Recent increase in European forest harvests as based on area estimates (Ceccherini et al. 2020a) not confirmed in the French case

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OPINION PAPER

Recent increase in European forest harvests as based on area estimates (Ceccherini et al. 2020a) not confirmed in the French case

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Abstract

• *Key message* A recent paper by Ceccherini et al. (2020a) reported an abrupt increase of 30% in the French harvested forest area in 2016–2018 compared to 2004–2015. A re-analysis of their data rather led us to conclude that, when accounting for the singular effect of storm Klaus, the rate of change in harvested area depended on the change year used to separate the two periods to compare. Moreover, the comparison with data on harvested volumes from different sources brought contrasted results depending on the source. Therefore, it cannot be concluded that wood harvest increased in France in 2016–2018 compared to 2004–2015. The discrepancy between Ceccherini et al.'s data and other data on harvested volumes points out the difficulty of reconciling different approaches to estimate wood harvest at a country level.

Keywords Estimation · Forest harvest · Forest inventory · Remote sensing · Windstorm

Forests bear an environmental (especially as a major reservoir of biodiversity), an economic (supporting valuable wood and non-wood marketable products), and a social dimension (providing use and non-use benefits to people), so that their multifunctional management often requires subtle trade-offs. Climate change mitigation through carbon storage in biomass or wood products and substitution effects (i.e., the reduced greenhouse gas emissions when wood is

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used instead of other, more emitting materials), adaptation to climate change, and the development of a forest-based circular, inclusive, and sustainable bioeconomy call for new priorities to be assigned to forests in the future. Thus, the balance between the different dimensions of forests and forest management is questioned and publicly debated. Shifting to these new priorities in the most consensual way requires precise assessment and monitoring of the different forest attributes, including wood harvest, i.e., the quantity of wood extracted from forests by human activities, whether expressed as a volume or as an area (i.e., the area where logging completely removed tree-cover canopy). This harvest is in fact not only an objective as such of forest management but also a means of ensuring one or more of the other objectives.

Based on estimates of harvested forest areas, a recent paper by Ceccherini et al. (2020a) stated that harvest had increased by 43% over Europe in 2016–2018 compared to 2004–2015, with the mean harvested patch size having increased by 34% between the same two periods. For France, the estimated increases were 30% and 44% for harvested area and patch size, respectively. However, such an unprecedented increase in wood harvest in Europe remains undocumented in national forest statistics (Niedzwiedz et al. 2018). Our primary objective here is to understand how such an abrupt change in wood harvests as claimed by Ceccherini et al. (2020a) may have gone unnoticed. Assuming that harvest intensity (i.e., the volume of harvested wood per unit of harvested forest area) and logging loss rate did not change across the 2004–2018 period but for random fluctuations, such an abrupt change in harvested forest area should go along with a marked change in harvested wood volumes. Our investigation thus is focused on the co-variation between harvested forest area as reported by Ceccherini et al. and harvested wood volumes as reported by different sources. We focused on the French case, even if the methodological limitations identified in this case may also apply to the results for the other European countries.

Harvested forest area in France here refers to the time series from 2004 to 2018 estimated by Ceccherini et al. using the Global Forest Change product by Hansen et al. (2010) after filtering out areas affected by forest fires but retaining those affected by windstorms. There are different statistics on harvested wood volumes in France for the same period. One source is the FAOSTAT database (FAO 2020) that was also used by Ceccherini et al. in their study. It indicates the total roundwood production defined as the amount of wood removed from the forest and other wooded land or other sites in m^3 under bark. It cumulates the marketed harvest and the self-consumption of wood from productive forests, other forests, and wooded lands. A second source is the Agreste database of the French Ministry of Agriculture and Food (MAA 2020). It gives an estimate of the harvested wood volumes based on a survey of forest logging companies and sawmills, and thus only includes the harvest for the inner market excluding exports (and excluding self-consumption) in all kinds of forests. A third source is the French National Forest Inventory (NFI 2020) that provides annual estimates of wood felled in productive forests (including harvest and logging losses) based on an inventory of trees felled in semi-permanent sample plots re-measured after a 5-year period. These different data sources thus differ by the kinds of forests they cover, the kinds of wood products (marketed, self-consumed, or total), and the kinds of estimation techniques (field inventory, survey of forest companies, survey on energy consumption, etc.) (Fig. 1).

