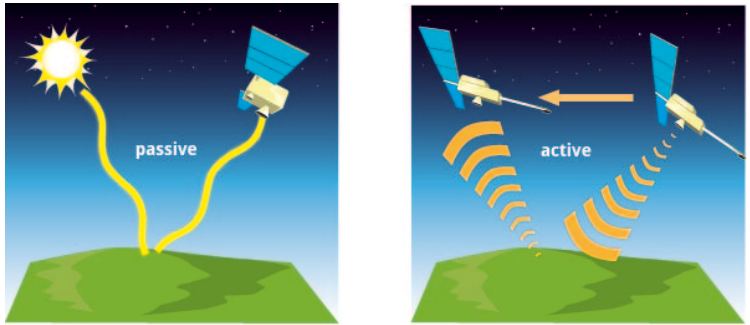
Remote Sensing Data for Economics and Social Sciences

Bodo Bookhagen, Aljoscha Rheinwalt, and team - Institute of Geosciences

Remote Sensing Data

1. Some physical background information and examples
2. GIS and Land-Use and Land-Cover (LULC Maps)
3. Applications of airborne and satellite multispectral data
4. Examples using active remote sensing methods (lidar and radar)
5. High-resolution data for environmental reconstruction

Active and Passive Remote Sensing

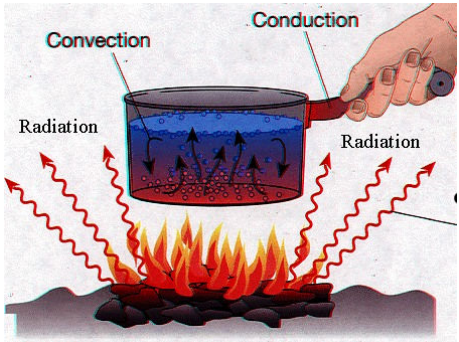


Passive Remote Sensing System: Landsat, Sentinel-2, GeoEye, WorldView, SPOT, ASTER, Pleaides, RGB-NIR airphotos, passive microwave data

Active Remote Sensing System: Lidar (IceSAT2, GEDI, airborne lidar), Radar (Sentinel-1, TerraSAR-X, SAOCOM, ALOS)

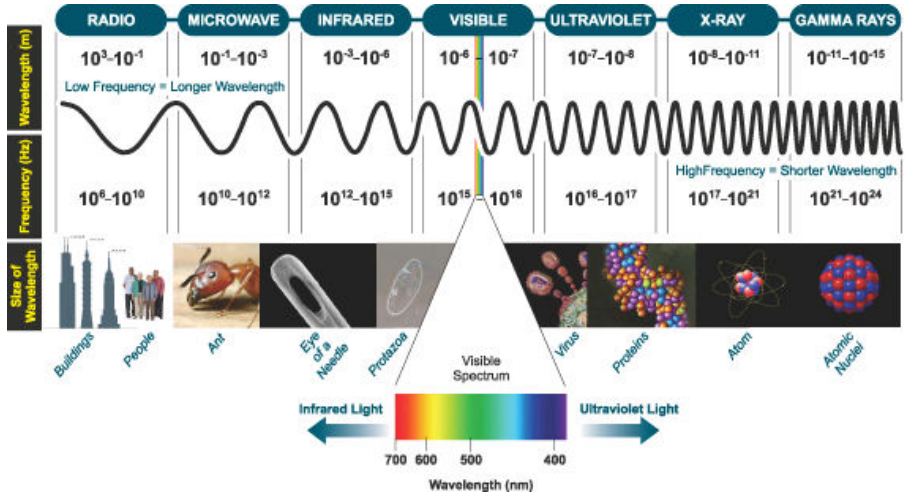
How is energy transferred?

Energy may be transferred three ways: conduction, convection, and radiation.



