


**universidad  
de León**

**GEOWEB** 5

TRAINING COURSE ON  
MODERN GEODETIC  
TOPICS

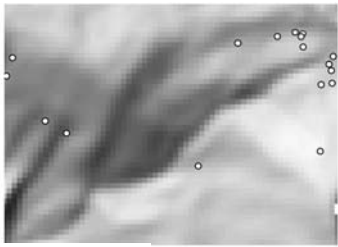


**GI-202 GEONCA**  
Grupo de investigación

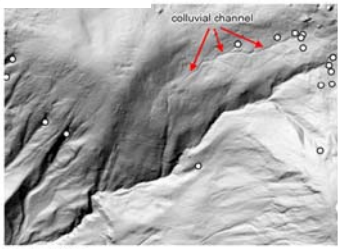
## Mapping with UAVs

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Faculty of Mining Engineering  
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Mostar, 20th october 2017



10m DTM





0.5m DTM

colluvial channel

0 50 100 m

Credits: P. Tarolli

**Overview**


I  
N  
D  
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X

- **Mapping with UAVs, Why?**
- ... , Terminology
- ... , Classification
- ... , Piloting a RPA
- ... , Choosing the Best RPA
- ... , Choosing the best camera
- ... , Planning the Field Work
- ... , Products and Applications
- ... , Our Projects in Ponferrada

Mapping using UAVs: Opportunities, Limits and Challenges - Mostar - October, 20<sup>th</sup> - 2017

**Mapping with Drones, Why?** Scope

**LAND SURVEYING**



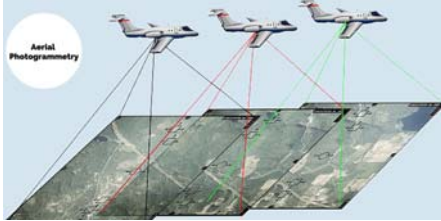
**ADVANTAGES**

- High precision and reliability
- Improved accuracy and efficiency with RTK GNSS

**DISADVANTAGES**

- Field intensive → Expensive
- **Uncompetitive in areas of medium size**

**LIDAR / AERIAL PHOTOGRAMMETRY**



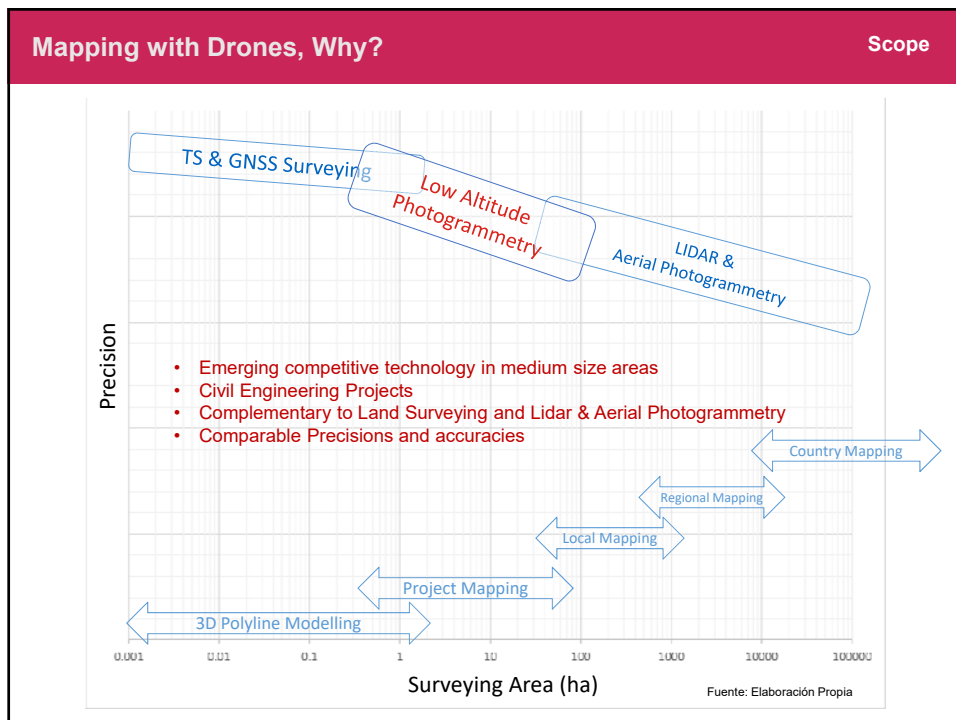
**ADVANTAGES**

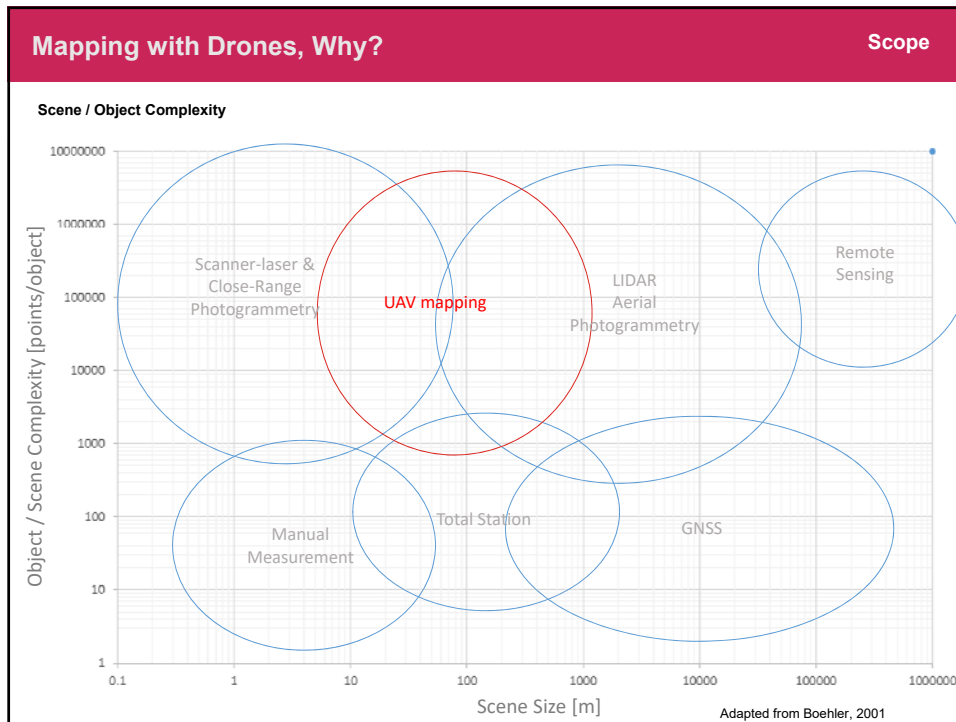
- Highly automatized processing of large areas

**DISADVANTAGES**

- High fixed costs
- Inflexibilities
- **Uncompetitive in areas of medium size**

Mapping using UAVs: Opportunities, Limits and Challenges - Mostar – October, 20<sup>th</sup> - 2017











### Mapping with Drones, Why? Beginning

**Beginning**

The idea of observing the earth from above, and at a distance, without getting on a plane, is not a novel idea.

<p><b>Animals</b></p>  <p>Neubronner, 1903</p>	<p><b>Air balloons</b></p>  <p>Capper, 1907 - Whittlesey, 1970</p>	<p><b>Kites</b></p>  <p>Addison, 1949</p>
<p><b>Helicopters</b></p>  <p>Wester-Ebbinghaus, 1980</p>	<p><b>Motor Paragliding</b></p>  <p>Kvamme et al., 2004; Hailey, 2005</p>	<p>Drones are not new either... - Drones were initially conceived for military applications</p> 


**Mapping with Drones, Why?** **Popularization**

**Popularization**

In the last 3-5 years, drones are becoming new and popular devices for many civil applications as mapping tool due to...

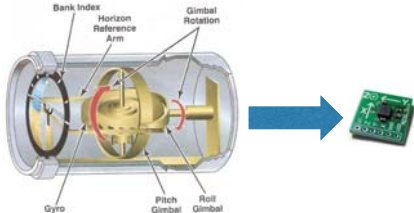
**1) New contributions from research:**

- Robotics
- Computer vision
- Electronics
- Digital Photogrammetry




**2) Cheapening and miniaturization of electronic navigation sensors...**

- GPS
- Accelerometers / Gyroscopes
- Digital compass
- Digital barometer



**... from SmartPhone industry**



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**Mapping with Drones, Why?** **Advantages for mapping**


- The market of drones has increased in the last years and the outlook is very bright
- The potential of Drones for earth mapping is obvious in term of:
  1. Lower cost than alternative technologies
  2. **Higher handiness**
  3. **Higher flexibility**
  4. New flight altitudes
  5. Risk reduction
- Among all the civil applications of drones, Mapping & Surveying is the third-fourth most relevant

Most discussed applications	Global	Europe	US	Asia <sup>4</sup>
Public safety & security <sup>1</sup>	●	●	●	●
Aerial imagery <sup>2</sup>	●	●	●	●
Agriculture	●	●	●	●
<b>Mapping &amp; surveying</b>	●	●	●	●
Energy / Oil & Gas	●	●	●	●
Real estate	●	●	●	●
Delivery & e-commerce	●	●	●	●

