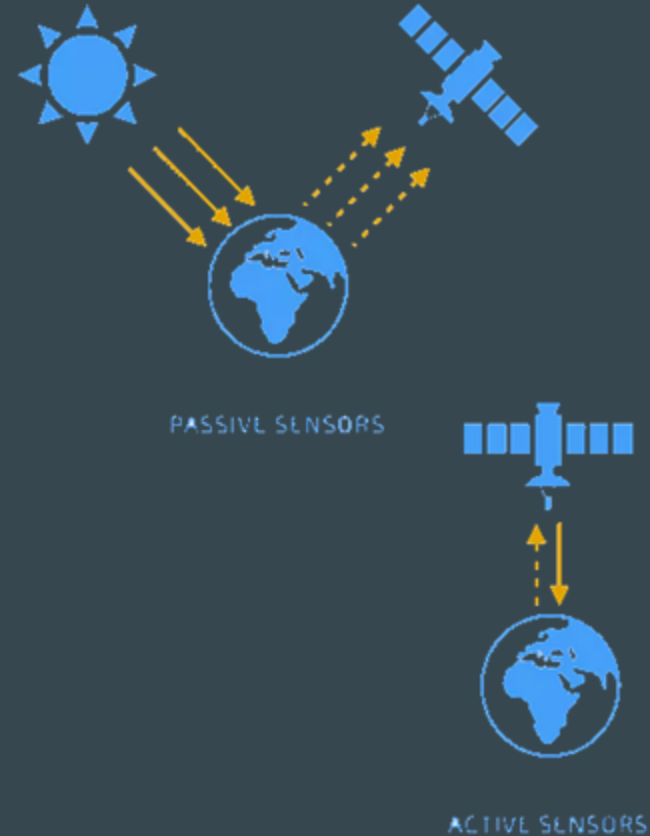
Detect natural energy (radiation - e.g. reflected sunlight)

- Optical Imagery
 - True color
 - 4 band - R, G, B, NIR (i.e. Multispectral)

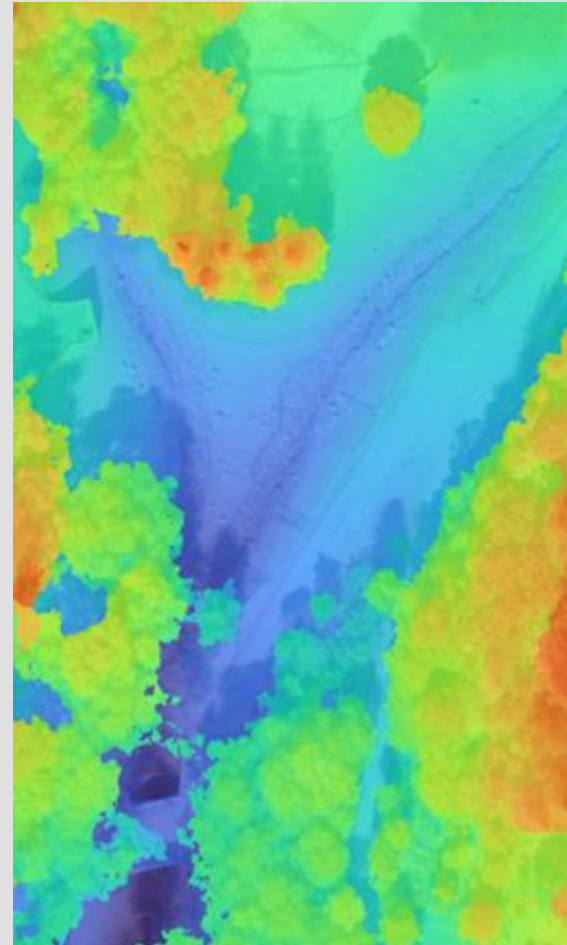
Active

Emit own radiation and observes reflection/backscatter.
Cloud cover and nighttime observations don't obstruct

- LiDAR (Laser Imaging, Detection, and Ranging)
- SAR (Synthetic-aperture Radar)

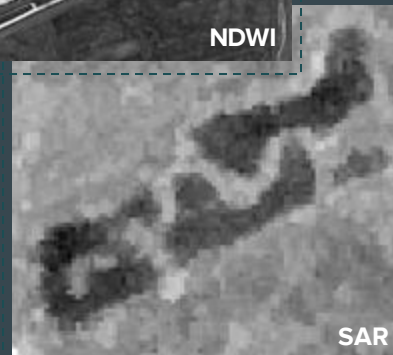


**Mapping
Analyses/Products:
What types of products can
be used?
How are wetlands mapped?**



Remote Sensing Data Products Used

- Imagery
 - True color imagery
 - 4 Band (Infrared) - false color
 - Indices
 - Normalised Difference Water Index (NDWI)
 - Normalised Difference Vegetation Index (NDVI)
- Elevation
 - Topographic Wetness Index (TWI)
 - Normalized Digital Surface Model (nDSM)
 - Roughness
- SAR (Radar)
 - Polarization