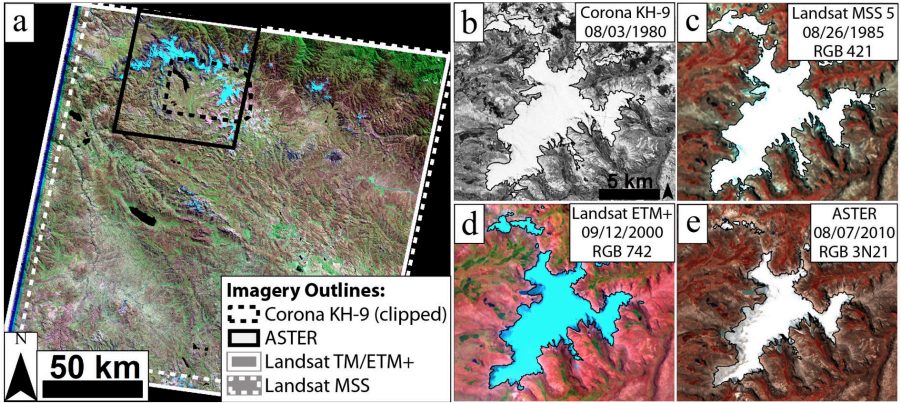
- **Conduction:** Energy may be conducted directly from one object to another as when a pan is in direct physical contact with a hot burner.
- **Convection:** The Sun bathes the Earth's surface with radiant energy causing the air near the ground to increase in temperature. The less dense air rises, creating convectional currents in the atmosphere.
- **Radiation:** Electromagnetic energy in the form of electromagnetic waves may be transmitted through the vacuum of space from the Sun to the Earth.

ElectroMagneticRadiation (EMR) Spectrum



Range of wavelength and frequencies (andor.com)

Optical Remote Sensing Data - Examples



Passive Remote Sensing System: Quelccaya Ice Cap between Bolivia and Peru (Hanshaw and Bookhagen, 2012)

Optical Remote Sensing Data - Examples

Passive Remote Sensing System: High-resolution Pleiades images

Raster Data

Raster primarily refers to a characteristic of a data structure, that is, a 2D or multi-dimensional array.

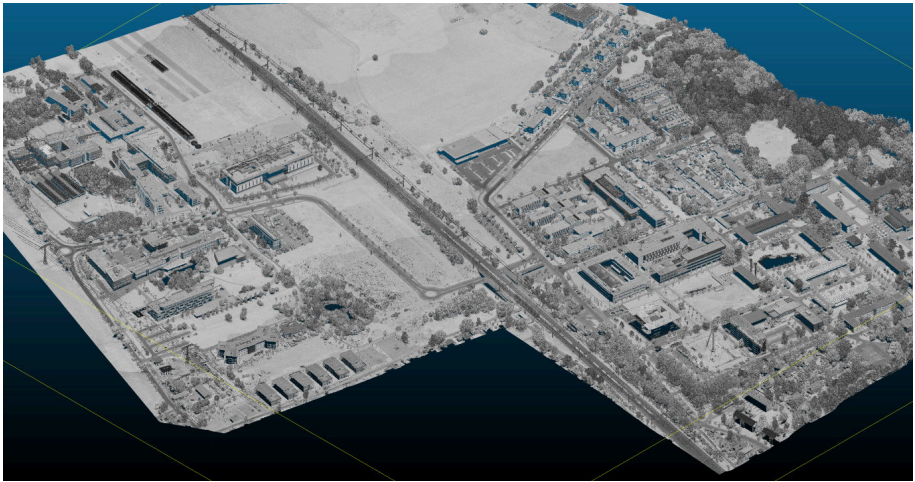
Example: satellite or airphoto raster data of a landscape and their time series.

Raster Data

Raster data can be projected onto an equally-spaced **grid**. Generally, **gridded data** refer to equal distances between grid cells in a raster-data structure.

