SentinelHub field delineation service as digitization auxiliary layer in crop mapping application: use case and model V1/V2 results comparison over trial AoI
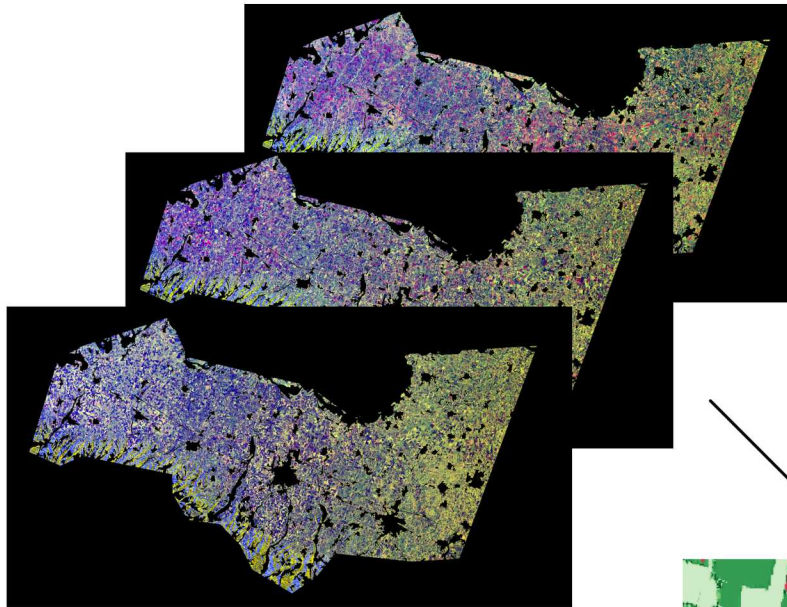
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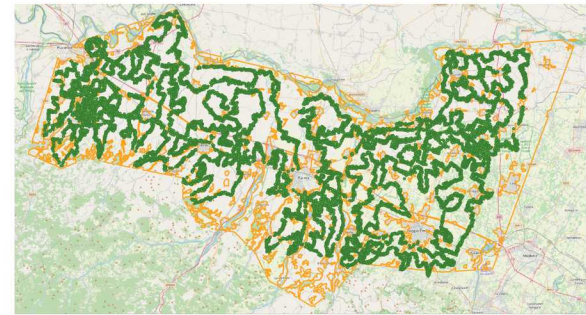## ESA NoR - grant ID 33237f

Use case for field delineation product:
a starting information layer for performing by hand digitization

Sentinel-1 multitemporal backscatter stack

Crop class ground points layer

Crop per-pixel classification ensemble requiring simplification for use in digitization

Sentinel-2 multispectral stack

a) For each feature P_i of the polygon vector file, we crop a classified image

Example of a Random forest classification perfomed in the region of interest "Caserta" (CC). The pixel classified as "tomato" are in red, while other color are refering to other crop type. The white lines are the edges of the fields P_i.

b) Each feature P_i have been assigned to a boolean crop type label (tomato(1)/other crop(0))
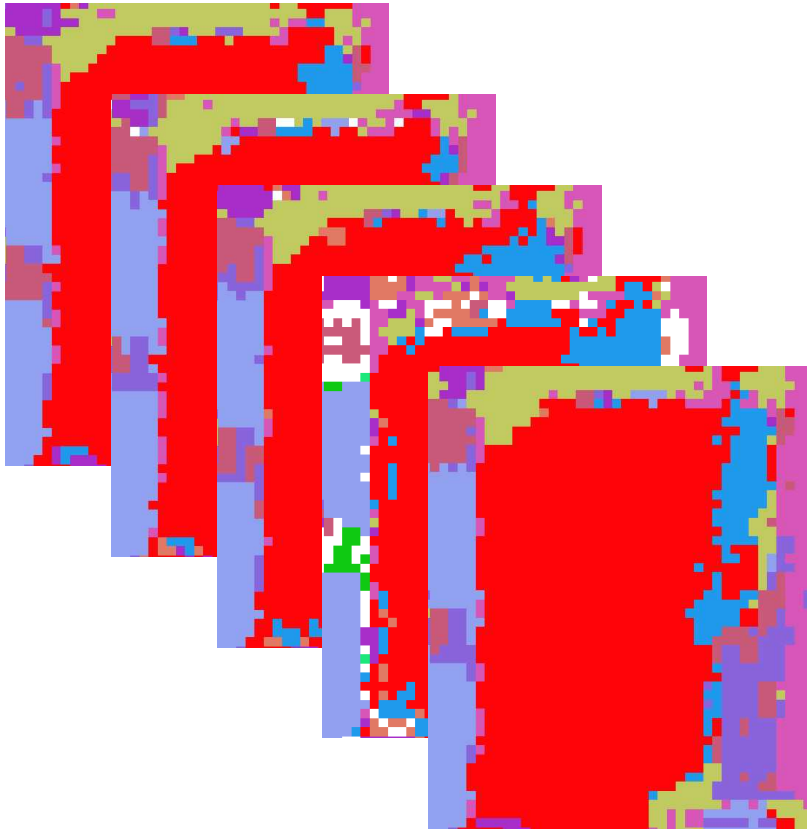