Mapping wetlands

Wetlands have characteristics that we can remotely detect:

- Hydrology / source of water / saturated soils
- Vegetation associated with wetlands / hydrophytes

We can use remote sensing to get clues and supporting evidence for where wetlands are on the landscape:

Source of water - topographic lows, or areas where water flows to them. Directly sensing open water

Vegetation - spectral signature of chlorophyll or healthy vegetation

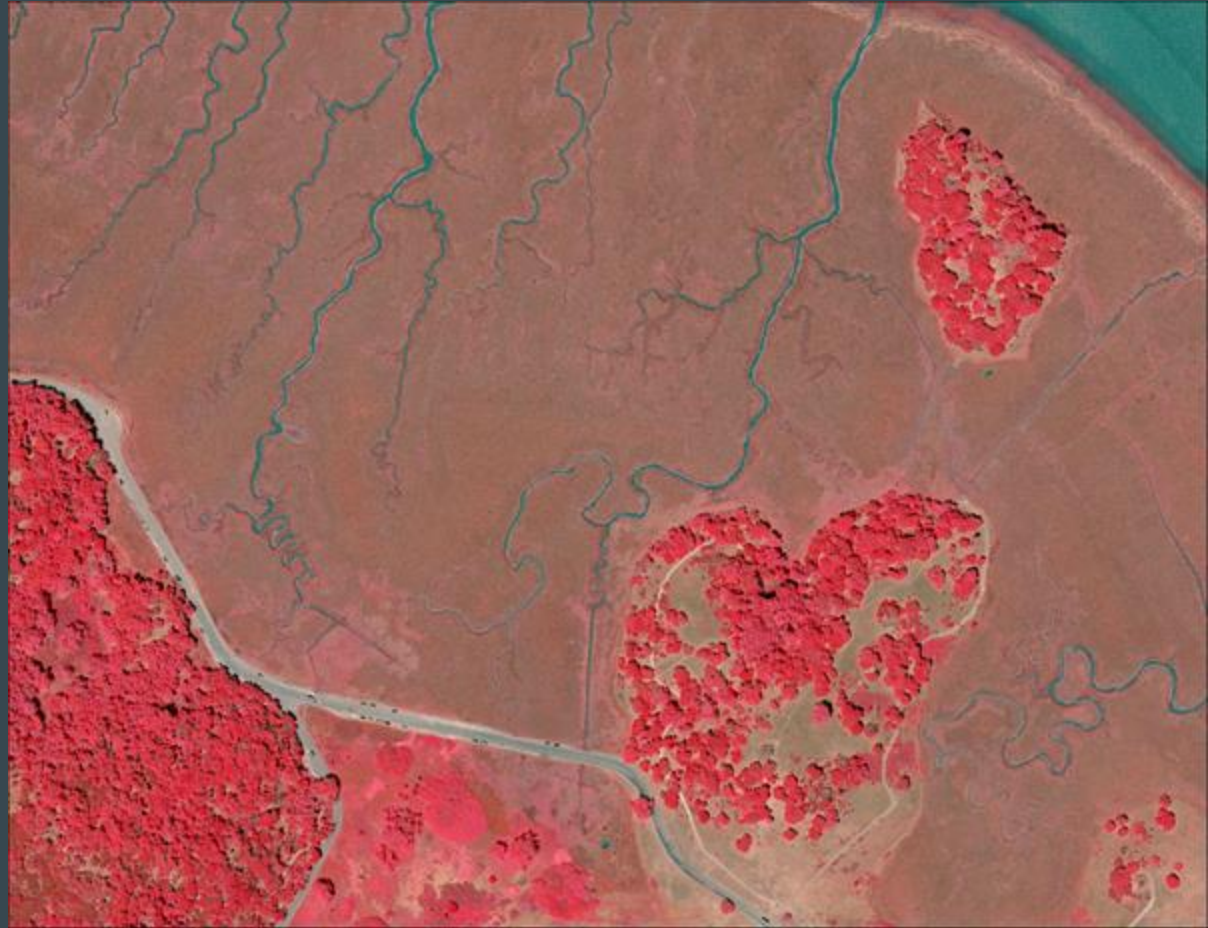
True Color Imagery

Red (red), Blue (blue), Green (green)
bands



NIR Composite

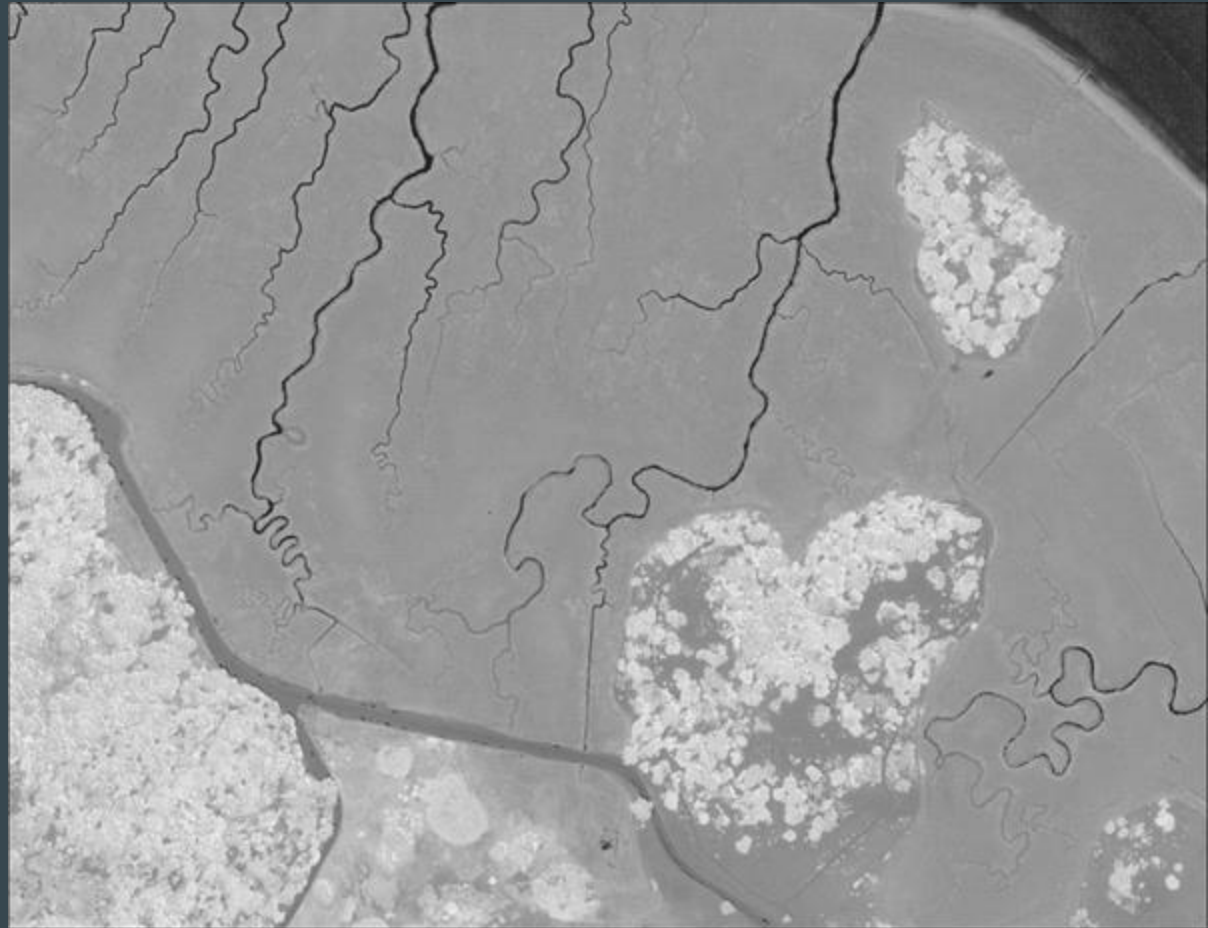
Near infrared (red), Green (blue), red (green) bands



