GEOWEB 5

TRAINING COURSE ON
MODERN GEODETIC TOPICS

Airborne LiDAR: applications to land surveying, engineering and forestry

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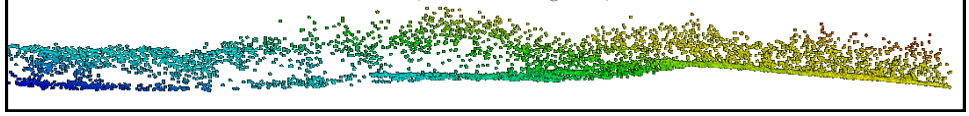
Mostar (Bosnia & Herzegovina)



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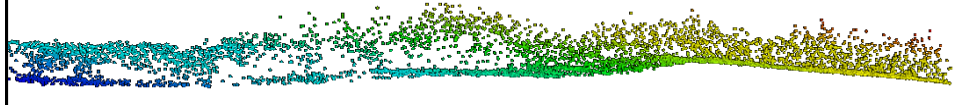

WHAT IS LIDAR?

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Light Detection And Ranging

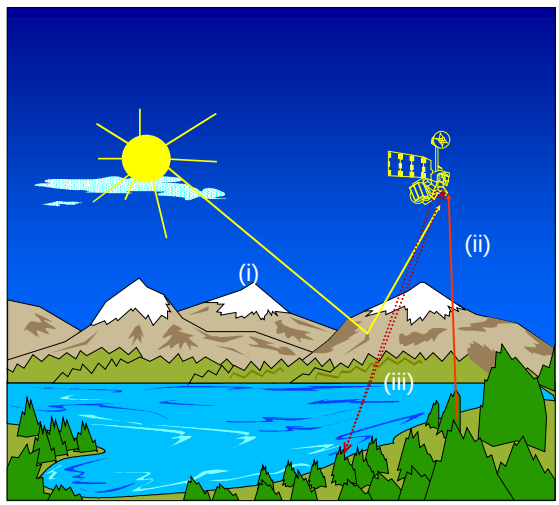
Laser Detection And Ranging (LADAR)

LIDAR

Airborne Laser Scanning (ALS)

1

WHAT IS LIDAR?

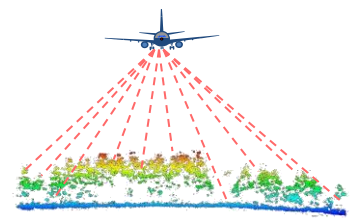


[Chuvieco, 2008]

ALS/LIDAR: SYSTEM WHICH MEASURES DISTANCES BY USING REFLECTED LASER PULSES

PASSIVE REMOTE SENSOR:
(I) REFLEXION
(II) EMISSION

ACTIVE REMOTE SENSOR:
(III) EMISSION-REFLEXION

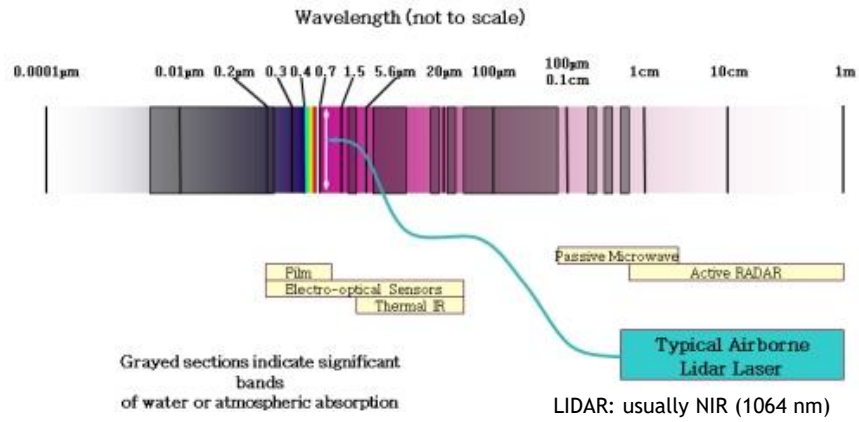


POINT CLOUD
X Y Z
INTENSITY

2

WHAT IS LIDAR?

ELECTROMAGNETIC CHARACTERISTICS



LIDAR: usually NIR (1064 nm)

https://www.e-education.psu.edu/lidar/l1_p3.html

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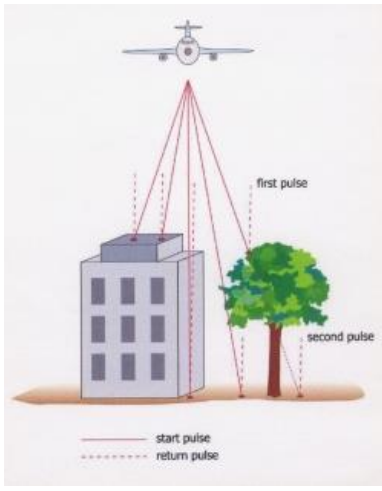
HOW DOES LIDAR WORK?



