

Land Cover Monitoring System with Sentinel-Hub and eo-learn

Is it possible to build a fast and cost-effective LCMS?

EO Research Team, Sinergise

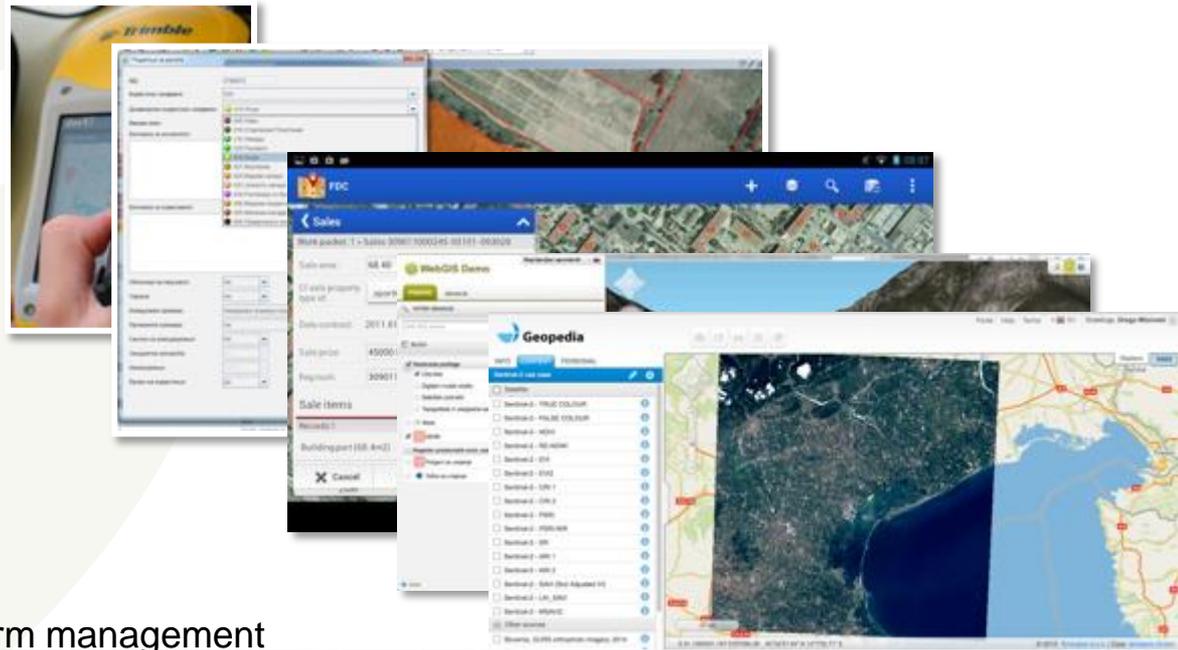
Matej Batič

25 November 2020



Sinergise

- 16+ years in GIS
- 60 people
- Business fields
 - Enterprise Solutions
 - Agriculture – IACS, LPIS, Farm management
 - Real-estate Management
 - Sentinel Hub
 - EO data
 - Data Science



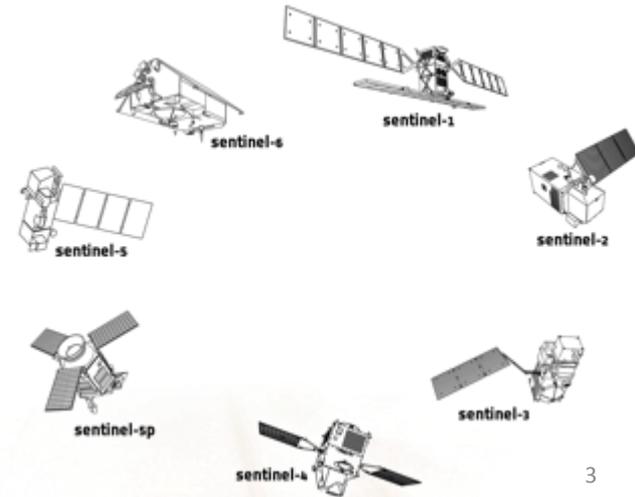
CLOUD API FOR SATELLITE IMAGERY

Browse. Pick. Enhance. Expose.