**Key:**  
 ● >20% of media  
 ● 10-20% of media  
 ● <10% of media

Source: Quid, BCG analysis, 2016 november

**Overview**



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- Mapping with Drones, Why?
- ... , **Terminology**
- ... , Classification
- ... , Piloting a RPA
- ... , Choosing the Best RPA
- ... , Choosing the best camera
- ... , Planning the Field Work
- ... , Products and Applications
- ... , Our Projects in Ponferrada

Mapping using UAVs: Opportunities, Limits and Challenges - Mostar – October, 20<sup>th</sup> - 2017

**Mapping with Drones, terminology**

**Definitions**

**Terminology**


- **Drone**. Military connotations. Favorite word in press for any small aerial vehicle. 
- **UAV**, "Unmanned Aerial Vehicle". Usual in scientific papers.
- **UAS**, "Unmanned Aerial System", Vehicle + Camera.
- **RPA(S)**. Civil and comercial applications.
  - "Remotely Piloted Aircraft System"
  - "Piloted" sounds less dangerous tan "unmanned"
  - Used by the International Civil Aviation Organization
  - Preferred in Europe
  - Official terminology in spanish legislation

**R**emotely

**P**iloted

**A**ircraft

**S**ystem




**Other terminology**

- **ROA** "Remotely Operated Aircraft"
- **sUAV**, "Small UAV".
- **MAV**, "Micro Aerial Vehicles"

Mapping using UAVs: Opportunities, Limits and Challenges - Mostar – October, 20<sup>th</sup> - 2017

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**Mapping with Drones; Classification**


**Basic Types**

**RPA CLASSIFICATION**

Rotary wing



Fixed wing



**Advantage:**


- Vertical take-off and landing
- Hover capacity
- Flights very close to the ground
- Lower price
- More compact
- Easy of use

**Basic Types**

## Mapping with Drones; Classification

### RPA CLASSIFICATION


#### Rotary wing



**Advantage:**

- Vertical take-off and landing
- Hover capacity
- Flights very close to the ground
- Lower price
- More compact
- Easy of use

#### Fixed wing



**Advantages:**

- Higher flight time  
→ Autonomy
- Increased speed
- Safer recovery from motor power loss

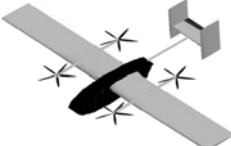
**Disadvantages:**

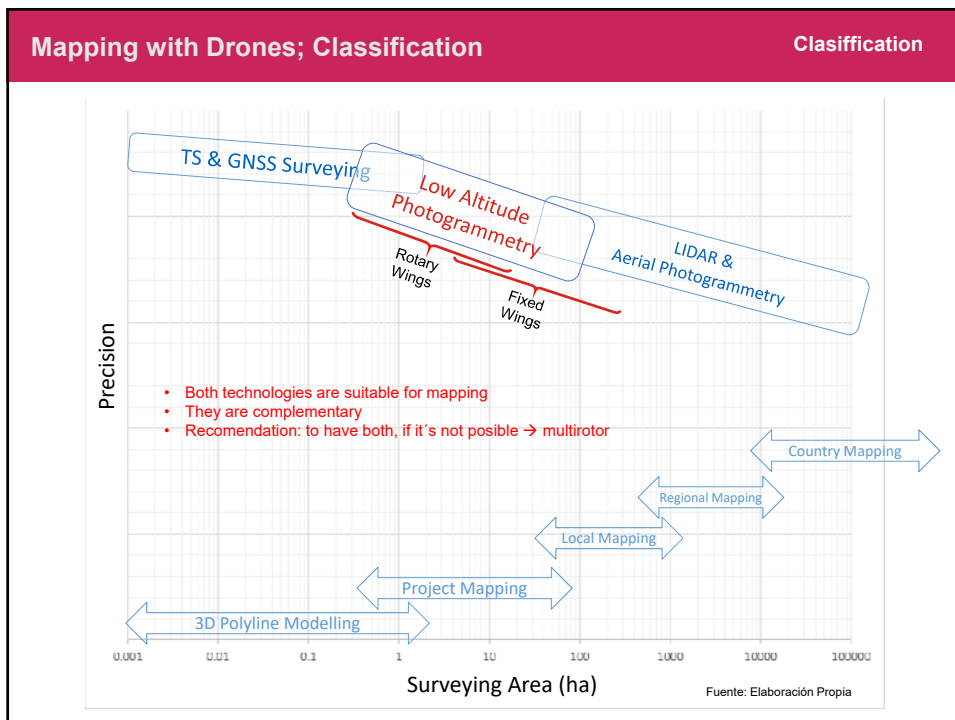
- Larger takeoff/landing zone required



Créditos: Ramiro Saiz

#### Hybrid "VTOL"

- Still developing
- There are no comercial options










Mapping with Drones; Classification		Comparison	
<b>Summary Comparison</b>			
Maneuverability	✓	✗	
Price	✓	✗	
Size / Portability	✓	✗	
Ease-of-use	✓	✗	
Range	✗	✓	
Stability	✗	✓	
Payload Capacity	✓	✗	
Safer Recovery from Motor Power Loss	✗	✓	
Takeoff / Landing Area Required	✓	✗	
Efficiency for Area Mapping	✓	✗	

Credits: adapted from [www.dronedeploy.com](http://www.dronedeploy.com)

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Mapping with Drones; Classification		Rotary Wings	
<b>UAV CLASSIFICATION</b>		<b>Rotary wings</b>	
- Helicopter	- Multirotors	- Tricopter	- Quads
			
		- Disadvantage: Requires moving parts for yaw rotation operation	- The most efficient but less reliable. If an engine fails, they will fall...
		- Hexacopter	- Octacopter
			
- Dangerous			

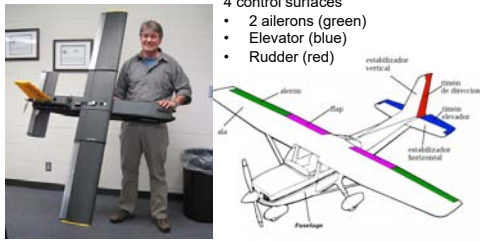


## Mapping with Drones; Classification

**Fixed Wings**

### UAV CLASSIFICATION: FIXED WINGS

**- Airplanes or planes**

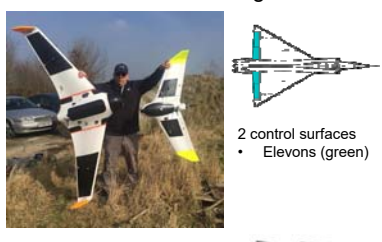


4 control surfaces

- 2 ailerons (green)
- Elevator (blue)
- Rudder (red)

**Advantages:** Better control of plane attitude

**- Elevons o "Fixed Wings"**




2 control surfaces

- Elevons (green)

**Advantages:** more compact and robust designs

**- "V-Tail" designs**




**Advantages:** Intermediate design

## Mapping with Drones; Classification

**Components**

### MAIN COMPONENTS: ELECTRONIC


**Flight controller**



Incorporate


- 1) **Sensors:** Barometer, Accelerometer, Gyroscope, digital compass
- 2) **Microprocessors:** IO sensor read, navigation control computation, data logs
- 3) **Information Leds**
- 4) Accessory **inputs** and servos (actuators) **outputs**

**GPS receptor**




Continuously calculate the position of the UAV with a high refresh rate, then sen to flight controller

**Radio Link**




Communicates the UAV with the pilot


**Security Switch**



**Buzzer**




**Telemetry Link**



Communicate the flight controller to the laptop at control station

**Power Module**




Powers the electronic and also measures the battery voltage and total current consumption

**Mapping with Drones; Classification** **Components**


**MAIN COMPONENTS: POWER SYSTEM**

**Battery**




Power source for  
 1) Motors  
 2) Electronic  
 3) Servos

**ESC (Electronic Speed Controller)**




It controls the voltage (and → current) that reaches the motors


**Servos o Actuators**



They move the control surfaces (Airplanes)




**Motors and Props**



**Mapping with Drones; Classification** **Components**

**OPTIONAL COMPONENTS**


**Precise Positioning**



RTK (Real Time)  
 PPK (Postprocess)

It allows to know the precise coordinates of the photos → **Direct Georeferencing**


**Laser Rangefinder**



Lightware SF02      Lightware SF10


Enhance landing maneuver

**Camera Gimbal**




Improve the control over photos attitude. Multicopter

**AirSpeed Sensor**




It improves landing and slow flight maneuvers and flying on windy days

**Digital Camera**




Mapping with Drones; Classification
Components

### GROUND CONTROL STATION




Laptop




- View all information from the UAV
- 2<sup>nd</sup> control unit for UAV

Radio Control System



Allows the pilot to control the UAV


Telemetry Link



Communicate the computer with the RPAS

Mapping using UAVs: Opportunities, Limits and Challenges - Mostar – October, 20<sup>th</sup> - 2017

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**Piloting a multirotor**


### PILOTING A MULTIROTOR

- To pilot a Multirotor it's very easy
- All multirotor operations for mapping can be **automatized**



However, (In Spain) a pilot must to have

- A theoretical and practical formation
- Special medical certificate



### PILOTING A PLANE

More challenging


- Taking-off
- Landing

**Piloting a plane**


### TAKING-OFF OPERATION (PLANES)

Fixed wings need a minimum of lift to start flying, which is only achieved with a certain initial speed with respect to the air. There are several ways to give that first impulse:


**“By hand”**



Operative, easy and convenient but In aircrafts having Rear Engine could be dangerous




**Catapult**



Complex and Time Consuming. Pneumatic or rubber-based catapults.