Ceccherini et al. (2020a) reported that the harvested area in France represented “fairly well the amount of harvests from final cut and salvage logging” as given by the harvested volumes from FAOSTAT, even if “part of the silvicultural treatments” (including thinnings) and “of the overall harvest” may have been missed in the harvested area “owing to the complex structure and heterogeneity of the management systems applied in France.” Nevertheless, our re-analysis of their data (Ceccherini et al. 2020b) provided a different view. The value of Pearson’s correlation

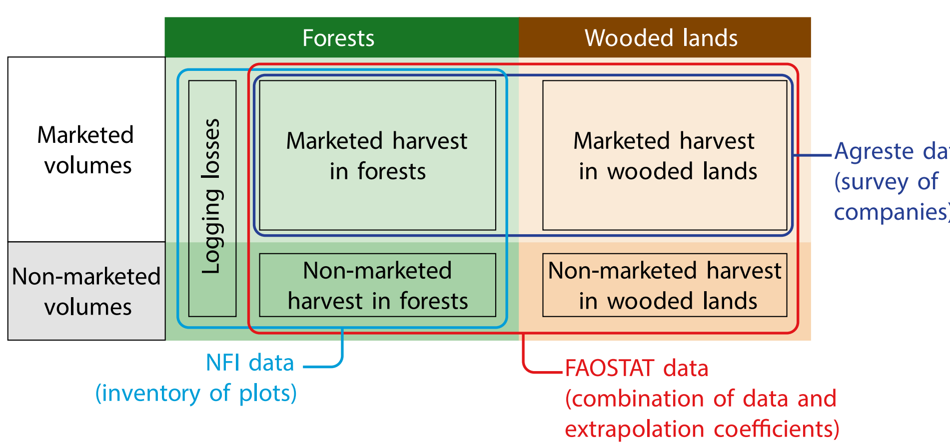

Fig. 1 Simplified description of the harvested volumes included in the Agreste, NFI and FAOSTAT data. The decomposition of the total harvest is actually more complex than reported in this chart because the NFI makes a distinction between productive forests and other forests; the NFI reports the volume of stems while FAOSTAT additionally includes the volume of large branches, etc

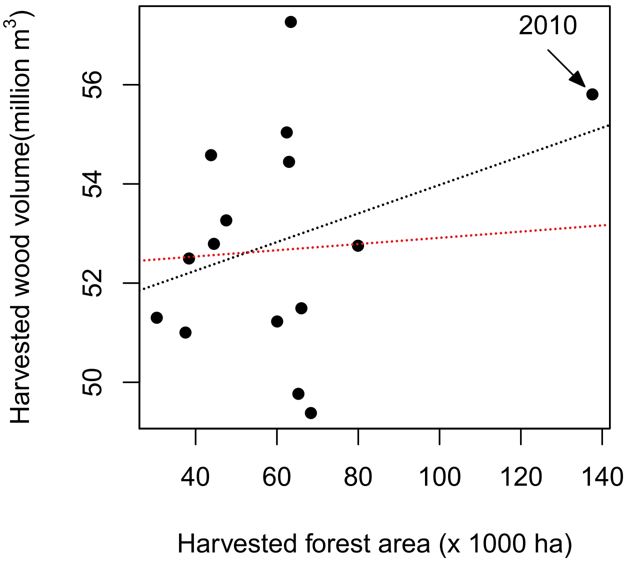

Fig. 2 Harvested wood volume (data from FAOSTAT) versus harvested forest area (as reported by Ceccherini et al. 2020b) in France between 2004 and 2018. Each dot corresponds to a year, with year 2010 following storm Klaus marked by an arrow. Dotted lines are the regression lines with (black line) or without (red line) year 2010

coefficient of 0.33 that Ceccherini et al. reported was due to a single leverage point corresponding to year 2010 when wood harvest was exceptionally high in France following the windstorm Klaus of 2009 in the Landes de Gascogne (south-western France) (Fig. 2). Windfall wood volume then amounted to 43 million m^3, a level comparable to the average annual harvested volume as estimated by the NFI. Removing year 2010 (which brings Pearson's coefficient down to 0.04, p value = 0.89) or using Spearman's coefficient as a more robust alternative to Pearson's coefficient with respect to leverage points (coefficient = 0.13, p value = 0.66) showed that no correlation could be evidenced between harvested forest area detected from remote sensing and FAOSTAT harvested volume in France over 2004–2018.