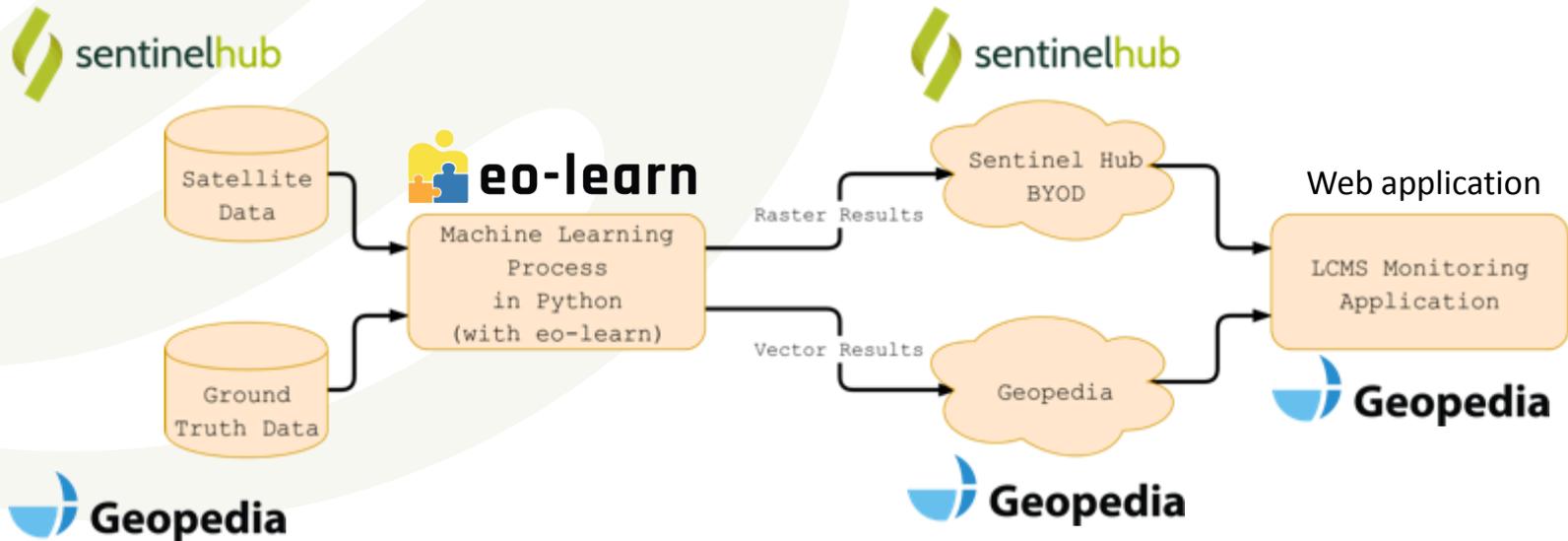
LCMS hypothesis

With the plethora of both open-source as well as commercial satellite data available, creation of Land Use / Land Cover maps is moving from the niche solutions, where data was almost hand processed, towards the services run real-time updates based on recurring satellite observations and Machine Learning pipelines.

*Is it possible to build a fast
and cost-effective LCMS system?*

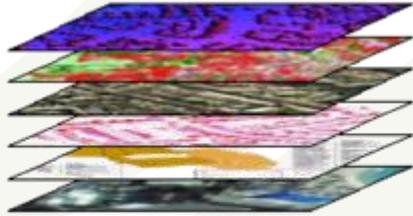


Basic flow of the system



Open EO data - Sentinel-1, Sentinel-2, Landsat, etc.

<https://www.sentinel-hub.com>



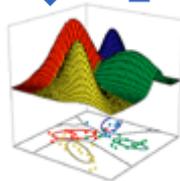
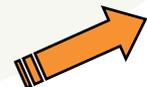
Commercial EO data



Aerial imagery (drone, plane)



Other raster data (bring your own)



Machine learning

WMTS

WMS

WCS

API



Cloud GIS



Web / Mobile apps



Desktop (QGIS,, ArcGIS...)



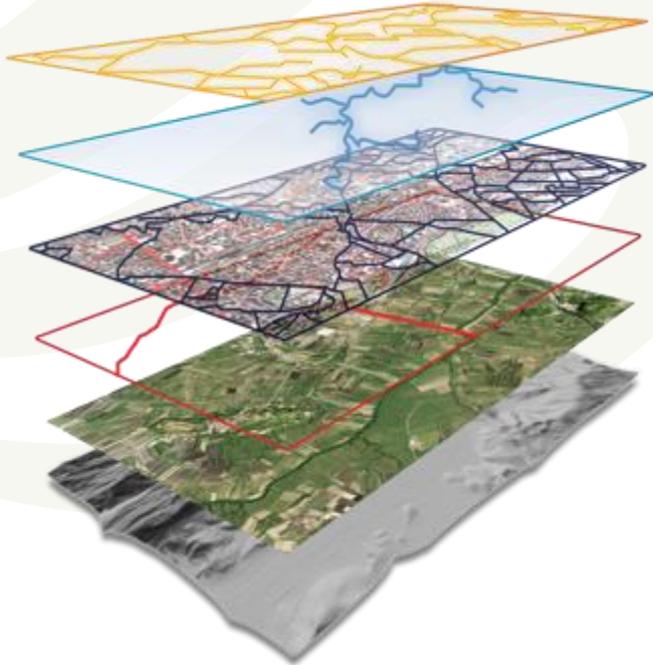
Scripting (Python, R, ENVI...)





Geopedia

Spatial Data Infrastructure



Various kinds of data

- Spatial data
- Temporal data
- Vector data
- Raster data
- Media (audio/video files, photos), documents, ...

Data from various sources

- governmental data
- crowdsourced data
- EO data
- ...

