Large scale automatic land cover map production with Sentinel-2 image time series: current status and outlooks

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Outline

1. **Fully automatic land cover map production**
2. Examples
3. How we do it
4. Conclusion
5. GEEE

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  - The so-called *washing machine*.

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  - `http://www.theia-land.fr/`
- Fully automatic production of LC maps at the national scale:
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- Compatible with and complementary to existing products:
  - CLC is less *fresh*, has lower temporal and spatial resolution, but has more classes (44);
  - Urban Atlas is very detailed but limited in spatial extent and not frequently updated;
  - High Resolution Layers: quality, status?

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  - Computationally efficient processing: short delivery delay, reprocessing when specs change.

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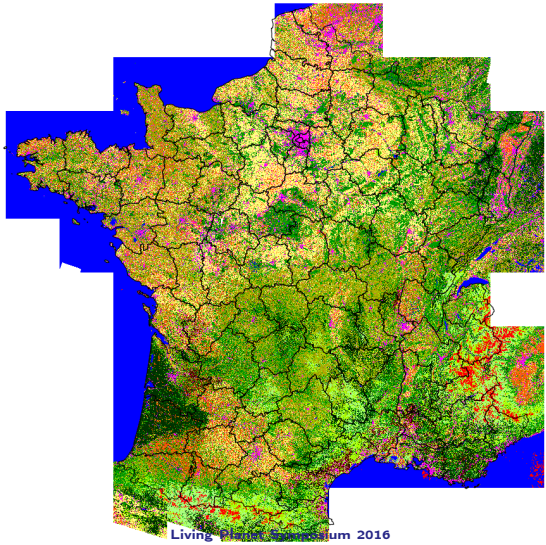
Product prototypes using Landsat8



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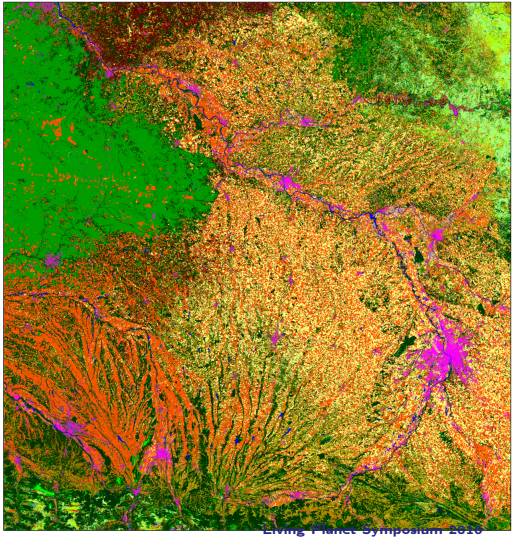
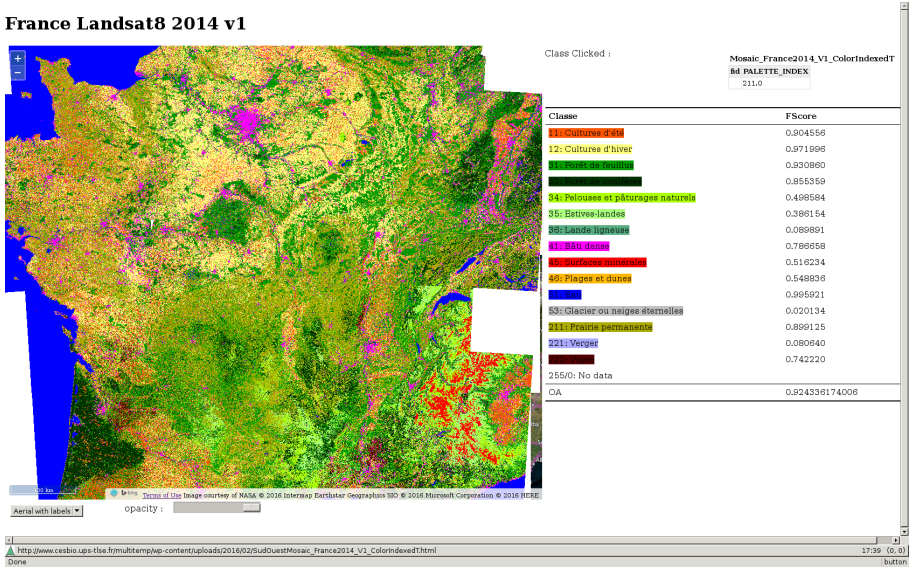
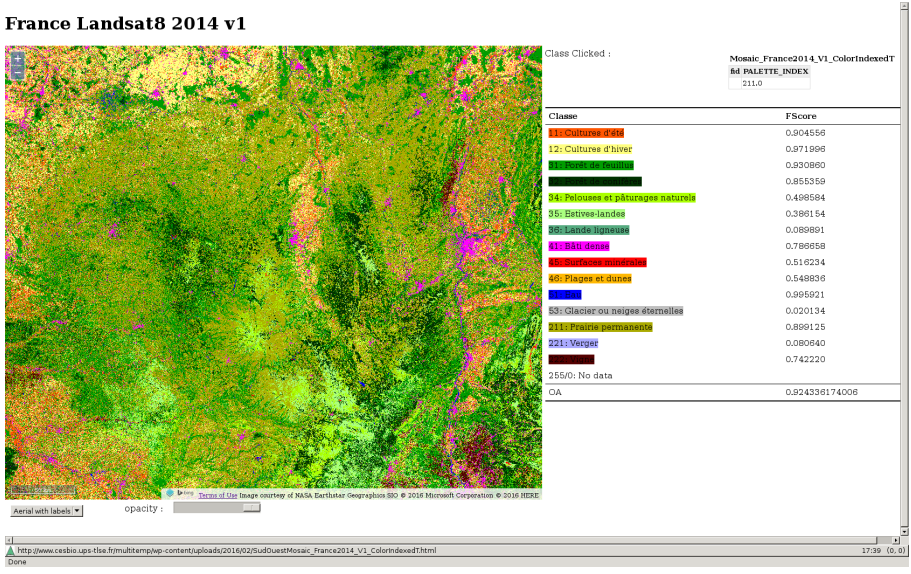




