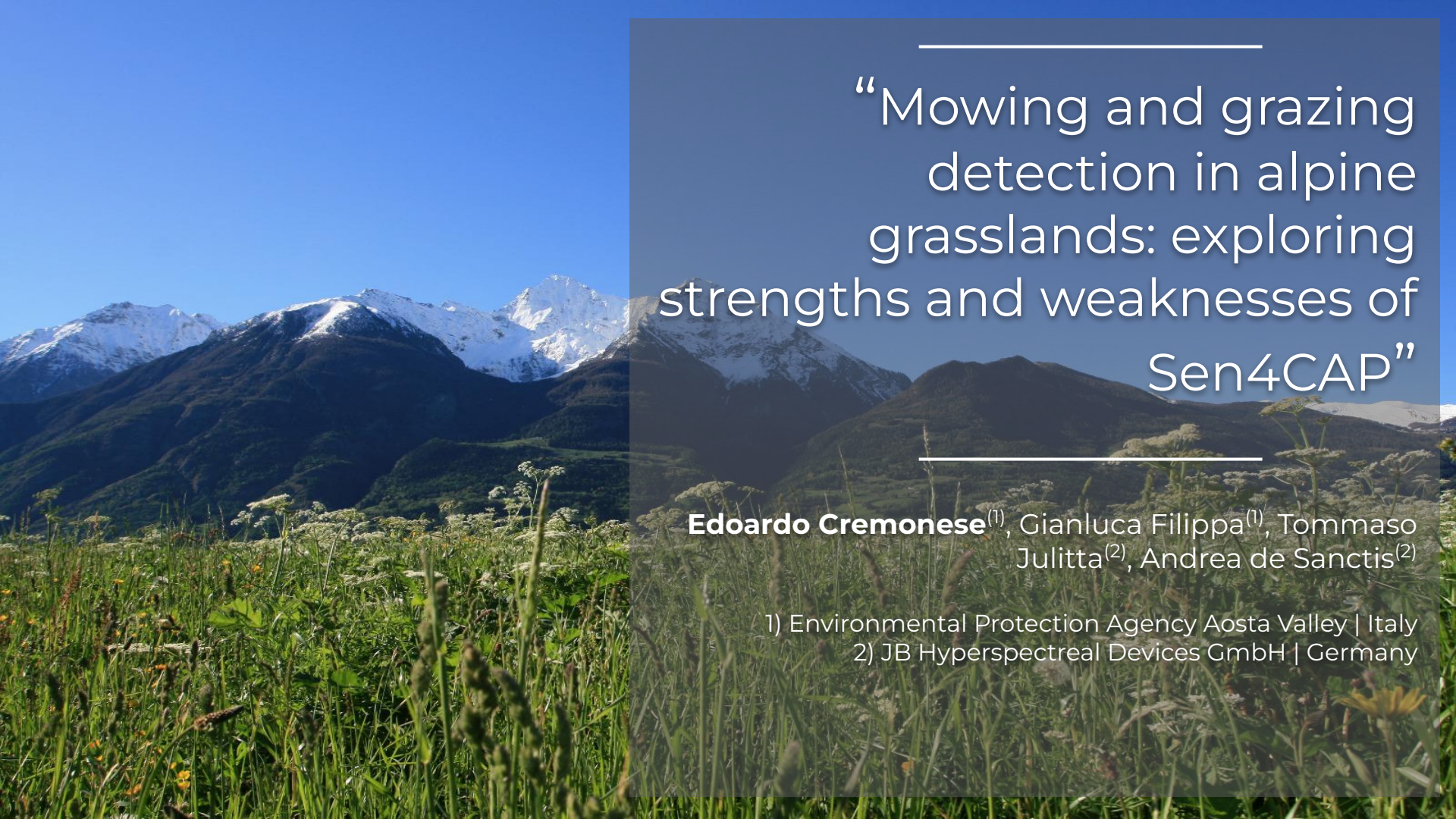


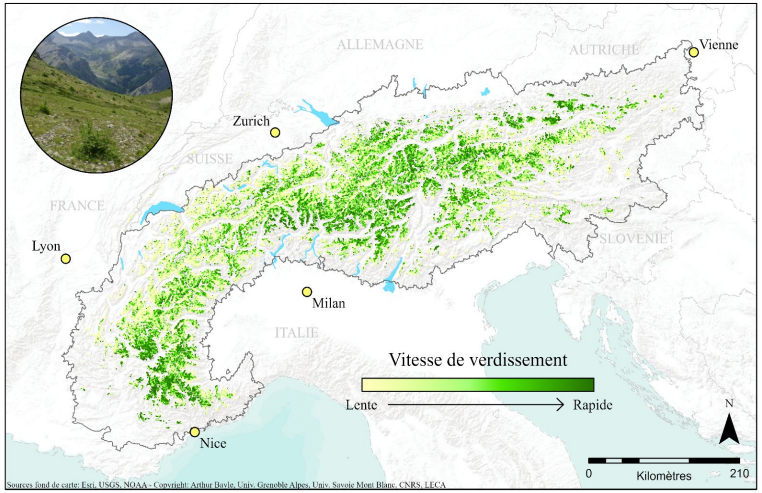
“Mowing and grazing detection in alpine grasslands: exploring strengths and weaknesses of Sen4CAP”

Edoardo Cremonese[1], Gianluca Filippa[1], Tommaso Julitta[2], Andrea de Sanctis[2]

1) Environmental Protection Agency Aosta Valley | Italy
2) JB Hyperspectreal Devices GmbH | Germany

1. Motivation and background

- pastoralism is the heart and soul of **mountain socio-ecological systems**
- pastoral systems **NCP**'s: habitat creation and maintenance, food and feed, and supporting identities (Dean et. al 2021)
- grasslands/agricultural areas: ~ 30% in EU, **80-95% in the Alps**
- **CAP** payments devoted to maintain ecological value and cultural landscape & Integrated Administration and Control System (**IACS**) checking of compliance measure
- **mowing and grazing detection** using **eo data** is receiving a great attention in the last years (fitting, drops, ML, thresholds, accuracy ~50-90% S1/S2 accuracy)



1. Motivation and background

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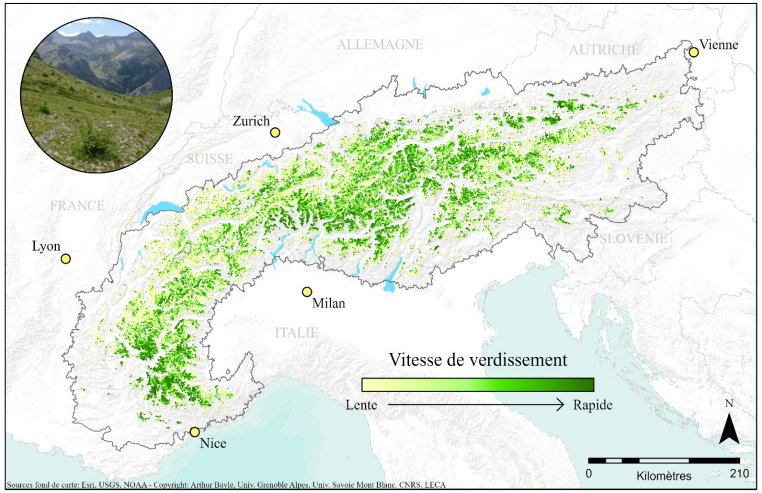


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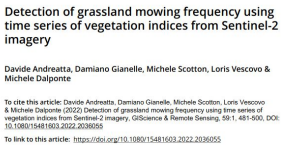
Towards national-scale characterization of grassland use intensity from integrated Sentinel-2 and Landsat time series

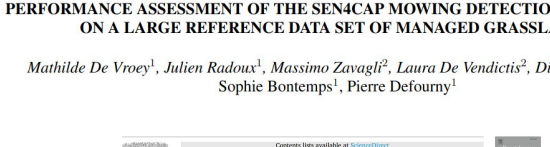
Patrick Griffiths[a,b,*], Claas Nendel[a], Jürgen Pickert[a], Patrick Hostert[a,d]


Detection of grassland mowing frequency using time series of vegetation indices from Sentinel-2 imagery

Davide Andreatta, Damiano Gianelle, Michele Scotton, Loris Vescovo & Michele Dalponte

To cite this article: Davide Andreatta, Damiano Gianelle, Michele Scotton, Loris Vescovo & Michele Dalponte (2022) Detection of grassland mowing frequency using time series of vegetation indices from Sentinel-2 imagery, GIScience & Remote Sensing, 59:1, 481-500, DOI: 10.1080/15481603.2022.2036055

To link to this article: https://doi.org/10.1080/15481603.2022.2036055


PERFORMANCE ASSESSMENT OF THE SEN4CAP MOWING DETECTION ALGORITHM ON A LARGE REFERENCE DATA SET OF MANAGED GRASSLANDS.