-> all data at one point



Geopedia

Spatial Data Infrastructure

- Web GIS application
- Mobile Apps
- Embeddable JS
- API

The image displays three overlapping screenshots illustrating Geopedia's capabilities:

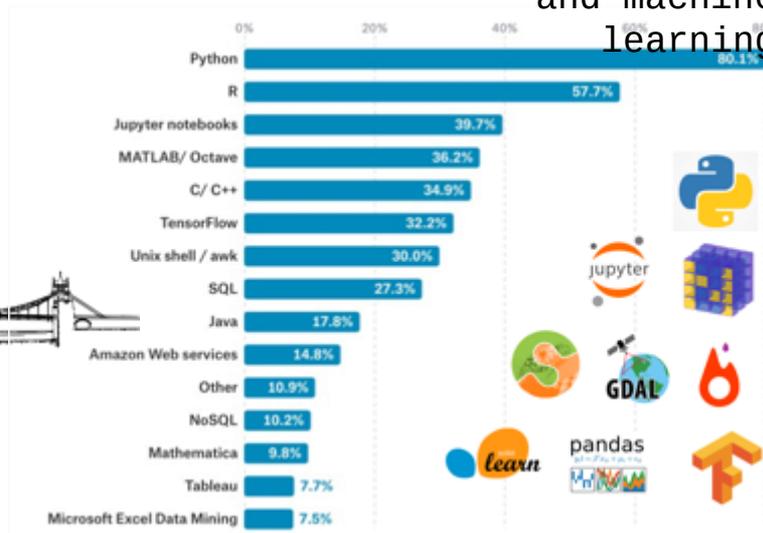
- Top Screenshot:** A mobile application interface titled "FFA KnowledgeHub Demo for FFA". It features a map of Indonesia with various colored overlays representing deforestation data. The interface includes a search bar and navigation icons.
- Middle Screenshot:** A desktop web application titled "LandSense" with the heading "DEFORESTATION CHANGE DETECTION IN INDONESIA". It features a map of Indonesia with various colored overlays representing deforestation data. The interface includes a search bar and navigation icons.
- Bottom Screenshot:** A desktop web application titled "Geopedia Portal" with the heading "Geopedia API". It features a search bar and a list of API endpoints. The "Geopedia World API" section includes a search bar and a list of endpoints, such as "POST /data/v2/search/tables/{tableId}/features" and "GET /data/v2/tables/{id}".



eo-learn



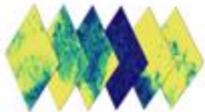
Python
ecosystem for
data science
and machine
learning



