SatCafé

Satellite Remote Sensing for Improved and Sustainable Coffee Production

Tim Pearson, RSAC Ltd, Project Manager (tim@rsacl.co.uk)

International Coffee Council Projects Committee
25 September 2019

International Maritime Organization (IMO), London, UK
VERY-HIGH-RESOLUTION SATELITE IMAGERY

Field-scale detail over limited areas
Very irregular infrequent coverage, expensive

Pleiades HiRi data, 0.7m resolution (pan-sharpened); NIR false-colour composite
COPERNICUS SENTINEL-2 IMAGERY

Global coverage every five days
Still provides good level of detail (10m)
Free!

Sentinel-2 MSI mosaic, 10m resolution, SWIR false-colour composite
- Aims to develop useful applications of satellite data for mapping and monitoring changes in coffee plantations, including deterioration due to climate change, as well as monitoring the condition of crops

- Feasibility study part-funded through Agri-Tech Catalyst Colombia, an ‘Innovate UK’ programme to support the uptake of new technologies and innovations in the Colombian Agriculture sector, particularly by female smallholder farmers in post-conflict areas; financed by the Colombian Prosperity Fund managed by the British Embassy, Bogotá

- Selected as one of only 7 projects starting in 2019, from more than 150 proposals

- Partners are RSAC, GEOLAT, Fedecafé, ICO

- Planned effort by RSAC and GEOLAT is 3 man-years over 18 months

- Project kicked off 1 February 2019
SATCAFÉ PARTNERS

Remote Sensing Applications Consultants Ltd (RSAC)
- Based in Hampshire, UK; created in 1986
- Small consultancy specialised in land use mapping derived from Earth Observation data, with expertise in forestry and agriculture
- Strong relationship with the European Space Agency
- South American crop monitoring experience in Paraguay, Peru and Colombia (Magdalena Valley)

GEOLAT SAS
- SME based in Bogotá
- Focused on developing remote sensing land applications using different types of satellite optical, radar (SAR), lidar and UAV data
- Extensive experience in research and operational projects on agricultural and environmental topics

Fedecafé (FNC)
- Colombian Coffee Growers' Federation
- Represents ~540,000 families growing coffee in Colombia, providing technical assistance and carrying out programmes to address environmental and pest and disease problems

ICO
Working with Fedecafé to

- improve accuracy and currency of information on coffee farms, enabling more effective and efficient operations (e.g. Extension Service visits)
- integrate results within national systems, providing a contribution to decision making processes enabling both government and growers to take timely action in response to potential threats

Working directly with smallholder farmers to provide information on the condition of crops

RSAC and GEOLAT part-funding their involvement in the project; project objectives include exploring opportunities for future commercial developments providing products and services to Fedecafé and coffee organisations in other countries
REQUIREMENTS REVIEW

Working sessions at Fedecafé

Discussions with women coffee growers’ associations
COFFEE FARM VISITS

Fincas visited in Tolima, Quindío and Risaralda
AVAILABLE SENTINEL-2 COVERAGE

20/12/2018  13/02/2019  24/05/2019  18/06/2019  07/08/2019

Only one completely cloud-free image in last two years

Automated cloud masking
DETECTION OF ‘RENOVATION’ EVENTS

Replanting

Vegetation index

Recorded 15 Mar

DETECTION OF ‘RENOVATION’ EVENTS

Pruning (zoca)