https://frama.link/ocs2014v1



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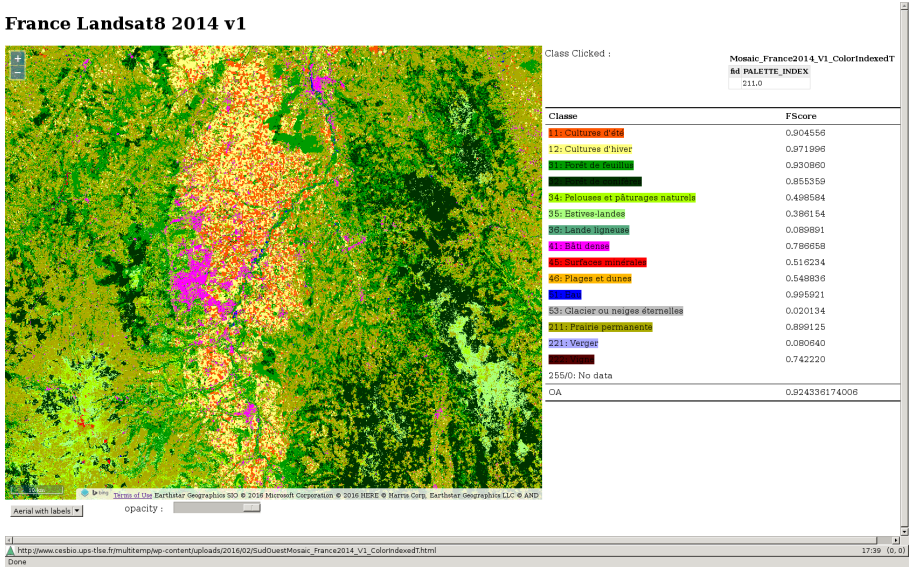

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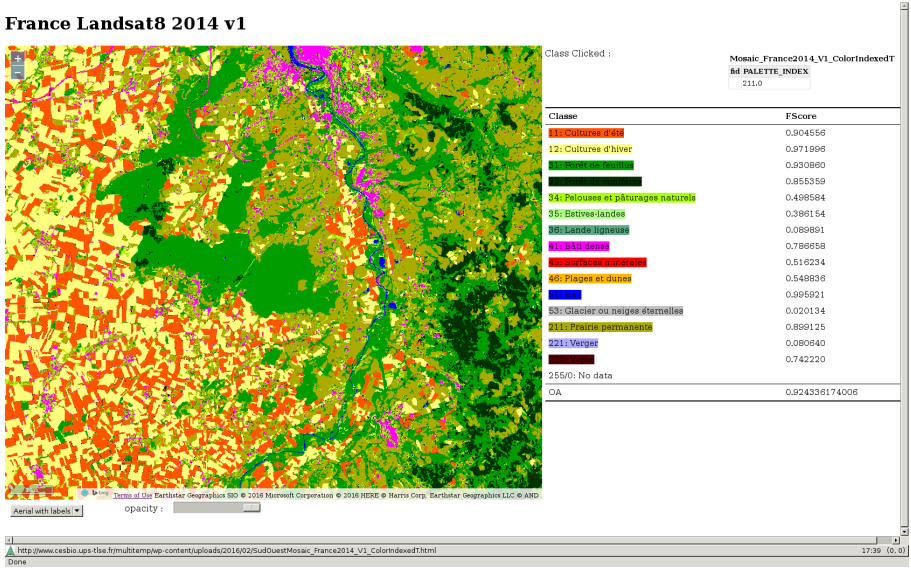

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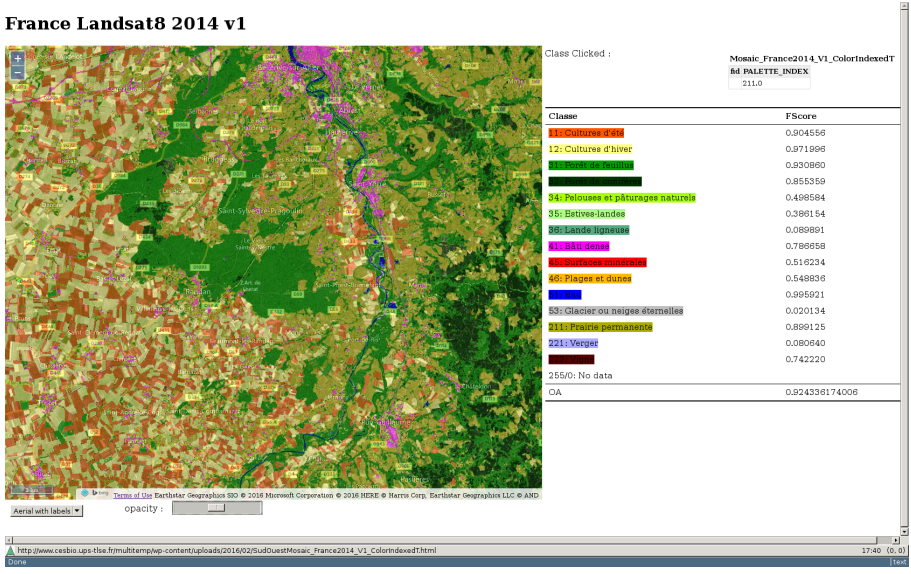

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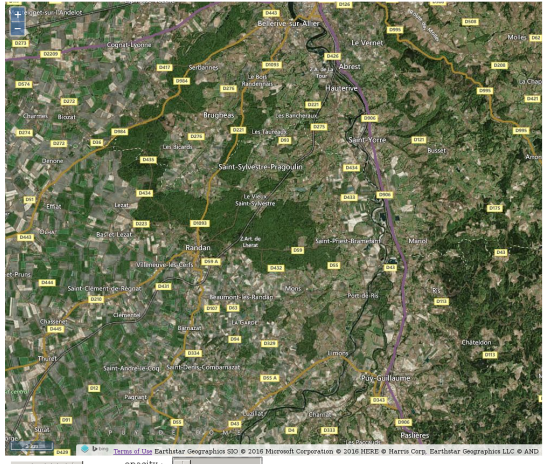

