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# Object-oriented multitemporal analysis of soil surface features in a vineyard using aerial photographs taken by a small drone Pixy©

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The hydrologist community calls for temporal data and temporal oriented spatial databases that could be used as an input in hydrological modelling. Furthermore, the knowledge of temporal distribution of soil surface features (SSF) in hydrological investigations is crucial for runoff-forecasting. In farmed areas, particularly, temporal variations of soil surface infiltration characteristics, as a consequence of agricultural practices, are considerable. The difficulties in monitoring the temporal evolution of of soil surface variables have limited the use of this information in hydrological modelling. However, distributed hydrological models require information obtained at field scale enhanced by a frequent temporal monitoring. In this context, VHR (Very High Resolution) remote sensing imagery offers a great potential for the identification of soil surface features and has proven to provide such information for various surface features variables. The analysis of VHR images requires innovative techniques that can optimize the extraction of rich information content and high data integrity available in this type of imagery. The leading idea of the presented work is: 1- to automate the interpretation of multitemporal digital aerial photos acquired by a drone Pixy using an object-oriented change detection approach and 2- to infer temporal knowledge on state evolution of soil surface components in relation with farming practices, rainfall and phenological evolution. The study area covers an experimental vine cultivated plot of 1 ha located in a Mediterranean vine producing region in the Hérault province, Southern France.

Based on ground observations of the rate of evolution of soil surface characteristics,

we selected to perform our analysis at monthly intervals over a time period going from January to July 2004. Our intention was to capture a significant amount and variety of change with which to evaluate and build the temporal knowledge base. To this end, digital aerial photographs obtained using a small drone Pixy were acquired concurrently with extensive ground-truth measurements aimed at determining soil surface variables in terms of surface crust typology, percentage of stoniness, of grass cover and organic litter. A total of 20 field surveys of SSF descriptions were conducted according to a protocol designed specifically to the identification of surface variables having a significant influence on runoff and erosion. On-site targets were installed at each aerial flight mission serving as ground control points for geometric rectifications as well as invariable references for radiometric calibrations.

The results of this preliminary analysis suggest that object-oriented classification of SSF has several advantages in terms of extraction of sunlit soil fraction and identification of major vineyard surface infiltration capacity categories. This observation applies to individually analysed scenes. Accuracy assessment of the object-oriented labelling results based on ground truth data ranged from 30% to 70% depending on the SSF category. The best class separabilities were observed between surfaces dominated by structural crust and those covered with organic litter or grass cover. The multitemporal object-oriented change detection approach can provide overall accuracies of 75% and 84% (Kappa coefficients 0.7 and 0.8) for periods that correspond to major agricultural interventions like soil tillage in May or vine pruning in July. Inferring temporal knowledge on SSF evolution over time from the classified images remains however a more complex task, since it requires a solidly founded set of decision rules. The integration of ancillary data (GIS database, field data, rainfall intensities…) could possibly provide more suitable decision rules and in consequence allow a better comprehensive scheme on the temporal changes affecting SSF. The upcoming step would be to transfer the decision rules to a different multitemporal dataset covering another vine cultivated area in order to refine the automatic classification procedure and to eventually establish a more efficient change detection methodology.