eo-learn-core



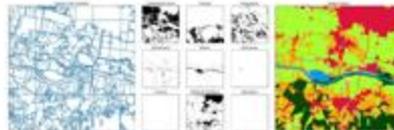
eo-learn-mask



eo-learn-geometry



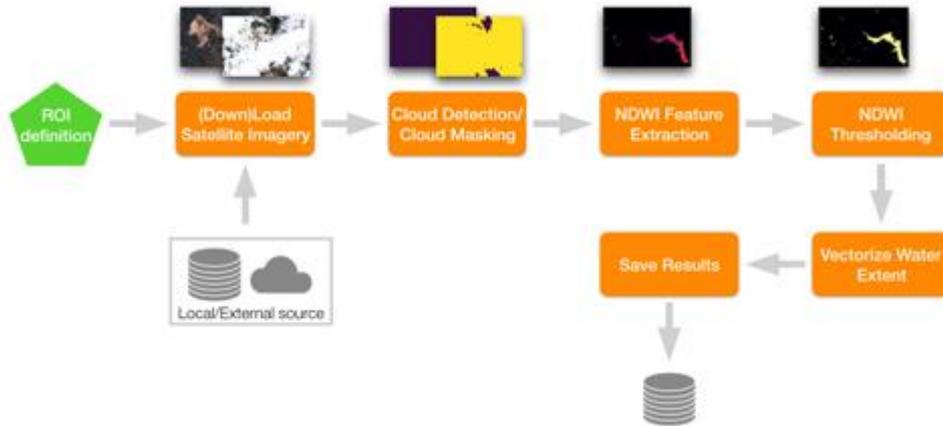
eo-learn-ml-tools



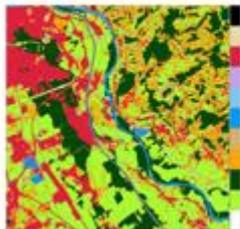
eo-learn-io

eo-learn-features

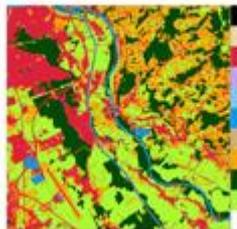
eo-learn-registration



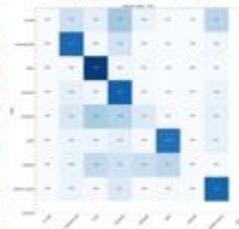
Ground truth



Predicted



Confusion Matrix



```
In [12]: path_out = './eopatches_small/' if use_smaller_patches else './eopatches_large/'
```

```

# Reference colormap
sys.path.append('../example_data/')
from lulc_cmap import lulc_cmap, lulc_norm
from lulc_classes import lulc_classes

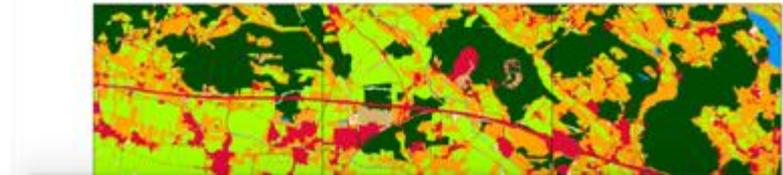
fig, axes = plt.subplots(figsize=(20,20*aspect_ratio), rows=1, ncols=1)

pbar = tqdm(total=9)
for i, ax in enumerate(axes.flat):
    eopatch = EOPatch.load(i)/eopatch_}.format(path_out, i) if save_choice else eopatches[i]
    in = ax.imshow(eopatch.mask_timeless['LULC'].squeeze(), cmap=lulc_cmap, norm=lulc_norm)
    ax.set_xticks([])
    ax.set_yticks([])
    ax.set_aspect('auto')
    pbar.update()
    del eopatch

fig.subplots_adjust(wspace=0, hspace=0)

cb = fig.colorbar(in, ax=axes.ravel().tolist(), orientation='horizontal', pad = 0.01, aspect=100)
cb.ax.tick_params(labelsize=20)
cb.set_ticks(np.array(list(lulc_classes.values)))
cb.ax.set_xticklabels(list(lulc_classes.keys()), rotation=45, fontsize=15)
plt.show()

HBox(children=(IntProgress(value=0, max=9), HTML(value='')))
```



Real use-case: Republic of Azerbaijan

User requirements:

- Access to Sentinel, Landsat and AzerSky imagery
- LCMS application for monitoring of the land
 - Easy to use, does not require an expert
- ML based classification of land cover and crops
 - Land cover every year / every 3 months