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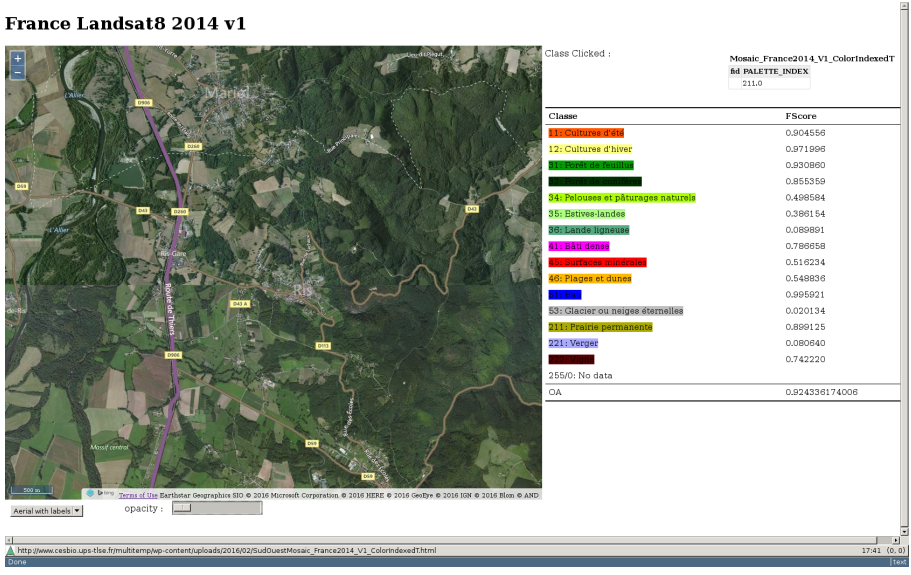

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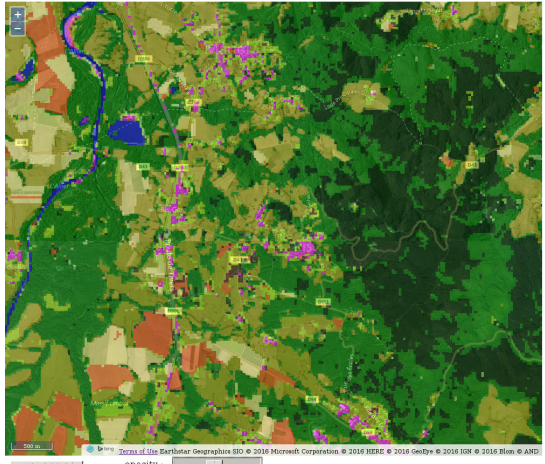

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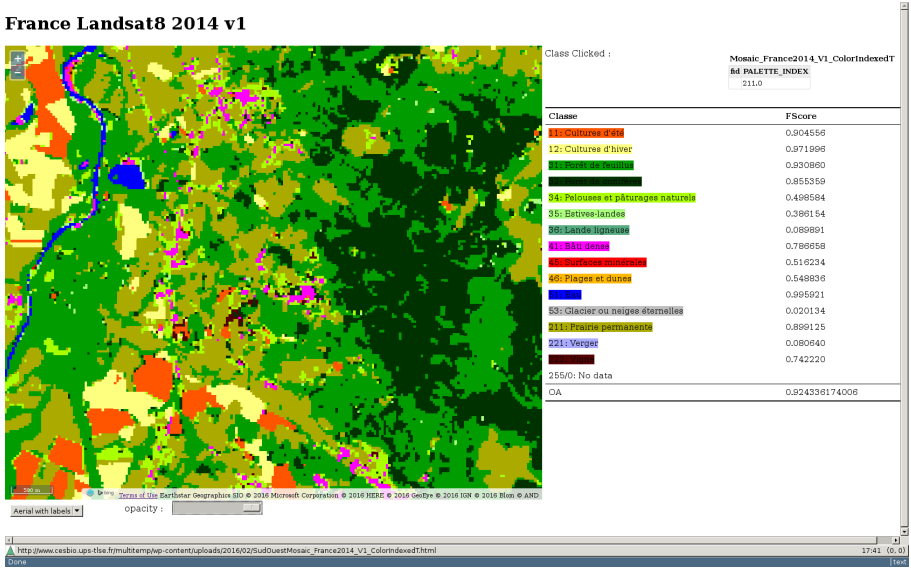

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- HPC cluster or classical workstation
- Total Physical Source Lines of Code (SLOC)=11,382

Language	SLOC	
python[1]	8476	(74.47%)
c++[2]	2044	(17.96%)
unix shell[3]	858	(7.54%)
other	4	(0.04%)

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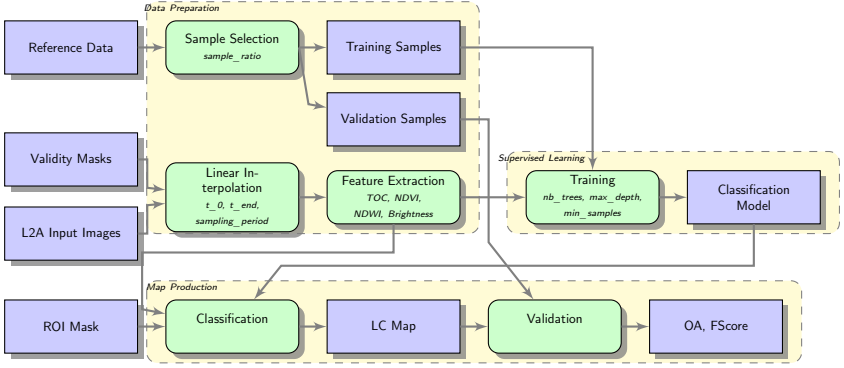
Kernel of the processing chain



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  - and some optimisations are on the way;
  - allows for easy benchmarking and evaluation.