**“Bungee”**




Not very professional but it works

**Mapping with Drones; Piloting a RPA** **Piloting a plane**


**LANDING OPERATION (Planes)**

When mapping with plans there is rarely an ideal track on which to land on wheels. The alternatives are:


**“belly-landing”**



**Parachute**




**“Deep Stall Landing”**



The airplane reduces the height at the same time as the speed tilting the nose upwards. The contact with the ground is at the lowest possible speed

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**Mapping with Drones; Choosing the best RPA** 4.1 Comercial Planes

AIRCRAFT PLATFORMS

“Pteryx”



“Trimble UX5 UAS”



“EasyMap”



“Micromaps”



“Aeromao”





“Mavinci / Topcon”



Parrot Ebee




And many more...

**Mapping with Drones; Choosing the best RPA** 4.2 Comercial Multirotors


MULTIROTOR PLATFORMS

“MD4-1000”




Microdrones, Alemania. Uno de los primeros fabricantes especializados en geomática

3DR Solo




3DR, USA

DJI Phantom




DJI. China Económicos.

Aeryon SkyRanger




“Microkopter”


Alemania.




Yuneec



DJI Matrix



Intel Falcon 8



USA

How can I Choose?

### Basic Requirements when choosing a Drone for Mapping Purposes



#### Mission capability

- Waypoints routes
- Camera trigger in WP



#### Camera

- Global Shutter
- Large sensor
- Manual exposure

**No more drone requirements!**

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## Overview



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**Mapping with Drones; Choosing the camera** **4.4 Digital Camera**

**Criteria** when choosing a camera for Mapping Purposes

- Weight**
  - The lighter the better
  - More important in multirotor
- Photo quality**
  - Large sensor (minimum 1")
  - Global shutter (Mechanical or fast)
- Manual Exposure**
  - All photos similar in radiometry
- Quality lens**
  - Fixed focal length (no zoom)
  - Geometric stability (no focusing group)
- Resolution**
  - The higher, the better

The senseFly S.O.D.A. is the first camera to be designed for professional drone photogrammetry




**75g !**  
**1,500\$**

Technical features	
Resolution	20 MP
Ground resolution at 100 m	2.3 cm/px
Sensor size	12.75 x 8.5 mm (1-inch)
Pixel pitch	2.33 um
Image format	JPEG and/or DNG
Upward looking irradiance sensor	No


Characteristics	
High wind & low light conditions	★★★★★
Usability	★★★★★
Mission flight time	★★★★★
Optimised aerodynamic profile	★★★★★
Orthomosaic & DSM	★★★★★
Ground Sampling Distance (GSD)	★★★★★
Band precision	★★★★

**Mapping with Drones; Choosing the camera** **Digital Camera**

**The Best**  
Trimble UAS UX5. → (Sony a7R 36 Mpixel)  
30 000 - 50 000\$




MicroDrones mdMapper  
**1000DG Sony rx1rii & Mount 42.4 megapixel**




30 000\$ - 50 000\$

**The good...**  
DJI Phantom 4 Pro → Global Shutter  
Solo + Sony Qx1



2 000\$ - 2 500\$

**It's OK...**  
DJI Phantom 3, 4 (Rolling Shutter so drone must hover)  
Yuneec → Rolling Shutter (Rolling Shutter so drone must hover)  
Ebee + Canon S100






Multispectral cameras


## Mapping with Drones; Choosing the camera

### MULTIESPECTRAL CAMERAS

**1.- Standard Bayer RGB sensor with manual exposure. (3 channels, RGB)**




Tetracam ADC / Lite




Maplr v2 - RGB

**2.- Modified Bayer RGB sensor (3 channels RGIR)**

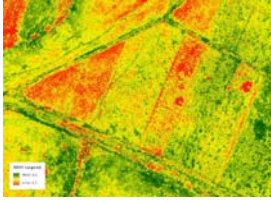
- The original IR-supresion filter is removed
- New filter, blocking short visible wavelengts is added
- Ir radiation is captured in blue channel



Maplr v2



Tetracam ADC



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Multispectral cameras

## Mapping with Drones; Choosing the camera

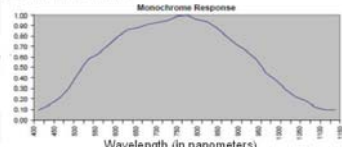
**3.- Panchromatic CMOS sensor + Filter (Fixed or interchangeable)**

Advantages:

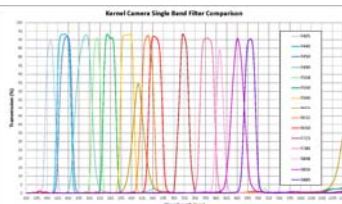
- Higher Selectivity
- Higher dynamic range

**CMOS Sensor Relative Sensitivity**


The graph below shows the relative efficiency of the sensor for different bands of visible and NIR light.



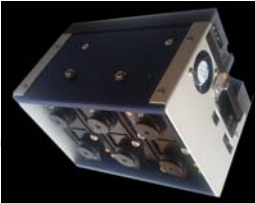
**Kernel Camera Single Band Filter Comparison**




**Parrot Sequoia**



**Tetracam (MCAW)**






**“MapIR Kernel”**

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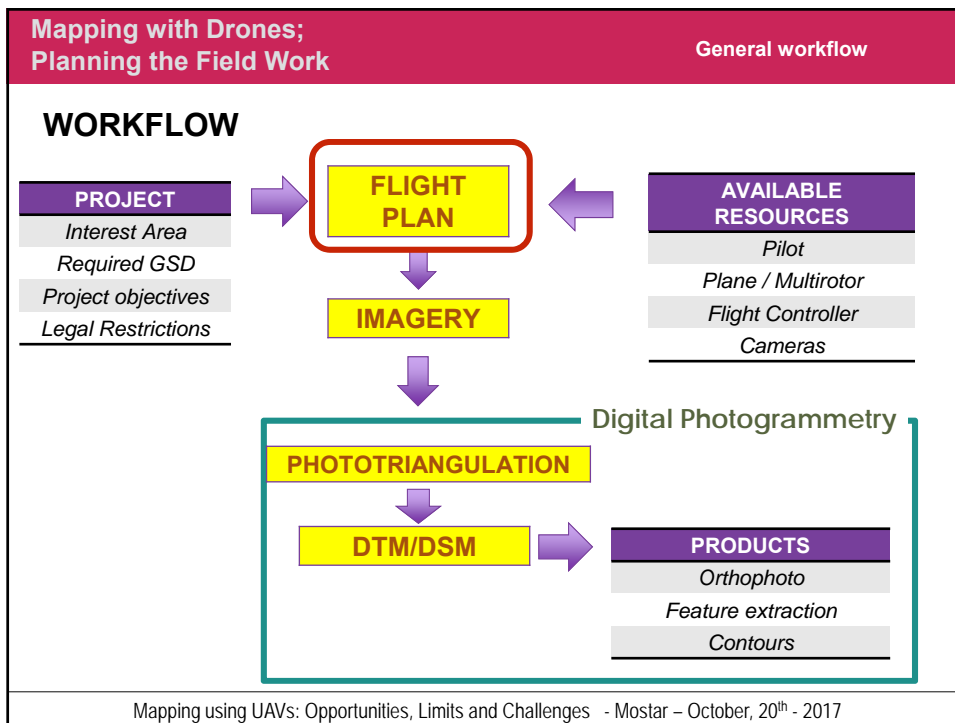
Overview



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**Mapping with Drones; Planning the Field Work** **Flight Design Variables**

**FLIGHT DESIGN VARIABLES**

**Total Area**

- Interest area
- Borders
- Take-off, ascent and landing operations

**Camera**

- Sensor Size
- Focal length
- Resolution

**GSD**

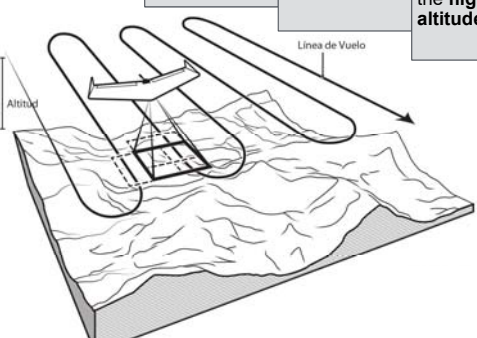
Along with camera resolution determinates the **flight altitude**

**Sidelap**

Depending on the **difficulty** of the terrain

**Required Flight Time**

If it is higher than the autonomy of RPA it will be necessary to make **more flights**.



