Response to the reviewers (#ESSD-2023-143)

Thanks for the positive comments from the Reviewers. The reviewers' requests are repeated below, in italics, and with our responses written below each suggestion. We have responded in full to each request.

Reviewer #2 (Remarks to the Author):

[*Reviewer* #2 General Comments] *This manuscript presents a new method to map distribution of trees between 2016 and 2021 using Planet and Sentinel-1 and RF model, offering high-resolution mapping capabilities. Although this dataset has the potential to make a significant contribution, there are several areas that require improvement, as identified below:*

[Response] We sincerely appreciate the reviewer's encouraging words and constructive comments. All issues have been adequately addressed both below and in the revised version of the manuscript.

[*Reviewer* #2 Comment 1] *1. The manuscript claims to characterize tree cover and its changes, but it only provides a map distinguishing between tree and non-tree, without indicating the percentage of tree coverage. It is essential to reconsider the definition of tree cover in the revised manuscript.*

[Response] Thanks a lot for pointing this out.

In this study, tree cover is defined as any geographic area dominated by trees without percentage of tree coverage at the pixel level (Zanaga et al., 2020; Hansen et al., 2013). This is attributed to the fact that the resolution of the Planet pixel (4.77 m) is closer to the size of trees in tropical areas, which leads to some difficulty in seeing tree cover percentage.

We have revised the text in Section 2.3.1 of the revised manuscript, which is "tree cover is defined as any geographic area dominated by trees without percentage of tree coverage at the pixel level (Zanaga et al., 2020; Hansen et al., 2013). This is attributed to the fact that the resolution of the Planet pixel (4.77 m) is closer to the size of trees in tropical areas." (P9L184-188 in the track version of the revised manuscript).

We have changed the subtitle of Section 2.3.1 to Definition of mapped tree cover.

[*Reviewer* #2 Comment 2] *2. The resolution of Sentinel-1 images is 10 meters, so it is unclear how the authors obtained tree distribution data at a resolution of 4.77 meters. Further clarification is needed regarding the methodology employed to achieve this higher resolution.*

[Response] Thanks a lot for your valuable comment.

The article is an extension of our published algorithms paper (Yang et al., 2023). Thus, this detailed information for changing 10 m Sentinel-1 SAR imagery to a resolution of 4.77 m is given in Section 2.3.2 of the algorithm article. It is "After loading the second biannual Planet red, green, blue, and near-infrared (NIR) bands (i.e., the time window is June to November) and the Sentinel-1 VV/VH bands from 1 June 2019 to 30 November 2019 in the Earth Engine Data Catalog, we leveraged the GEE mosaic function to produce spatially continuous SAR imagery and resampled it using bilinear interpolation to match the spatial resolution of Planet imagery."

We have also revised the text in Section 2.3.2 of the revised manuscript, which is "…match the spatial resolution of Planet-NICFI imagery…" (P9L197-198 in the track version of the revised manuscript).

Reference:

Yang, Feng, Xin Jiang, Alan D. Ziegler, Lyndon D. Estes, Jin Wu, Anping Chen, Philippe Ciais, Jie Wu, and Zhenzhong Zeng. Improved fine-scale tropical forest cover mapping for Southeast Asia using Planet-NICFI and Sentinel-1 imagery. Journal of Remote Sensing (2023).

[*Reviewer* #2 Comment 3] *3. While the aim of this dataset is to provide information* *about changes in tree distribution, the validations conducted thus far seem to focus solely on the spatial pattern of trees. To strengthen the manuscript, it is necessary to include statistical validation regarding changes in tree distribution, ensuring a comprehensive assessment.*

[Response] The points are well taken!

We have added two example time series tree cover maps for the mainland and maritime Southeast Asia locations from 2016 to 2019, respectively (Figs. R1 and R2), to allow the reader to visually assess our tree cover map product. Note that we have not shown the years 2020 and 2021 due to inconvenient visualization for monthly resolution Planet-NICFI imagery collected from QGIS. Compared to the original Planet-NICFI imagery, our mapped tree cover map product exhibits better accuracy.

In addition, we have counted the time series of the area of tree cover maps during 2016-2021 (Fig. R3) and we showed a slight increase trend for the area of tree cover from 2016 to 2021.

