JECAM/SEN2AGRI CROSS SITES
BENCHMARKING FOR CROP TYPE

JECAM Annual Science Meeting
16-17 November 2015 – Brussels, Belgium
Crop-type product

- Delivered as soon as possible after the end of the season
- Spatial resolution between 10 to 20 meters
- Main regional crop types or crop group mapping
- Quality metrics: Overall Accuracy and F-Score per class
- 4 key crops:
  - wheat
  - maize
  - rice
  - soybean
From 12 sites used for benchmarking 9 are JECAM sites:

Argentina, Belgium, China, Ukraine, South-Africa, Madagascar, France, Morocco and Russia
In each site:

1. **Satellite imagery:**
   - Simulation of Sentinel-2 time series based on SPOT4-Take5 and/or LANDSAT 8 imagery of 2013

2. **In-situ field data:**
   - From field observations
   - From institutional data
Goals:

• to set up a single processing chain that will operate with good performances on all different sites

• to evaluate a high number of combinations of the processing steps of a typical processing chain for land cover map production:
  - Feature extraction
  - Classifiers and definition of ranges for the values of the parameters of the different algorithms
  - Dealing with cloudy pixels
Final procedure implemented for the assessment of the crop type map production chain
ARGENTINA

ARGENTINA Site OA (95% conf. Intervalles)

<table>
<thead>
<tr>
<th>Site</th>
<th>OA (95% conf. Intervalles)</th>
<th>F-Score of main crop</th>
<th>F-score minimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>0.904 ± 0.026</td>
<td>0.9399</td>
<td>0.7586</td>
</tr>
</tbody>
</table>

Image dataset -> Very good:
- Coverage from February to April covering the end of the summer crop season (October/November to April)
- Winter crops are not covered at all
Image dataset -> Moderate:
- High cloudiness
- At least one acceptable image per month during the summer crop season (from March to September)

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</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>0.822 +/- 0.001</td>
<td>0.8735</td>
<td>0.7796</td>
</tr>
</tbody>
</table>
Image dataset -> Moderate:
- High presence of aerosols in February and March
- April and May are well covered, as well as the beginning of June

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<tbody>
<tr>
<td>China</td>
<td>0.927 +/- 0.010</td>
<td>0.9616</td>
<td>0.4455</td>
</tr>
</tbody>
</table>
Image dataset -> Moderate:
- Covers the end of the winter crops and the complete summer crop cycles with more than one image per month
- Lacking the starting of the winter crops

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<tbody>
<tr>
<td>France</td>
<td>0.904 +/- 0.004</td>
<td>0.9310</td>
<td>0.5250</td>
</tr>
</tbody>
</table>
**Image dataset -> Moderate/bad:**
- Images were taken almost weekly from the middle to the end the growing season (from the end of February to the end of April)
- High cloudiness in the eastern half of the image, where the validation data are located

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<tr>
<td>Madagascar</td>
<td>0.502 +/- 0.058</td>
<td>0.0488</td>
<td>0.0488</td>
</tr>
</tbody>
</table>
Image dataset -> Very good:
- Good coverage from January to June (one image approximately every 5 days)

### Morocco

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<th>F-score minimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morocco</td>
<td>0.897 +- 0.005</td>
<td>0.9326</td>
<td>0.2734</td>
</tr>
</tbody>
</table>
Image dataset -> Bad:
- Presence of clouds
- No SPOT4 (Take5) or Landsat images available
- RapidEye imagery was used covering the middle end of the summer crops from the end of April to July. Only 4 images were free of clouds

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</thead>
<tbody>
<tr>
<td>Russia</td>
<td>0.668 +- 0.019</td>
<td>0.8435</td>
<td>0.2237</td>
</tr>
</tbody>
</table>
Image dataset -> Good:
- The dataset provides good coverage with a good image every week, except for the beginning of the cycle (December/January) and field data correspond to summer crops.

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</tr>
</thead>
<tbody>
<tr>
<td>South-Africa</td>
<td>0.908 +/- 0.011</td>
<td>0.9542</td>
<td>0.3941</td>
</tr>
</tbody>
</table>
Ukraine

Image dataset -> Moderate:
- April, May and June are covered, which corresponds to the end of the winter crops and the beginning of the summer crops
- From December to March, there is no image due to clouds

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<tr>
<td>Ukraine</td>
<td>0.752 +/- 0.025</td>
<td>0.8589</td>
<td>0.5493</td>
</tr>
</tbody>
</table>
SOME IMAGES ...

Argentina

France

Belgium

Russia

Maize
Soybeans

Maize
Potatoes
Sugar beet
Winter wheat
Winter barley
Other annual crops

Wheat
Maize
Barley
Rapeseed
Sunflower
Other annual crops

Winter wheat
Spring barley
Rapeseed
Sunflower
Other annual crops
CONCLUSION

• Different kind of sites:
  - Good in-situ data and good EO data (weather)
  - Good in-situ data and bad EO data (weather, aerosols)
  - Few classes in in-situ data and growing season elapsed for the available period of EO data

• Same processing chain applied for all sites

• General better conditions with Sentinel 2 in its full configuration: more repeatability, more spectral bands, higher spatial resolution

Many thanks to the site managers for providing their in-situ data
1.1 F-Score

The F-Score (also known as F-1 score or F-measure) is the harmonic mean of the Precision and Recall and reaches its best value at 1 and worst score at 0:

\[
F_{\text{Score}} = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}
\]

**Precision** or User's Accuracy (UA) for the class \(i\) it is the fraction of correctly classified pixels with regard to all pixels classified as this class \(i\) in the classified image:

\[
UA_i = \sum_{j=1}^{r} \frac{n_{ij}}{n_{ij}}
\]

**Recall** or Producer's Accuracy (PA) for the class \(i\) it is the fraction of correctly classified pixels with regard to all pixels of that ground truth class \(i\):

\[
PA_i = \sum_{j=1}^{r} \frac{n_{ij}}{n_{ji}}
\]
1.1 Overall accuracy

The Overall Accuracy (OA) is calculated as the total number of correctly classified pixels (diagonal elements of the confusion matrix) divided by the total number of test pixels:

$$OA = \frac{\sum_{i=1}^{r} n_{ii}}{\sum_{i=1}^{r} \sum_{j=1}^{r} n_{ij}}$$