Mathilde De Vroey[1], *Julien Radoux*[1], *Massimo Zavagli*[2], *Laura De Vendictis*[2], *Diane Heymans*[1], Sophie Bontemps[1], Pierre Defourny[1]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Mapping grassland mowing events across Germany based on combined Sentinel-2 and Landsat 8 time series

Marcel Schwieder[a,b,*], Maximilian Wesemeyer[a], David Frantz[b,c], Kira Pfoch[b,d], Stefan Erasmi[b], Jürgen Pickert[a], Claas Nendel[a,b,e], Patrick Hostert[a,f]


remote sensing
MDPI
Article

Exploiting Time Series of Sentinel-1 and Sentinel-2 Imagery to Detect Meadow Phenology in Mountain Regions

Laura Stendardi[1,*], Stein Rune Karlsen[2], Georg Niedrist[3], Renato Gerdol[4], Marc Zebisch[5], Mattia Rossi[5] and Claudia Notarnicola[5]


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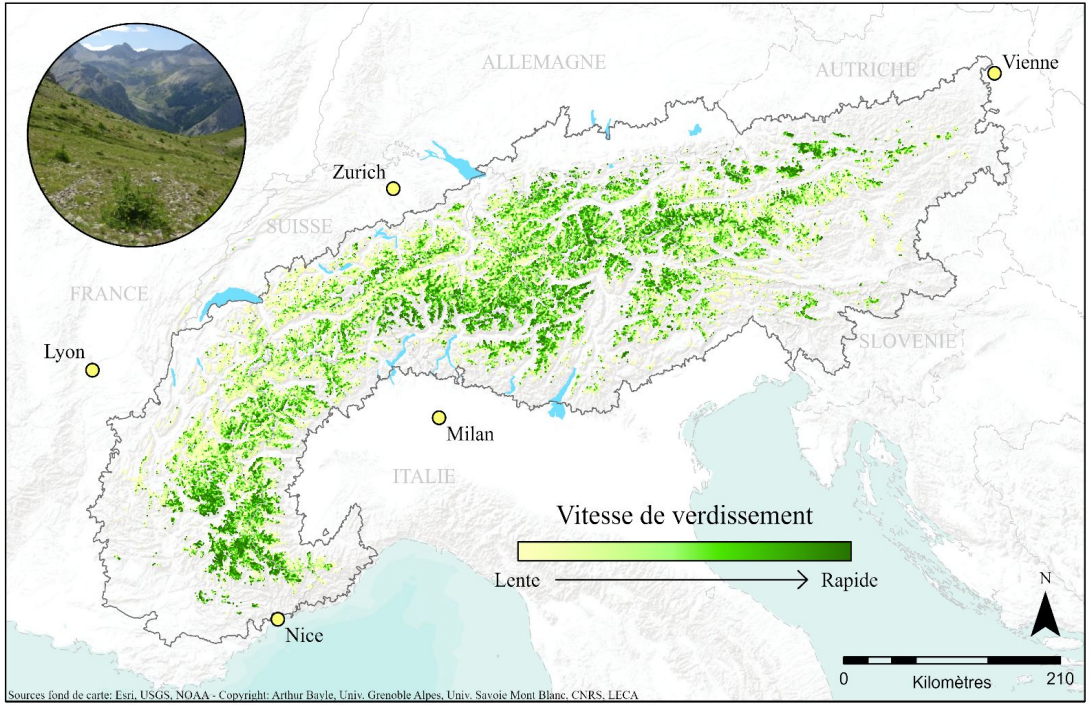
ELSEVIER

Mowing event detection in permanent grasslands: Systematic evaluation of input features from Sentinel-1, Sentinel-2, and Landsat 8 time series

Felix Lobert[a,*], Ann-Kathrin Holtgrave[b], Marcel Schwieder[a], Marion Pause[c], Juliane Vogt[d], Alexander Gocht[a], Stefan Erasmi[b]

1. Motivation and background

- widespread **greening** processes at alpine scale deriving from the interaction of **climate change** and **land-use change** (intensification in lowlands and abandonment in medium-high elevations)

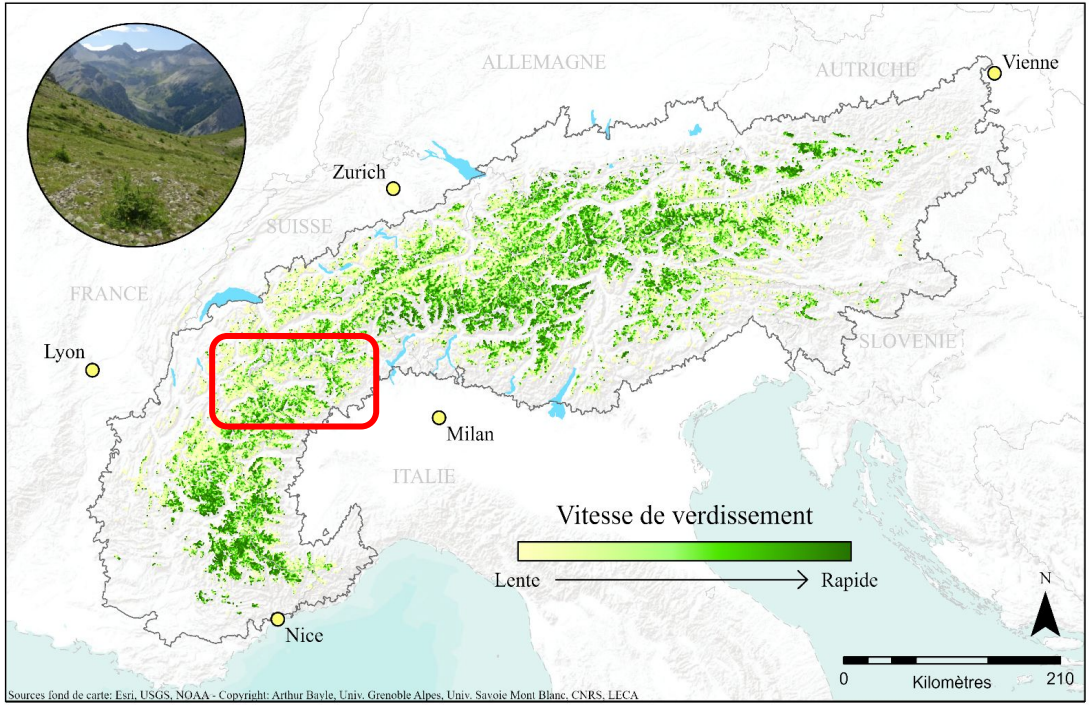


Choler et al. 2021, GCB, https://onlinelibrary.wiley.com/doi/10.1111/gcb.15820

1. Motivation, background and study area

- widespread **greening** processes at alpine scale deriving from the interaction of **climate change** and **land-use change** (intensification in lowlands and abandonment in medium-high elevations)

- **Aosta Valley**
  - 3000 Km2
  - mean elevation 2100m asl
  - mean snow melt in late April
  - < 1800 m asl: mowing
  - > 1800 m asl: rotational grazing schemes (variable stocking density)
  - 95% cows
  - 2-3 mowing/grazing events per year



Choler et al. 2021, GCB, https://onlinelibrary.wiley.com/doi/10.1111/gcb.15820

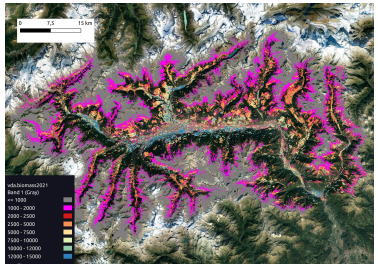
1. Motivation and background

- **permanent grasslands (meadow and pastures) mapping**

  PastorAlp project: Pastures vulnerability and adaptation strategies to climate change impacts in the Alps - LIFE16 CCA/IT/000060 (https://www.pastoralp.eu/homepage/)

  Filippa et al. 2022 https://doi.org/10.1016/j.jag.2022.102718

- **functional/structural properties estimation** (e.g. biomass productivity tonn/ha d.m.)