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  - data volume;
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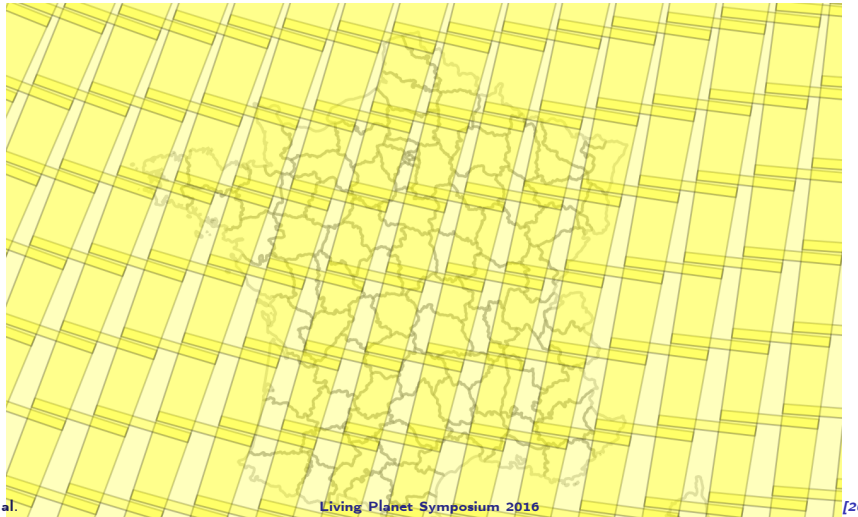
- Reference data availability
  - spatial distribution;
  - outdated samples;
  - quality of the reference data (label noise).

The problem of homogeneous cover

- The area to map

The problem of homogeneous cover

- Image acquisitions: each orbit has different dates



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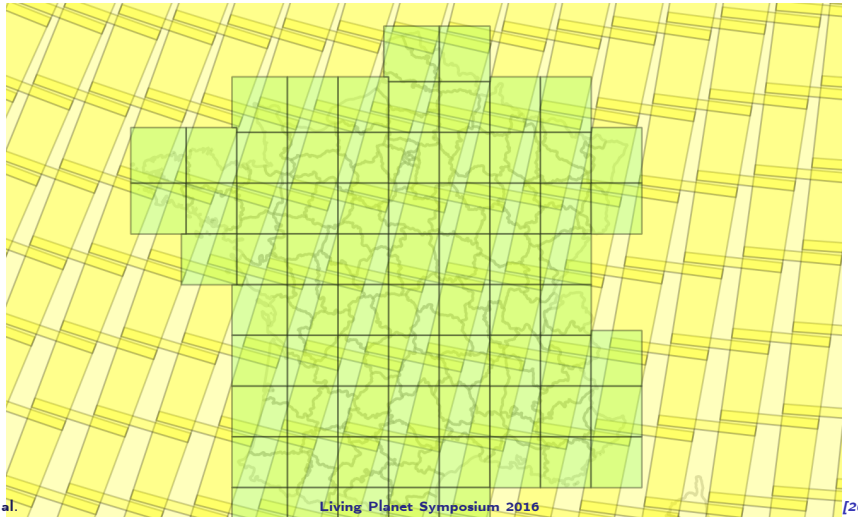
- Data storage: tiles for convenience



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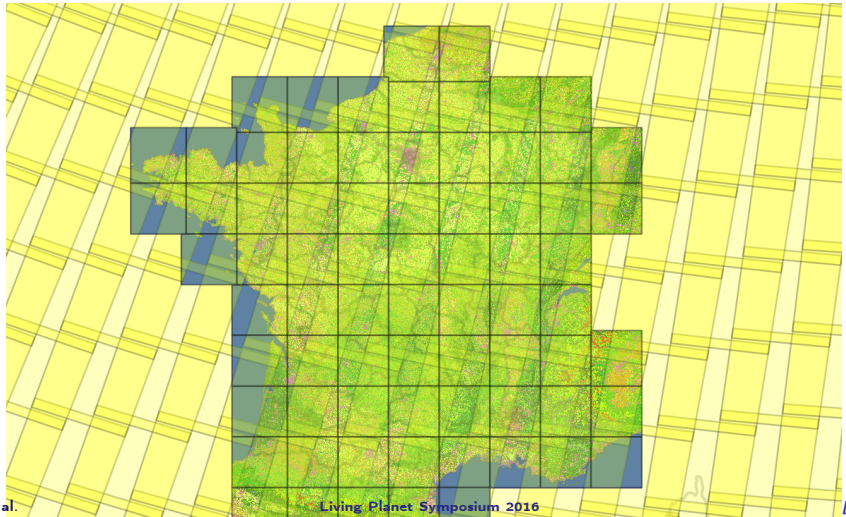

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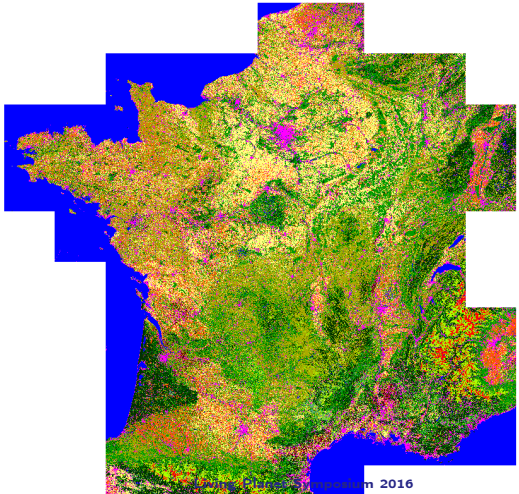

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Site	OA original	OA resampled	p-value
Argentina	0.904 ± 0.026	0.893 ± 0.028	0.120
Belgium	0.816 ± 0.001	0.816 ± 0.001	0.312
Burkina Faso	0.522 ± 0.018	0.503 ± 0.018	0.122
China	0.927 ± 0.010	0.911 ± 0.031	0.193
France	0.904 ± 0.004	0.905 ± 0.004	0.770
Madagascar	0.501 ± 0.058	0.498 ± 0.070	0.818
Morocco	0.876 ± 0.004	0.875 ± 0.009	0.771
Pakistan	0.727 ± 0.035	0.723 ± 0.036	0.684
Russia	0.665 ± 0.019	0.665 ± 0.019	0.947
South Africa	0.907 ± 0.011	0.894 ± 0.015	0.023
Ukraine	0.740 ± 0.025	0.724 ± 0.024	0.019
US-Maricopa	0.911 ± 0.006	0.911 ± 0.006	0.939