Given a polygon P_i, and the crop type C_j, we can calculate f_{ij}: the fraction of P_i's area filled by C_j.

e.g. in P_1 we have tree different classified crops filling different fraction of P_1 surface:
- C_1 (Tomato) -> f_1
- C_2 -> f_2
- C_3 -> f_3

When Tomato is the dominant crop type we labeled P_i as 1, 0 otherwise.

c) P_i assignment when m classification results are available

When m different classifiers are available, we calculate the weighted average ensemble of the assignment showed at the point (b).

if the weighted average is greater than 0.5 we labeled P_i as 1, 0 otherwise.

c) P_i assignment when m classification results are available
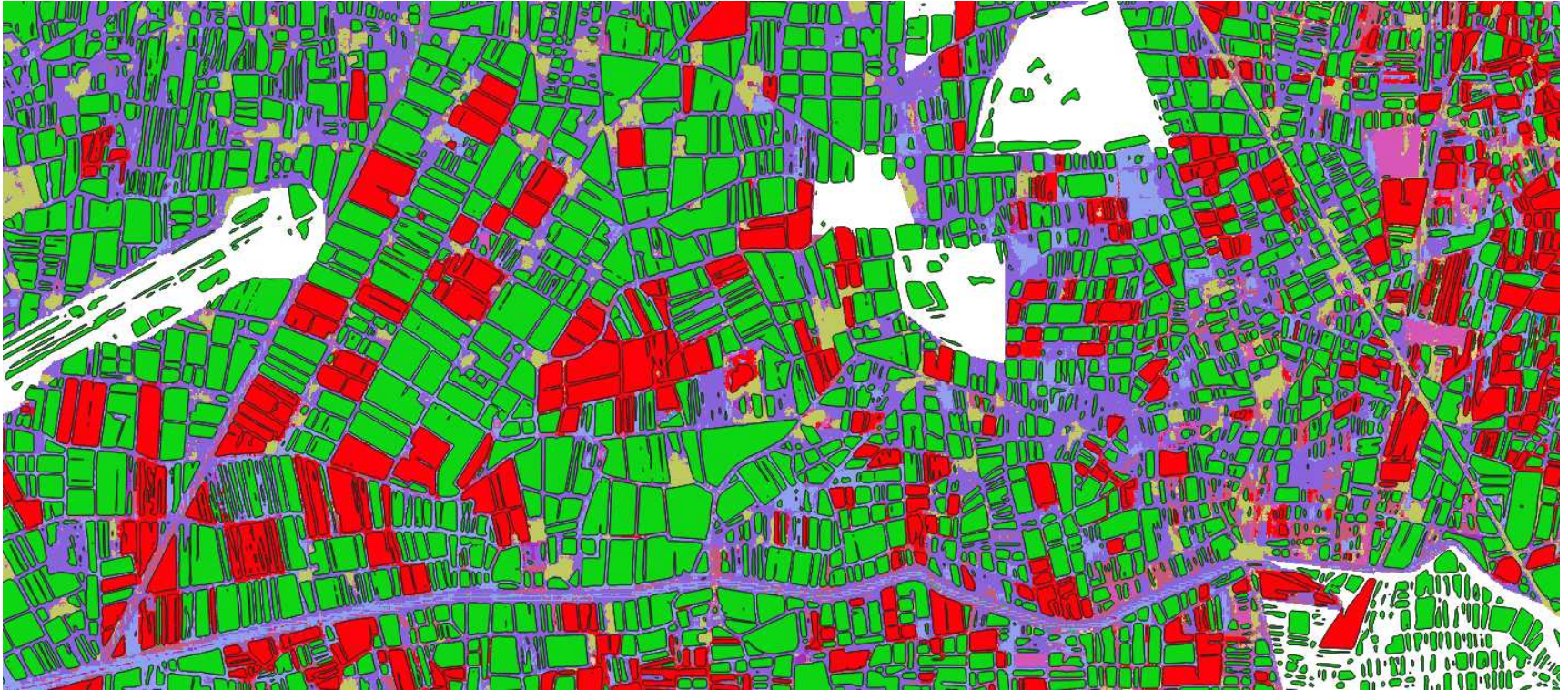
An example of the final results of the assignment process when m classifiers are available. In red the polygons assigned to tomato, in green the ones assigned to the other crop.