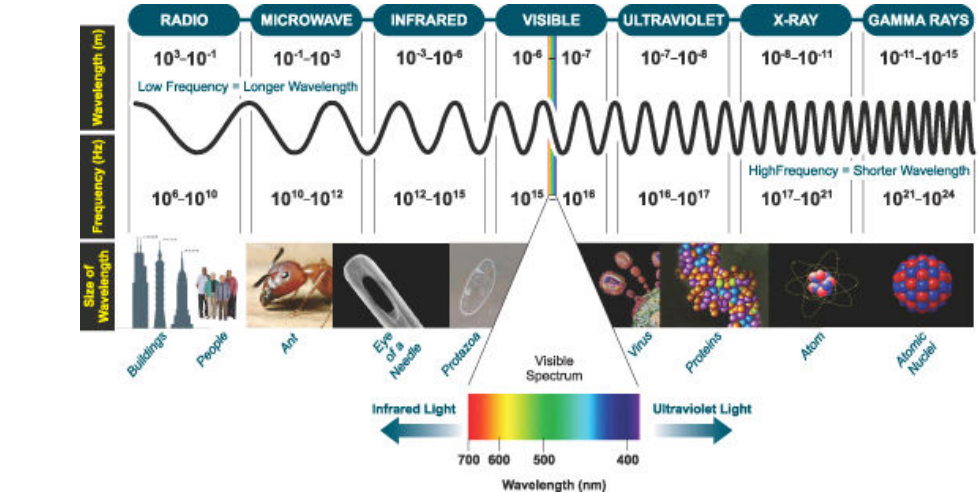
Note: Gridded data are rasters, but not all rasters are grids.

Airborne Lidar Example (Point Cloud data in the NIR)



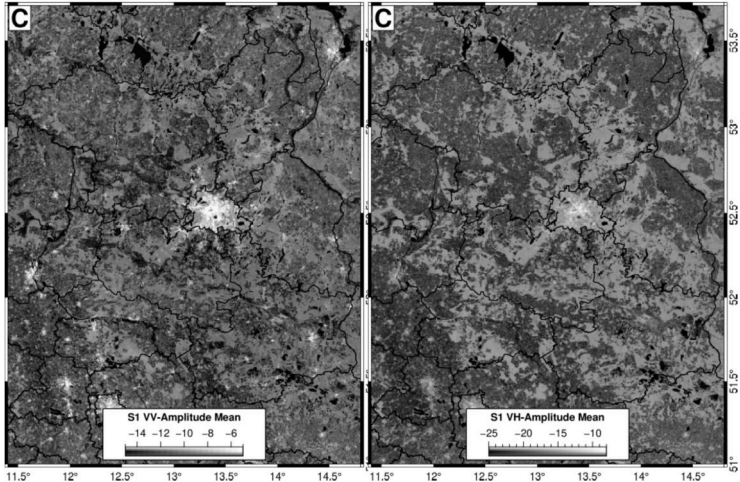
Active Remote Sensing System: Airborne Lidar for Campus Golm

ElectroMagneticRadiation (EMR) Spectrum



Range of wavelength and frequencies (andor.com)

Radar (SAR) Example Sentinel-1

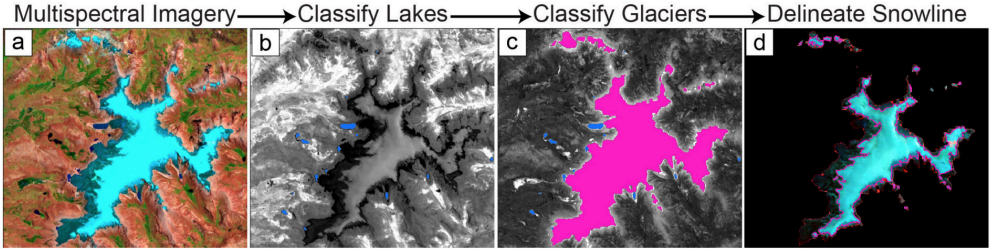


Active Remote Sensing System: Sentinel-1 C-band radar and amplitudes for measuring land-cover structures.

Remote Sensing Data

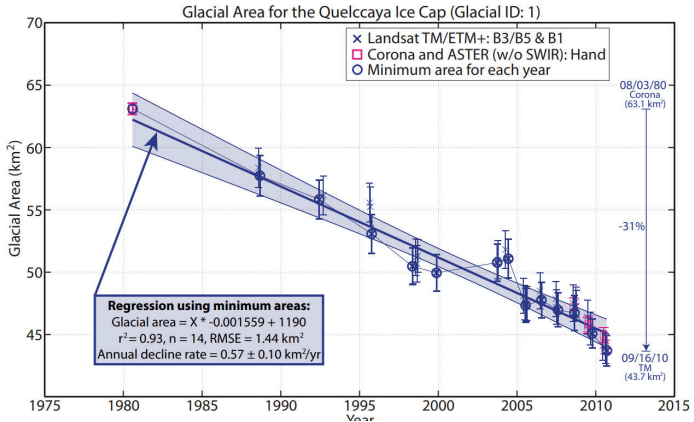
1. Some physical background information and examples
2. **GIS and Land-Use and Land-Cover (LULC Maps)**
3. Applications of airborne and satellite multispectral data
4. Examples using active remote sensing methods (lidar and radar)
5. High-resolution data for environmental reconstruction