NDVI

Normalized Difference Vegetation Index

Areas with higher chlorophyll levels
typically have a higher value



NDWI

Normalized Difference Water Index

Areas that have spectral signatures of water and wet areas have a higher values



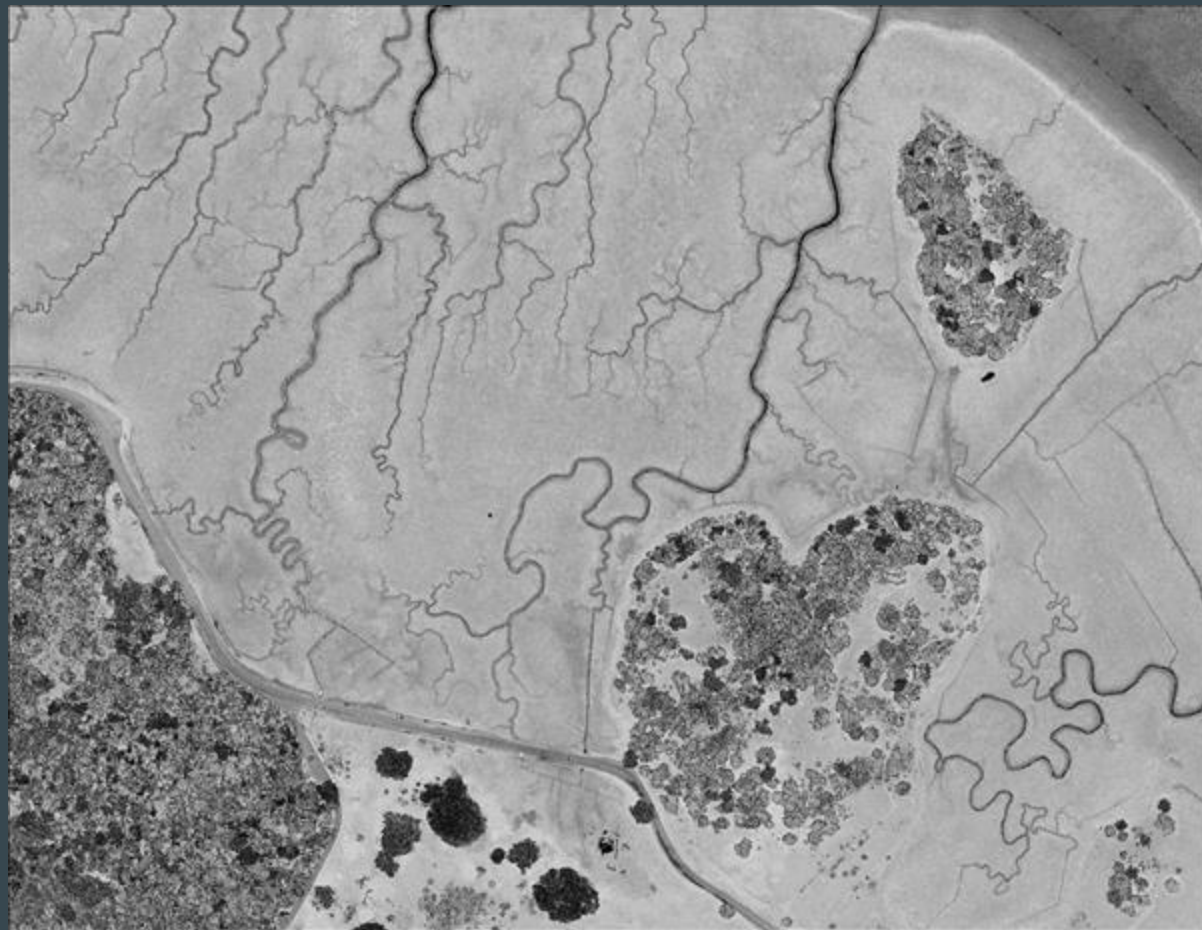
DEM (LiDAR)

Digital Elevation Model



LiDAR Intensity

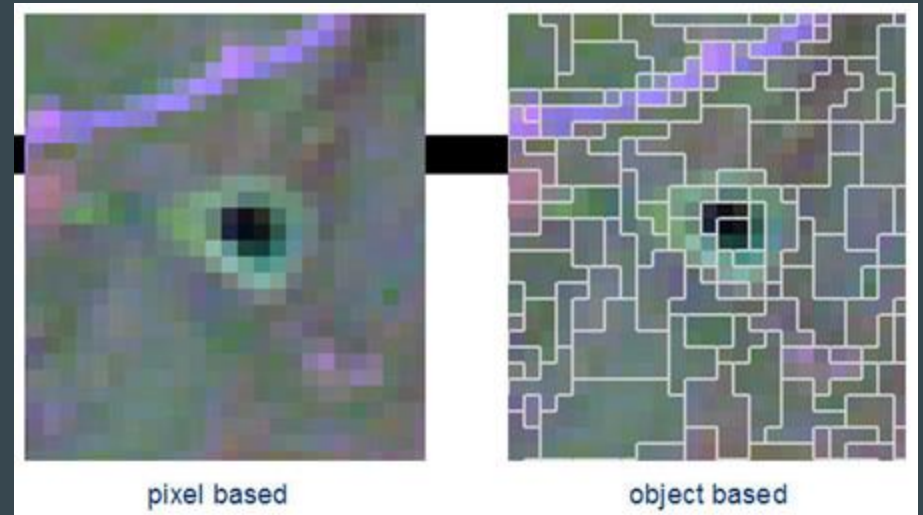
Return Strength of laser beam



Wetland Mapping Analysis

- Heads up digitizing
 - Historically approach
- Image Analysis
 - Pixel based image analysis
 - Pixels in a raster are the unit being classified
 - Object based image analysis (OBIA)
 - Segmentation - create objects/polygons to classify

