Airborne Remote Sensing for detection and monitoring Albanian cannabis plantations

2018, 30th November
benecon a bridge between the world of knowledge and the world of know-how

Benecon features a human resource of 250 researchers, belonging to four athenaeums (Napoli Second University, Napoli Federico II University, Sannio University, University of Salerno), and a resource of scientific instruments of about 9.6 millions euro.

The Center created a network for the upgrading of multicriteria competences for the technological transfer and support to the territorial stakeholders.

Regional Research Center Benecon
Project Leader Prof. Ant. Casarino
Scientific and Technical Board (CST):
- Prof. G. Ruocco (Napoli Second University)
- Dr. L. Casarino (University of Salerno)
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environment representation structures
BENECON increases its asset

The TECNAM P2006T Aircraft

- Tecnam P2006T is a twin-engine four-seat aircraft
- The superior high-wing configuration offers stability, superior cabin visibility and easy access for passengers and equipment
- The specifically modified version to carry out airborne remote sensing actions, the Tecnam P2006T provides inside the presence of special trapdoors to host the on-board sensors
- Integral fuel tanks are located outboard of the engines, holding 100 litres each for a total of 200 litres
- Particular attention has been paid to the cabin’s structural design in order to ensure the required crashworthiness as prescribed in recent amendments to the FAA-FAR23 and EASA-CS23 codes.
- The engines have automatic mixture adjustment, so there is no mixture control required on the panel. The link between the flight controls and the flight surfaces is by pushrod, rather than the usual cables
As the eyes perceive passively radiation emitted by the light sources (natural or artificial) and refracted by the objects, so the sensors:

- hyperspectral sensor records passively radiation emitted by natural and artificial elements below in specific segments of the light spectrum

- high resolution photogrammetric camera measuring the three-dimensional reality of the Territory through photogrammetric pairs at very high resolution.
Airborne Remote Sensing

Open-source platform

Hyperspectral sensor

- Data type: Multidimensional images save 'invisible' territory data in a large number of bands between 370 and 1040 nm
  - Ground resolution > 40 cm

Very-High definition Medium format camera

- Data type: Multidimensional images save 'invisible' territory data in a large number of bands between 370 and 1040 nm
  - Ground resolution > 40 cm

Data type: Thermal images of the investigating surface

- Sensitivity > 0.5 °C

Hyperspectral 3D modelling

- Orthographic Nadiral Images 80Mpx
  - Ground resolution > 1 cm
From the Flight Path to the Plantation report

1. FLIGHT PLAN
2. ACQUISITION FLIGHT
3. RAW DATA STORAGE
4. NAVIGATION DATA PROCESSING
5. CASI IMAGES PROCESSING
6. ROI CREATION
7. PLANTATION REPORT
Research Laboratory and work flow

- Flight-planning
- Acquisition
- Processing
- Analysis

The team:

- Draws Flight plans
- Monitors flights
- Stores data acquired
- Processes data acquired by five different sensors
- Integrates data for complex analysis
- Analyzes the cannabis’ spectral signatures
- Draws thematic maps
- Perimeters and calculates the position of the cannabis plantations

All the collected data will be necessary to define the semi-automatic algorithm to detect cannabis plantations all over the World.
Airborne Remote Sensing data and Analysis data are collected and managed in the Geographic data-base.
Each plantation is identified by:

- **ID Code**
- **Geographic coordinate**
- **Spectral signature**
- **Area**
- **Hyperspectral picture**
- **Photographic picture**
Plantation Report example delivered to Albanian State Police

Each plantation is identified by
ID Code / Area / Growth status / Flight date / District / Municipality / Geographic coordinate

Each plantation is described by
spectral signature / hyperspectral image / photographic image
CONVENZIONE PER ATTIVITA’ DI TELERILEVAMENTO MEDIANTE SENSORI AVIOTRASPORTATI TRA
il Comando Generale della Guardia di Finanza, con sede in Roma, Viale XXI Aprile, 51, in persona del Capo di Stato Maggiore del Comando Generale

e

il CRdC Benecon Centro Regionale di Competenza “Boni culturali, ecologia, economia per il recupero produttivo, la riconversione ecocompatibile e il design di supporto di sistemi ambientali e valenza culturale” (in seguito denominato CRdC Benecon) Consorzio interamente a capitale pubblico di quattro Università della Campania (Campofelice, Seconda Università degli Studi di Napoli, Federico II, Università del Sannio, Università di Salerno) con sedi operative presso le Facoltà di Architettura Luigi Vanvitelli in Aversa (CE), alla Via S. Lorenzo, Monastero di San Lorenzo ed Scuolamuseo e in Finanzia (CE) in persona del Prof. Arch Camine Gambardella, Presidente della Facoltà di Architettura e Presidente del CRdC Benecon, il Rettore della Seconda Università degli Studi di Napoli, Prof. Francesco Rossi.