From Remote Sensing to Classified Data



Classification of raster data: Quelccaya Ice Cap between Bolivia and Peru (Hanshaw and Bookhagen, 2012)

Time Series Data of Classified Satellite Data

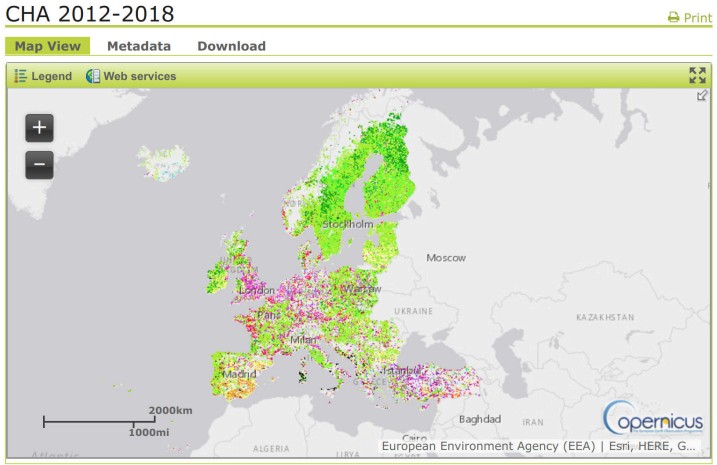


Quelccaya Ice Cap time series (Hanshaw and Bookhagen, 2012)

CORINE - COoRdination of InformatioN on the Environment

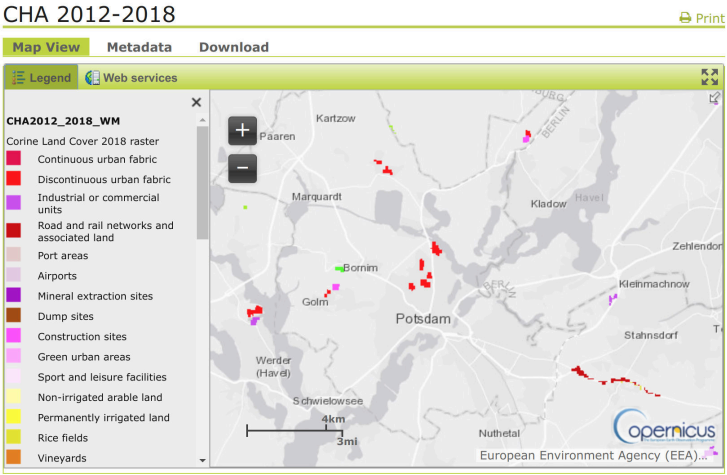
- produced by the European Environment Agency (EEA)
- free data access at: https://land.copernicus.eu/pan-european/corine-land-cover
- earlier versions (1990, 2000) based on Landsat and SPOT data
- newer version (2018) based on Sentinel-2
- next iteration expected in 2024
- spatial resolution 100 m, minimum mapping unit 25 ha
- 39 country effort, only for Europe

CORINE - COoRdination of InformatioN on the Environment



Explore yourself:
https://land.copernicus.eu/pan-european/corine-land-cover/lcc-2012-2018

CORINE - Change from 2012-2018



Land-cover changes from 2012-2018 in the Potsdam-Golm area

Remote Sensing Data

1. Some physical background information and examples
2. GIS and Land-Use and Land-Cover (LULC Maps)
3. **Applications of airborne and satellite multispectral data**
4. Examples using active remote sensing methods (lidar and radar)
5. High-resolution data for environmental reconstruction

Hurricane Katrina 2005: Disaster Recovery

(a) (b)

Figure 2. (a) shows a subset of the 2006 true color aerial image; (b) shows a subset of the same area in 2007.