Real use-case: Republic of Azerbaijan

Sentinel-2



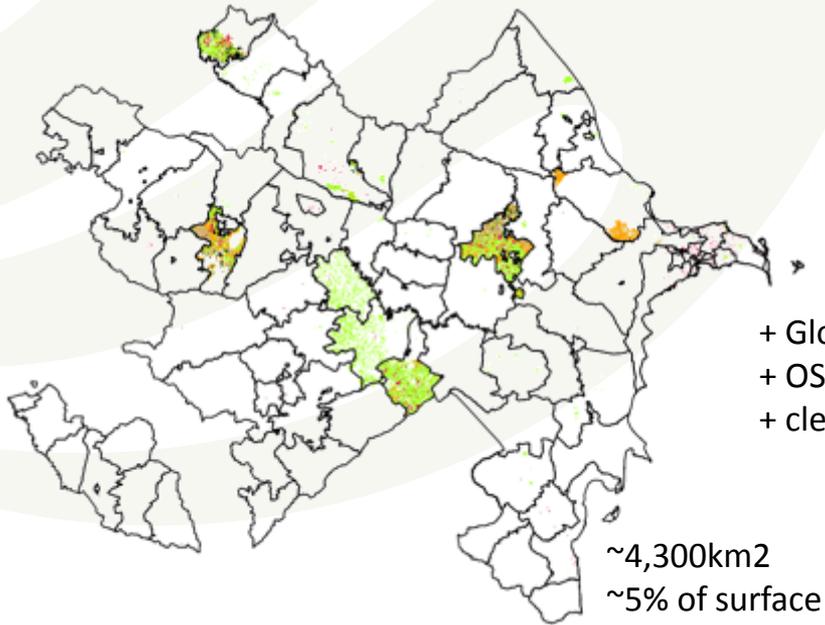
Landsat-8



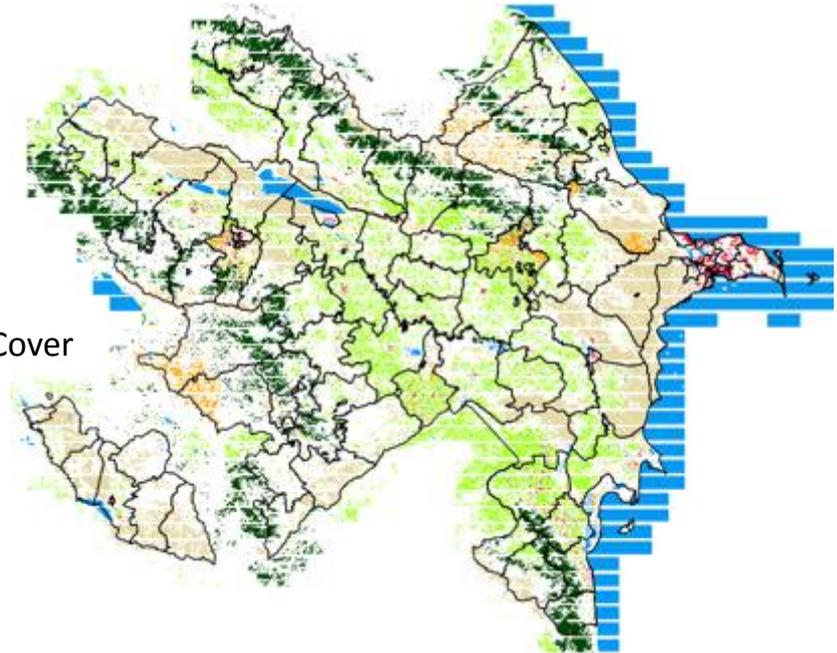
AzerSky



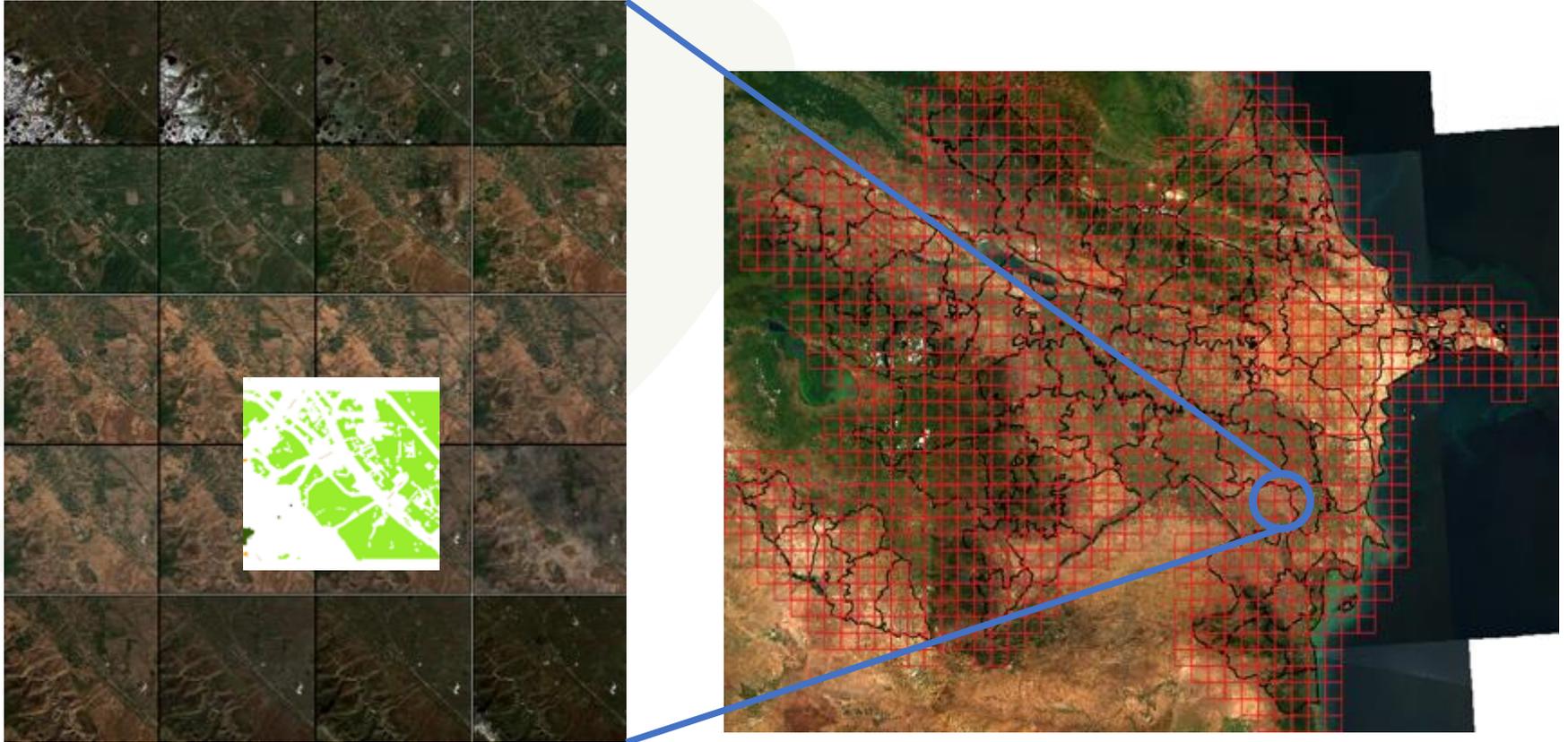