	Multirotor	Fixed Wing
Flight Time (min)	15	45
Velocity (m/s)	7	12
Lineal Travel (m)	6 300	<b>32 400</b>
		<b>5X</b>

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**Mapping with Drones; Planning the Field Work** **Traditional vs SfM Photogrammetry**

VARIABLES OF DESIGN AND TIME OF FLIGHT: OVERLAPS

Usual overlaps	Longitudinal overlap	Sidelap	Images per point	
Traditional Aerial Photogrammetry	60 %	30 %	2-6	
RPA - SfM Photogrammetry	80 %	65 %	<b>20-50</b>	<b>10x</b>

- In **traditional photogrammetry**, the number of photos is minimized. It requires a camera-intensive stabilization to get perfect zenith photos.
- In **SfM photogrammetry**: High degree of automation → High number of images allowed → High redundancy: Contributes positively to 3D model reconstruction
  1. Increases likelihood of success in alignment of photos
  2. Enhances camera auto-calibration
  3. Avoid shaded (without points) areas

CONS: High overlaps generate very long flights and projects with a large number of photos

## Mapping with Drones; Planning the Field Work

### Control Points

#### CONTROL POINTS

**Control points** are visible elements in photographs of which their precise coordinates are known. They serve to georeference the photogrammetric model.

- Landscape elements (stones, plants, corners, poles)
- "ad hoc" targets → Presignaling

Presignaling has to be done before flight, which is difficult with conventional photogrammetry, but easy with photogrammetry with UAV images.

#### Advantages:

- The visibility of the control is guaranteed
- Flat signaling elements are used
- Once the flight is done, it is not necessary to return to the field

#### Recommendations:

- High reflectivity materials such as white plastics
- Round or square targets
- Large size, around 10-15GSD side or diameter





## Mapping with Drones; Planning the Field Work

## Quality Evaluation

### GROUND CONTROL POINTS

- The **more control**, the **better accuracy**
- The points must be **homogeneously distributed** throughout the entire area
- When few points are available most should be on the **periphery** of work, but some must also be at the **center** of the survey

### QUALITY CONTROL

- The quality must be measured at independent **checkpoints**, not at control points
- The maximum accuracy to be expected is:
  - \* Planimetry, GSD
  - \* Vertical, GSD \* 3



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 Grupo de Investigación

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Mapping with Drones;  
 Products and Applications

Mapping Products

**Drone Mapping Photogrammetric Products**

Orthophoto



DEM / DTM / DSM



Points Clouds



Reflectance / Ratios Maps



3D Models




Contours




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**Mapping with Drones; Products and Applications** **Comercial Applications**


**Urbanism and cadastre**




**Mining Management**



**Archeological documentation**



**Stock Piles Measurement**

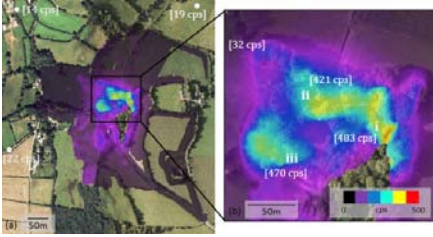


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**Mapping with Drones; Products and Applications** **Research Areas**

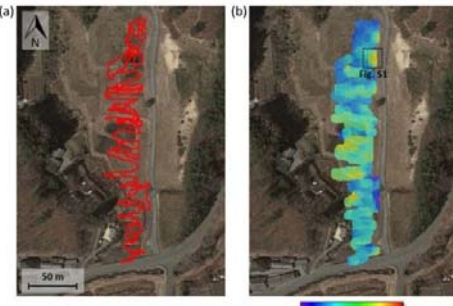
**Research Drone Mapping Applications**

**Mapping of legacy uranium mines**



P.G.Martin et al. The use of unmanned aerial systems for the mapping of legacy uranium mines. Journal of Environmental Radioactivity. Volume 143, May 2015, Pages 135-140

**Vehicle radiation mapping for assessing contaminant distribution and mobility**

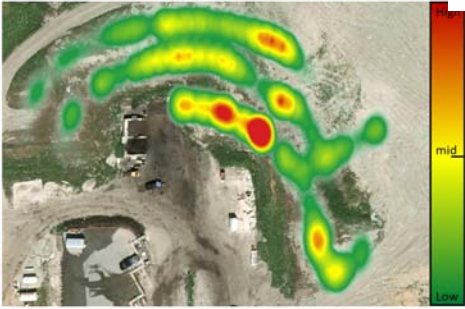


P.G.Martin et al. International Journal of Applied Earth Observation and Geoinformation Volume 52, October 2016, Pages 12-19

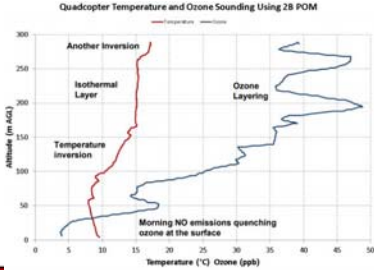
**Mapping with Drones; Products and Applications** **Research Areas**

**Air Quality and Meteorological Measurements**

**Methane Concentration Mapping**



**Quadcopter Temperature and Ozone Sounding Using 2B POM**



Robert A. Baxter

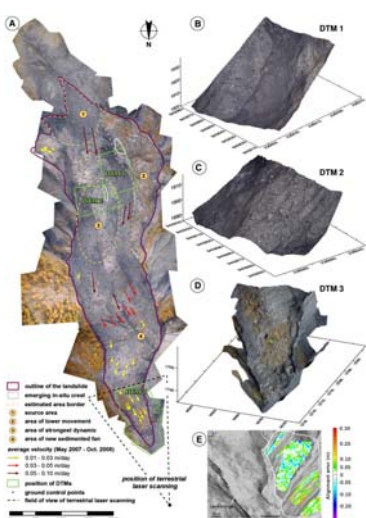
[Bara J. Emran et al.](#) Low-Altitude Aerial Methane Concentration Mapping

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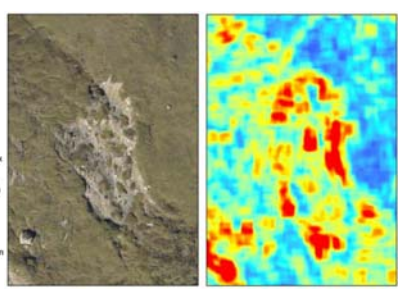
**Mapping with Drones; Products and Applications** **Research Areas**

**Drone Mapping Applications (Research)**

Landslide evaluation



Landslide detection



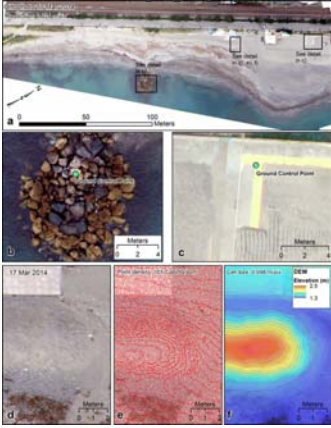
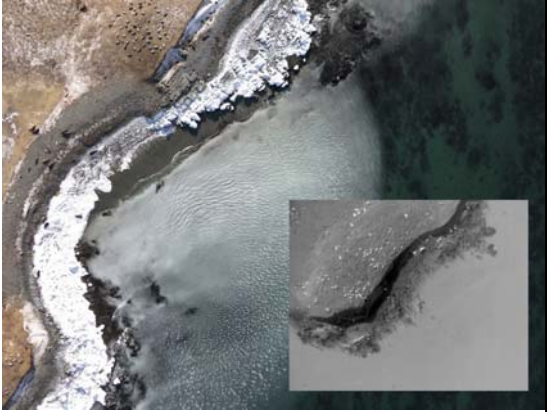
U.Niethammer et al. UAV-based remote sensing of the Super-Sauze landslide: Evaluation and results. Engineering Geology Volume 128, 9 March 2012, Pages 2-11



**Mapping with Drones; Products and Applications** Research Areas

**Drone Mapping Applications (Research)**

**Monitoring Coastal changes and beach topography**

**TRACKING COASTAL CLIMATE CHANGES**




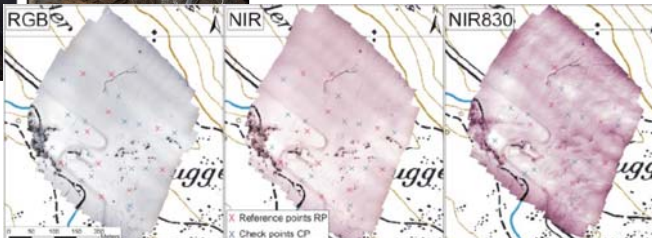
Mapping using UAVs: Opportunities, Limits and Challenges - Mostar - October, 21<sup>th</sup> - 2017

**Mapping with Drones; Products and Applications** Research Areas

**Drone Mapping Applications (Research)**

**Glacier dynamics**

W.W.Immerzeel et al. High-resolution monitoring of Himalayan glacier dynamics using unmanned aerial vehicles  
Remote Sensing of Environment  
Volume 150, July 2014, Pages 93-103

**Snow Cover Mapping**

**Mapping with Drones; Products and Applications**

**Research Areas**

**Agronomy Management and Forestry Inventory**

Adaptive Estimation of Crop Water Stress in Nectarine and Peach Orchards Using High-Resolution Imagery from an Unmanned Aerial Vehicle (UAV). Remote Sensing.