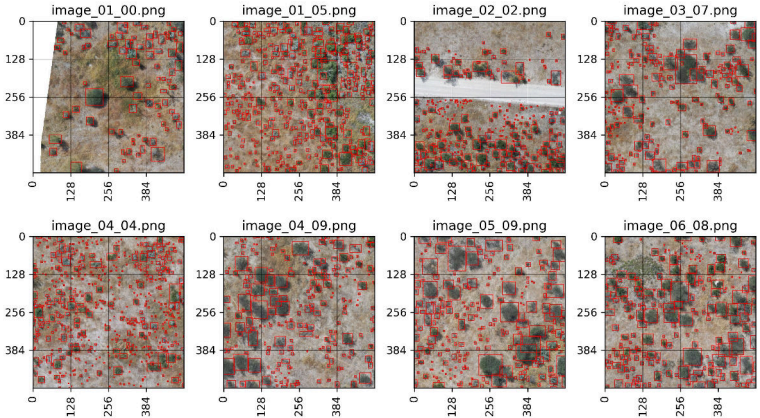
Reginald Archer, 2012 (UC Santa Barbara PhD thesis)

Hurricane Katrina 2005: Disaster Recovery - Blue Tarps

Figure 3. Example of different color rooftops, and similarities between colors of features.

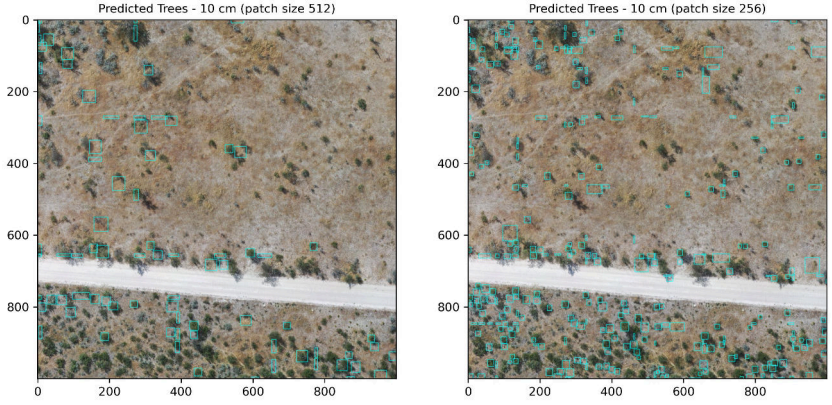
Reginald Archer, 2012 (UC Santa Barbara PhD thesis)

Machine Learning: Savanna regions



Wildlife Management in Namibia (ORYCS): UAV and airphoto-based training on tree-crown and species detection

Machine Learning: Savanna regions



Wildlife Management in Namibia (ORYCS): UAV and airphoto-based training on tree-crown prediction

Mapping Solar panals in Berlin using 10-cm DOP

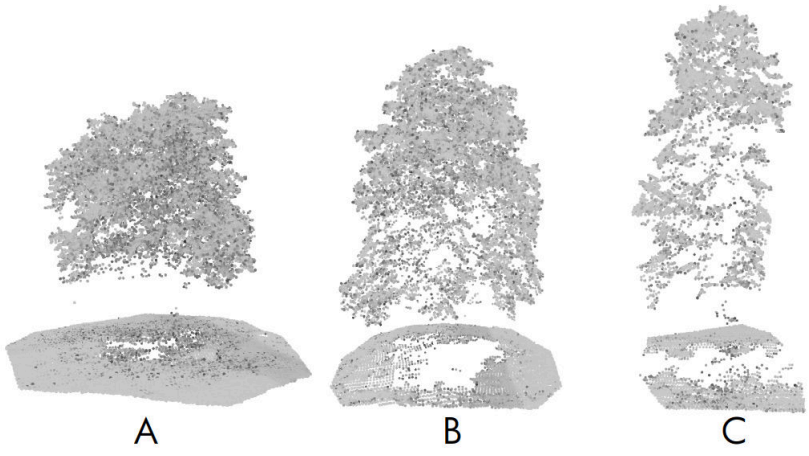
Small-scale solar panels on private building

Large-scale solar panels on commercial building

Remote Sensing Data

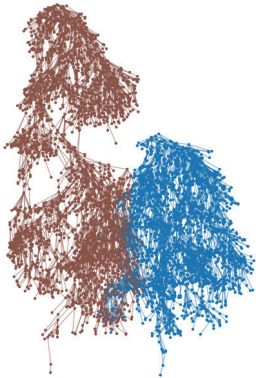
1. Some physical background information and examples
2. GIS and Land-Use and Land-Cover (LULC Maps)
3. Applications of airborne and satellite multispectral data
4. **Examples using active remote sensing methods (lidar and radar)**
5. High-resolution data for environmental reconstruction