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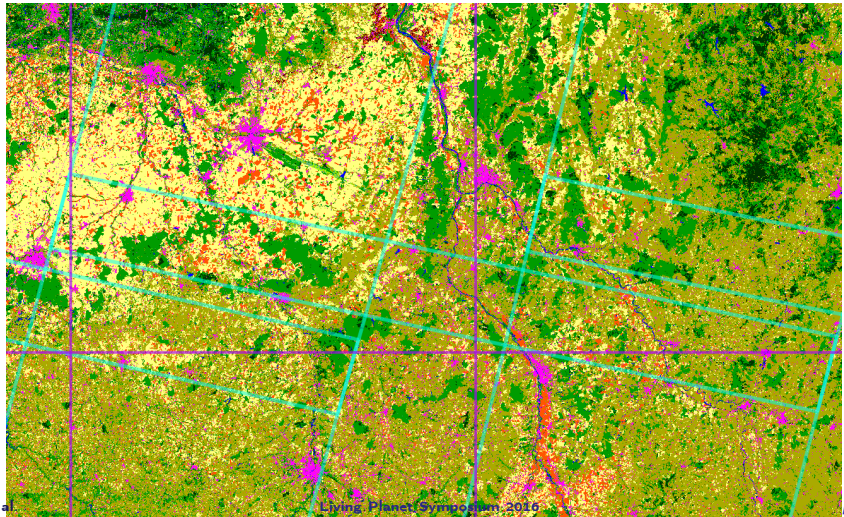

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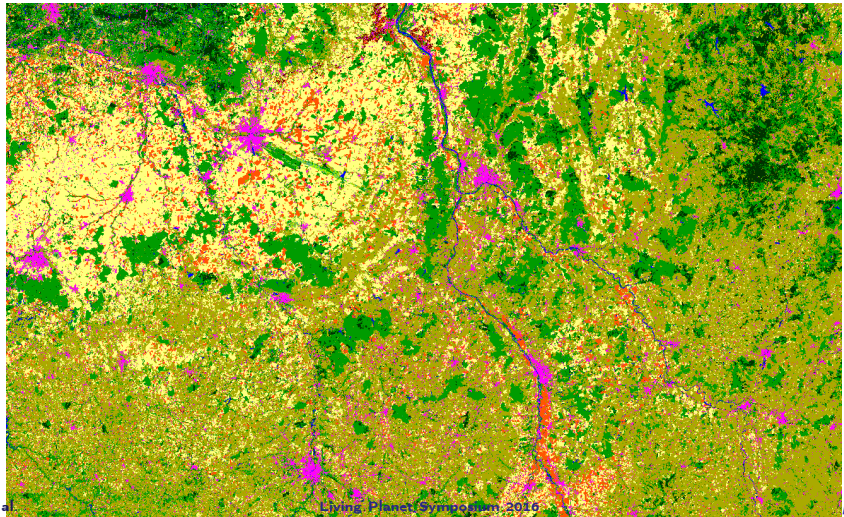

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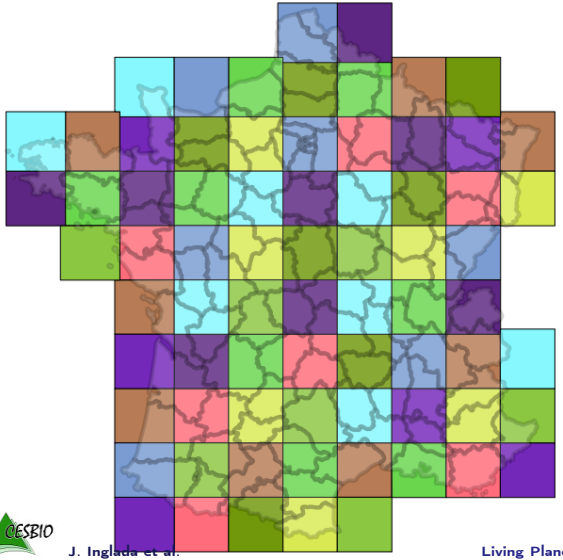

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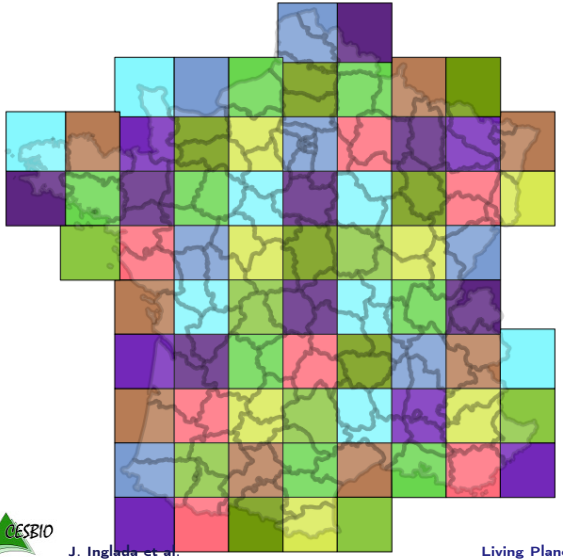

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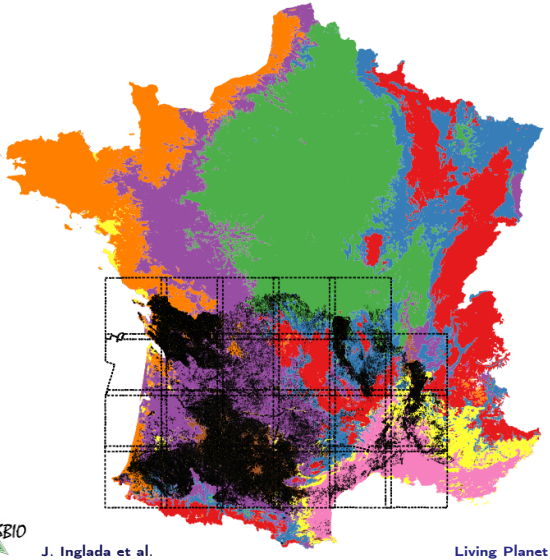
- Classification step
  - classifier fusion for robustness and spatial homogeneity.