Detection and Segmentation of Vine Canopy in Ultra-High Spatial Resolution RGB Imagery Obtained from Unmanned Aerial Vehicle (UAV): A Case Study in a Commercial Vineyard  
[Carlos Poblete-Echeverría et al](#)

Dr. Chungan Li. China's Guangxi Forest Inventory and Planning Institute

**Mapping with Drones; Products and Applications**

**Research Areas**

**Wildlife research**

Photographs taken from UAS demonstrating (a) a group of killer whales (platform: APH-22 hexacopter, study by NOAA) and (b) a foraging sea otter (platform: Aeryon Scout, study by the University of Alaska Coastal Marine Institute).

Infrared images taken with an Aeryon Scout UAS of caribou (a) in an open field and (b) in a patch of forest.

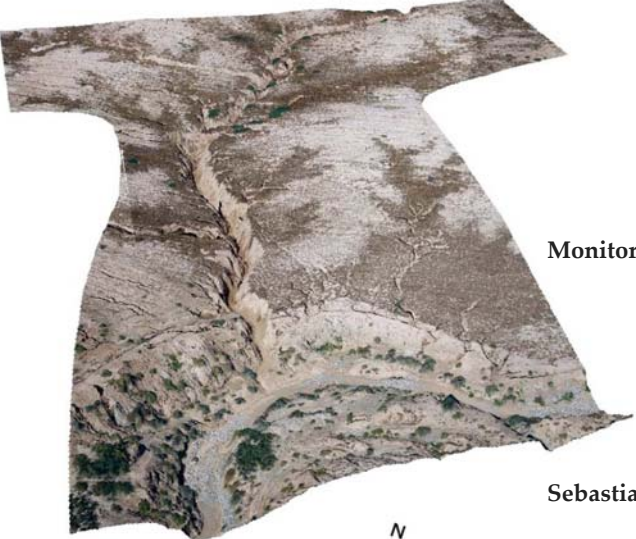
Cape Wrangell Steller sea lion rookery at Attu Island, Alaska.

Credits: Katherine S Christie et al.

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**Mapping with Drones;  
Products and Applications** Research Areas

**Erosion**




**Monitoring Soil Erosion in Morocco**

Sebastian d'Oleire-Oltmanns et al

N

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**Overview**



**I  
N  
D  
E  
X**

- Mapping with Drones, Why?
- ... , Terminology
- ... , Classification
- ... , Piloting a RPA
- ... , Choosing the Best RPA
- ... , Choosing the best camera
- ... , Planning the Field Work
- ... , Products and Applications
- ... , **Our Projects in Ponferrada**

Mapping using UAVs: Opportunities, Limits and Challenges - Mostar - October, 20<sup>th</sup> - 2017

**GI-202 GEINCA**  
Grupo de investigación

**RPAS available in Ponferrada**



**Fixed Wing X5**  
- Cameras RGB e IR  
- Working area 100ha



**Fixed Wing X8**  
- Mapping upto 1200ha



**Multirotor**  
- Small areas



**Phantom 3 Professional**



**Samsung NX 500**



**Mapir V2 cameras**

***"Utilización de UAV en la Gestión de Los Recursos Mineros de Castilla y León"***

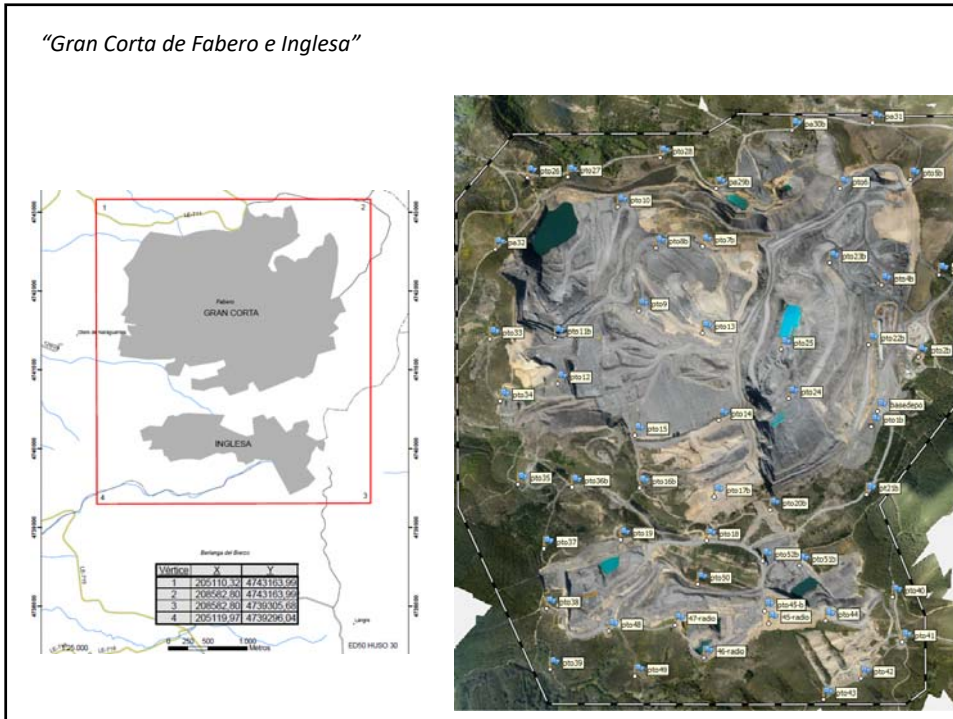
**Mining Activity Control by Regional Government**



Zona	Provincia	Tipo Minería	Superficie (ha)
Los Santos Fuenterrobles	Salamanca	Metálica	268
Mina Santa Lucía "La Pastora"	León	Carbón	1 253
Alto Bierzo y Alto Bierzo II	León	Carbón	612
Cortas de Barruecopardo	Salamanca	Metálica	344
San Pedro de Trones - Sotillo	León	Pizarra	467
San Pedro de Trones - Armadilla	León	Pizarra	466
San Pedro de Trones - Arcas	León	Pizarra	1 092
Gran Corta de Fabero e Inglesa	León	Carbón	1 141
<b>TOTAL</b>			<b>5.643</b>

Mapping using UAVs: Opportunities, Limits and Challenges - Mostar - October, 20<sup>th</sup> - 2017

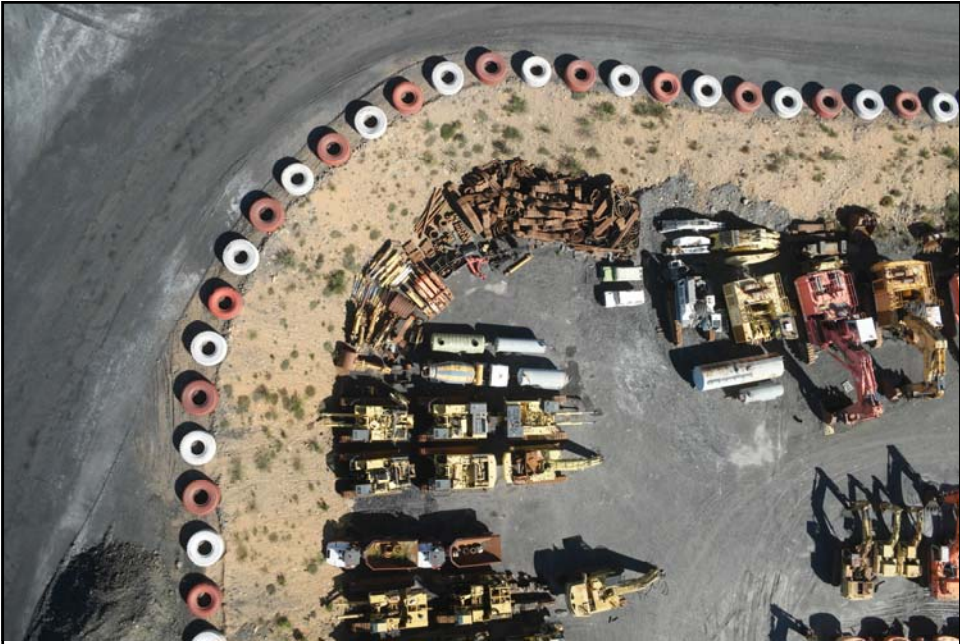
*"Gran Corta de Fabero e Inglesa"*



Mapping using UAVs: Opportunities, Limits and Challenges - Mostar - October, 20<sup>th</sup> - 2017

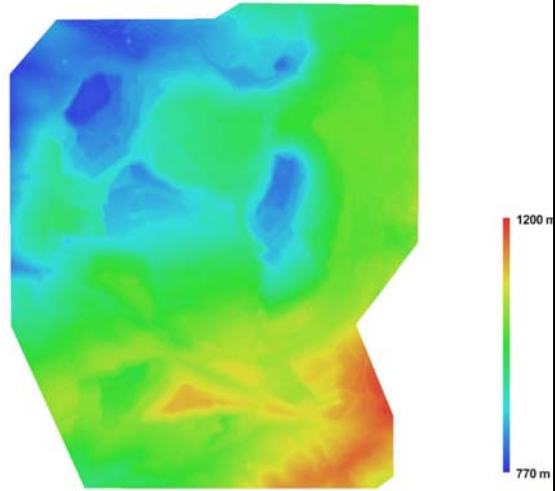


Mapping using UAVs: Opportunities, Limits and Challenges - Mostar - October, 20<sup>th</sup> - 2017



