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| **The European Forest Disturbance Atlas: towards an operational monitoring of forest dynamics using the Landsat archive** |
| Forests disturbances have increased sharply in response to climate and land use changes in recent decades. Changes in disturbances have strong impacts on forest dynamics, structure and demography, endangering essential ecosystem services to society. The risk of losing important ecosystem services is strongly related to interactions between individual disturbance events, such as between insect outbreaks and windthrows, between individual fires (i.e. recurring fires) or also between natural disturbances and harvests. To better understand how increasing disturbances and their interactions impact Europe’s forests and their ecosystem services, consistent and spatially explicit information on forest disturbances is urgently needed. We aimed at filling this gap by creating an exhaustive forest disturbance atlas for Europe, striving towards an operational monitoring system of forest dynamics.  The disturbance atlas is based on the full Landsat archive at 30 m resolution and covers over four decades (1984-2023). As a data basis we built a consistent data cube of ready-to-use Landsat surface reflectance data (including atmospheric and topographic corrections, as well as cloud and shadow masking) using FORCE (Frantz, 2019) and totalling to 115,663 images. Annual seamless gap-free composites were derived from the image database using the Best Available Pixel (BAP) selection algorithm, which choses high quality pixels closest to a target date (1st August ± 60 days) to avoid phenological changes and ensure intra-annual consistency while simultaneously avoiding clouds and other contaminations.  Based on the BAP images from a target year and the previous year, a Random Forest classification model was trained on manually labelled reference pixels (Senf, 2019) for mapping forest disturbances annually at the pixel level. Independent validation using 2,500 manually interpreted reference pixels stratified per country and forest area revealed map accuracies (measured as F1-score) of 0.75 and 0.98 for disturbed and undisturbed pixels, respectively. The pixel-based disturbance information was aggregated at the patch level and together with contextual information on the surrounding landscape assigned to a specific disturbance agent (bark beetle, fire, windthrow or harvest). Summarising annual disturbance maps over time ultimately allowed to detect multiple disturbance events per pixel and thus for the characterization of disturbance interactions (e.g., multiple fires, thinnings before final harvest).  The layers included in the European Forest Disturbance Atlas (Viana-Soto & Senf., 2023) provide insights not only into the year of disturbance, but also on the actual frequency of disturbances and the underlying causal agent, paving the road for a consistent disturbance monitoring system of Europe's forests. Upcoming improvements will advance the quantification of disturbance severity by means of vegetation and ground cover fractions using regression-based unmixing, thereby yielding information on, e.g., the percentage of tree cover loss at both the pixel and patch level. A first version of the maps can be explored online: <https://albaviana.users.earthengine.app/view/european-forest-disturbance-map>    Frantz, D. (2019). FORCE—Landsat+ Sentinel-2 analysis ready data and beyond*. Remote Sensing*, 11(9), 1124. |