Spatial stratification



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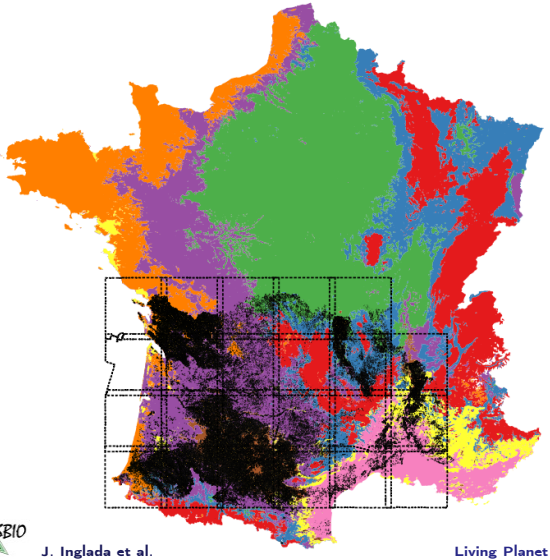

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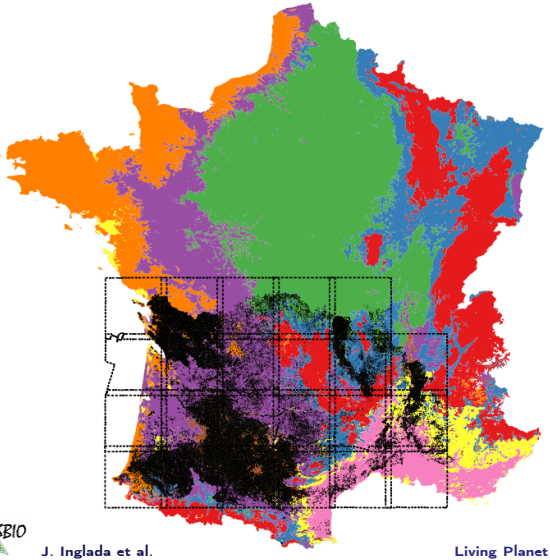

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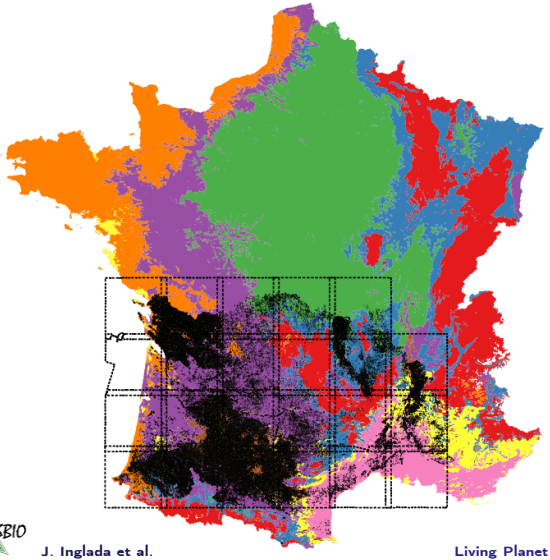

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- No improvement noticed so far
  - the Random Forest classifier already generates sub-classes;
  - may be useful when reference data is really scarce.

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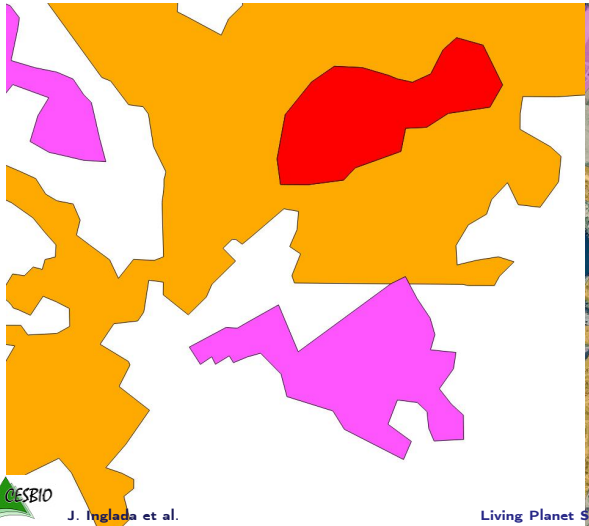
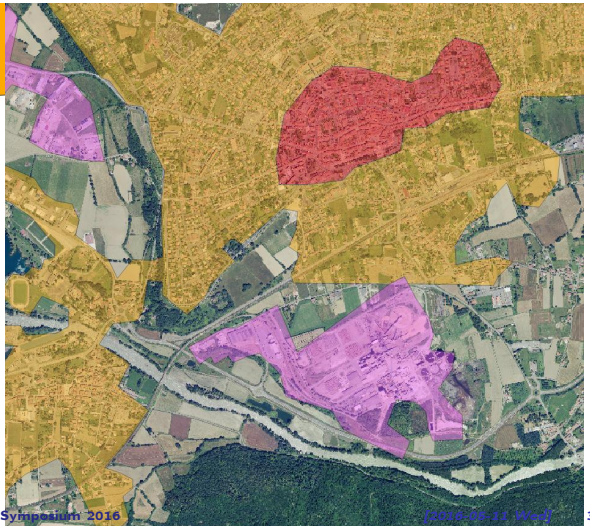
- Automatic tools to merge existing data bases.
- Classifiers with high tolerance to label noise.