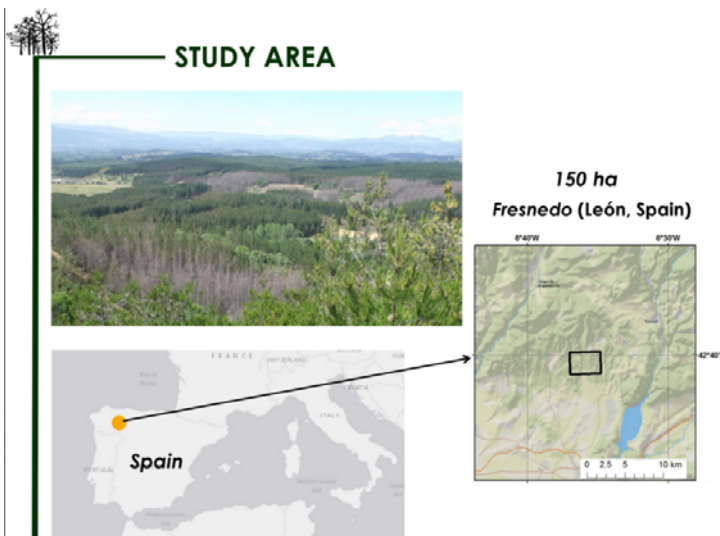
Mapping using UAVs: Opportunities, Limits and Challenges - Mostar - October, 20<sup>th</sup> - 2017

Productos Fotogramétricos



Mapping using UAVs: Opportunities, Limits and Challenges - Mostar - October, 20<sup>th</sup> - 2017

Seguimiento y Bases para la Gestión de las Masa Forestales Afectadas por Defoliación de Lymantria en Fresnedo



Mapping using UAVs: Opportunities, Limits and Challenges - Mostar - October, 20<sup>th</sup> - 2017

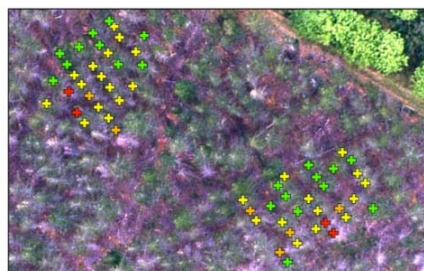
Project: "Seguimiento y Bases para la Gestión de las Masa Forestales Afectadas por Defoliación de Lymantria en Fresnedo"



Mapping using UAVs: Opportunities, Limits and Challenges - Mostar - October, 20<sup>th</sup> - 2017

Seguimiento y Bases para la Gestión de las Masa Forestales Afectadas por Defoliación de Lymantria en Fresnedo

- FieldWork
- Landsat OLI
- RPA Images



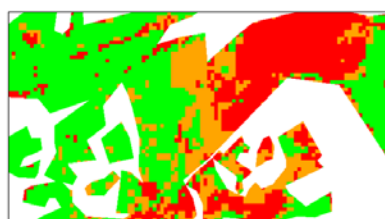
Mapping using UAVs: Opportunities, Limits and Challenges - Mostar - October, 20<sup>th</sup> - 2017



### Seguimiento y Bases para la Gestión de las Masa Forestales Afectadas por Defoliación de *Lymantria* en Fresno

- Cartografía precisa del área afectada
- Clasificación automática en función del grado de afectación

Landsat OLI	Validation				UA (%)	UAV RGB	Validation				UA (%)
Classification	1	2	3	Total		Classification	1	2	3	Total	
No defoliation (1)	35	0	0	35	100.00	No defoliation (1)	37	6	3	46	80.43
Intermediate (2)	2	16	0	18	88.89	Intermediate (2)	0	9	1	10	90.00
Total defoliation (3)	0	0	31	31	100.00	Total defoliation (3)	0	2	27	29	93.10
Total	37	16	31	84	-	Total	37	17	31	85	-
PA (%)	94.59	100.00	100.00	<b>OA (%): 97.61</b>		PA (%)	100.00	52.94	87.10	<b>OA (%): 85.88</b>	



None Intermediate Total



0 250 500 1,000 m

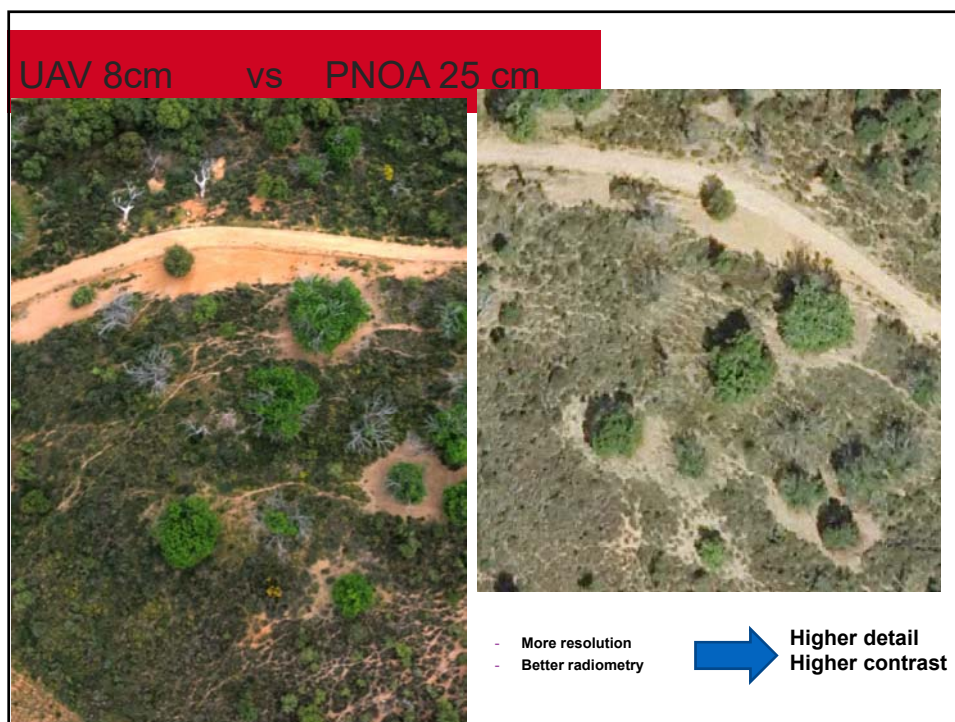
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### Project: "Estudio de los niveles de severidad por chancro del castaño en el noroeste de España"

Chancro del Castaño is a fungal disease whose most characteristic symptom is the presence of cankers on the trunk, branches or shoots



Mapping using UAVs: Opportunities, Limits and Challenges - Mostar - October, 20<sup>th</sup> - 2017

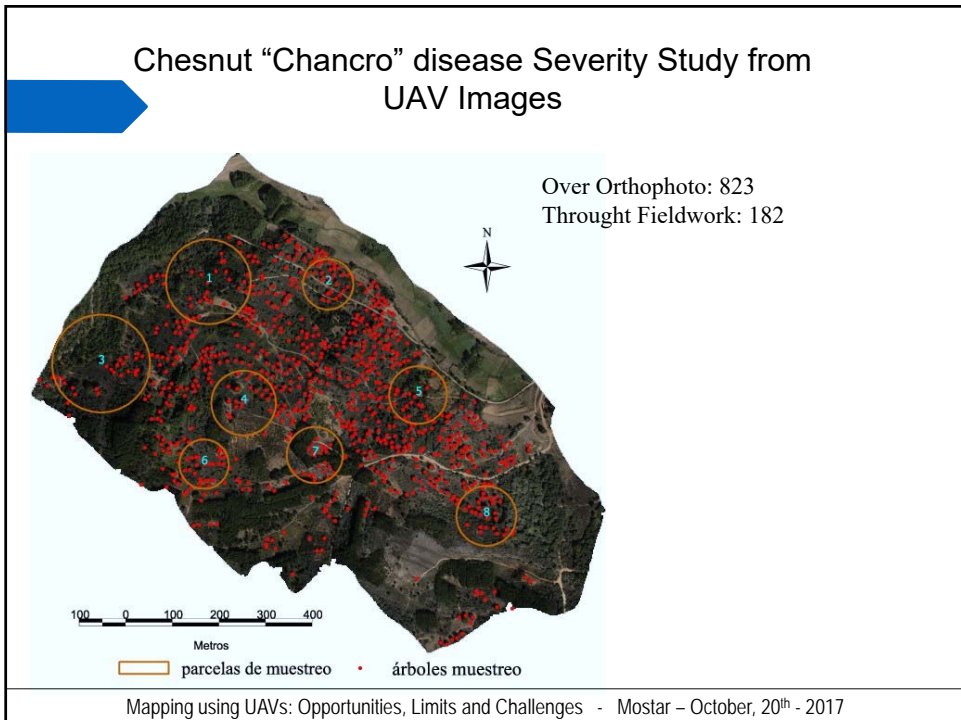


### RPA (Developed in 2012)




Plataforma	Skywalker X8 Fixed Wing
Wingspan	2,3m
Flight Controller	Opensource (hw APM 2.5 con fw Arduplane 2.3)
GPS	L1 - Ublox Neo 6M
Telemetry	433Mhz – 100mw 2,4Mhz- 100mw
Autonomy	35 min – 35km
Digital Camera	Canon Powershot S100 12 MPix

