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| **Identifying the Drivers of Biomass Change in European Forests: Insights from Remote Sensing and Geo-Wiki Analysis** |
| Forest biomass stock and its changes serve as crucial indicators of ecosystem health, biodiversity, and the effectiveness of climate change adaptation and mitigation efforts. With the advancement of remote sensing technology and data processing techniques over the last decade, our ability to monitor these changes has significantly improved. However, the validation of these changes and the identification of their underlying causes often lack accurate quantification.  The European Space Agency's Climate Change Initiative (ESA CCI) Biomass project offers above-ground biomass (AGB) maps with a spatial resolution of 100 meters, covering the years 2010 to 2020. This product benefits from the integration of diverse remote sensing tools, including radar, lidar, and optical sensors. The set of maps includes the standard deviation of AGB estimates and a quality flag for AGB changes. However, set of sensors used for AGB estimation vary from year to year, that affect the reliability of biomass change analysis.  To validate and identify the drivers behind these reported biomass changes, we employed Geo-Wiki.org, a renowned tool for the visual interpretation of high-resolution imagery and vegetation indices. This approach allowed us to check if changes detected by CCI Biomass is visible, and to discern the drivers of changes, including natural regrowth, forest management (planting, thinning, harvesting), natural disturbances (fires, pests, wind, flooding) and land use change. Our methodology employed a threefold stratification based on geographic regions, the magnitude of biomass changes (loss and gain), and the reliability of change detection (indicated by a quality flag). This stratification enabled the estimation of area changes attributable to specific drivers at a regional level.  Our findings indicate that 92% of forest gains in Europe were due to reforestation or natural growth, 6% to afforestation, and 2% to urban expansion, tree crops, and agroforestry. Biomass losses revealing that 72% are associated with forest management (harvesting or thinning), 12% with land use change or activities outside of the forest (infrastructure, cropland, tree crops), 11% with wildfires, 4% with insects and deceased, 1% with windthrow, and 1% with other natural disturbances.  A visual inspection of the CCI Biomass change product revealed that roughly half of the reported changes were not verifiable using freely available very high-resolution images. This discrepancies arising from both methods - the invisibility of certain changes in the images and false detections due to utilization of different sensors over the observed period.  This work is supported by the Horizon Europe EYE-CLIMA project (101081395) and the European Space Agency's FRM4Biomass project (RFP/3-18237/23/I-EF-bgh). |