Leveraging machine learning to produce a cost-effective national building height map of Ireland

Eoghan Keany, Geoffrey Bessardon, and Emily Gleeson
Met Éireann, Climate Services, Research, Environment and Applications Division, Dublin 9, Ireland

To represent surface thermal, turbulent and humidity exchanges, Numerical Weather Prediction (NWP) systems require a land-cover classification map to calculate surface parameters used in surface flux estimation. The latest land-cover classification map used in the HARMONIE-AROME configuration of the shared ALADIN-HIRLAM NWP system for operational weather forecasting is ECOCLIMAP-SG (ECO-SG). The first evaluation of ECO-SG over Ireland suggested that sparse urban areas are underestimated and instead appear as vegetation areas (1). While the work of (2) on land-cover classification helps to correct the horizontal extent of urban areas, the method does not provide information on the vertical characteristics of urban areas. ECO-SG urban classification implicitly includes building heights (3), and any improvement to ECO-SG urban area extent requires a complementary building height dataset.

Openly accessible building height data at a national scale does not exist for the island of Ireland. This work seeks to address this gap in availability by extrapolating the preexisting localised building height data across the entire island. The study utilises information from both the temporal and spatial dimensions by creating band-wise temporal aggregation statistics from morphological operations, for both the Sentinel-1A/B and Sentinel-2A/B constellations (4). The extrapolation uses building height information from the Copernicus Urban Atlas, which contains regional coverage for Dublin at 10 m x10 m resolution (5). Various regression models were then trained on these aggregated statistics to make pixel-wise building height estimates. These model estimates were then evaluated with an adjusted RMSE metric, with the most accurate model chosen to map the entire country. This method relies solely on freely available satellite imagery and open-source software, providing a cost-effective mapping service at a national scale that can be updated more frequently, unlike expensive once-off private mapping services. Furthermore, this process could be applied by these services to reduce costs by taking a small representative sample and extrapolating the rest of the area. This method can be applied beyond national borders providing a uniform map that does not depend on the different private service practices facilitating the updates of global or continental land-cover information used in NWP.

(1) G. Bessardon and E. Gleeson, “Using the best available physiography to improve weather forecasts for Ireland,” in Challenges in High-Resolution Short Range NWP at European level including forecaster-developer cooperation, European Meteorological Society, 2019.

(2) E. Walsh, et al., “Using machine learning to produce a very high-resolution land-cover map for Ireland,” Advances in Science and Research, (accepted for publication).