Mapping using UAVs: Opportunities, Limits and Challenges - Mostar – October, 20<sup>th</sup> - 2017

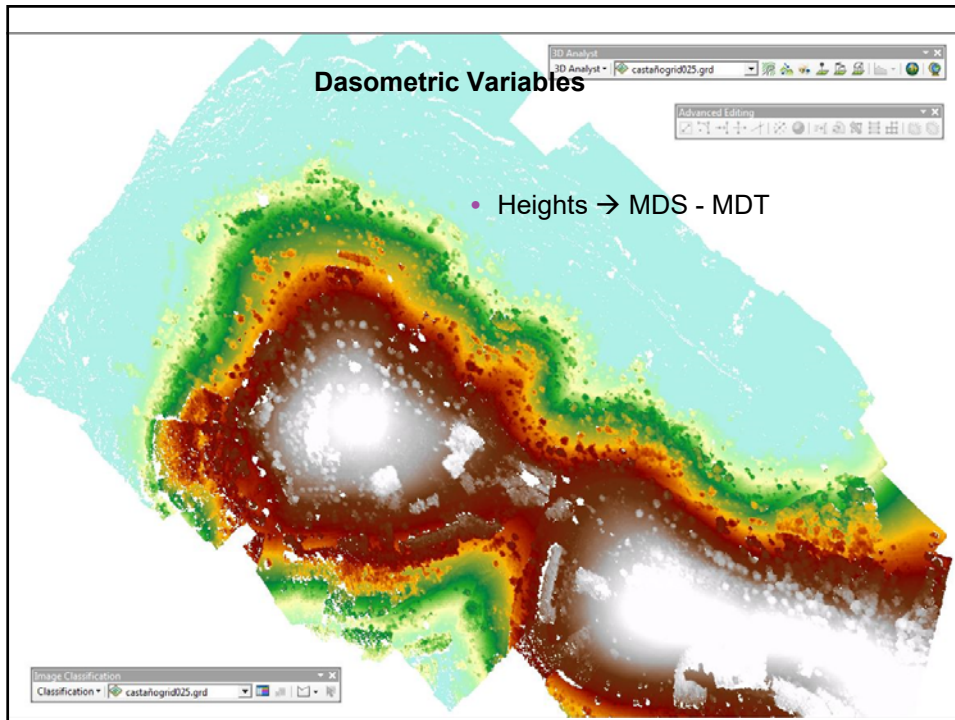


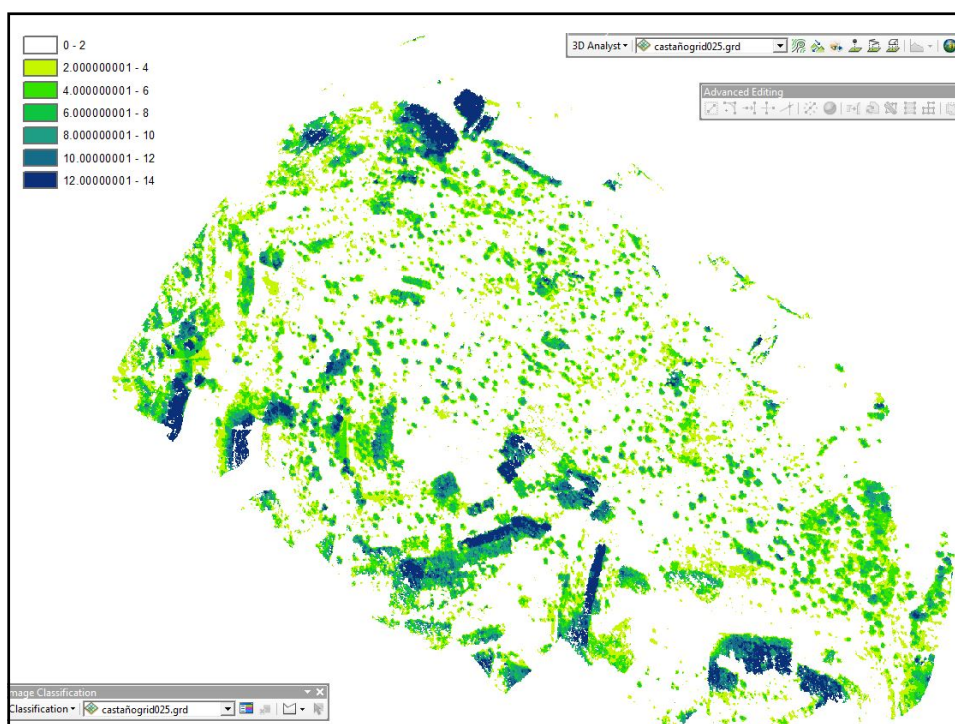
## Orthophoto Severity Evaluation Code



Code	0	1	2	3	4
Damage (%)	0	0-25	26-50	51-75	76-100

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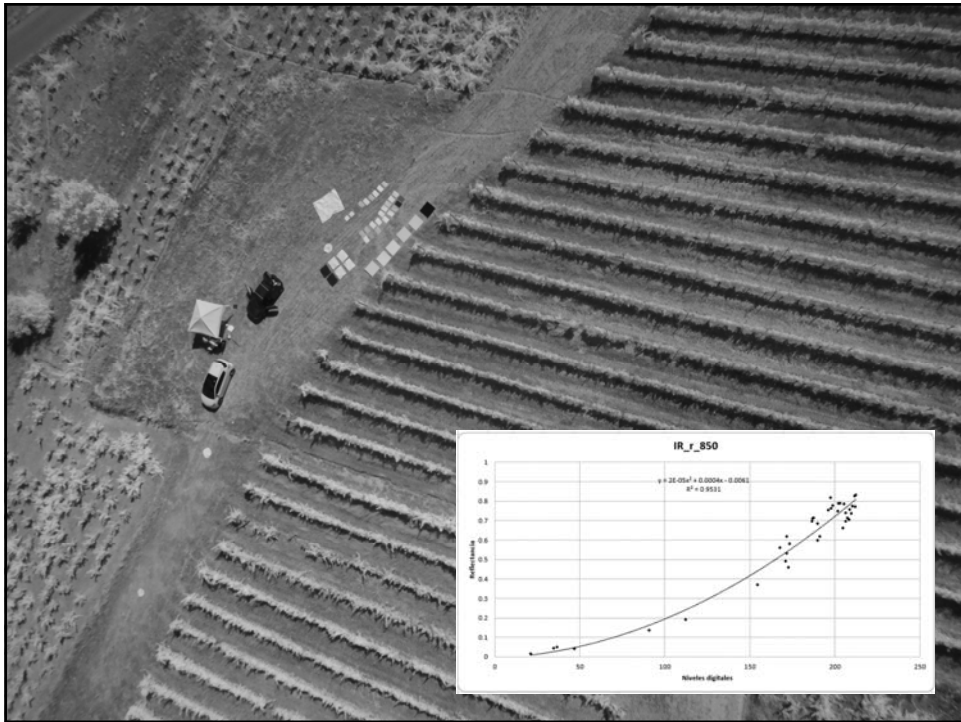
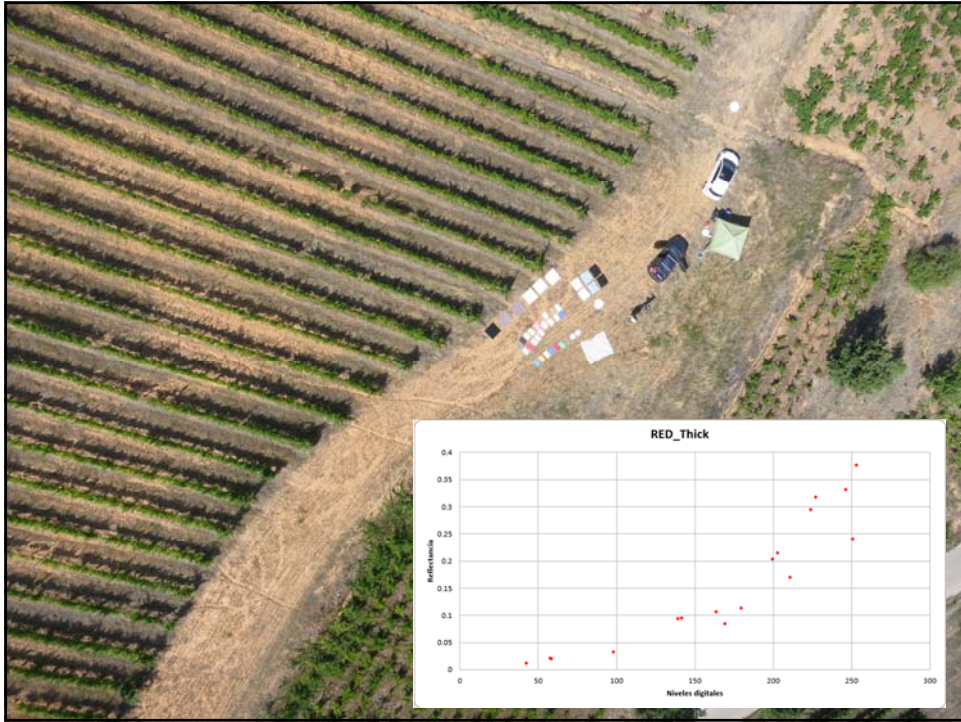