premesso che

il Centro Regionale di Competenza “Boni culturali, ecologia, economia per il recupero produttivo, la riconversione ecocompatibile e il design di supporto di sistemi ambientali e valenza culturale” – BENECON” nella realizzazione del proprio progetto ha acquisito sofisticate strumentazioni per il monitoraggio, l’analisi e lo studio ambientale del territorio, sia da terra che da piattaforma aerea;

il CRdC Benecon, a supporto delle proprie attività, ha costituito un potente centro di riferimento, già operativo, per l’elaborazione e l’ottimizzazione dei dati acquisiti, che comprende la rappresentazione tridimensionale georeferenziata del rilevato e la modellazione atta ad effettuare simulazioni dinamiche di eventi calamitosi e/o previsionali nel campo ambientale sia terrestre che marino;

è interessato del CRdC Benecon non soltanto incrementare le proprie esperienze in settori di intervento scientificamente consolidati, ma anche individuare e mettere a punto nuove metodologie di monitoraggio, analisi, studio ed intervento ambientale mediante l’applicazione integrata di avanzate tecnologie a mare, sul territorio, avvistamento e da piattaforma satellite;

a tal fine, è intenzione del CRdC Benecon avviare alcuni innovativi progetti modulari di ricerca applicata pluridisciplinare, che richiedono anche il compimento di attività di telerilevamento aereo;

il CRdC Benecon non dispone di veicoli per l’utilizzo dei propri sofisticati sensori avitrasportati;

ART. 6 (Durata della convenzione)
La presente convenzione ha durata pari ad anni 2 (due) a decorrere dalla data di sottoscrizione ed alla scadenza è tacitamente rinovata per un ulteriore biennio, fatto salvo la facoltà per ciascuna delle Parti di:
a. proponere, in qualsiasi momento, la modifica del contenuto dell’accordo. detta modifica opererà solo in caso di accordo dalla controparte;
b. manifestare, entro la scadenza del biennio di operatività, la volontà di non dar luogo al rinnovo tacito;
The Air fleet of Guardia di Finanza GEA - Gruppo Esplorazione Aeromarittima

The P180 Avanti II aircraft to three surfaces, one of a kind, that contribute to the optimization of the performance in terms of higher speed, lower power consumption and greater autonomy. Because of these characteristics is used as a tactical transport aircraft for the fast operational units and support vehicles and personnel employed outside air.

The Piaggio P166 plane, used for maritime air medium-long range exploration, is characteristic for the wing to "gull" and engines with pusher propeller. On the P166 version DP1 are installed engines P & WC PT6A-121, the most powerful and highest performing and a new supply system and fuel system. The carriers, supplied with the GEA perform, in addition to a training function, tasks of exploration and maritime patrol, search and rescue and anti-pollution prior surveillance through the use of a sensor for remote sensing.

The aircraft ATR42MP (Multi purpose) is a twin-engine turboprop, characterized by a wide fuselage where the heart is the seat of the operating system, the ATOS (Airborne Tactical System Operator): from the console you can control various operational mission sensors interfaced and integrated by a sophisticated computer management. This aircraft is dedicated to operational missions such as Maritime Patrol (Maritime Patrol), the airdrop Paratroopers (Paratroops), Evacuation Health (Medevac), the passenger transport / troop (Passengers) and the transport of goods / materials (Cargo). Its high degree of autonomy (7 hours in research) makes it suitable for long-range patrols, with frequent transfer also in international contexts.
Source: Guardia di Finanza / Benecon
Source: Guardia di Finanza / Benecon
The Lazarat case
Lazarat 2007, July 26th