We have added some descriptions in the revised manuscript, "We further visually compared our time-series tree cover map product with the original Planet-NICFI imagery during 2016-2019 (Figures 4-5). Note that we have not shown the years 2020 and 2021 due to inconvenient visualization for monthly resolution Planet-NICFI imagery collected from QGIS. In comparison, our tree cover map product showed better consistencies with Planet-NICFI imagery, such as roads, the spatial distribution pattern of tree cover, and non-tree cover. However, our tree cover product potentially exhibited salt and pepper salt and pepper phenomenon in some years (i.e., 2017 and 2018) due to the employment of the RF approach. In practical applications, we need to pay attention to this phenomenon. In addition, we counted the time series of the area estimates of tree cover maps during 2016-2021 and showed a slight increase trend from 2016 to 2021, which is in line with the area estimates of ESA tree cover for the years 2020 and 2021. This may be due to forest restoration after the 2015 El Niño phenomenon (Wigneron et al., 2020), as well as the impact of expanded plantations (Xu et al., 2020)." (P13L288-

P14L298 in the track version of the revised manuscript).

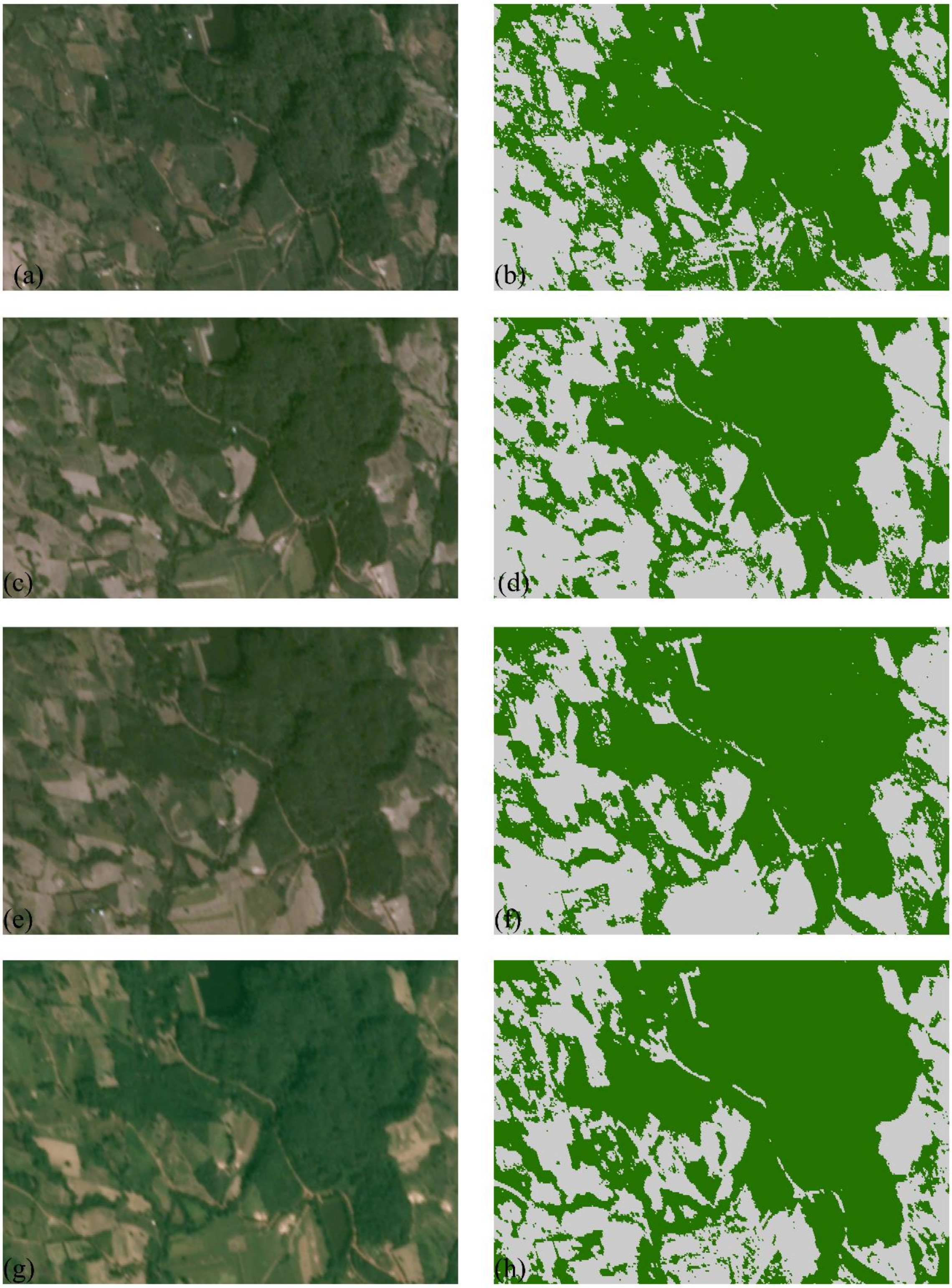

Fig. R1 Time series of the derived tree cover maps for the selected mainland Southeast Asia area (100.301°-100.322°E, 18.400°-18.409°N). (a) and (b), (c) and (d), (e) and (f), and (g) and (h) indicate 2019, 2018, 2017 and 2017, respectively.