- Classification
 - Machine Learning
 - Rule Based



Importance of Validation Data

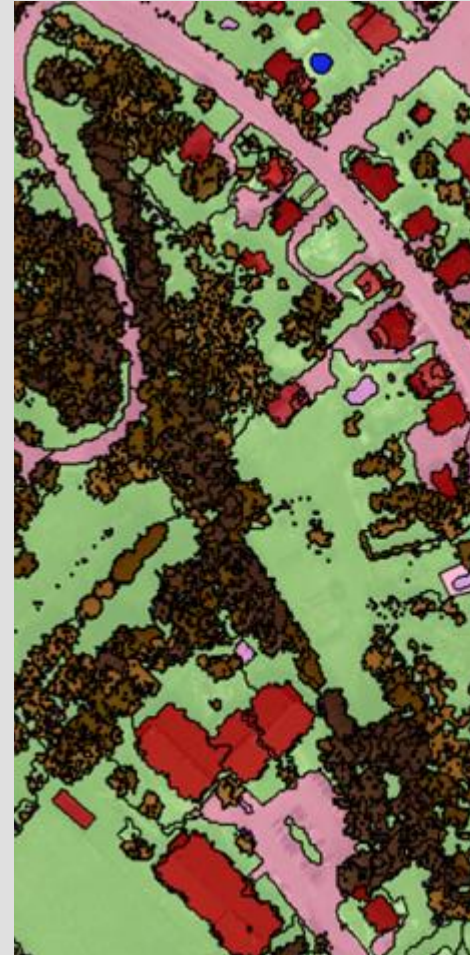
High quality validation data is extremely important for **training classification models** and for **accuracy assessments of final mapping products**

Validation Data

- Collection
 - Field data
 - Remotely sensed at higher resolution
- Classification used should be the same for validation as for mapping product
- Opportunity for wider scale participatory science.

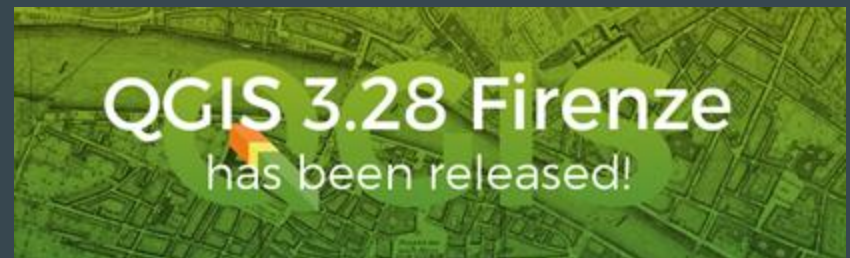
Software:

What types of software is used for mapping wetlands?



Software for Mapping Wetlands

- Proprietary
 - ESRI - ArcGIS Pro
 - Trimble - eCognition
- Open Source
 - QGIS
 - *Python library*
 - *R libraries*
- Other
 - Google Earth Engine



Available Datasets:

What data is available and relevant to mapping wetlands?



Public Existing Databases

- Mapped Wetlands and Aquatic Features
 - NWI - [National Wetland Inventory](#) - USFWS
 - NHD - [National Hydrography Dataset](#) - USGS
 - CARI - [California Aquatic Resource Inventory](#) - SFEI
- Imagery
 - NAIP - airborne (1m - 60cm, 4 band) (National Agriculture Imagery Program - USDA)
 - Sentinel - spaceborne (10m - 60m 13 spectral bands)
 - Landsat - spaceborne (30m visible and NIR, 15m panchromatic)
- LiDAR
 - Various collections - USGS - The National Map, NOAA - Digital Coast
- SAR
 - Sentinel + others - NASA (Earthdata or ASF Alaska), ESA (Copernicus Hub)



Public Remote Sensing Data Sources

- Google Earth Engine
 - Access to a wide range of datasets for use
- USGS
 - [The National Map](#) (Elevation data + NHD +)
 - [Earth Explorer](#) (Imagery)
 - [GloVis](#) (Imagery)
- NOAA - [Digital Coast](#)
- NASA - [Earthdata](#)
- ESA - [Copernicus Open Access Hub](#)



Questions?

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Image Credit: SFEI