- ✓ ANYTIME THE LASER (LIGHT AMPLIFICATION BY STIMULATED EMISSION OF RADIATION) WORKS:

  - A pulse is emitted (PULSE: signal of very short duration which travels as a beam)

  - The pulse is reflected on the ground and its return signal (echo) is sensed by a photodiode

  - The elapse time (between the pulse emission and its return) is measured (t)

  - That time is converted into distance (between the target and the airplane)

- ✓ MULTIPLE ECHOES (RETURNS) FROM THE SAME PULSE ARE POSSIBLE.
- ✓ 200,000 PULSES/S
- ✓ HIGH PRECISION IN RANGING, NOT WEATHER DEPENDENT**

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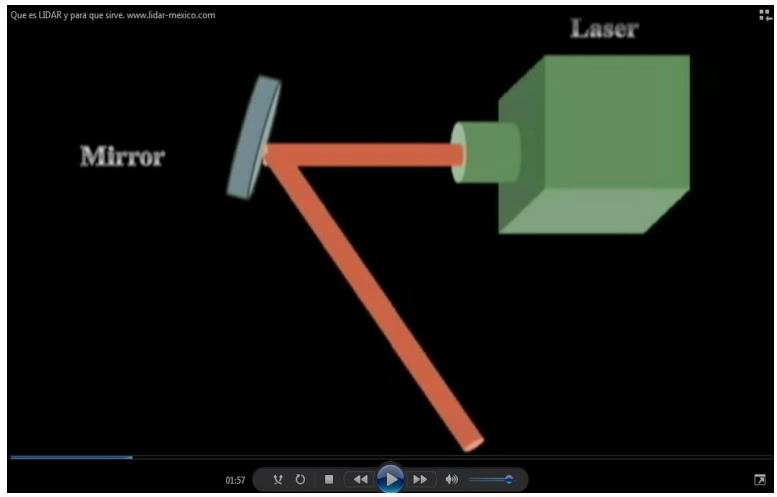
HOW DOES LIDAR WORK?



https://www.youtube.com/watch?v=giKv9AbM7NI
https://www.youtube.com/watch?v=EYbhNSUnIdU

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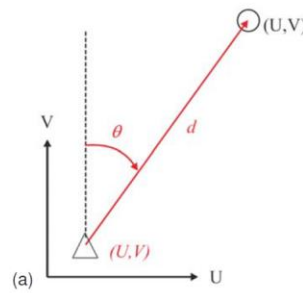
HOW DOES LIDAR WORK?

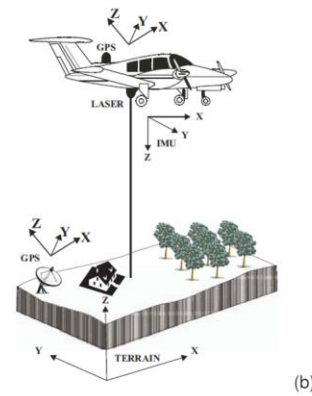
FROM THE PULSE TO A GEOREFERENCED (X, Y, Z) POINT

LASER PULSE TRAVELLING TIME (T)

↓ HOW?

RANGING (R) (DISTANCE)





$R = c \cdot t/2$

\+

Sensor position

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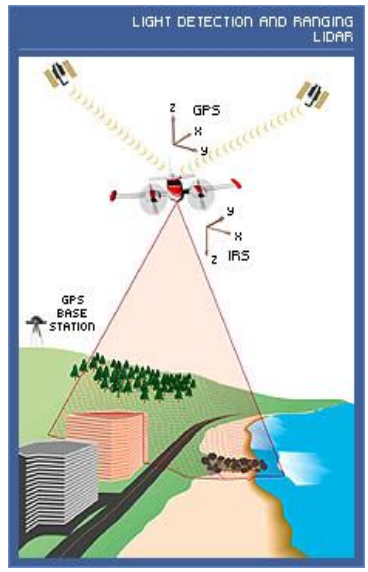
LiDAR system: Components



- Airplane
- LASER scanning unit (transmitter-receiver) (scanning mirror**)
- DGPS
- IMU (Inertial Motion Unit)
- Computer (quick processor)

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LiDAR system: Components

LEICA ALS50-II (2008)
https://www.e-education.psu.edu/lidar/l1_p5.html

LEICA ALS80 (2016)
http://leica-geosystems.com/-/media/files/products/datasheets/leica_als80_ds_en.ashx?la=en

- LS70-LP Scanner Assembly
- System Electronics (LC60 Laser Controller + SC70 System Controller)
- OC52 Operator Interface
- OC50 Pilot Interface
- Vibration-isolated interface plate assemblies for both scanner and electronics
- GNSS + GLONASS antenna
- Interconnecting cables

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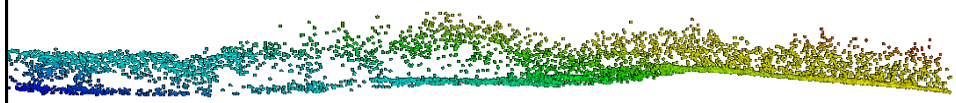
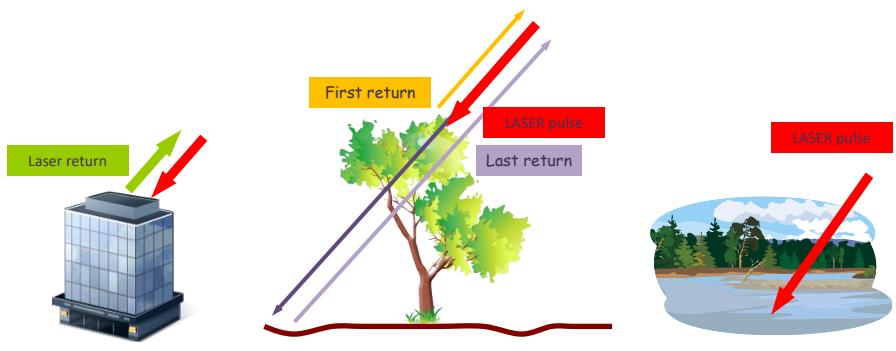
- What is LiDAR?
- How does LiDAR work?
- **Laser characteristics**
- Data
- Types of LiDAR systems
- Applications