Real use-case: Republic of Azerbaijan



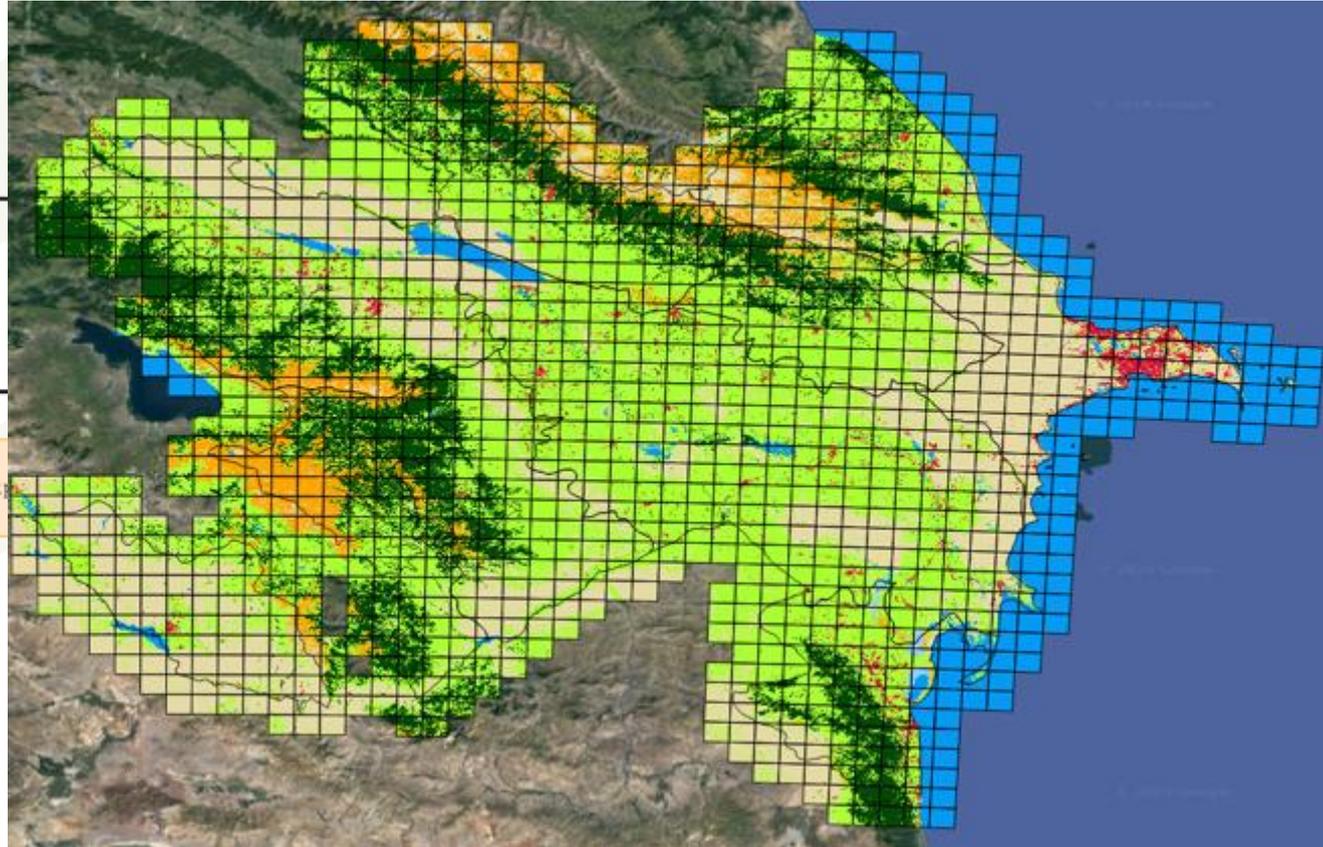
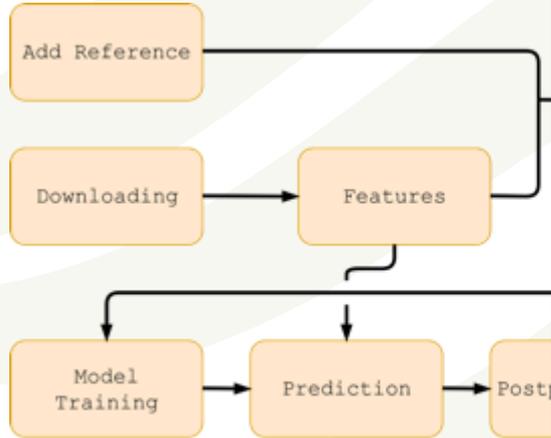
+ Global Land Cover
+ OSM
+ cleaning up