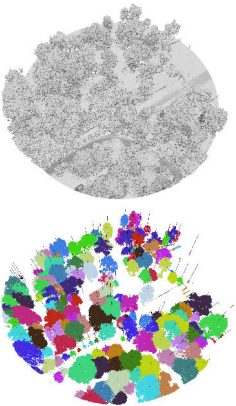
ALS: Tree Classification and Delineation



A: Quercus robur (*Stieleiche*), **B:** Fagus sylvatica (*Rotbuche*, *Birke*), and **C:** Tilia intermedia (*Holländische Linde*)

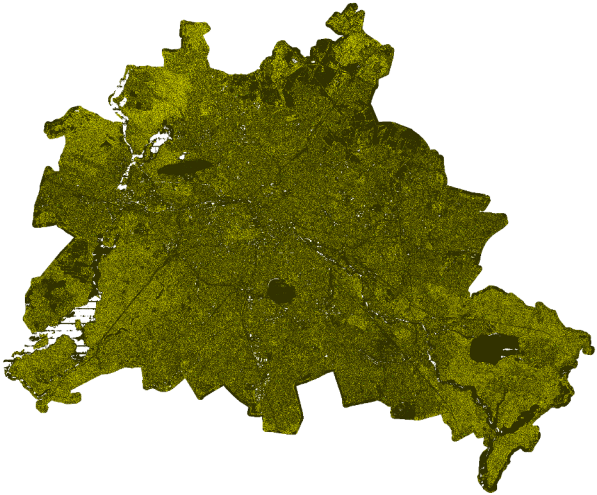
ALS: Tree Classification and Delineation