LASER CHARACTERISTICS: RETURNS



DISCRETE RETURN LIDAR

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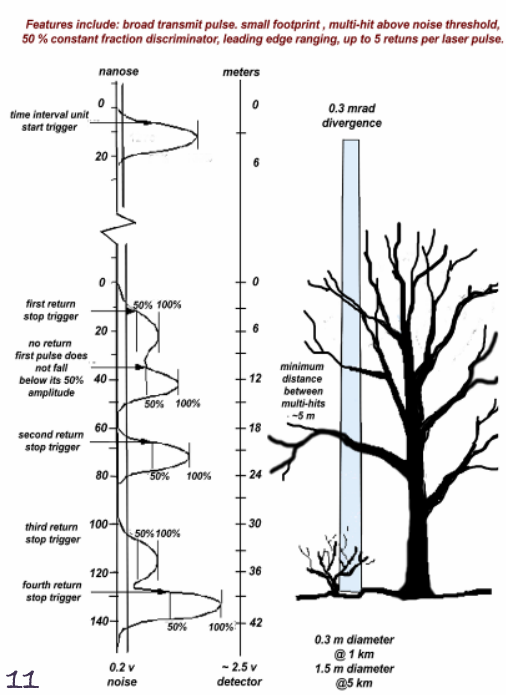

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DISCRETE RETURN LIDAR

- X,Y,Z POINTS
- SPATIAL RESOLUTION: "POST SPACING" (AVERAGE DISTANCE ON THE GROUND BETWEEN POINTS).
- RETURNS ARE TRIGGERED IF THE LASER PULSE IS REFLECTED BY A LARGE ENOUGH OBJECT TO EXCEED AN ENERGY THRESHOLD
- ABILITY TO REGISTER THE INTENSITY OF EACH RETURN
- SMALL FOOTPRINT
- TOPOGRAPHIC LIDAR

LIDAR: MUCH MORE THAN X,Y,Z DATA

FOR EACH RETURN WE CAN ALSO OBTAIN…

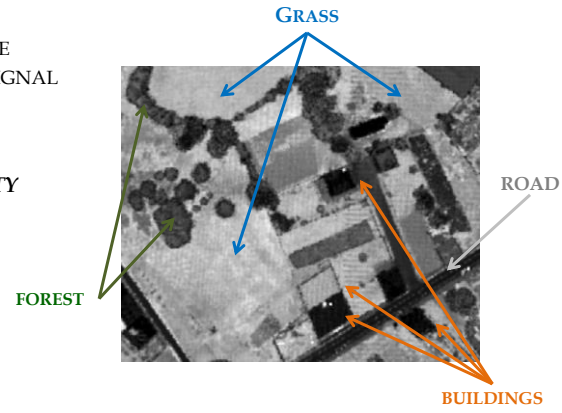
INTENSITY

MEASURE OF THE AMPLITUDE (STRENGTH) OF THE REFLECTED SIGNAL (RETURN)

↓ *REFLECTIVITY* ↓ *INTENSITY*

LAVA (8%)
ASPHALT (17%)

SNOW (80%-90%)
METAL (90%)



FROM THE INTENSITY DATA WE CAN CREATE AN INTENSITY IMAGE (RASTER)

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DISCRETE RETURN LIDAR

HOW DOES A COMMERCIAL LIDAR SYSTEM GATHER DATA?

http://www.youtube.com/watch?v=LZ2j4NLqJ4U

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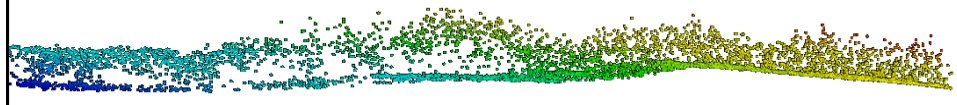
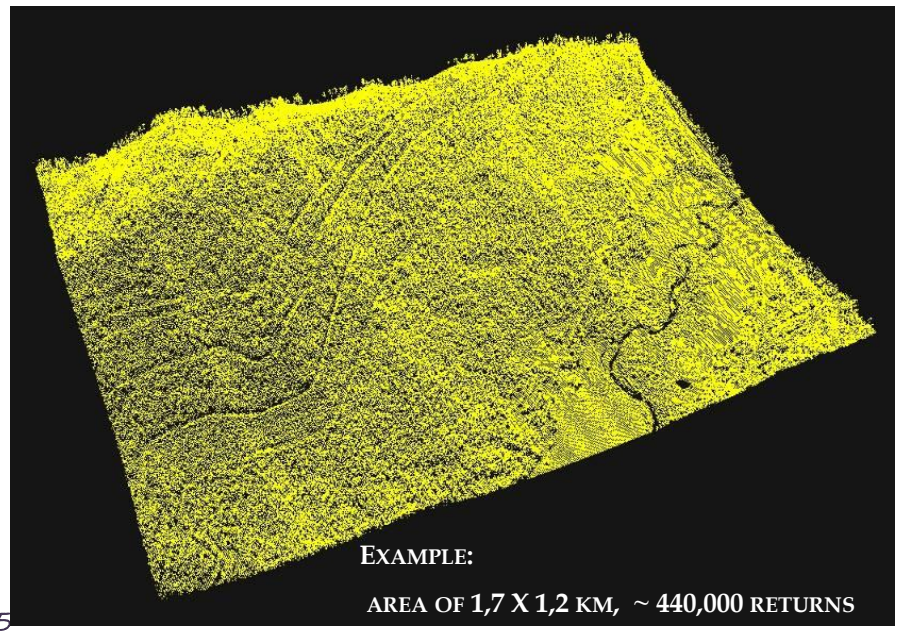


LiDAR DATA: millions of X,Y,Z points (POINT CLOUD)



