



Large-scale detection of scooping areas from space for amphibious firefighting aircrafts

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In recent years, the frequency and severity of wildfires worldwide have increased substantially, driven by climate change, deforestation, population growth and progressively drier environmental conditions in many regions. In this context, the identification of suitable scooping areas within inland waterbodies is critical for the operational efficiency and safety of aerial firefighting operations. Amphibious firefighting airplanes require reliable scooping areas to refill water tanks during touch-and-go maneuvers, thus enabling rapid response to wildfires. This study investigates the feasibility of leveraging Earth Observation data to identify potential scooping areas that satisfy stringent operational requirements, namely a minimum length of 2,000 m, a minimum width of 100 m, and a minimum water depth of 3 m to ensure safe and effective operations. We utilize DLR's Surface Water Inventory and Monitoring (SWIM) water extent product to delineate permanent inland waterbodies from Sentinel-1 and Sentinel-2 imagery. These waterbodies are intersected with exclusion zones, such as road and rail infrastructure or protected areas, and subsequently filtered based on geometric and physical criteria, including waterbodies' size, shape, and estimated depth, to eliminate unsuitable candidates. Due to the lack of consistent, large-scale bathymetric data, we train a regression model to classify water surfaces in Sentinel-2 satellite imagery as either deeper or shallower than 3 m, because only waterbodies exceeding this threshold are considered suitable for aerial scooping. For each remaining waterbody, a computationally efficient, grid-based iterative shape-fitting algorithm is applied to identify a finite set of potential scooping configurations. These candidate sites are further evaluated through an additional filtering step that assesses the availability of unobstructed approach and departure flight corridors, taking surrounding surface elevation into account. The complete workflow is implemented as a modular processing chain that integrates automated data acquisition, preprocessing, and analysis. It was developed and validated for a representative study region in Germany and scaled to continental Europe.