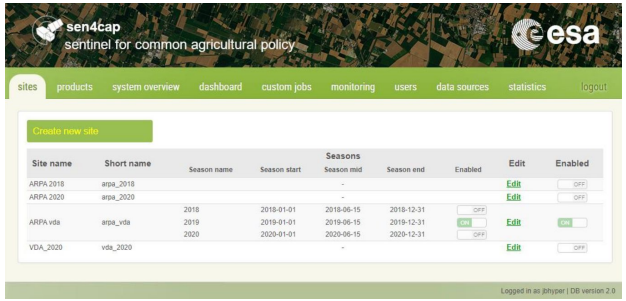


Poster Session Today!!
A remote sensing approach to map productivity in mountain grasslands, Gran Paradiso National Park, NW Italy

- **mowing & grazing detection**

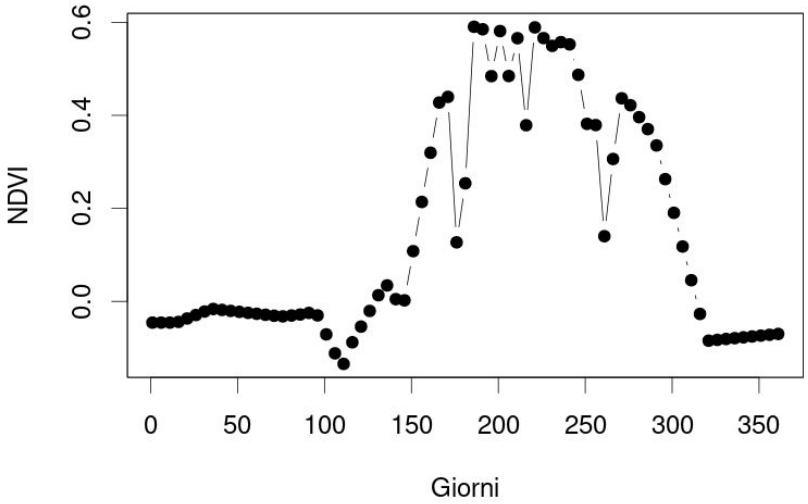
2. Methods

- **Sen4CAP**
  - S1 (increases in interferometric coherence time series) S2 (NDVI time series drops + decreasing rate)
  - output @ parcel level
    - # mowing events
    - mowing events dates
    - confidence level
  - De Vroey et al. 2021: 58% true positive 42% false positive (S1, grazing-mowing) & confidence level > 0.8 high precision
  - IT implementation: CREOdias (https://creodias.eu/-/sen4cap)

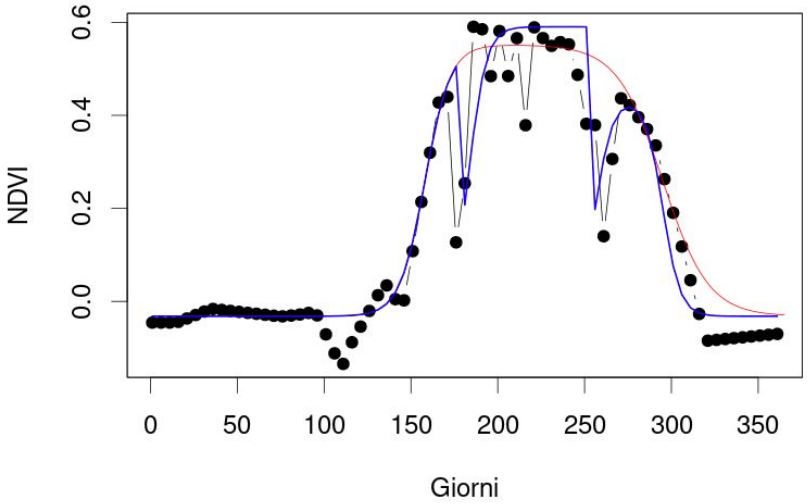


- **“Sen4Alps”**
  - S2 NDVI: mowing/grazing events as deviations from undisturbed phenology
  - change detection approach
  - output @ pixel level
    - # mowing events
    - mowing events dates
    - confidence level
  - output aggregated @ parcel level
  - gee and R

2. Methods: “Sen4Alps” workflow



2. Methods: “Sen4Alps” workflow



- S2 L2A **ndvi** timeseries & **filtering** according to sen2corr SCL (~20/25 clear-sky data Mar-Nov)
- **gapfilling** (max gap 25 days): linear interpolation 5d timestep
- **fitting**: double logistic (phenopix R package, Filippa et al. 2015)
- mowing/grazing event **detection**: ndvi drop fixed threshold
- **L0 output**
    - fitting accuracy: Obs vs Pred (R2, slope, intercept)
    - Used (boolean) / # use / Time use
    - NDVI drop (use intensity)
    - Perturbation index [sum(abs(diff(obs))]

2. Methods: “Sen4Alps” pixel-raster-parcel upscaling

Filter step 1a

R2 > 0.85
0.75 < slope < 1.1
-0.1 < intercept < 0.1

Filter step 1b →maps masked

Perturb > 5 & dem <2000 m asl

Include highly perturbed, low elevation meadows

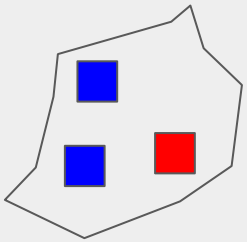
Filter step 2 → maps masked step 2

time window check

Layer recalculation + composite

Filter step 3 →maps masked step 3
Slope > 35°
Dem > 2700 m asl

Raster2Polygon (i.e. parcel)



N pixels
N used pixels
N unused pixels
Classification
Classified area (%)
Confidence level

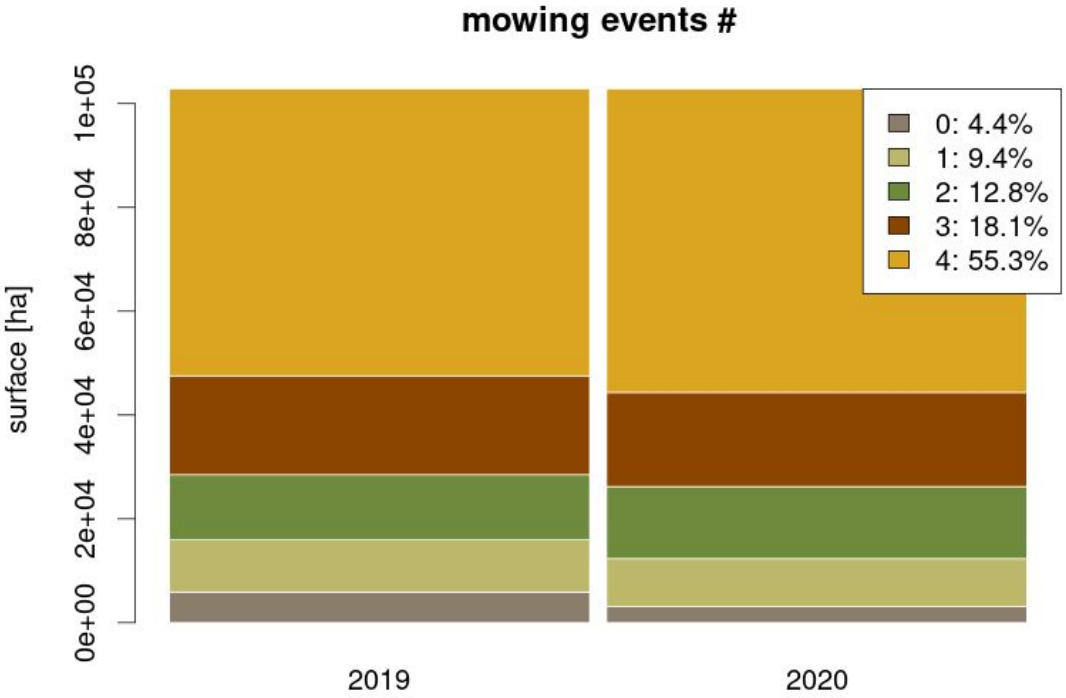
TOT grasslands surf: 104k ha

Classified surf: 87k ha

3. Results

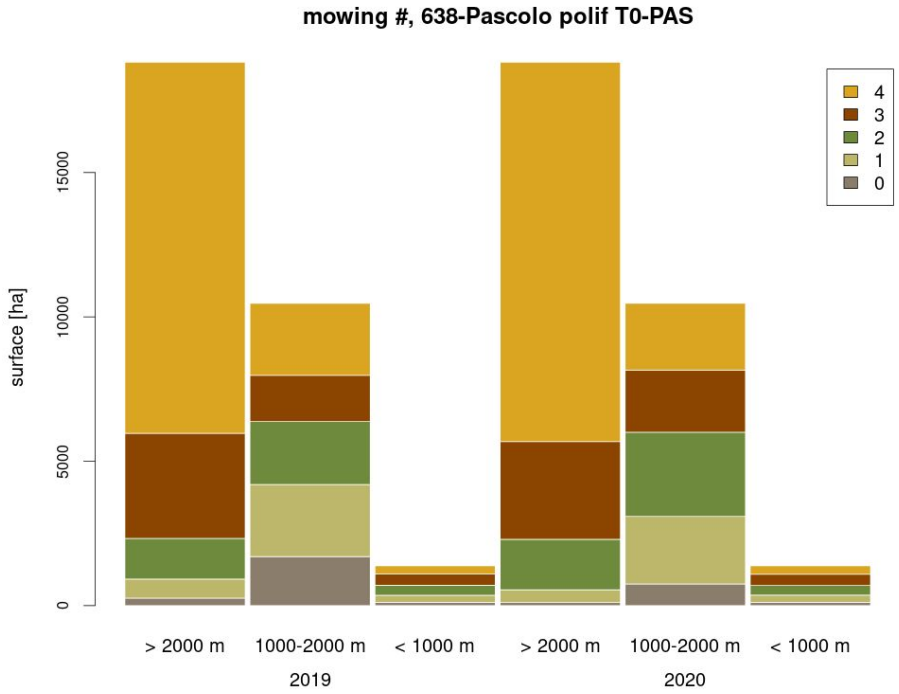
- **Sen4CAP**
- Sen4CAP - Sen4Alps comparison
    - number and dates of mowing/grazing events
    - spatial distribution
- Sen4Alps: accuracy assessment perspectives