Vegetation index

Recorded 22 Mar
DETECTION OF ‘RENOVATION’ EVENTS

<table>
<thead>
<tr>
<th>Parcel.No</th>
<th>Labour</th>
<th>Date Recorded</th>
<th>Date Sentinel-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RENOVACION ZOCA</td>
<td>07/07/2018</td>
<td>02/08/2018</td>
</tr>
<tr>
<td>3</td>
<td>RENOVACION ZOCA</td>
<td>01/07/2018</td>
<td>28/07/2018</td>
</tr>
<tr>
<td>4</td>
<td>RENOVACION SIEMBRA</td>
<td>11/12/2012</td>
<td>25/03/2018</td>
</tr>
<tr>
<td>5</td>
<td>RENOVACION SIEMBRA</td>
<td>05/05/2018</td>
<td>03/06/2018</td>
</tr>
<tr>
<td>7</td>
<td>RENOVACION SIEMBRA</td>
<td>01/06/2016</td>
<td>15/11/2016</td>
</tr>
<tr>
<td>10</td>
<td>RENOVACION SIEMBRA</td>
<td>01/02/2011</td>
<td>24/01/2018</td>
</tr>
<tr>
<td>14</td>
<td>RENOVACION SIEMBRA</td>
<td>06/11/2015</td>
<td>12/08/2019</td>
</tr>
<tr>
<td>18</td>
<td>RENOVACION SIEMBRA</td>
<td>28/11/2015</td>
<td>03/06/2018</td>
</tr>
<tr>
<td>22</td>
<td>RENOVACION ZOCA</td>
<td>01/02/2015</td>
<td>08/06/2019</td>
</tr>
<tr>
<td>26</td>
<td>RENOVACION ZOCA</td>
<td>01/02/2014</td>
<td>24/01/2019</td>
</tr>
<tr>
<td>29</td>
<td>RENOVACION SIEMBRA</td>
<td>28/02/2019</td>
<td>24/05/2019</td>
</tr>
<tr>
<td>30</td>
<td>RENOVACION ZOCA</td>
<td>03/07/2016</td>
<td>07/08/2016</td>
</tr>
<tr>
<td>36</td>
<td>RENOVACION ZOCA</td>
<td>10/11/2016</td>
<td>07/08/2016</td>
</tr>
<tr>
<td>40</td>
<td>RENOVACION ZOCA</td>
<td>01/07/2016</td>
<td>07/08/2016</td>
</tr>
<tr>
<td>41</td>
<td>RENOVACION SIEMBRA</td>
<td>27/08/2017</td>
<td>17/08/2017</td>
</tr>
<tr>
<td>43</td>
<td>RENOVACION SIEMBRA</td>
<td>11/12/2012</td>
<td>07/08/2016</td>
</tr>
<tr>
<td>50</td>
<td>RENOVACION SIEMBRA</td>
<td>10/04/2017</td>
<td>21/09/2017</td>
</tr>
<tr>
<td>52</td>
<td>RENOVACION SIEMBRA</td>
<td>22/05/2013</td>
<td>18/07/2017</td>
</tr>
<tr>
<td>53</td>
<td>RENOVACION SIEMBRA</td>
<td>01/04/2011</td>
<td>28/02/2019</td>
</tr>
<tr>
<td>55</td>
<td>RENOVACION ZOCA</td>
<td>01/06/2016</td>
<td>07/08/2016</td>
</tr>
</tbody>
</table>

Sentinel-2 automated dating of replanting and pruning (zoca) events, compared with date recorded.
AUTOMATIC MAPPING OF COFFEE PARCEL BOUNDARIES

Very-High Resolution Image  
Segmentation  
Coffee Parcel Map
- Field surveys using UAVs will be used for detailed investigations of the spectral properties of coffee crop conditions, working directly with smallholders.
MicaSense Altum produces aligned thermal, multispectral, and high-resolution imagery in one flight for advanced analytics.

- Potential Coverage area: 2km × 2km = 200Ha
- GSD: 5.2 cm per pixel @ 120m (~400 feet)
- Applications: Coffee crop health mapping, water stress analysis, fertiliser management, zone mapping, etc...
NEXT STEPS

- **Large Area Monitoring (parcel crop and growth conditions)**
  - use free Sentinel-2 satellite data
  - concentrate initially on selected study areas (total 900km²)
  - develop strategy for maximising use of cloud-free pixels
  - prepare maps showing mature coffee, renovation, young coffee, other crops, also maps showing changes over longer periods
  - develop automated techniques to prepare regional and national maps

- **Detailed Coffee Mapping (using VHR satellite and UAV data)**
  - use of data at highest available resolution (e.g. 50cm or better)
  - investigate potential for identifying coffee areas/coffee plants using pattern and feature recognition techniques
  - investigate potential for automated delineation of coffee-growing parcels
  - investigate use of thermal spectrum (UAV-mounted sensor) to detect condition of coffee crops