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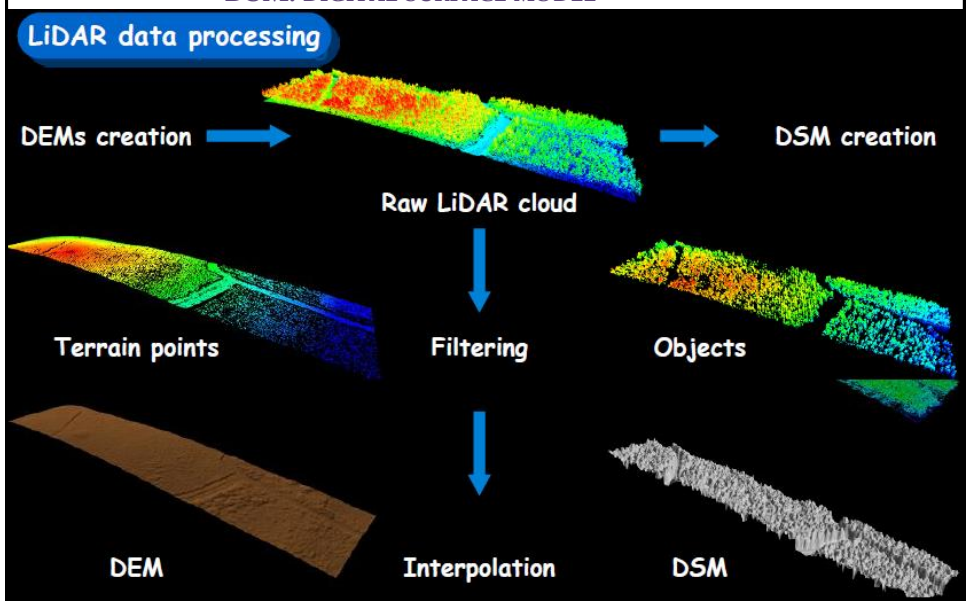
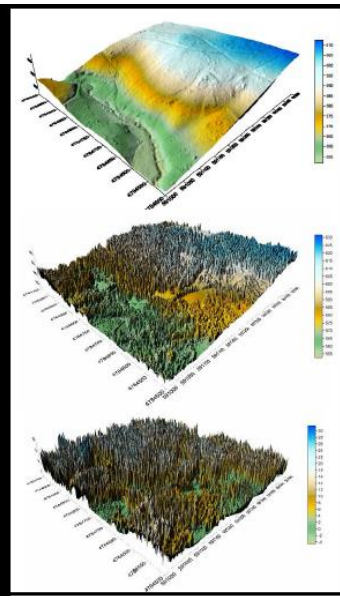
LiDAR DATA: basic workflow

DEM: DIGITAL ELEVATION MODEL
DSM: DIGITAL SURFACE MODEL



LIDAR DATA: basic workflow

CHM: CANOPY HEIGHT MODEL =
NDSM: NORMALIZED DIGITAL SURFACE MODEL

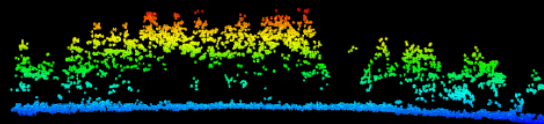


1. DEM
2. DSM
3. CHM = DSM - DEM

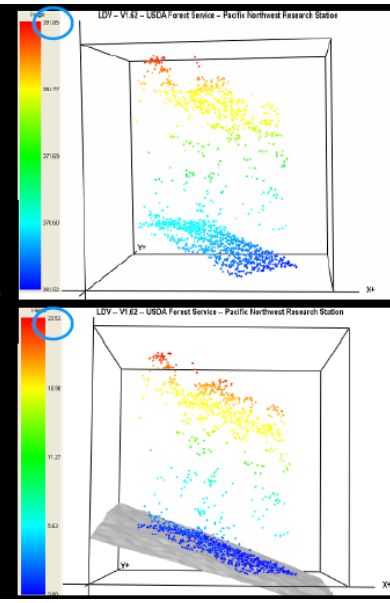
LIDAR DATA: basic workflow

CHM: CANOPY HEIGHT MODEL =
NDSM: NORMALIZED DIGITAL SURFACE MODEL

1. EH (ellipsoidal height).



2. NHD = DSM - DEM



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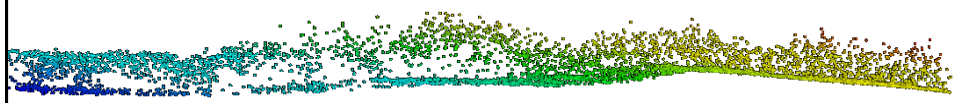
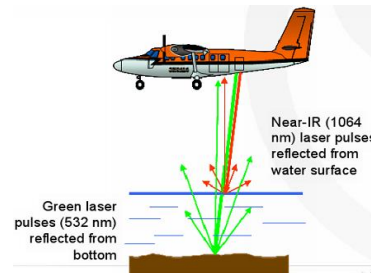