Product evaluation

1) Delineated polygons are assigned univocally by intersecting area to one reference polygon for IoU calculation (not intersecting discarded);
2) Delineated polygons assigned to same reference are evaluated together as one multipolygon geometry. Given the task at hand (grouping per-pixel classifications) and approach used for reference digitization, oversegmentation would be otherwise overly penalized.
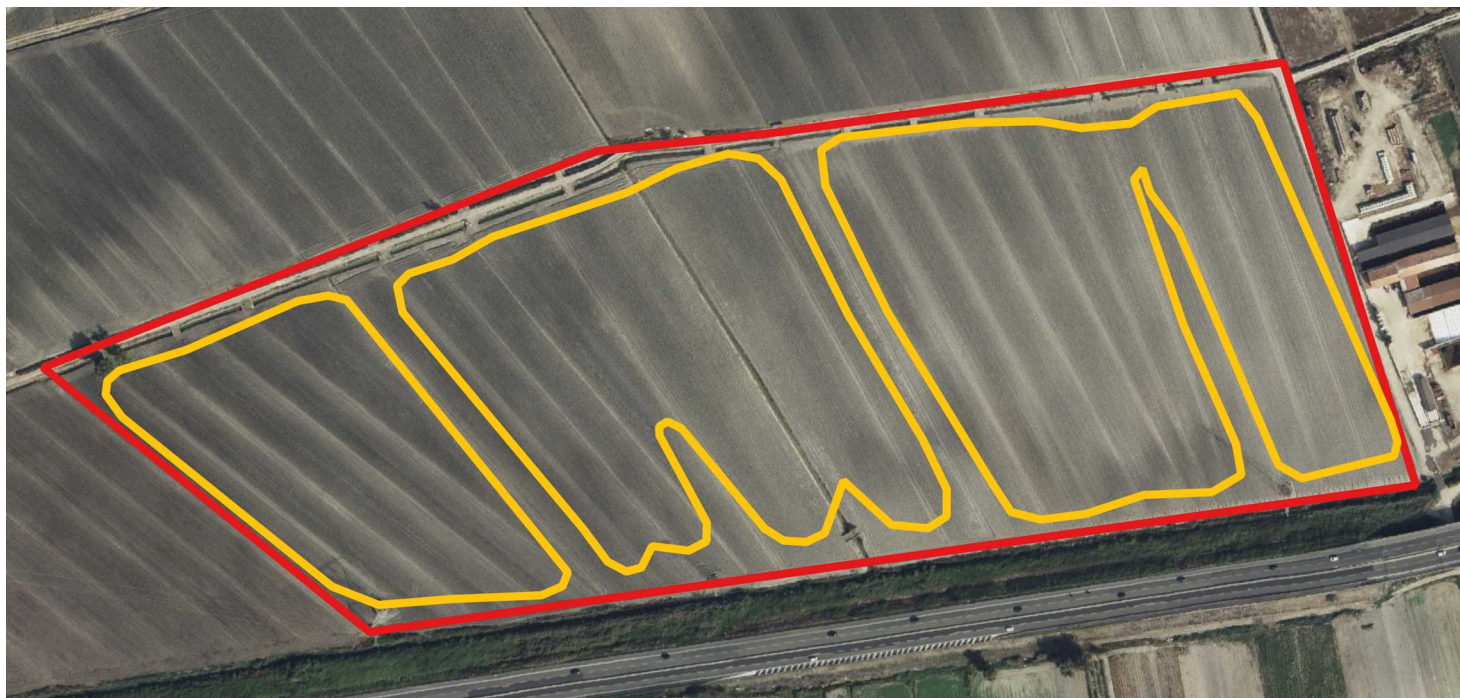