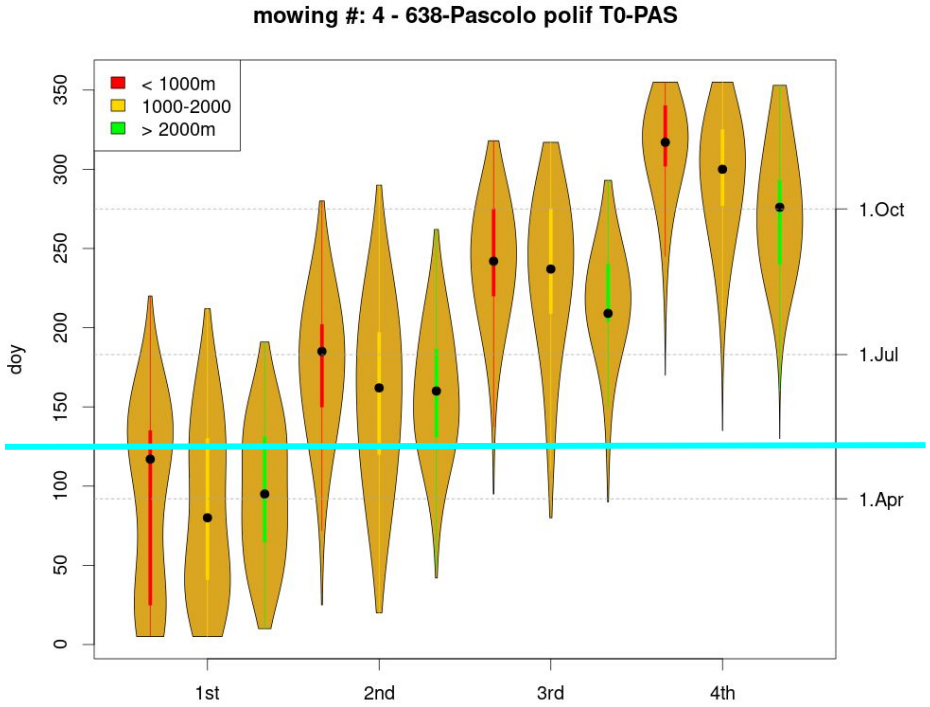
3. Results: Sen4CAP



- > 50% surface with **4 events**

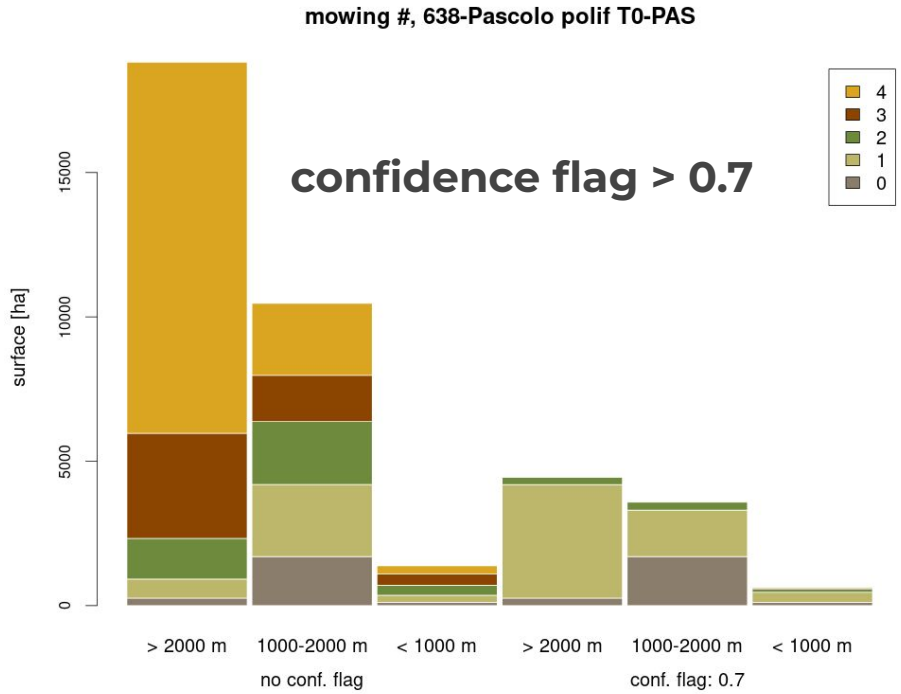
3. Results: Sen4CAP - elevation subsets & mowing dates distribution





- **4 events** @ high elevation (>2000m)
- unreliable **dates**(e.g. 1st use ~ 1Apr @2000m)
- inconsistent **dates~elevation**

3. Results: Sen4CAP - confidence flag effect

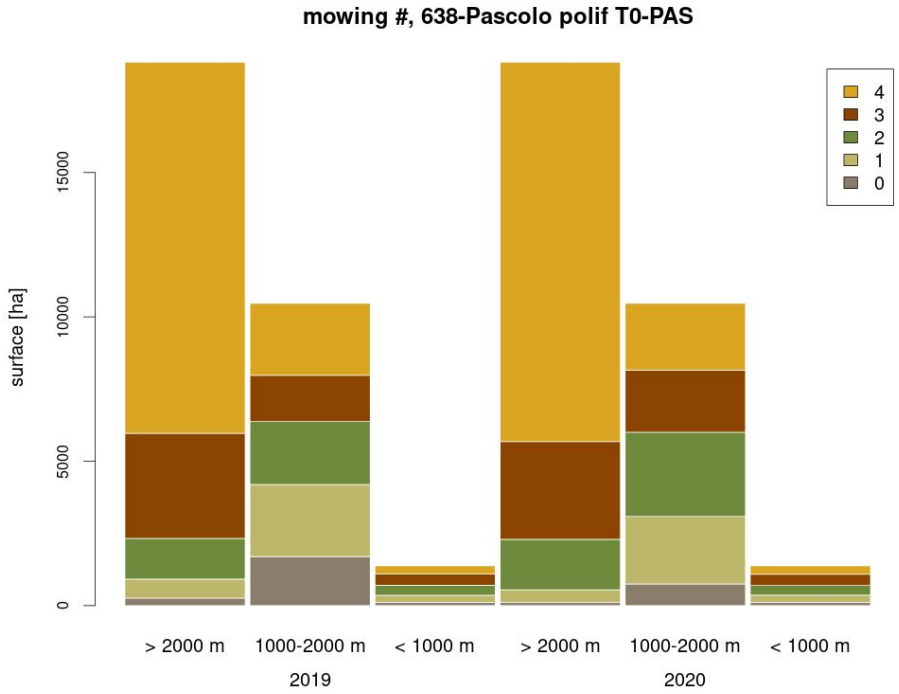


- reduction of 3&4 events
- reduction of the “classified” surface

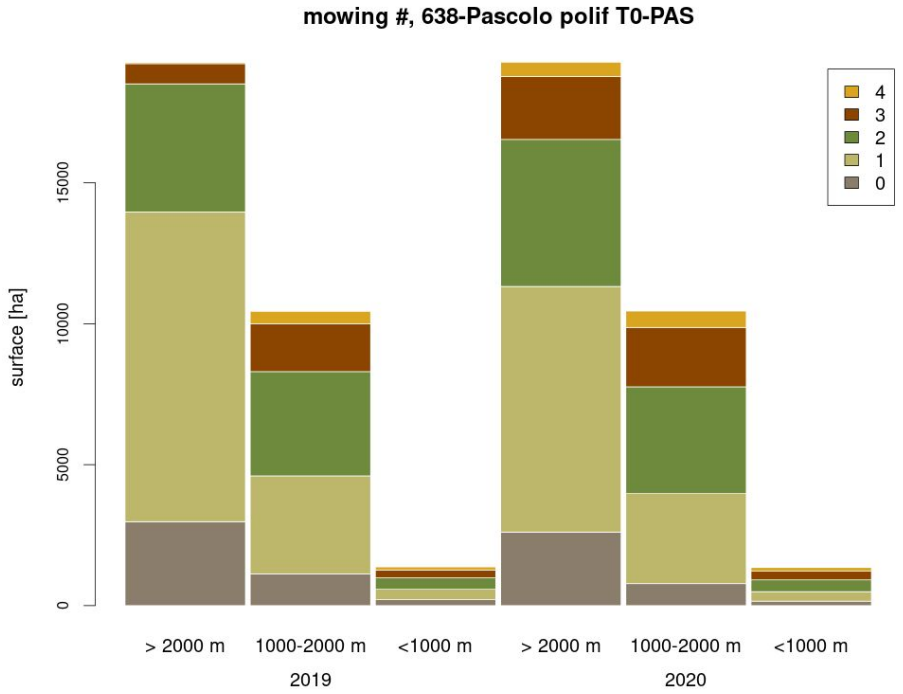
3. Results

- **Sen4CAP**
- **Sen4CAP - Sen4Alps comparison**
    - **number and dates of mowing/grazing events**
    - **spatial distribution**
- Sen4Alps: accuracy assessment perspectives