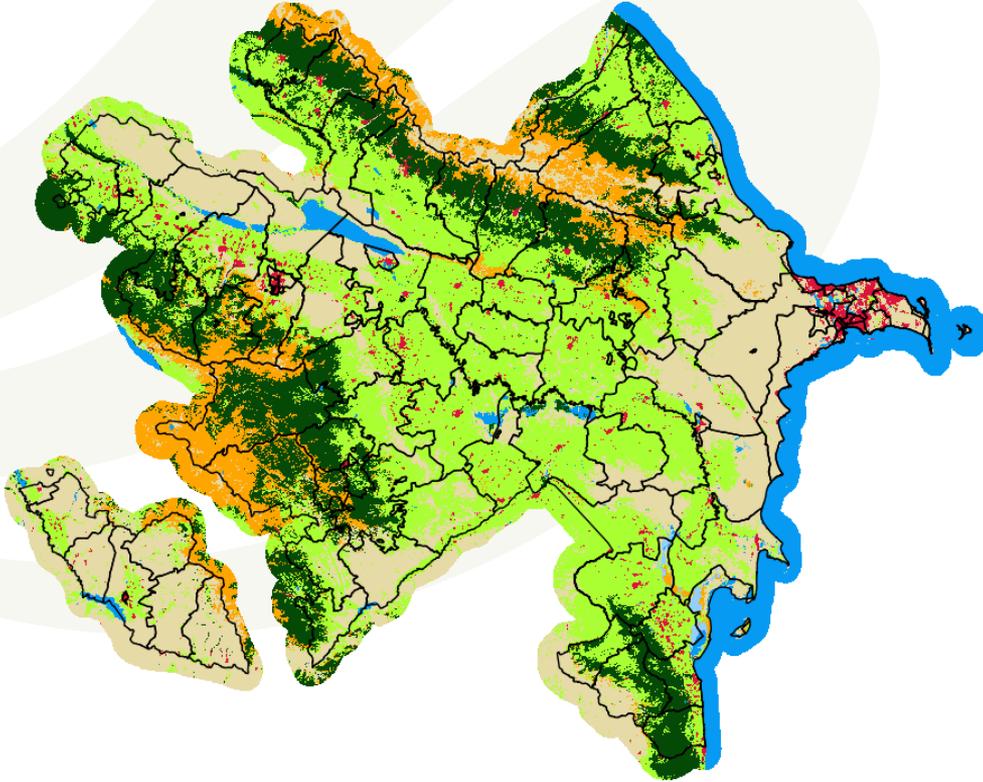
Real use-case: Republic of Azerbaijan



Real use-case: Republic of Azerbaijan

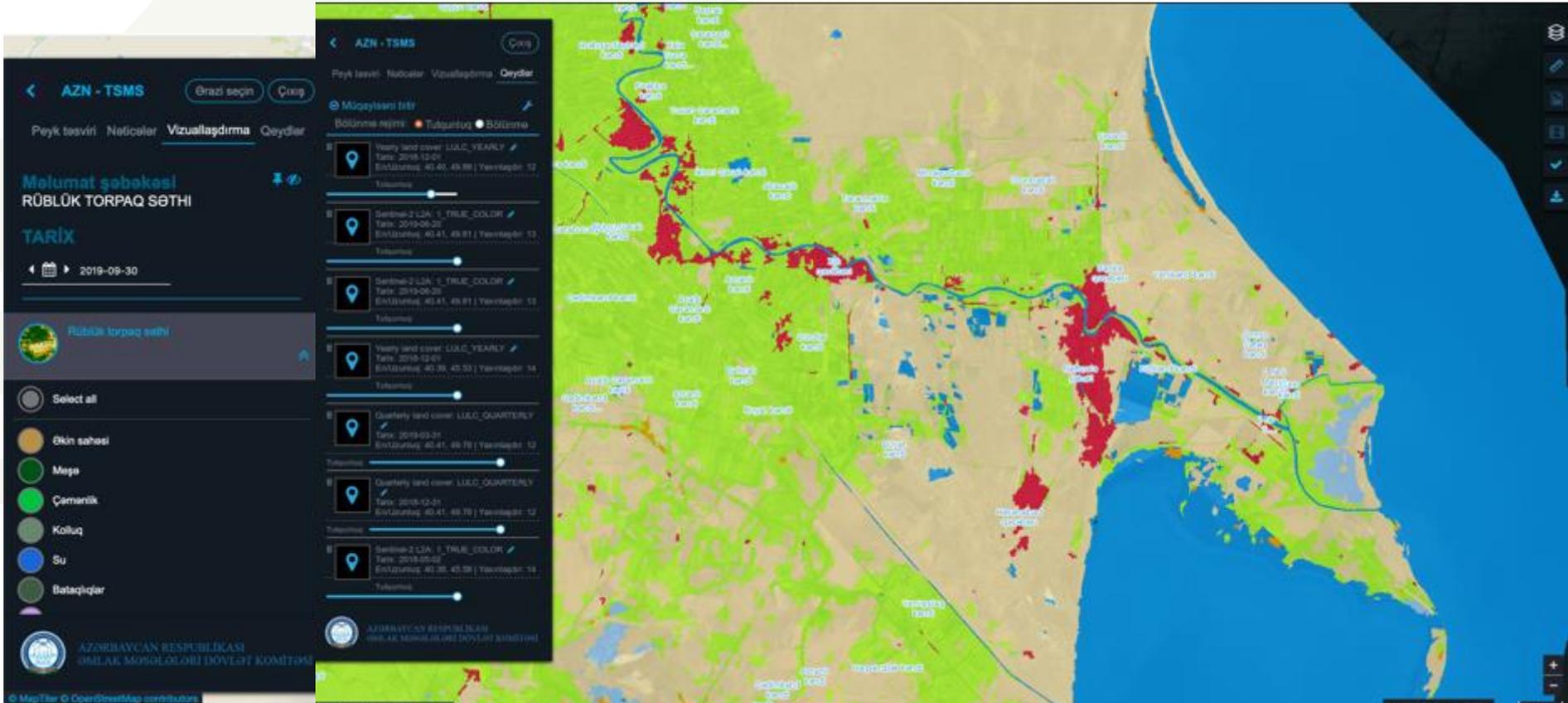


Real use-case: Republic of Azerbaijan

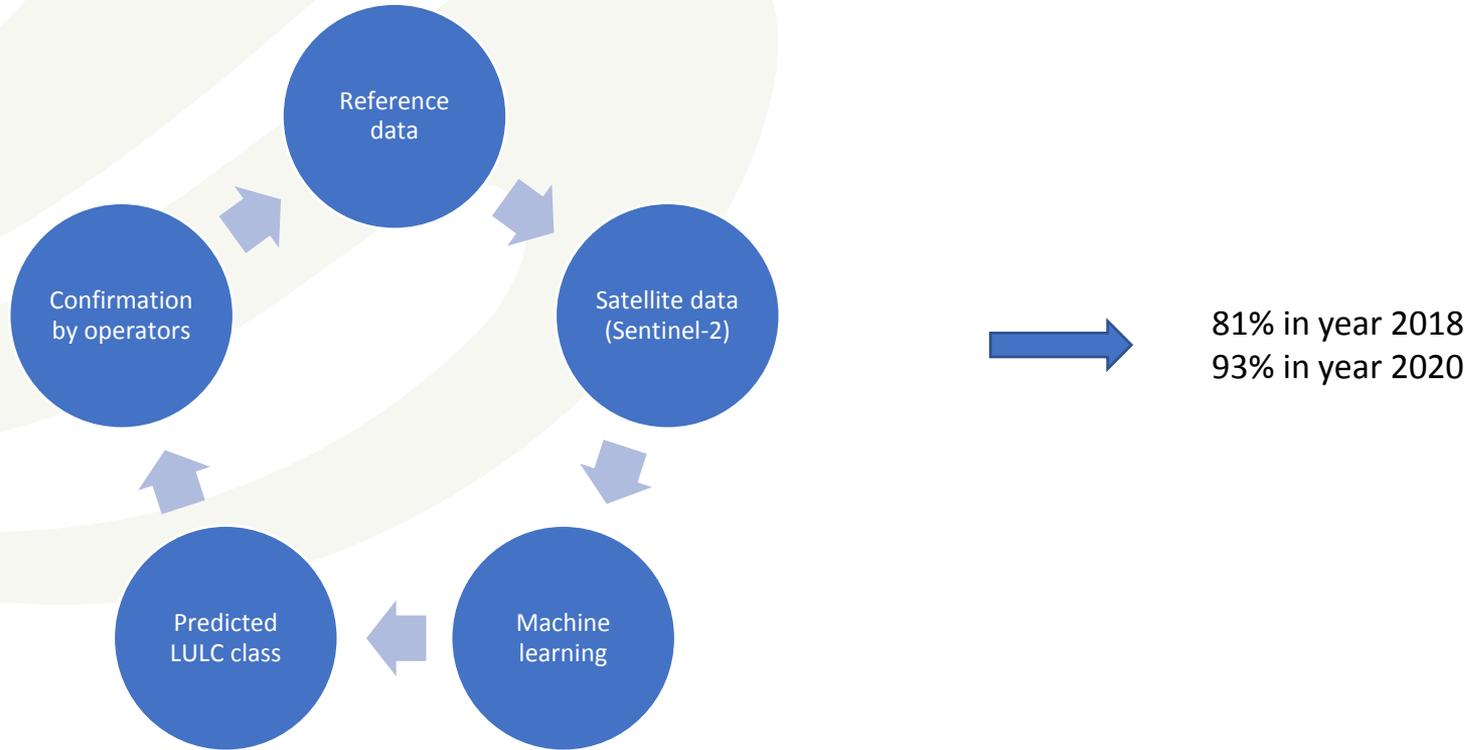


Classes	F1-score
Cultivated land	87%
Forest	95%
Grassland	32%
Water	98%
Urban	91%
Bareland	69%
Overall	81%

Real use-case: Republic of Azerbaijan



Real use-case: Republic of Azerbaijan



Real use-case: Republic of Azerbaijan

AZN - TSMS Gratı seçin Çıx

Peyk təsviri Nəticələr **Vizuallaşdırma** Qeydlər

Məlumat şəbəkəsi Q + - ↺ ↻

AZERSKY

TARİX

📅 2020-01-27

🌐 Haqqı rəng

🌐 Yalın rəng

AZERBAIJAN REPUBLICASI
DİŞLƏK MƏNSUPLARI DÖVLƏT KOMİTƏSİ

BUILDING VALIDATION TOOL

Təsdiqlənmə v01 Yenilə

- Building detection ID: 5886661
- Building detection ID: 5886662
- Building detection ID: 5886663
- Building detection ID: 5886664
- Building detection ID: 5886665
- Building detection ID: 5886666
- Building detection ID: 5886667

Version v01

Confirmation time

Is building?

Təsdiqlə Leğv et 🗑️

- Building detection ID: 5886668
- Building detection ID: 5886669
- Building detection ID: 5886670
- Building detection ID: 5886671
- Building detection ID: 5886672

Yeni sənəyə keç Previous Next Çıxış (ekspert)

Enlik: 40.486257, Uzunluq: 48.91941 50 m

MapTiler OpenStreetMap contributors

Lessons learned

- Bad reference data => bad results (?)
 - Semi-supervised / unsupervised approach to cleaning reference data
 - Reference data is not timeless
- Using open-source data 😊
 - Not everything is EU city
 - Unclear licensing
- The most valuable part: validation from operators (volunteers) fed back to the loop
- *Is it possible to build a fast and cost-effective LCMS system?*
 - *Confident enough that we've just started H2020 project GEM*



More info

<https://www.sentinel-hub.com/>

<https://www.geopedia.world/>

<https://github.com/sentinel-hub/eo-learn>

<https://medium.com/sentinel-hub/land-cover-monitoring-system-84406e3019ae>



Thank you!

matej.batic@sinergise.com
@matejbatic

Sinergise Ltd.
Cvetkova 29
1000 Ljubljana
Slovenia