## Determinación de variables Vitivinícolas desde Imágenes Aéreas tomadas desde UAV

- El objetivo es el de tratar de zonificar en calidades una viña utilizando imágenes aéreas tomadas desde un Multitrotor
- RGB e IR
- Se tomaron muestras de suelo, de uva, de sarmientos...
- Ensayos de laboratorio



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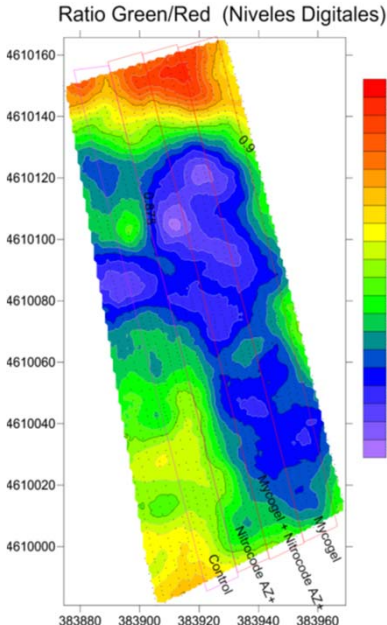




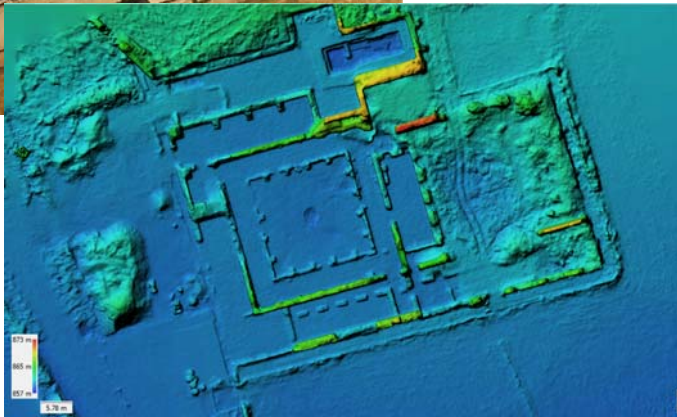
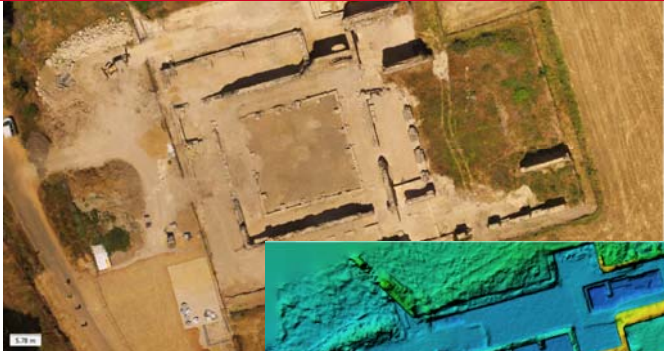
Project: "Early detection of Fungus Armillaria in Pear Trees"



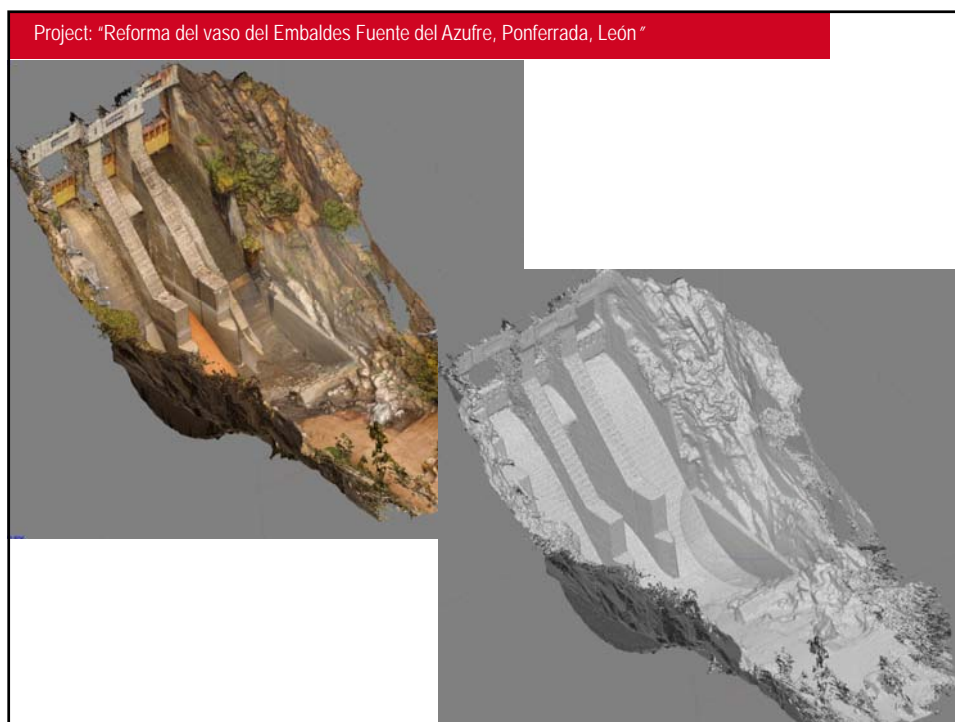
Project: "Testing treatments efficacy on Vineyards "



Project: "Metric Survey of Monasterio de Eslonza, Leon"







Project: "*Estimación de pérdida de suelo tras un incendio utilizando fotogrametría con imágenes UAV*"

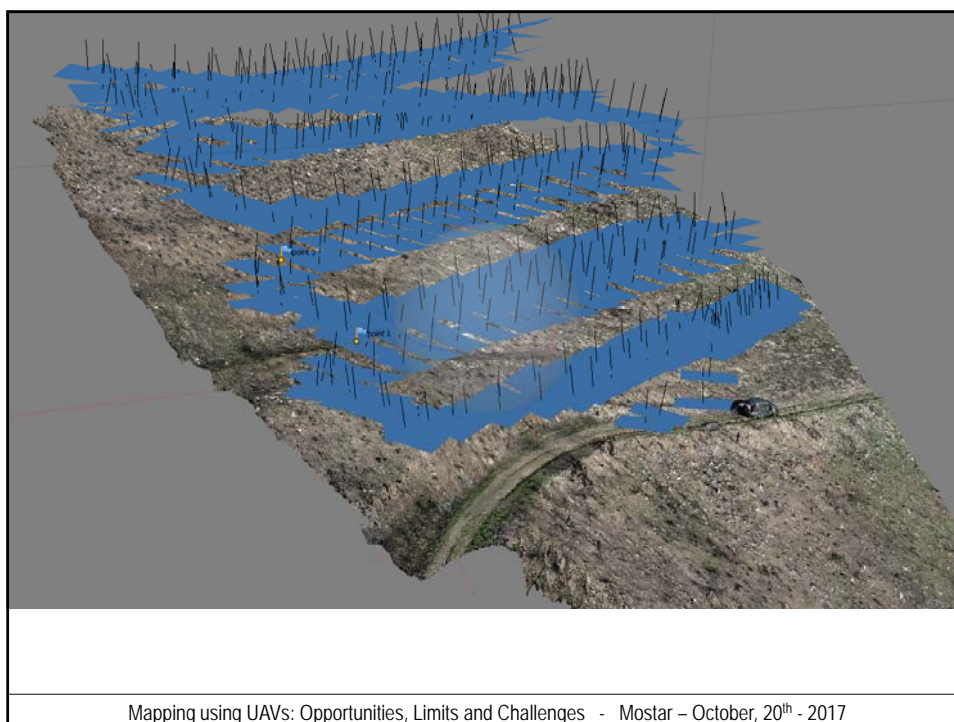
**AIM:**

Measure soil erosion  
after a forest fire



Mapping using UAVs: Opportunities, Limits and Challenges - Mostar - October, 20<sup>th</sup> - 2017





**GEOWEB 5**  
 TRAINING COURSE ON  
 MODERN GEODETIC  
 TOPICS

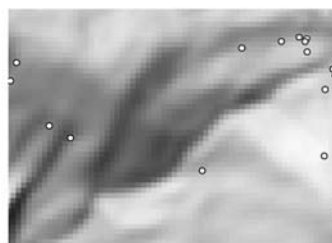
**GI-202 GEONCA**  
 Grupo de Investigación

- I hope this class encourages you to start mapping with RPAs.
- It is neither too expensive nor difficult
- Many research opportunities open up.

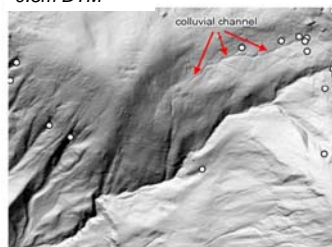
**Enoc Sanz Ablanedo**  
 Universidad de León  
 Faculty of Mining Engineering  
[esana@unileon.es](mailto:esana@unileon.es)

Mostar, october 20th 2017

10m DTM



0.5m DTM



Credits: P. Tarolli