Reference data cleaning

- CLC polygons: minimum mapping unit too large





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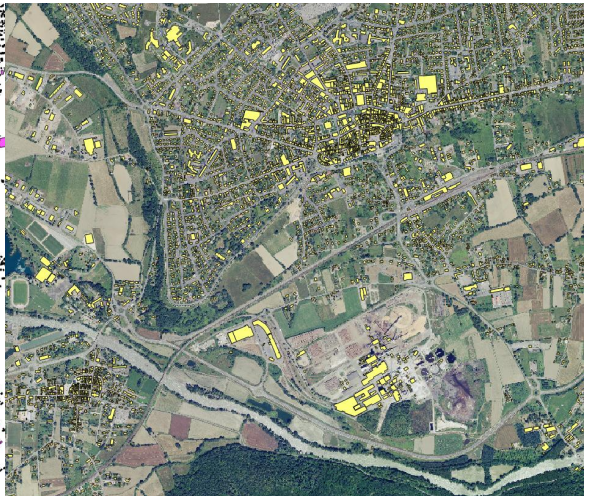
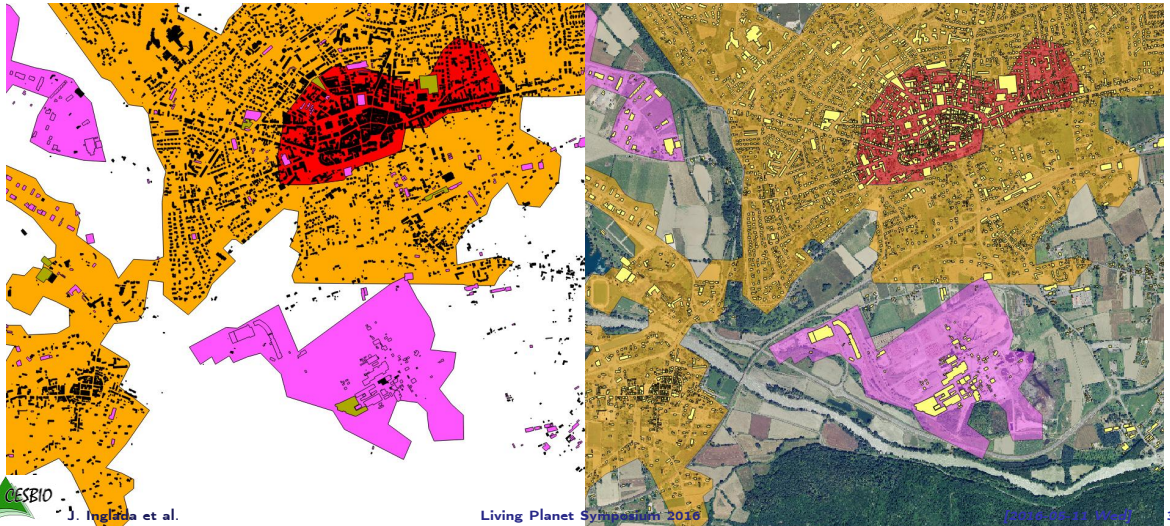
- Topographic DB: different LC semantics, but spatially accurate