TYPES OF LIDAR SYSTEMS

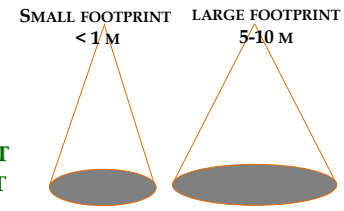
- SURFACE TO MEASURE
  - TOPOGRAPHIC
  - BATHYMETRIC
  - ATMOSPHERIC



- PLATFORM
  - TERRESTRIAL (TLS)
  - AERIAL (ALS)
  - SATELLITE
  - VEHICLE (VLS)
  - UAV

- RETURN (data gathering)
  - DISCRETE
  - FULL WAVEFORM

- FOOTPRINT SIZE
  - SMALL-FOOTPRINT
  - LARGE FOOTPRINT



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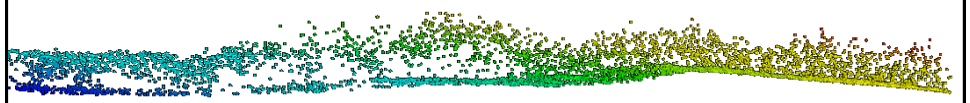
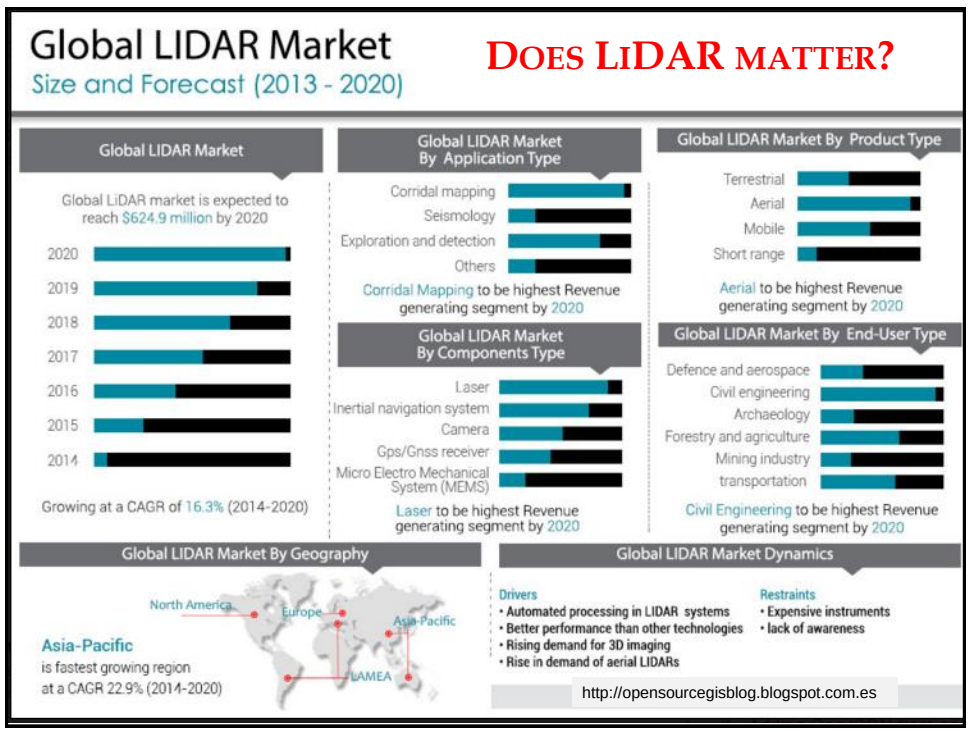
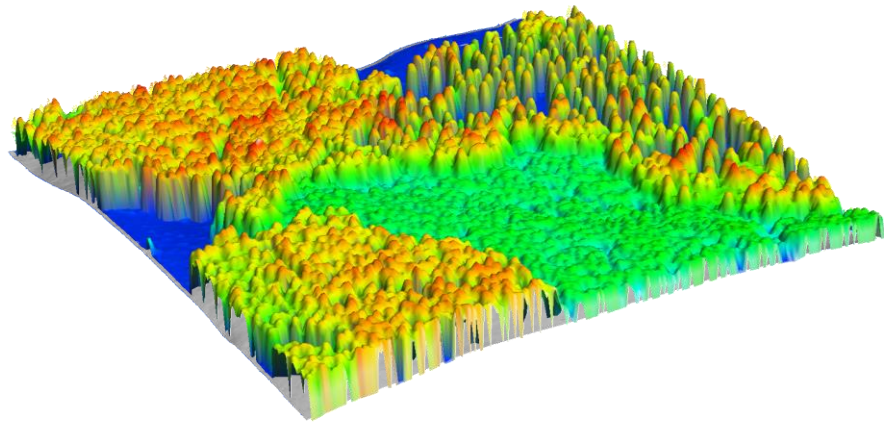


DOES LIDAR MATTER?



APPLICATIONS

DIGITAL ELEVATION MODELS



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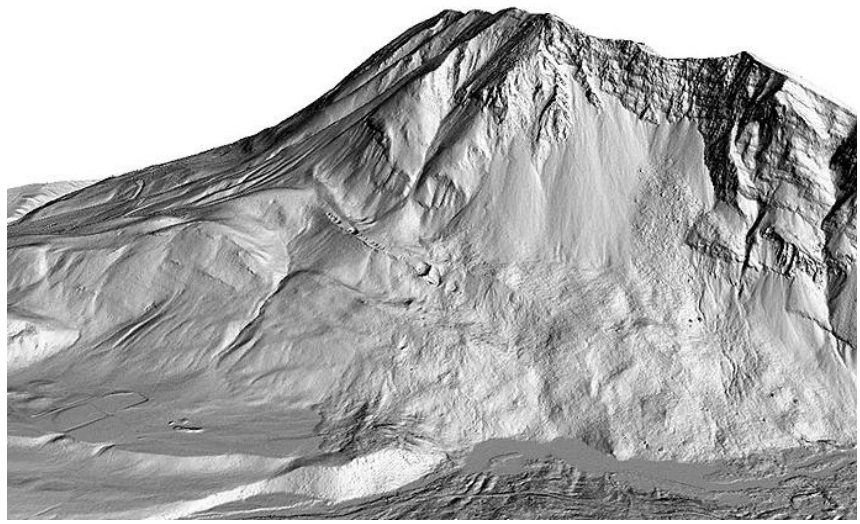
DIGITAL ELEVATION MODELS: LANDSLIDES



http://www.ags.gov.ab.ca/geohazards/turtle_mountain/lidar.html

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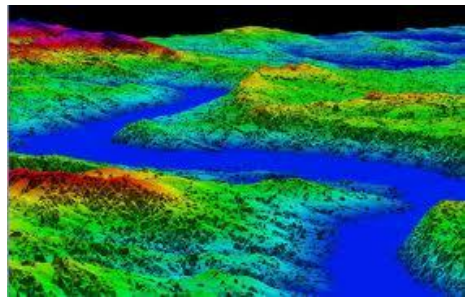
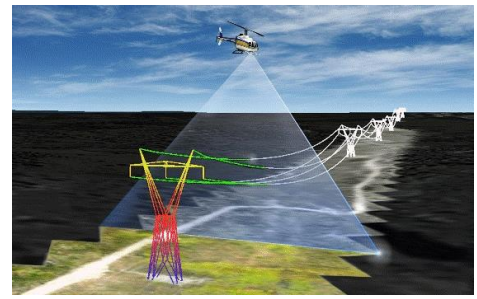
HYDROLOGY