Source: satellite image
Lazarat 2011, September 2nd

Source: satellite image
Lazarat 2013, July 22th

Source: Guardia di Finanza / Benecon
Lazarat 2015, July 23th

Source: Guardia di Finanza / Benecon
Lazarat 2013, July 22th

Lazarat 2015, July 23th

Source: Guardia di Finanza / Benecon
2013_LAZARAT

Cannabis' plantation area

319 hectares

Multispectral satellite image by EROS-B

anthropized area
2013 LAZARAT

Cannabis plantation area

319 hectares

Hyperspectral Image by CASI 1500

anthropized area
Airborne Remote Sensing Missions: chronological table

The following data are not comparable analytically, because they refer to Albanian areas geographically close, but not perfectly overlapping; and then the total amount of scanned Albanian surface was different year by year.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERIOD (months)</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>FLIGHT MISSIONS</td>
<td>12</td>
<td>25</td>
<td>39</td>
<td>39</td>
<td>32</td>
<td>47</td>
<td>65</td>
</tr>
<tr>
<td>OVERFLOWN AND SCANNED AREA</td>
<td>990 Km²</td>
<td>3618 Km²</td>
<td>4313 Km²</td>
<td>4549 Km²</td>
<td>5066 Km²</td>
<td>7488 Km²</td>
<td>7336 Km²</td>
</tr>
<tr>
<td>ALBANIAN SCANNED AREA PERCENTAGE</td>
<td>3,4 %</td>
<td>12,6 %</td>
<td>15,1 %</td>
<td>15,8 %</td>
<td>17,6 %</td>
<td>23,8 %</td>
<td>25,5 %</td>
</tr>
<tr>
<td>NUMBER OF SUSPECTED CANNABIS PLANTATIONS REPORTED</td>
<td>61 + Lazarat</td>
<td>304 + Lazarat</td>
<td>815 + Lazarat</td>
<td>1368</td>
<td>2086</td>
<td>90</td>
<td>27</td>
</tr>
<tr>
<td>AREA OF SUSPECTED CANNABIS PLANTATIONS REPORTED</td>
<td>0,02 Km² + 0,385 Km² (Lazarat)</td>
<td>0,045 Km² + 3,19 Km² (Lazarat)</td>
<td>0,162 Km² + Lazarat</td>
<td>0,447 Km² + 0,00 Km² in Lazarat</td>
<td>2,135 Km²</td>
<td>0,022 Km²</td>
<td>0,0085 Km²</td>
</tr>
<tr>
<td>HYPERSPECTRAL COLLECTED DATA</td>
<td>325 GB</td>
<td>497 GB</td>
<td>892 GB</td>
<td>2100 GB</td>
<td>1700 GB</td>
<td>2200 GB</td>
<td>3980 GB</td>
</tr>
<tr>
<td>TRUECOLOR IMAGES COLLECTED DATA</td>
<td>675 GB</td>
<td>680 GB</td>
<td>792 GB</td>
<td>524 GB</td>
<td>450 GB</td>
<td>635 GB</td>
<td>892 GB</td>
</tr>
</tbody>
</table>
NUMBER OF PLANTATIONS REPORTS
60

NUMBER OF SUSPECTED CANNABIS PLANTATIONS REPORTED
27

AREA OF SUSPECTED CANNABIS PLANTATIONS REPORTED
0.85 ha

AVERAGE AREA OF SUSPECTED CANNABIS PLANTATION
315 m²

MINIMUM AREA OF SUSPECTED CANNABIS PLANTATION
51 m²

MAXIMUM AREA OF SUSPECTED CANNABIS PLANTATION
925 m²

PLANTATIONS IN GREENHOUSE
0
NUMBER OF PLANTATIONS REPORTS
60

NUMBER OF SUSPECTED CANNABIS PLANTATIONS REPORTED
27

AREA OF SUSPECTED CANNABIS PLANTATIONS REPORTED
0.85 ha

AVERAGE AREA OF SUSPECTED CANNABIS PLANTATION
315 m²

MINIMUM AREA OF SUSPECTED CANNABIS PLANTATION
51 m²

MAXIMUM AREA OF SUSPECTED CANNABIS PLANTATION
925 m²

PLANTATIONS IN GREENHOUSE
0
Flight plans, 2018

MAP OF FLIGHT PLANS
(4th April – 31th October)
- 66 designed flight plans
- 52 completed flights
- 6 incompletely flown flights
- 8 not flown flights

Legend
- Completed flights
- Incompletely flown flights
- Not flown flights
- Albanian districts
Flight tracks, 2018

Airborne Remote Sensing for Detection and Monitoring Albanian Cannabis Plantation _ Flight mission 2018

MAP OF FLIGHT PATHS
(4th April – 31th October)

- 65 flight missions

Legend

+ Tirana International Airport

- Flight paths of the missions

- Albanian districts

0 25 50 100 km
Airborne Remote Sensing for Detection and Monitoring Albanian Cannabis Plantation _ Flight mission 2018

MAP OF SCANNED AREA
(4th April – 31th October)

- 7,336,50 km²
Suspected plantations
Compare 2017-2018
Airborne and Satellite Remote Sensing for monitoring and preventing forest fires and flooding phenomena

2018, 30th November
Fires risk prevention protocol

- Regional scale of observation
- Costant updates
- Pixel dimension: 20 m
- Processing based on reflectance measurements at VNIR, SWIR and Thermal Infrared wavelength
The innovative BENECON technology with the extension for an appropriate use of the Canadair
BENECON increases its technological asset

**TABI 1800 Thermal sensor:**
- Classification of organic and inorganic ground materials based on the relative surface temperature
- Fires mapping
- Thermal dispersion mapping
- Thermal anomalies mapping