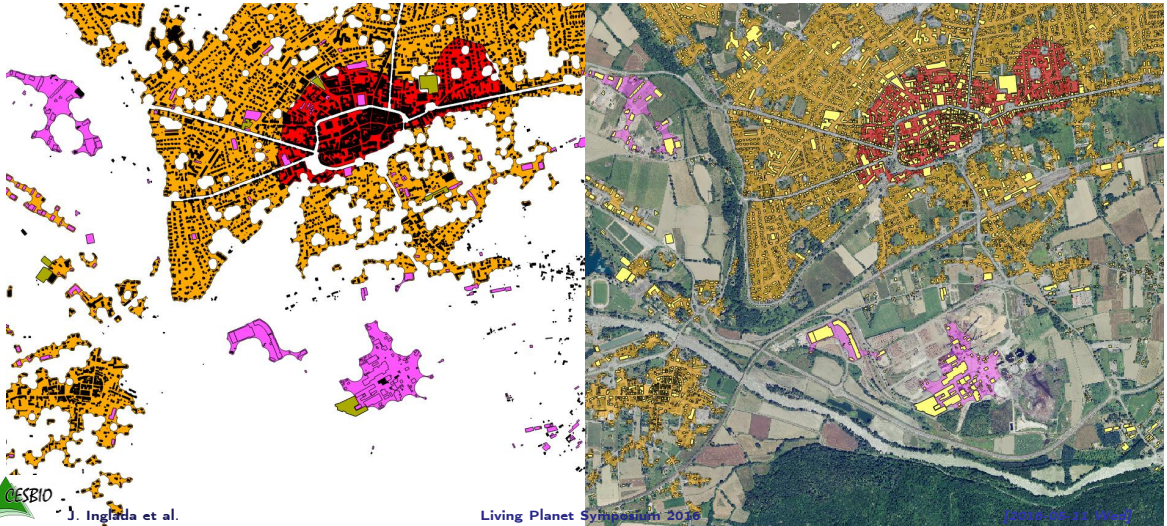
Reference data cleaning

- Fusing both data sources



Reference data cleaning

- Spatial and semantic accuracy



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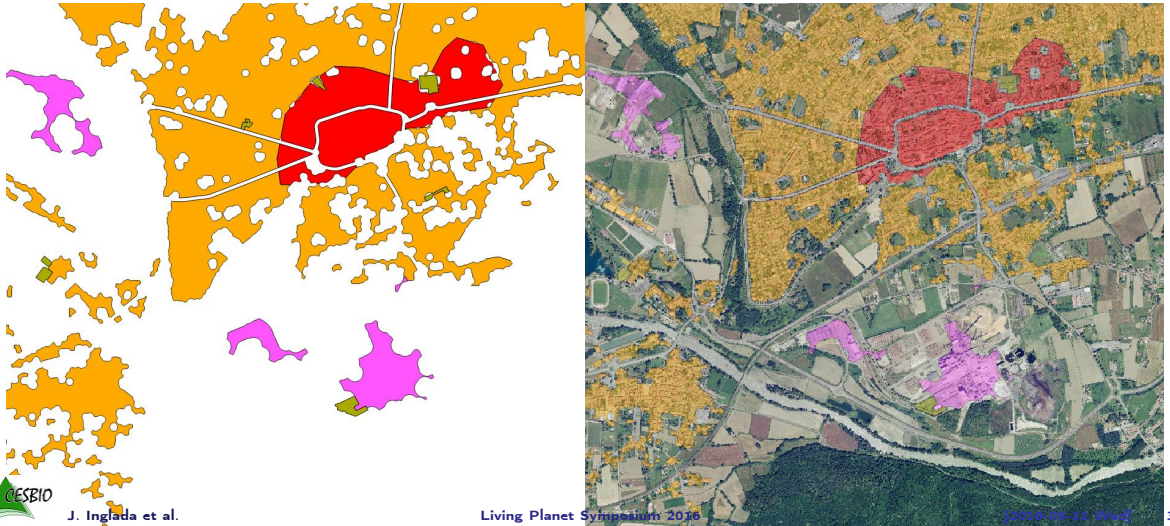
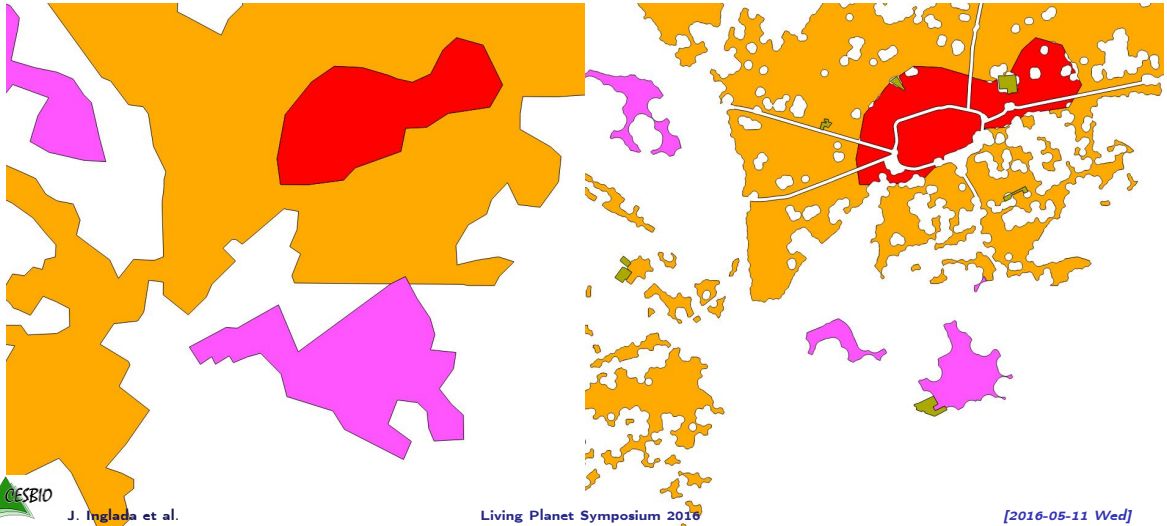


Reference data cleaning

- Improved reference data



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- Use the wisdom of crowds
  - many inaccurate but decorrelated data sources may become good *on average*.

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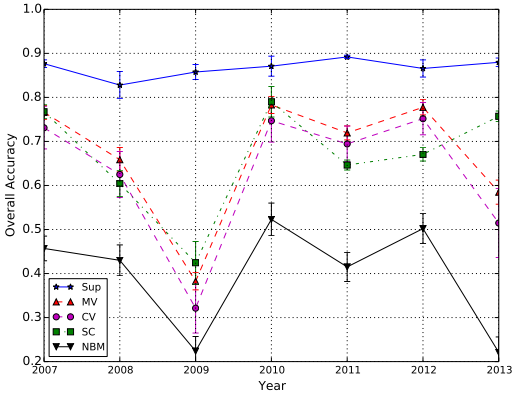
- Example using other periods (images and reference data)



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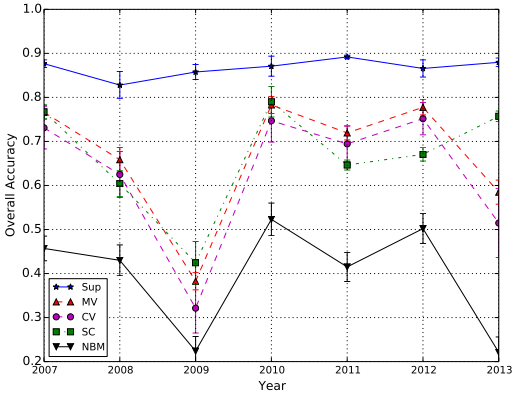

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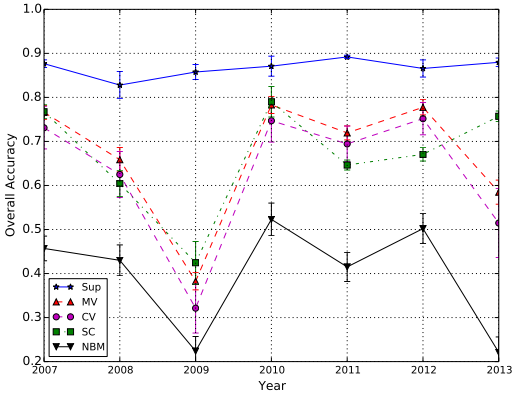

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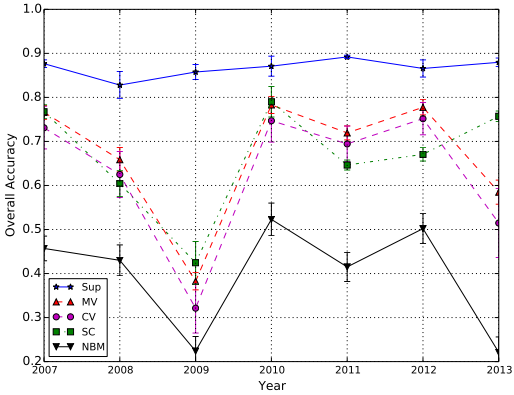

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- Best result with just one another year
- Using all other years and one single classifier
- Majority voting with one classifier per year
- Confidence-based fusion with one classifier per year

Other ongoing improvements

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- Use of VHR optical data (SPOT6, Pléiades)
  - single date, used for object-based image analysis.

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3. How we do it
4. **Conclusion**
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    - this is much cheaper than launching a satellite!

Q&A

- Get the slides: `https://frama.link/inglada-landcover`
- Get the washing machine: `https://frama.link/iota2`