Similar results were obtained with the other national statistics on wood harvest. The positive correlation between harvested forest area and the Agreste data on marketed volumes were slightly higher (Pearson's coefficient of 0.44, p value = 0.09) than with the FAOSTAT data on total harvested volumes, but again, this correlation was due to the year 2010 alone acting as a leverage point and disappeared when removing this point (coefficient = 0.15, p value = 0.60) or when using Spearman's coefficient (coefficient = 0.21, p value = 0.45). The correlation between harvested forest area and the NFI data on wood removals from forests available for wood supply was even negative and not significantly different from zero (coefficient = − 0.11, p value = 0.71). It is worth noticing that correlations among national statistics on wood harvest were not higher (Pearson's correlation between FAOSTAT data and Agreste data = 0.07, p value = 0.81; correlation between Agreste data and NFI data = 0.41, p value = 0.15), or even negative (correlation between FAOSTAT data and NFI data = − 0.53, p value = 0.05).

The absence of a significant correlation between harvested forest area and harvested volumes in France from three data sources across the period 2004–2018 questions in turn the abrupt increase of 30% in harvested forest area in 2016–2018 compared to 2004–2015 that Ceccherini et al. reported after filtering out area losses due to windstorms. An increase in harvested area together with a no-change in harvested volume could be explained by a decrease in harvest intensity. Nevertheless, because year 2010 acts as a leverage point, including or excluding the area losses due to windstorms in 2010 as Ceccherini et al. did depending on the analysis is problematic.

Considering the full temporal range from 2004 to 2018 and following a statistical approach, we tested if a change point in the time series of harvested areas occurred, and when. The test relied on the Bayes factor of the likelihood of observations knowing that there is one change point over the likelihood knowing that there is no change point (Zhang et al. 2007). It is implemented in the "changepoint" package of R (Killick and Eckley 2014). The test allowed us to detect a significant change point in 2012 (red point in the inset of Fig. 3a) instead of 2015. The mean harvested area in 2013–2018 was 24% lower than that in 2004–2012, thus contrasting with the 30% increase reported by Ceccherini et al. for 2016–2018 compared to 2004–2015. An exceptional year like 2010 has a strong influence on the harvest statistics, which advocates for a statistical approach that considers statistical fluctuations along the whole time series 2014–2018 (inset of Fig. 3). In contrast, Ceccherini et al. adopted a historical rather than a statistical approach. The statistical approach indicates that the direction of the change in harvested forest area is sensitive to the breakpoint used and that the time series is too short to conclude that a change occurred in 2015.

Hence, the re-analysis of Ceccherini et al.'s data and its comparison with alternative data on harvested wood brings no justification for comparing 2004–2015 to 2016–2018 rather than some other periods (Fig. 3). Reporting on the reconstructed estimate of the total harvested volume (FAOSTAT data) or some component of this total harvest (Agreste or NFI data) is already enough to bring differences that are greater than the temporal changes of any of these quantities over 2004–2018 (compare panels in Fig. 3, also shown by the absence of significant correlation between those data). Therefore, it cannot be concluded that wood harvest increased in France in 2016–2018 compared to 2004–2015.

The main interest of Ceccherini et al.'s study rather lies in illustrating the difficulty of reconciling different