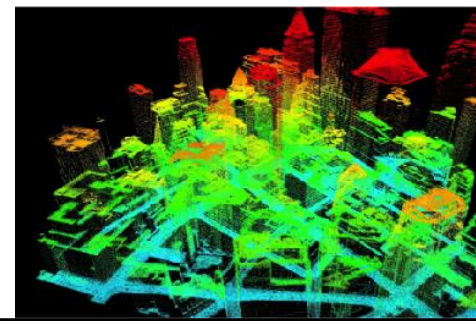


POWER LINES



CIVIL ENGINEERING

URBAN PLANNING



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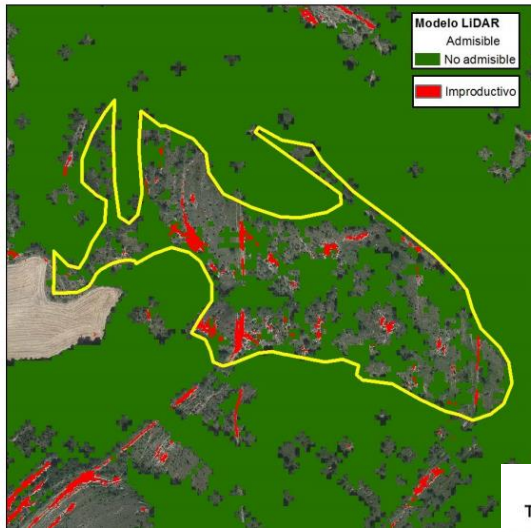
ELIGIBILITY OF AGROFORESTRY PARCELS FOR CAP BASIC PAYMENTS (EUROPEAN UNION)



CRITERIA TO BE ADMISSIBLE:
VEGETATION HEIGHT < 60 CM

YOU NEED LIDAR DATA!!

INSTITUTO TECNOLÓGICO AGRARIO DE CASTILLA Y LEÓN

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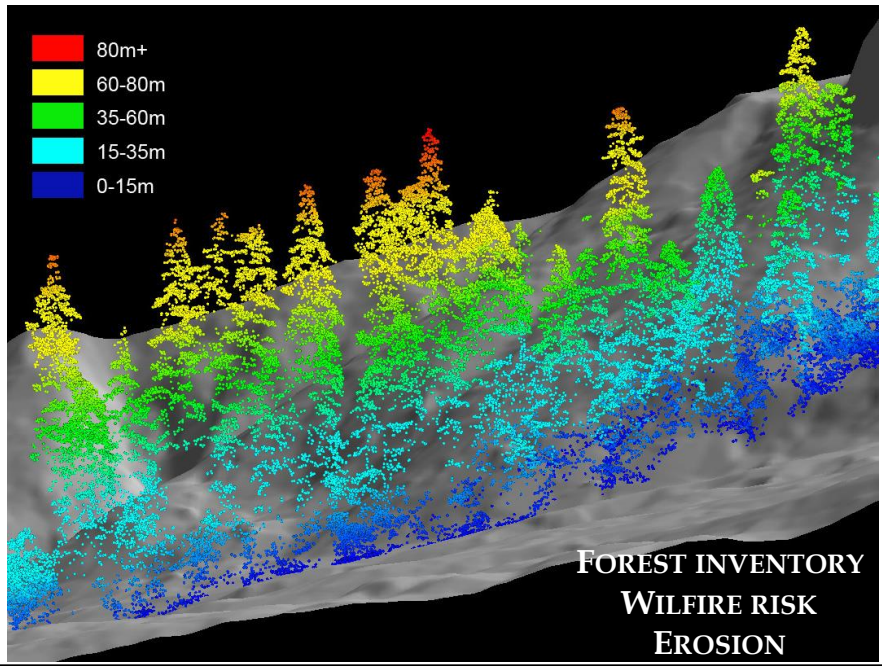
FORESTRY AND NATURAL RESOURCES



FOREST INVENTORY
WILFIRE RISK
EROSION

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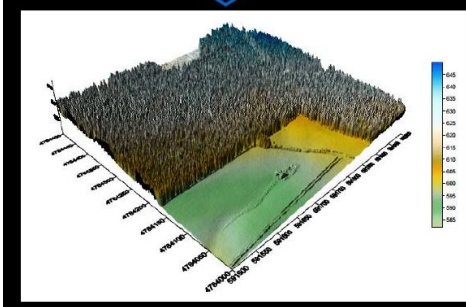
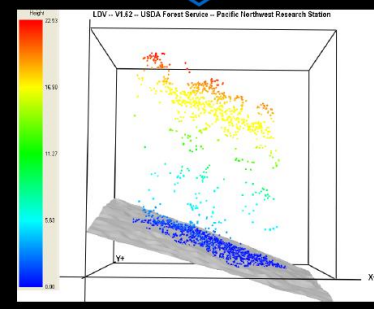
FOREST INVENTORY
(How much timber, biomass, carbon... do we have?)