Figure 6: in the shown case IoU is calculated between the reference polygon (red) and a single grouped geometry (yellow).
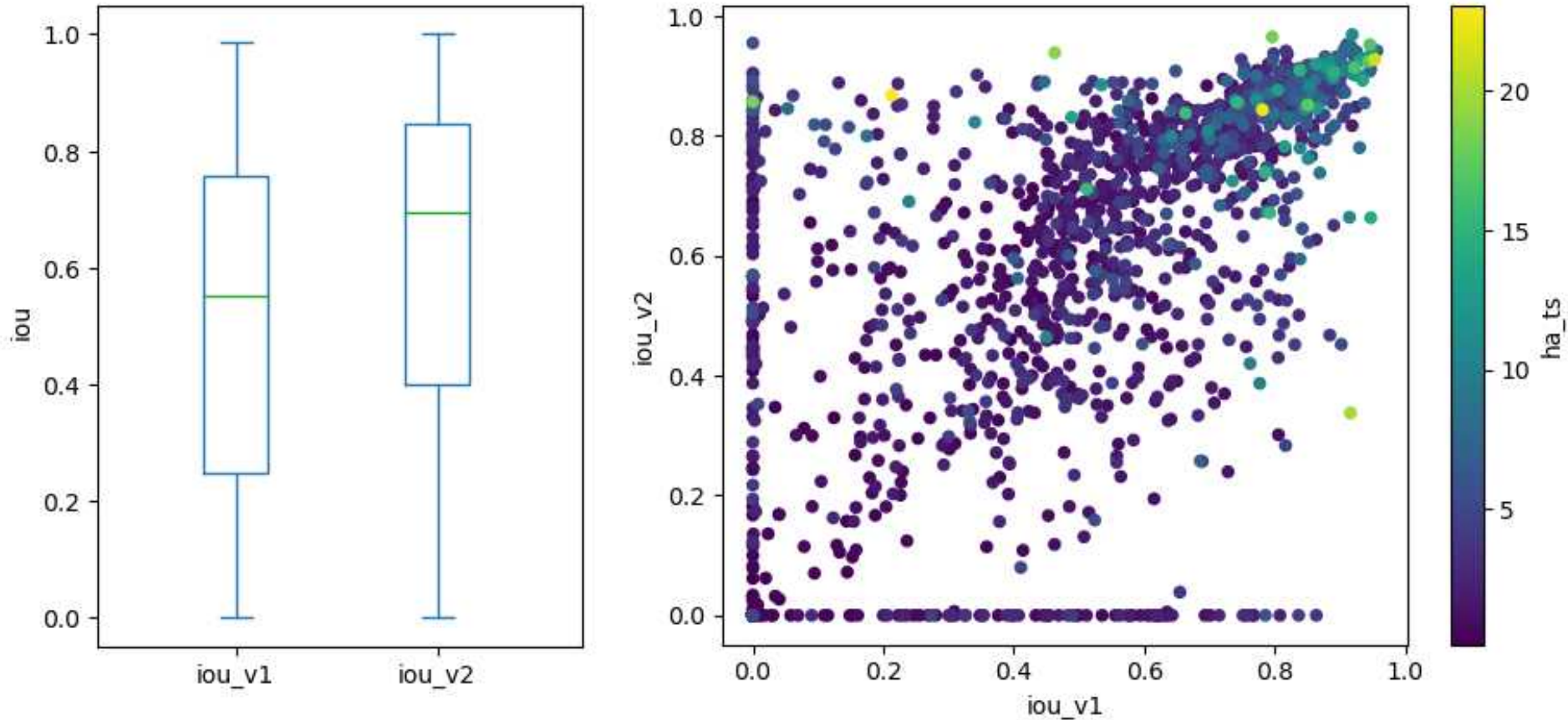
Product evaluation

Figure 7: adoption of V2 model seems to have led to some improvements in IoU although not generalized. Colour is based on reference area.

Product evaluation

Figure 8: by visual inspection model V2 (green) seems to overconnect in comparison to 1) model V1 (blue), 2) our reference (red) and 3) later images (here 1st June 2022). Morphological operations could probably mitigate the problem. Previously shown drops in IoU for some features with V2 model seem to be related to this issue and general overextending past reference borders.

Conclusions

- Product has been considered useful as information layer to guide digitizing crew in their task reducing arbitrary decisions;

- Currently in use for mapping season 2023 over southern and northern Italy;

- Direct adoption of delineated polygons inside final digitized maps has been considered as of now too risky and time consuming if needed to be edited;

- Further use as base layer for classification (instead of per-pixel) might be explored in the future.