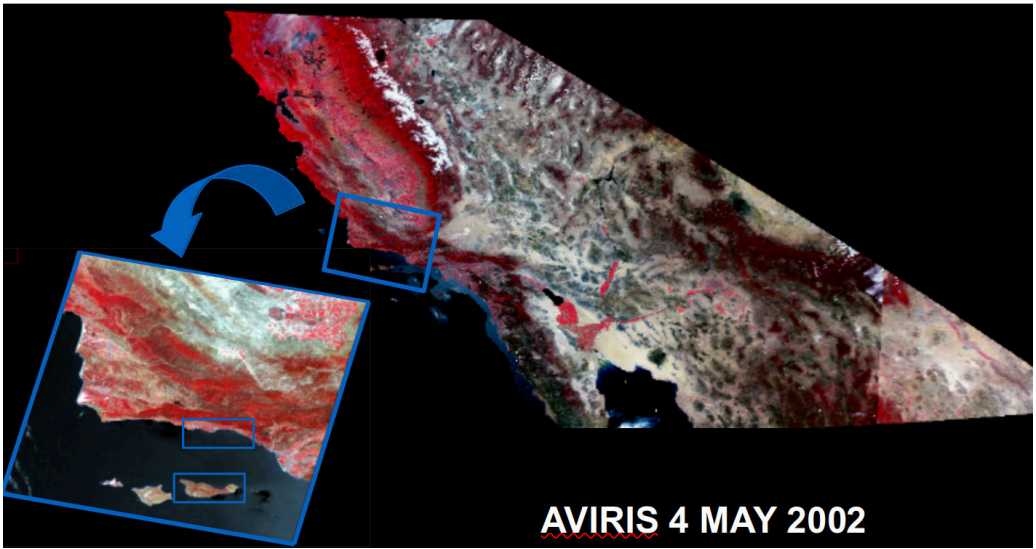


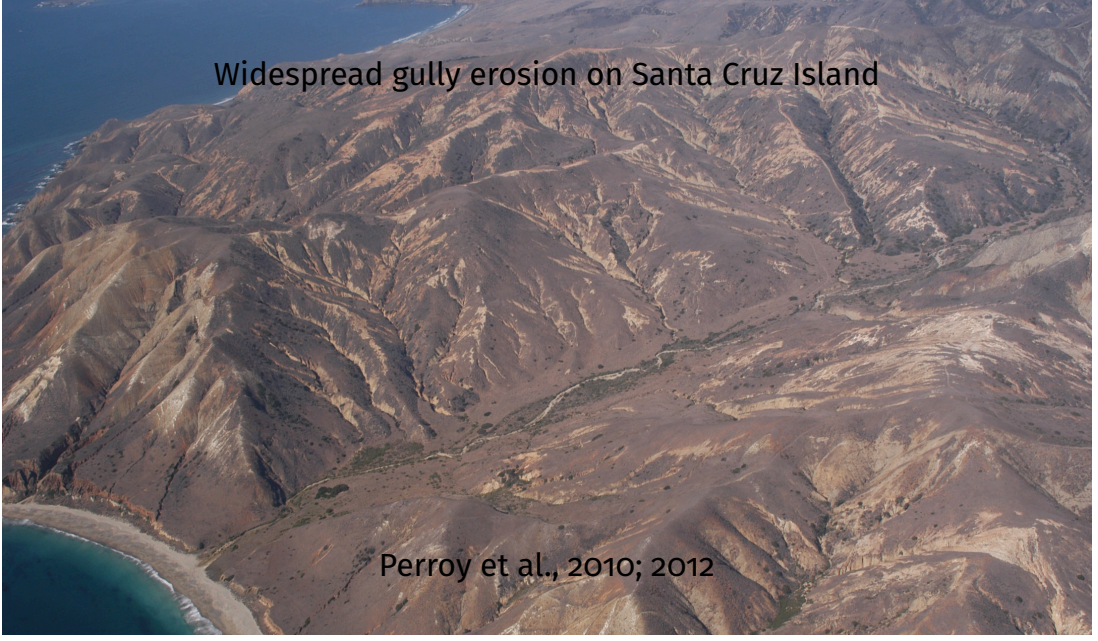
Delineation of trees from dense airborne lidar point clouds using geometric network approaches (Max Hess, Aljoscha Rheinwalt). Individually segmented trees are then used as for a machine-learning classification input.