- Two main approaches
  - ·Individual-tree based inventory
  - ·Stand level inventory



CHM



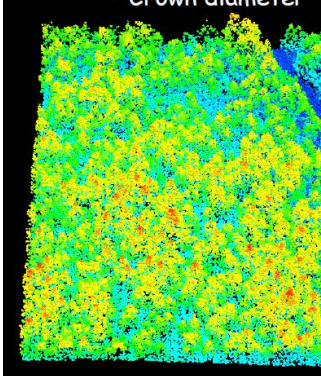
NHD

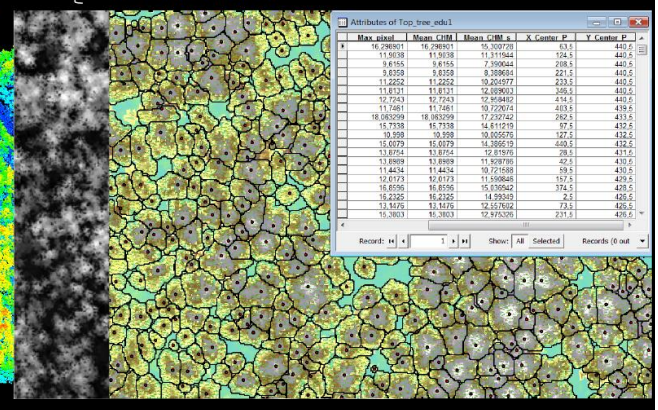
FOREST INVENTORY: INDIVIDUAL-TREE BASED

- Measured variables
  - Tree position
  - Tree height
  - Crown surface
  - Crown diameter

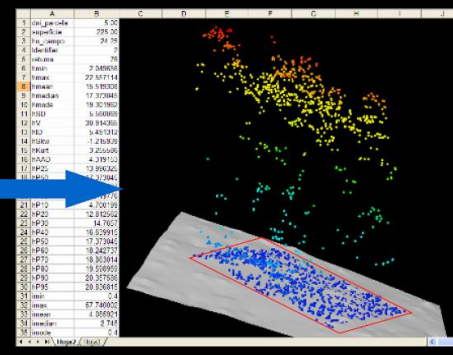
⇨
- Tree volume
- Tree diameter
- Tree basal area

⇨ Stand-level variables





FOREST INVENTORY: STAND-LEVEL



Field data measurements

LiDAR metrics

Statistical analyses

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon$$

OUR LIDAR PROJECTS

- TOPOGRAPHIC MAPPING
- VALIDATION OF LOW DENSITY LIDAR DATA FOR TOPOGRAPHIC MAPPING (NATIONAL COVERAGE)**
- LAND USE CLASSIFICATION
- FOREST INVENTORY (TIMBER, BIOMASS, CARBON)
- FOREST FIRE RISK ASSESSMENT
- PRESCRIBED FIRE MONITORING

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OUR LIDAR PROJECTS

TOPOGRAPHIC MAPPING

VALIDATION OF LOW DENSITY LIDAR DATA FOR TOPOGRAPHIC MAPPING (NATIONAL COVERAGE)**

LAND USE CLASSIFICATION

FOREST INVENTORY (TIMBER, BIOMASS, CARBON)

FOREST FIRE RISK ASSESSMENT

PRESCRIBED FIRE MONITORING

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https://www.youtube.com/watch?v=6oNntMQBHwI

http://www.lne.es/asturias/2015/12/28/fuego-cerca-urbanizacion-fresneda-siero/1861462.html

Un centenar de incendios en Asturias y 20 en Cantabria obligan a actuar a la UME

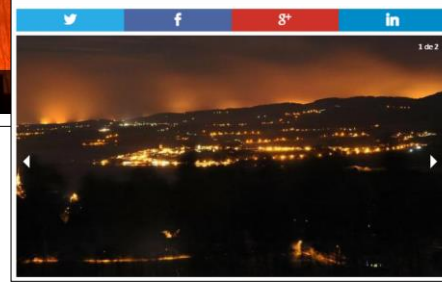
INCENDIOS

Militares y bomberos se vuelcan en la costa Cantábrica para sofocar más de 100 incendios

M.T
Domingo, 20 de diciembre del 2015 - 00:41

comentar [0]

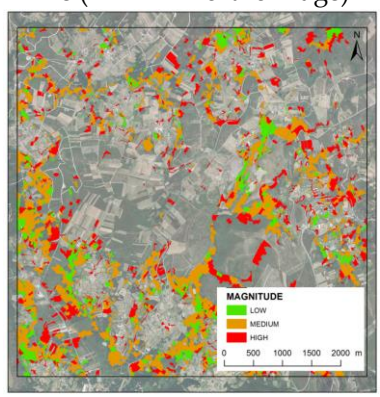
- Movilización absoluta con el ejército incluido para sofocar cerca de 100 incendios en la costa cantábrica con especial intensidad en Asturias. Los incendios podrían haber sido provocados.
- La lluvia se ha convertido en una aliada para poder acabar con los focos.



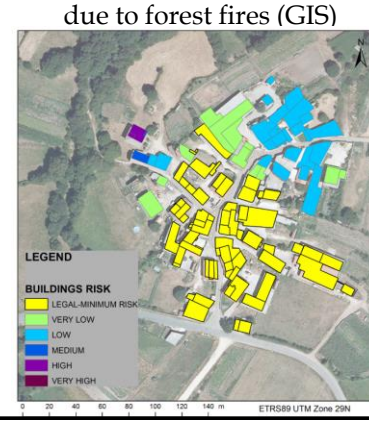
Characterization of the wildland-urban interface using LiDAR data and OBIA as a tool for fire risk prevention at a local scale.

