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Development of a Software Based on Automatic Multi-Temporal Aerial Images Classification to Assess Retrospective Environmental Exposures to Pesticides in Epidemiological Studies

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Environmental exposure to agricultural pesticides (EEAP) resulting from the drift of agricultural pesticides applied on fields and is suspected to be a risk factor for several diseases. Geographic Information System (GIS) are increasingly used in environmental epidemiological studies to assess EEAP. Crop acreage proximate to subjects residences has been suggested as a surrogate for EEAP. Retrospective characterization of EEAP is essential due to long latency. Earlier data are lacking and limiting the capacity to capture the life-course effects of exposure. We aimed to develop an innovative software to analyze the historical monochromatic aerial images to reconstruct land use to characterize EEAP retrospectively.

Three phases were adopted: firstly, we have collected a new multi-scale multi-date dataset (HistAerial) composed of 4.9 million non-overlapping patches of the French territory (1970-1990). Secondly, an extensive comparison study of computer vision methods has carried out. Using 6000 randomly sampled patches per class of the HistAerial dataset, we compared the performance of 59 computer vision methods for automatic land use identification. An ergonomic software has been designed to generate a land use with the most efficient algorithms.

The handcrafted filters have performed similarly to the learned DCNNs around 90%. The best classification rate for land use with the three different sizes of patches and with the different handcraft filter methods varied from 45% to 89%. The most accurate method was a combination of handcrafted filters (89,3%) on 100-pixel patch size. The resulting software has been applied on aerial images representing 1.5 km² areas.

This study has developed a software to generate retrospective land use that will be integrated into a GIS to assess EEAP. It was able to produce realistic historical land use in 5 minutes. The availability of an accurate retrospective land use dataset is a requirement to assess EEAP in epidemiological studies.