3. Results: Sen4CAP - Sen4Alps comparison

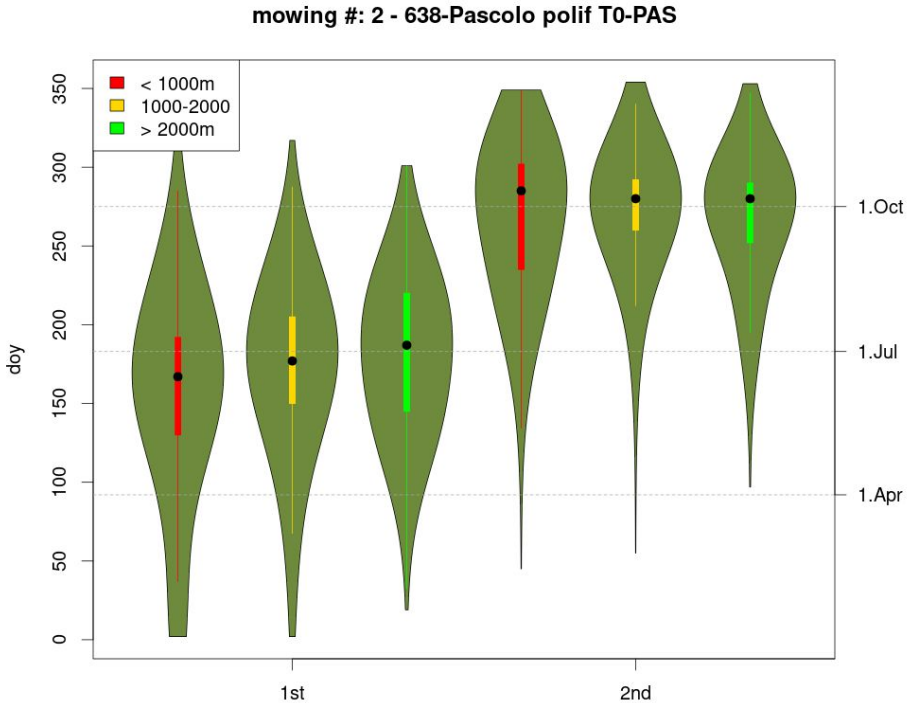


Sen4Cap

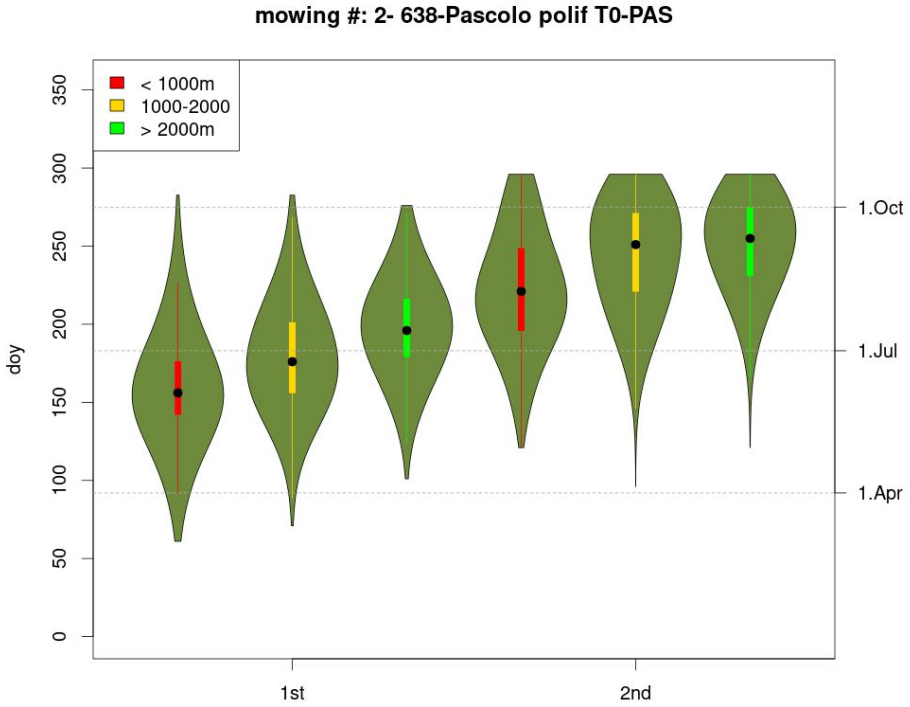


Sen4Alps

3. Results: Sen4CAP - Sen4Alps comparison

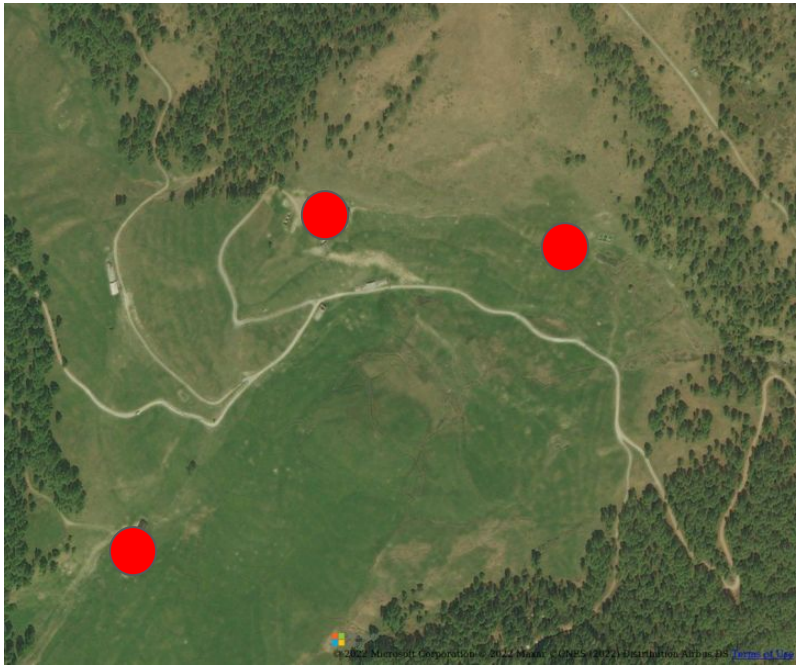


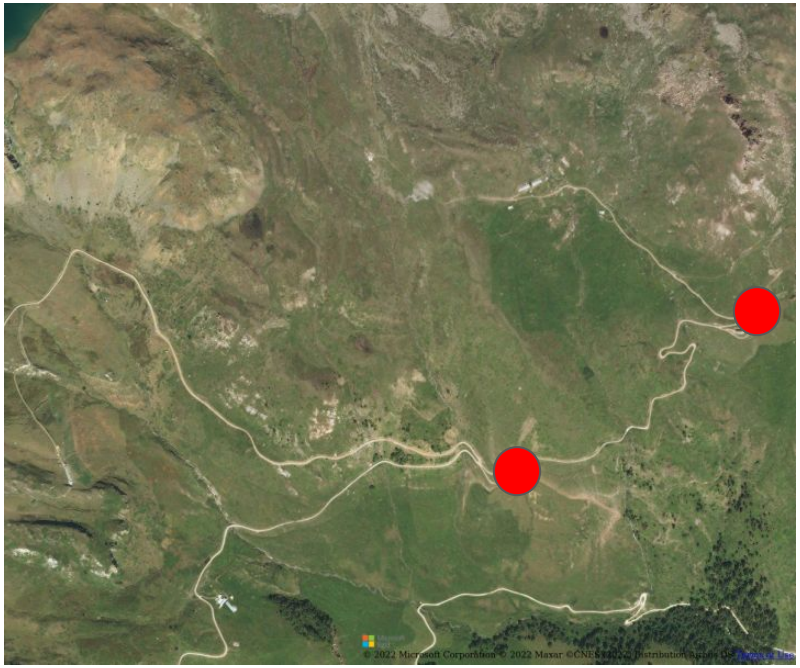
Sen4Cap



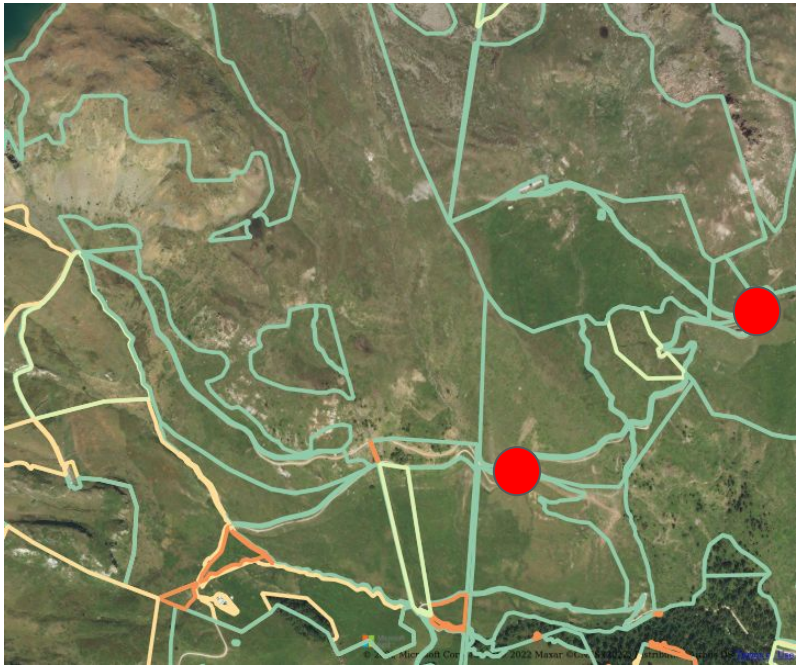
Sen4Alps

3. Results: Sen4CAP - Sen4Alps comparison: spatial distribution #events



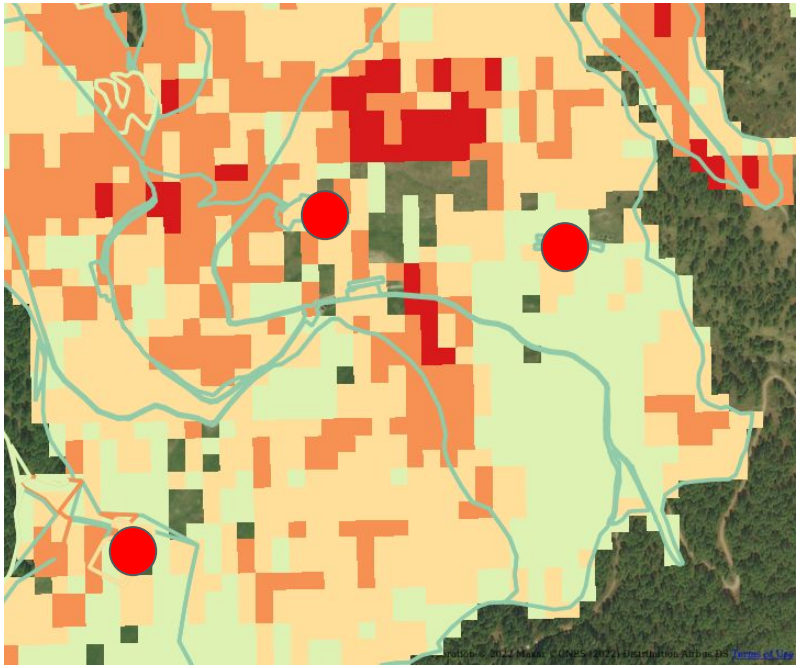


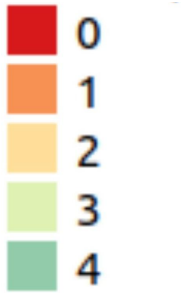