Rodríguez-Garrido M. A., García-López, J.C., Alvarez-Taboada F. (2016)
https://www.dropbox.com/s/9rxgpz4794wct3x/ALVAREZ_Characterization%20of%20the%20wildland_ForestSAT_2016_Proceedings.pdf?dl=0

1. Mapping the forests regarding the magnitude of a possible forest fire (**LiDAR** + orthoimage)

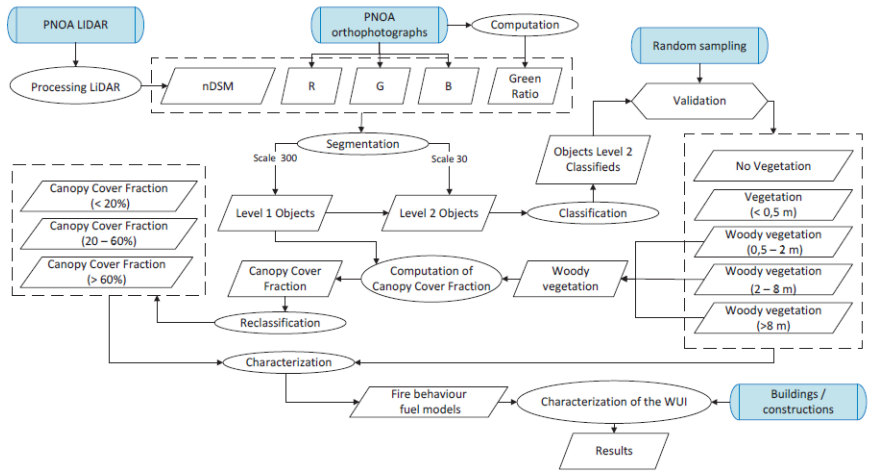


2. Classifying & mapping the buildings according to their risk due to forest fires (GIS)



Characterization of the wildland-urban interface using LiDAR data and OBIA as a tool for fire risk prevention at a local scale.

Rodríguez-Garrido M. A., García-López, J.C., Alvarez-Taboada F. (2016)



OUR LIDAR PROJECTS

TOPOGRAPHIC MAPPING

VALIDATION OF LOW DENSITY LIDAR DATA FOR TOPOGRAPHIC MAPPING (NATIONAL COVERAGE)**

LAND USE CLASSIFICATION

FOREST INVENTORY (TIMBER, BIOMASS, CARBON)

FOREST FIRE RISK ASSESSMENT

PRESCRIBED FIRE MONITORING

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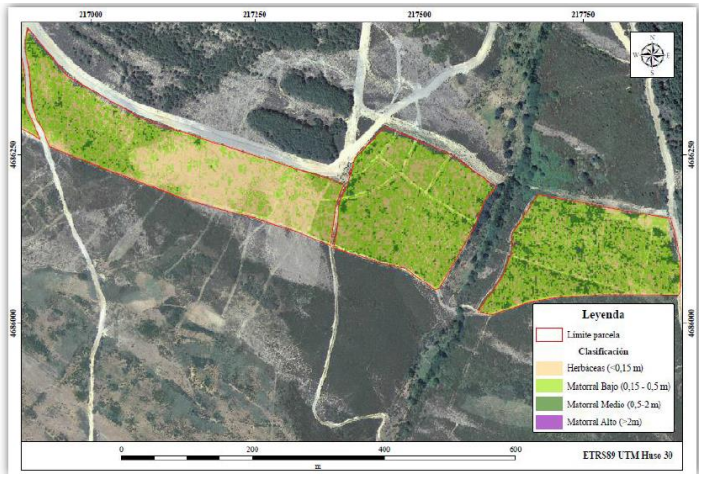
WILDFIRE PREVENTION: CHARACTERIZATION OF FUELS IN PRESCRIBED FIRES USING LIDAR & LANDSAT DATA

Arias-López, D., Castedo-Dorado, F., Alvarez-Taboada F. (2017)

1. Mapping fuel height/cover after prescribed fires (+1, +4, +5 years)

2. Prioritizing the areas for new prescribed fires



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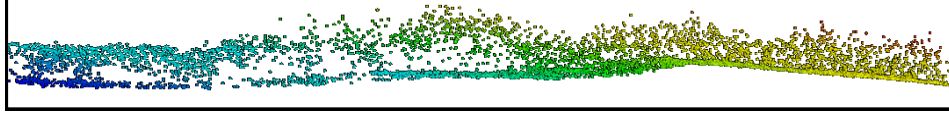
To know more…

Barreiro-Fernández, L., Sandra Buján, David Miranda , Ulises Diéguez-Aranda , Eduardo González-Ferreiro (2016). Accuracy assessment of LiDAR-derived digital elevation models in a rural landscape with complex terrain *J. Appl. Remote Sens.* 10(1), 016014 (Feb 18, 2016). doi:10.1117/1.JRS.10.016014

Buján, S., González, E., Barreiro, L., Santé, I., Corbelle, E., Miranda, D., 2013. Clasification of rural landscapes from low-density LiDAR data: is it theoretically possible? *International Journal Of Remote Sensing*, 34(16), 5666-5689.

Buján, S., González, E., Reyes, F., Barreiro, L., Crecente, R., Miranda, D., 2012. Land use classification from LiDAR data and ortho-images in a rural area. *The Photogrammetric Record*, 27(140), 401-422.

González-Ferreiro E , U Diéguez-Aranda, F Crecente-Campo (2014). . Modelling canopy fuel variables for Pinus radiata D. Don in NW Spain with low-density LiDAR data *International Journal of Wildland Fire* 23 (3), 350-362.



AND… WHAT IS NEXT?

USING IT! (Training WP 4.1)

- LiDAR Workflow

P1. Introduction to LiDAR data processing with FUSION

P2. Outlier removal and LiDAR data filtering

P3. LiDAR data interpolation

P4. Model validation