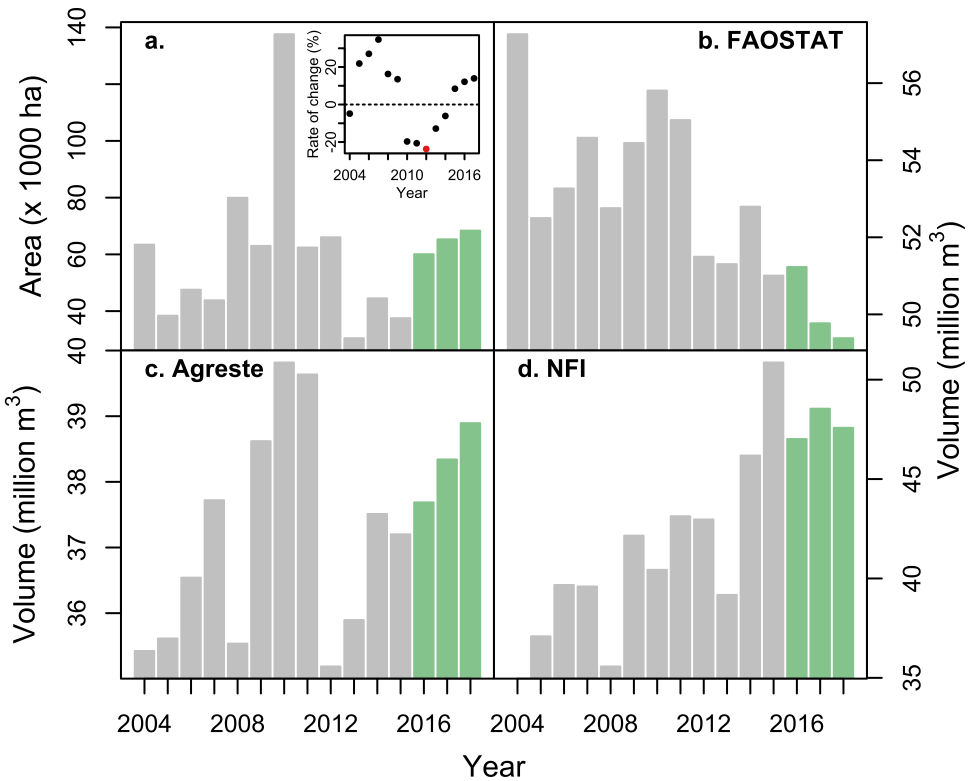

Fig. 3 Temporal changes across 2004–2018 in harvested forest area (**a**, data from Ceccherini et al. 2020b) and harvested wood volumes (**b**–**d**) from different data sources: **b** FAOSTAT, **c** Agreste, and **d** National Forest Inventory. Green bars correspond to 2016–2018. The inset in **a** shows the rate of change in harvested area depending on the year considered as the change point over 2004–2018, with year 2012 indicated in red

approaches to estimate wood harvest at a country level (Gschwantner et al. 2019). Reconstructing total wood harvest in France relies on data from surveys and sampling techniques, and additional coefficients to convert or extrapolate these estimates (e.g., the damage rate to convert wood removals into wood harvest for the NFI data, or the self-consumption rate given by the French National Institute of Statistics and Economic Studies (INSEE) housing survey to extrapolate marketed harvested volumes to total harvested volumes) (Niedzwiedz et al. 2018). Additional difficulties may come from the tree components considered (e.g., the French NFI reports wood volumes for the stem only whereas large branches are included in harvested volumes in FAOSTAT) and cumulate with inherent uncertainties in sampling techniques (NFI 2011; Waggoner 2009).

Rather than relying on estimates of harvested volumes, Ceccherini et al. used a different approach based on a cartographic product, the Global Forest Change by Hansen et al. (2010), to estimate the area of harvested patch sizes. Several difficulties linked to this approach were highlighted by the authors, including the difficulty to delineate forests based on canopy cover or to filter out canopy gaps due to other factors than logging (viz. wildfires and storms). More importantly, Ceccherini et al. relied on the finest pixel grain of 30 m × 30 m of the GFC to delineate harvested patches while the GFC map is itself the outcome of a regression estimator procedure that restricts its capacity to bring precise estimates on small areas (Hansen et al. 2010; Wernick et al. 2010). Despite its current methodological limitations and its lack of consistency with statistics on harvested volumes, Ceccherini et al.'s study brought the idea of using high-resolution satellite images to infer harvested forest area. Additional work is still needed to turn this idea into an operational tool, especially because remote sensing is efficient at detecting clear-cuts and canopy gaps but may miss thinnings and selective logging that does not heavily affect canopy closure.

Even if data do not support the presence of an abrupt increase in wood harvest after 2015 in France, Ceccherini et al.'s study raises the question of the planned intensification of wood harvest in European countries in the context of the development of a wood-based bioeconomy. Several forest policy documents in France have assigned an objective of increased wood harvest. The National Forest and Wood Programme 2016–2026 has set an objective of an additional 12 million m^3 of wood harvest by 2026 (MAA 2017), while the National Low-Carbon Strategy has set an objective to increase wood harvest from 48 million m^3 in 2015 to 65 million m^3 in 2030 and 83 million m^3 in 2050 (MTES 2020). Such an increase in harvest has to be compared to the simultaneous increase in growing stock (Bontemps et al. 2020), the ratio of wood harvest over growing stock being remarkably stable (around 1.6%) in France over the last 20 years. Sustainability of forest management and the role and functions to be assigned to forests in the uncertain context of global changes is beyond the scope of this paper. However, as pointed out in the French Forest Research and Innovation Plan 2015–2025, current limitations in reconciling different approaches to estimate wood harvest at national level calls for additional efforts in forest monitoring systems using diversified techniques (remote sensing, field-based inventories, possibly crowdsourcing of data).

Data availability Data sharing not applicable to this article as no datasets were generated during the current study.

Compliance with ethical standards

Conflicts of interest The authors declare that they have no conflict of interest.

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