3. Results: Sen4CAP - Sen4Alps comparison: spatial distribution #events

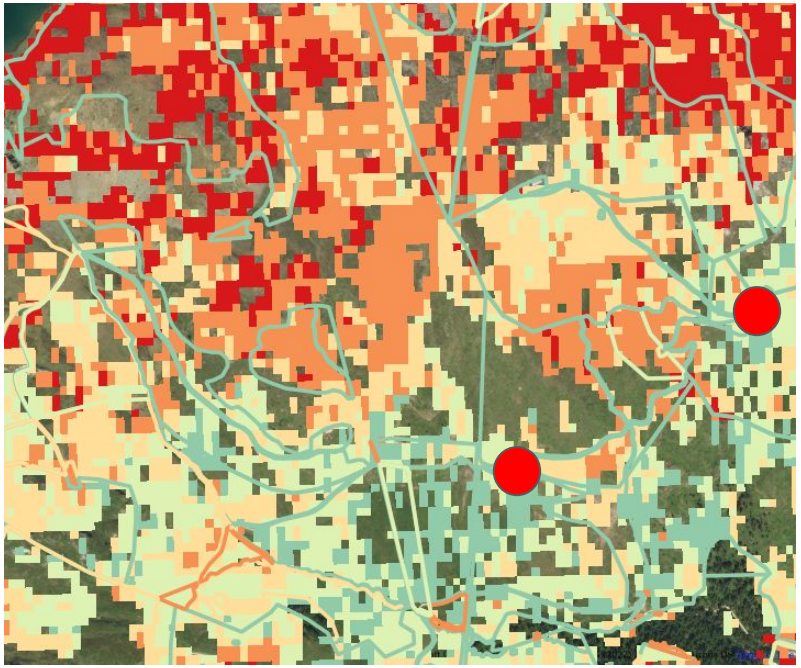


- Sen4CAP: 4 events @ parcel level

3. Results: Sen4CAP - Sen4Alps comparison: spatial distribution #events

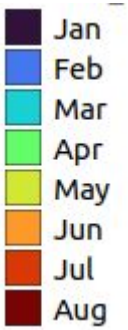






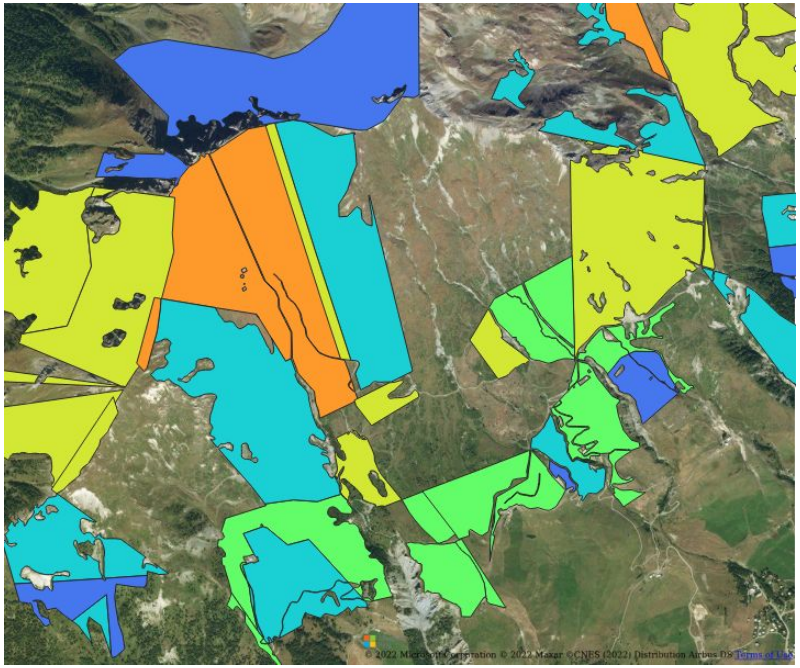
- Sen4CAP: 4 events
- Sen4Alps: mainly 1-2 events (3-4 only stables surroundings) & coherent altitudinal distribution

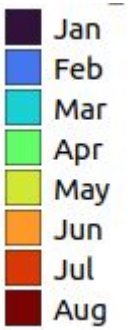
3. Results: Sen4CAP - Sen4Alps comparison: spatial distribution dates (1st event)