**INTRODUCING iTRES TSR-1800**
BENECON activities for fire risk monitoring in Campania – Best practices 2016-2017

Diachronic compare of the realised fire risk maps
BENECON activities for the fire risk monitoring in Campania

Active fires maps after Sentinel-2B satellite data processing
BENECON activities for the fire risk monitoring in Campania

Burned area maps on CASI-1500 hyperspectral images
VESUVIO FIRES ON 22 LUGLIO 2016
ACTIVE FIRES AND BOUNDARY

BENECON activities for fires risk monitoring in Campania
VESUVIO FIRES ON 12 LUGLIO 2017
ACTIVE FIRES AND BOUNDARY

BENECON activities for fires risk monitoring in Campania
BENECON activities for the fire risk monitoring in Campania – Best practices 2017-2018
Diachronic compare of the realised fire risk maps

Live Fuel Moisture Content
17 June 2017

Live Fuel Moisture Content
17 June 2018
BENECON activities for the fire risk monitoring in Campania – Analytical data upgraded on 02/07/2018

☑ Compare between NDWI and meteorological conditions (average precipitation) for the Vesuvio area
☑ The rainy season just passed has been determined an almost constant trend of the NDWI

![Graph showing NDWI and average precipitation trends from May 24 to July 05, 2018. The graph indicates a decrease in NDWI values during the rainy season, with an almost constant trend throughout June and July.]
BENECON activities for the fire risk monitoring in Albania – The Valona fire on 2017
BENECON activities for the fire risk monitoring in Albania – The Valona fire on 2017
BENECON activities for the fire risk monitoring in Albania – Focus on Orikum fire
BENECON activities for the fire risk monitoring in Albania – Focus on Orikum fire
# Perimeter of flooding areas in CALABRIA – Best Practice 2015

<table>
<thead>
<tr>
<th>Flooding event</th>
<th>Flight pianification</th>
<th>Flight date</th>
<th>Delivering of the scientific report</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 August 2015</td>
<td>13 August 2015</td>
<td>14 August 2015</td>
<td>24 August 2015</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Satellite SENTINEL</th>
<th>Itres CASI 1500</th>
<th>Itres TABI 1800</th>
<th>Leica ALS50II</th>
<th>PhaseOne iXA</th>
<th>MMS Topcon IPS2</th>
<th>Faro Laser Scanning 3D</th>
<th>Georadar</th>
<th>Spectrometry γ-Ray</th>
<th>ROV Nautec Perseo</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="satellite.png" alt="Satellite" /></td>
<td><img src="casi.png" alt="Itres CASI 1500" /></td>
<td><img src="tabi.png" alt="Itres TABI 1800" /></td>
<td><img src="leica.png" alt="Leica ALS50II" /></td>
<td><img src="phaseone.png" alt="PhaseOne iXA" /></td>
<td><img src="topcon.png" alt="MMS Topcon IPS2" /></td>
<td><img src="faro.png" alt="Faro Laser Scanning 3D" /></td>
<td><img src="georadar.png" alt="Georadar" /></td>
<td><img src="spectrometry.png" alt="Spectrometry γ-Ray" /></td>
<td><img src="rov.png" alt="ROV Nautec Perseo" /></td>
</tr>
</tbody>
</table>

**Perimeter of FLOODING AREAS**

- ✔
- ✔
- ✔
Perimeter of flooding areas in CALABRIA – Best Practice 2015
Perimeter of flooding areas in CALABRIA – Best Practice 2015

CALABRIA: Thermal, hyperspectral and optical Remote Sensing activity after the flooding event in Rossano e Corigliano Calabro (Calabria, Italy) on 12 August 2015.
False color images “RedVeg” have been used to make the perimeter of flooding areas in agriculture environment.

Thermal images have been used to make the perimeter of flooding areas in agriculture environment.

The PhaseOne IXA images allow us to define infrastructure damages. In the figure above we can see the subsidence of a road.

The processing of hyperspectral and thermal data and the application of a mathematical algorithm allow us to make the detailed perimeter of the flooding areas in the extra-urban environment.
Preliminary Analysis of the Serbian Territory

2018, 30th November
Serbia – Country and its limits
Serbia – Country and its maps

Hydric map

Road map

Railway map
Serbia – Digital Elevation Model (DEM)
Serbia – True color images

RGB images by Sentinel 2B - Focus around the Bovansko Jezero lake

2018, February 06th

2018, June 01st

2018, October 09th
Serbia – Vegetation monitoring

RedVeg images by Sentinel 2B - Focus around the Bovansko Jezero lake

2018, February 06th

2018, June 01st

2018, October 09th
Serbia – Agriculture and Water State Monitoring

False Colour images by Sentinel 2B - Focus around the Bovansko Jezero lake

2018, February 06th

2018, June 01st

2018, October 09th