Berlin Airborne Lidar Data

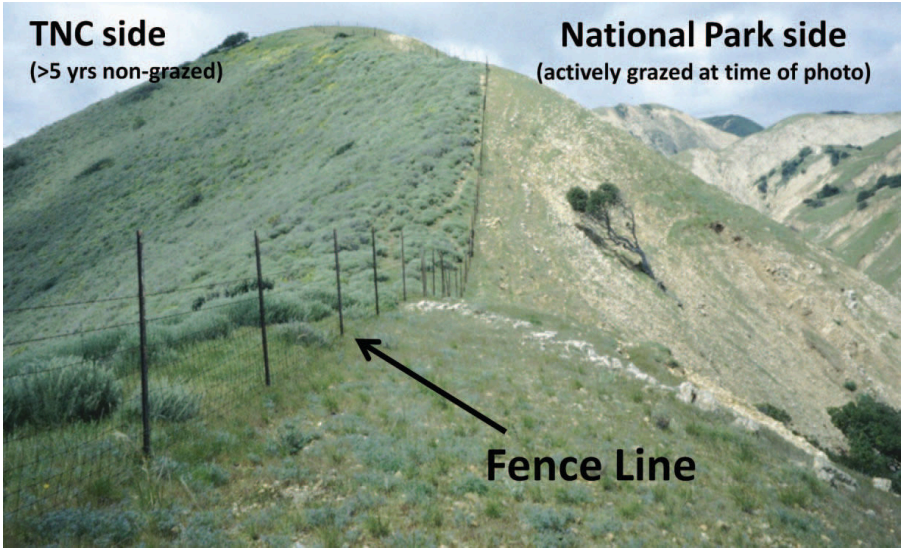


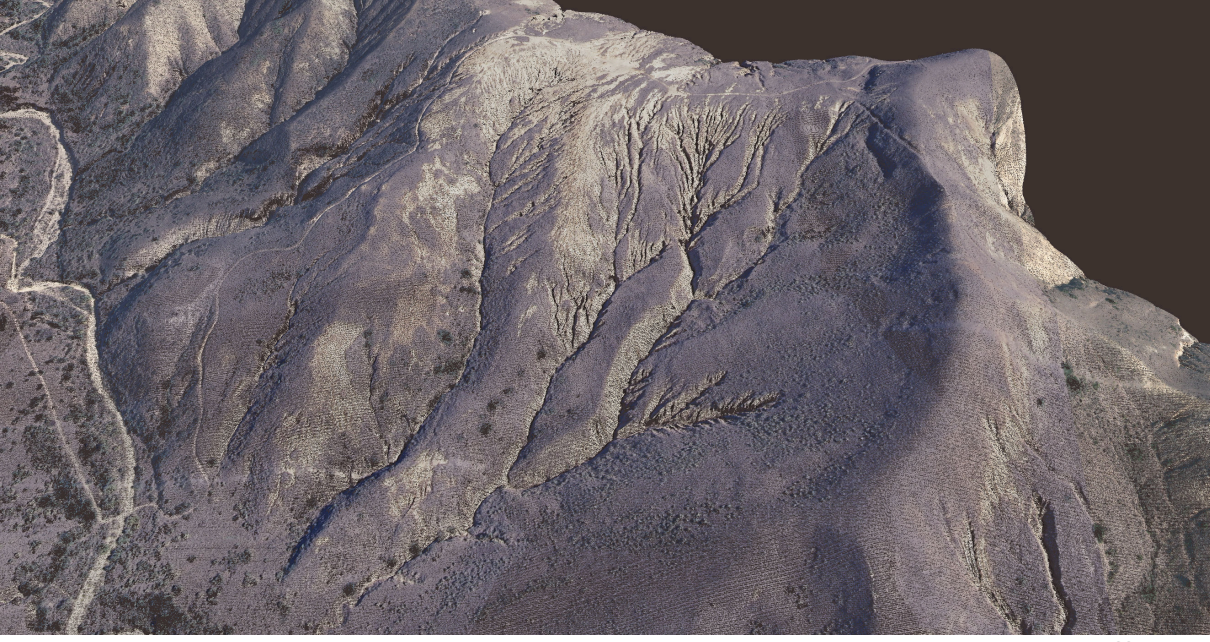
Santa Cruz Island - South-Central California




Widespread gully erosion on Santa Cruz Island
Perroy et al., 2010; 2012

Cattle and Sheep Grazing on Santa Cruz Island





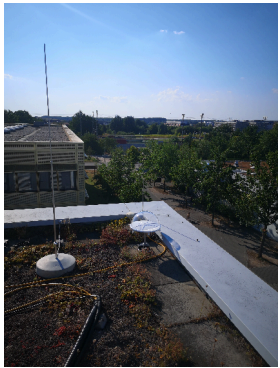
Rheinwalt, A., Goswami, B., and Bookhagen, B. (2019):
A network-based flow accumulation algorithm for point clouds: Facet-Flow Networks (FFN)

Remote Sensing Data

1. Some physical background information and examples
2. GIS and Land-Use and Land-Cover (LULC Maps)
3. Applications of airborne and satellite multispectral data
4. Examples using active remote sensing methods (lidar and radar)
5. **High-resolution data for environmental reconstruction**

Point Cloud Golm (Nov-25-2020)

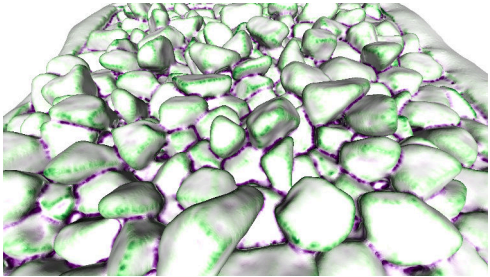
Golm: permanent markers and dGNSS station



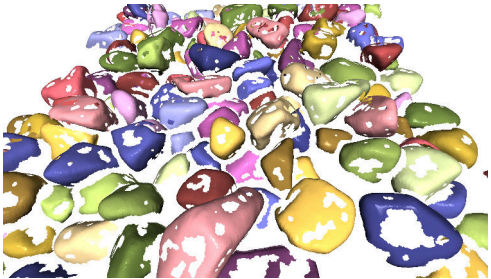
Pebble Delineation and Counting

Each pebble approx. 3 cm diameter.

Pebble Delineation and Counting



Point-cloud based curvature calculation



Segmented Pebbles