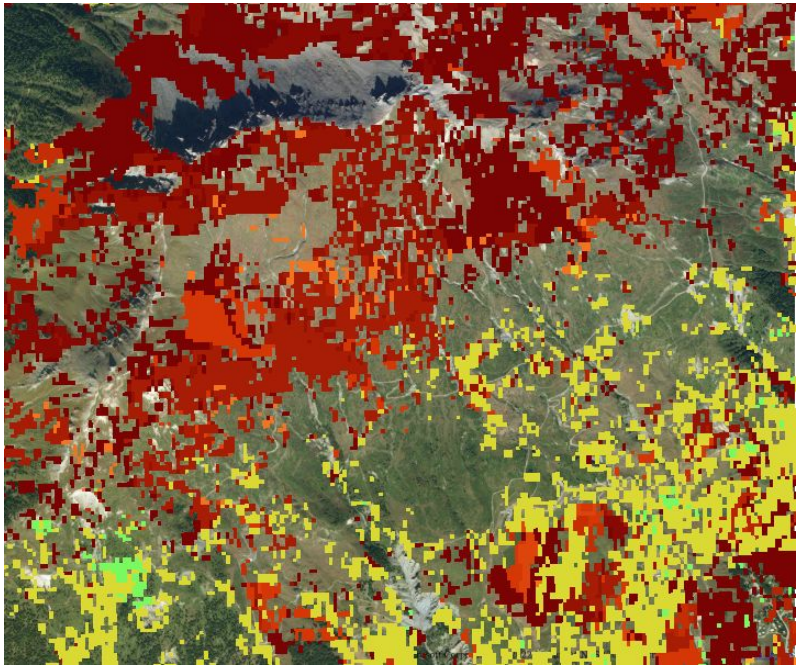


- mowing dates spatial distribution
- approximately 1500-2500 m asl

3. Results: Sen4CAP - Sen4Alps comparison: spatial distribution dates (1st event)







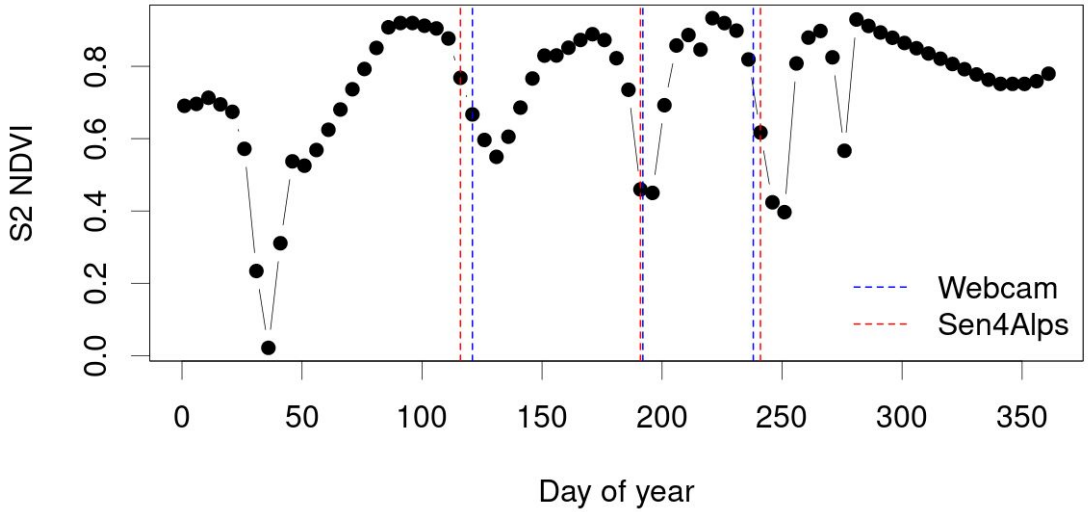
- **Sen4CAP**: incorrect timing (too early) & incoherent altitudinal and spatial patterns

- **Sen4Alps**: correct timing (May-Jul) & altitudinal distribution & coherent spatial patterns

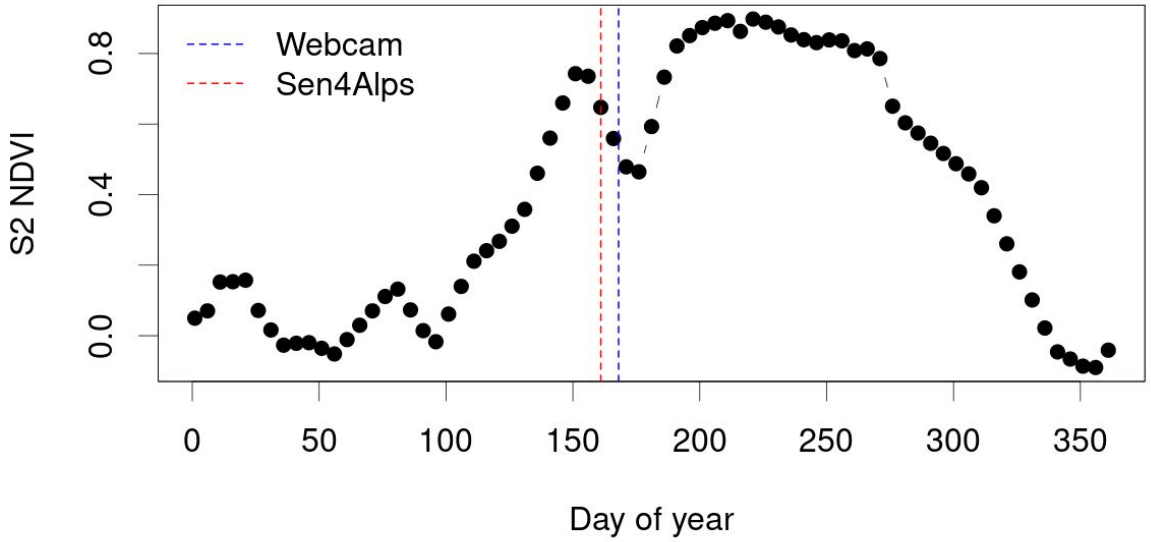
3. Results

- **Sen4CAP**
- **Sen4CAP - Sen4Alps comparison**
    - **number and dates of mowing/grazing events**
    - **spatial distribution**
- **Sen4Alps: accuracy assessment perspectives**

3. Sen4Alps: accuracy assessment perspectives



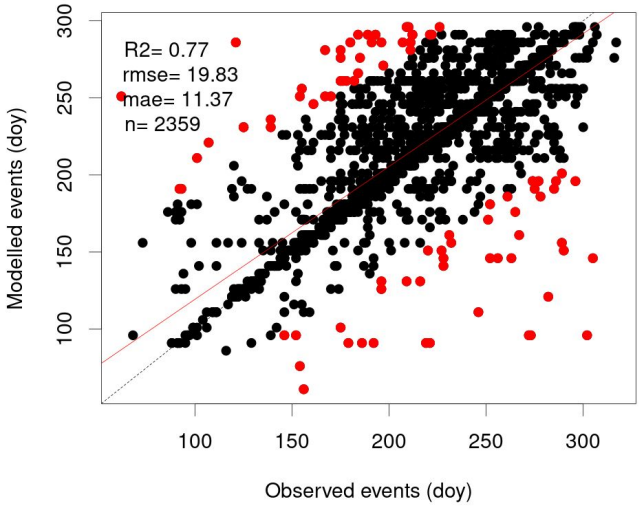
3. Sen4Alps: accuracy assessment perspectives



3. Sen4Alps: accuracy assessment perspectives

Visual detection on NDVI trajectories (>2k pixels)

Metric	Use/noUse	# events
Accuracy	0.90	0.58
Recall (false negative)	**0.91**	-
Precision	0.72	-
F1-Score	0.80	0.69*



* F1-Score computed for first event (the most frequent)

4. conclusions and future perspectives

- **Sen4CAP** preliminary results in mountain areas are not extremely satisfying
- **Sen4Alps**, complementary mountain tailored method, results seems more promising
- further **validation** (independent datasets) and comparison is still needed
- given the impact that the application of these methods can have on control systems and CAP payments, further developments and **validation dataset collection and sharing** is needed
- call for a **cooperative effort**


Thanks for your attention
e.cremonese@arpa.vda.it

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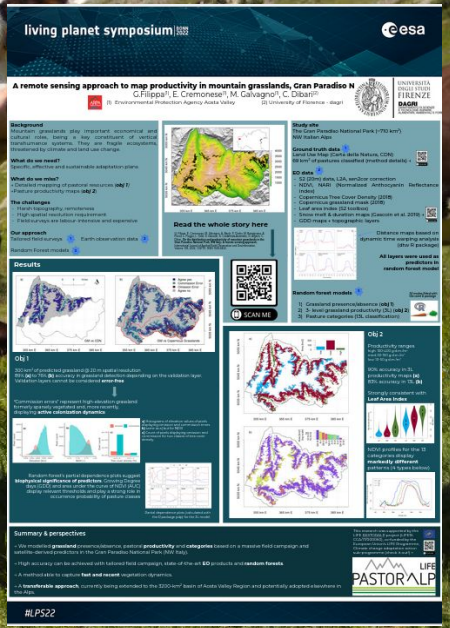
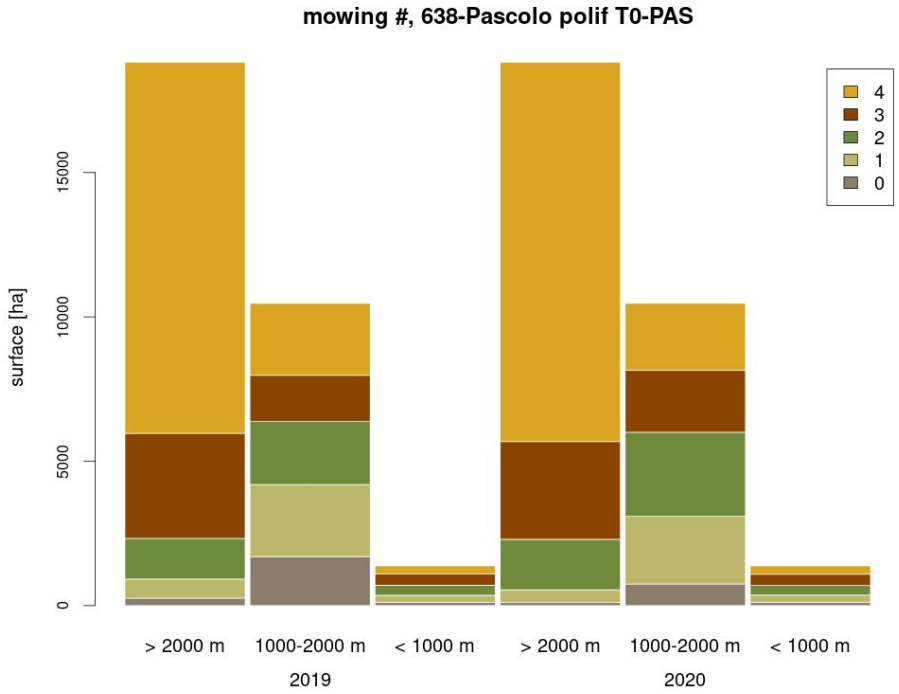
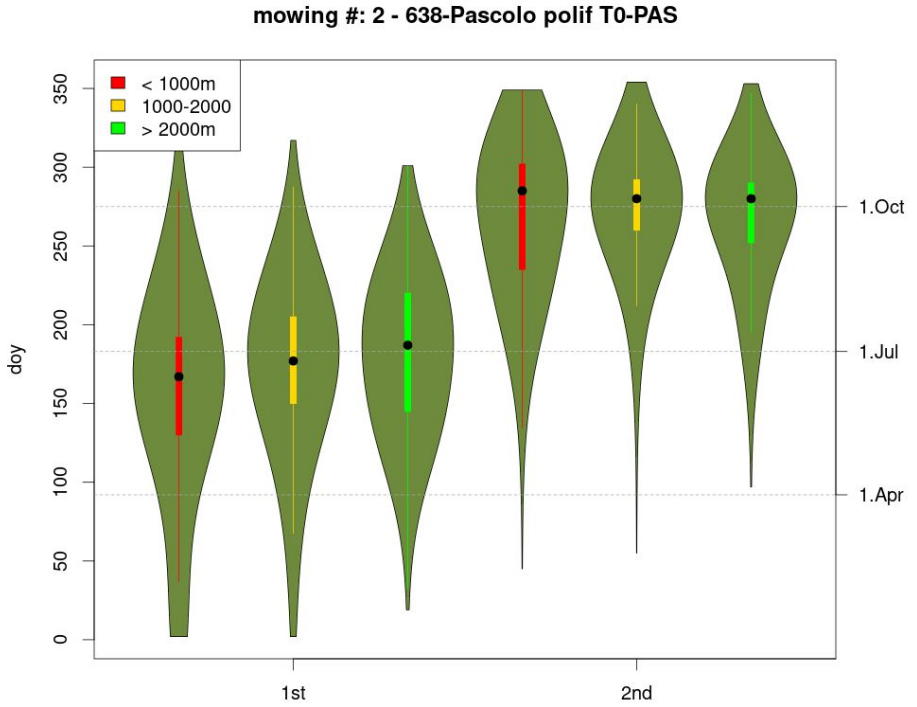


Poster Session Today!!

A remote sensing approach to map productivity in mountain grasslands, Gran Paradiso National Park, NW Italy

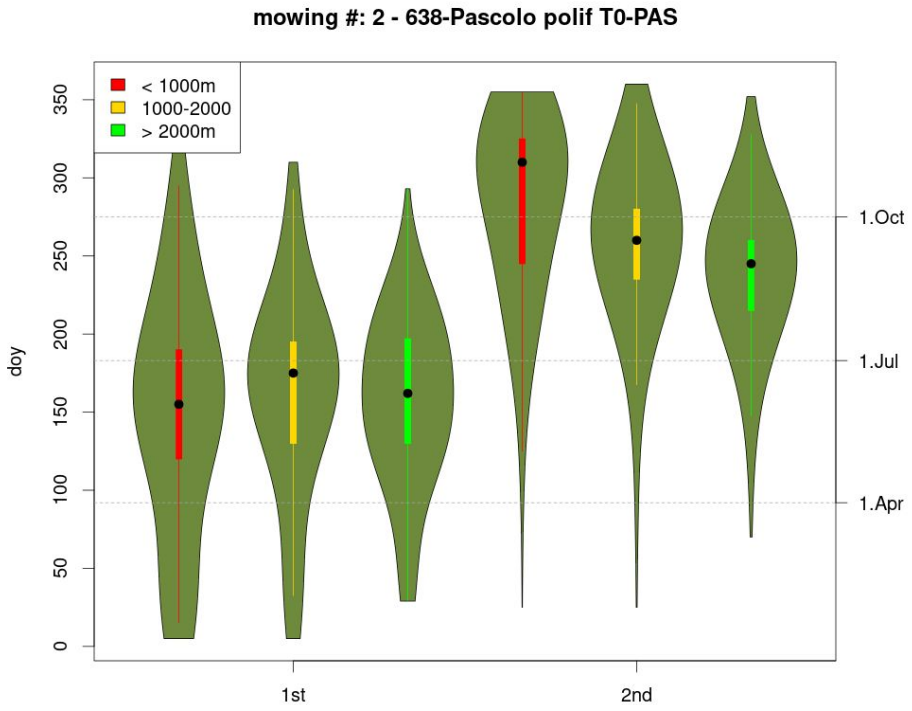
3. Results: Sen4CAP - elevation subsets & mowing dates distribution

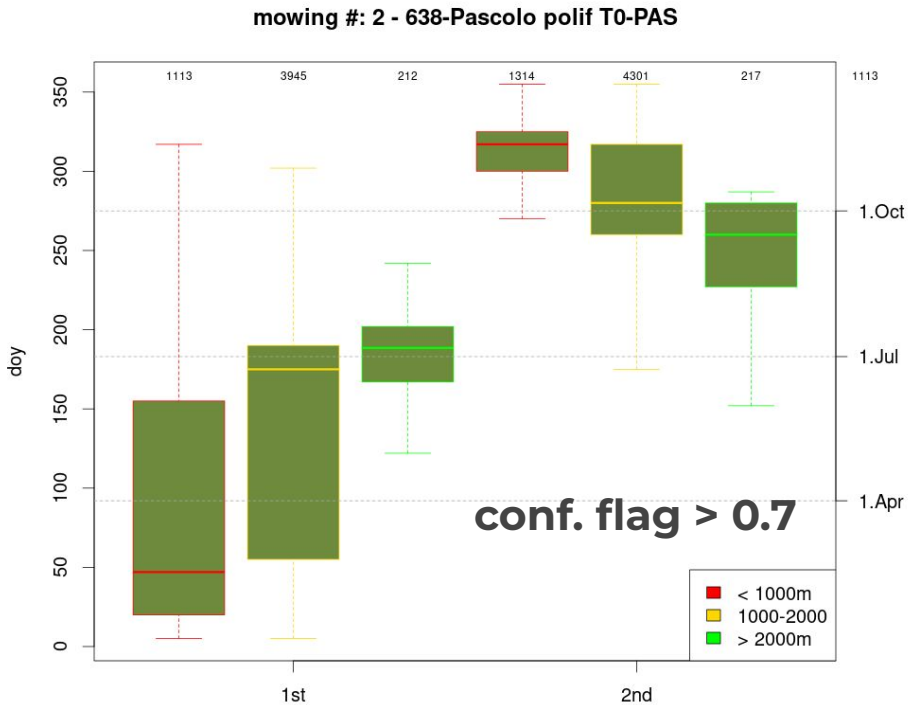




- 4 events @ high elevation (>2000m)
- absolute dates values (e.g. 1st use ~ 1Apr @2000m)
- inconsistent dates elevation distribution

3. Results: Sen4CAP - confidence flag effect





- more reliable dates ~ elevation relationship 1st and 2nd use

3. Results: Sen4CAP - data source effect