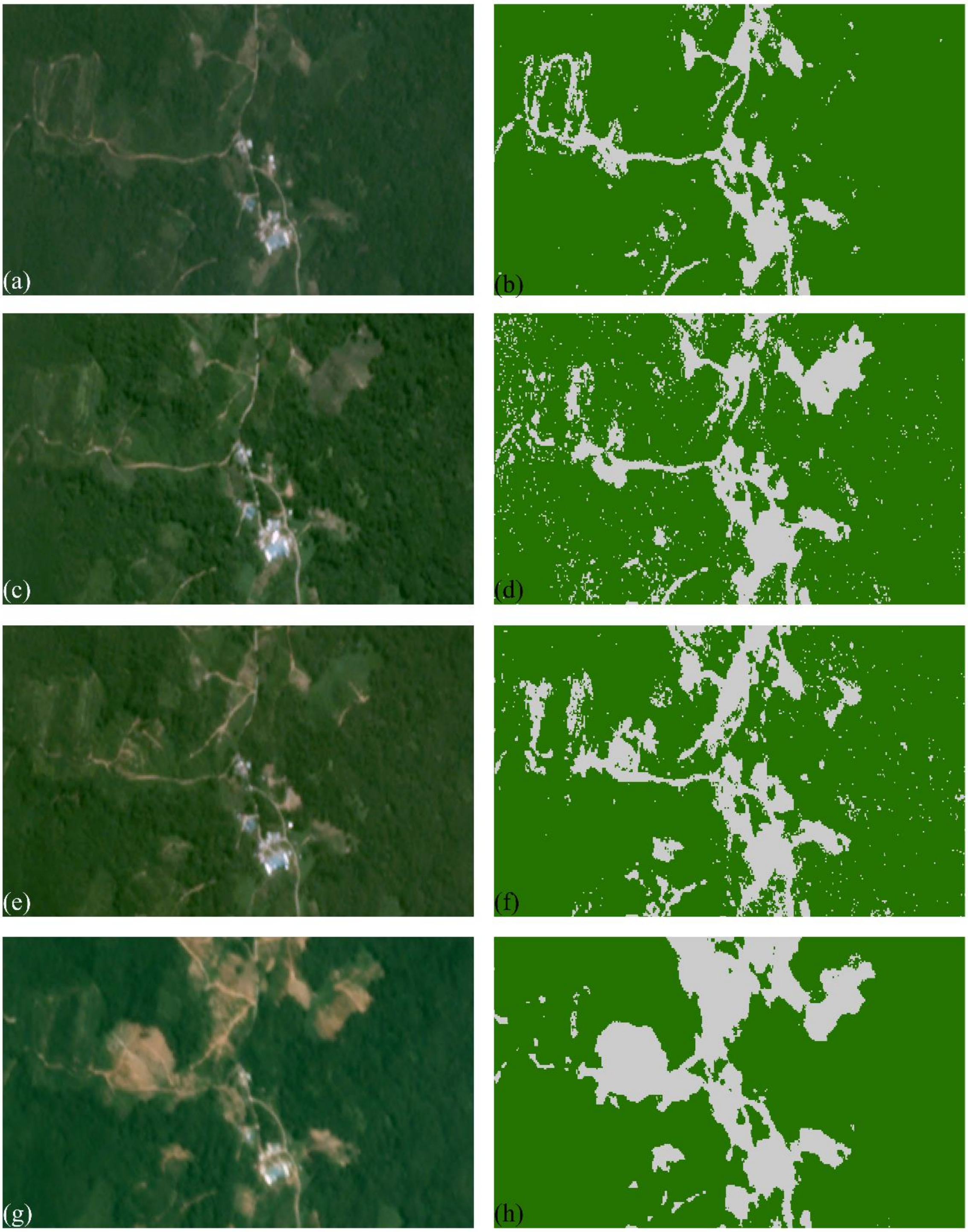

Fig. R2 Time series of the derived tree cover maps for the selected maritime Southeast Asia area (111.789°-111.806°E, 2.032°-2.040°N). (a) and (b), (c) and (d), (e) and (f), and (g) and (h) indicate 2019, 2018, 2017, and 2017, respectively.

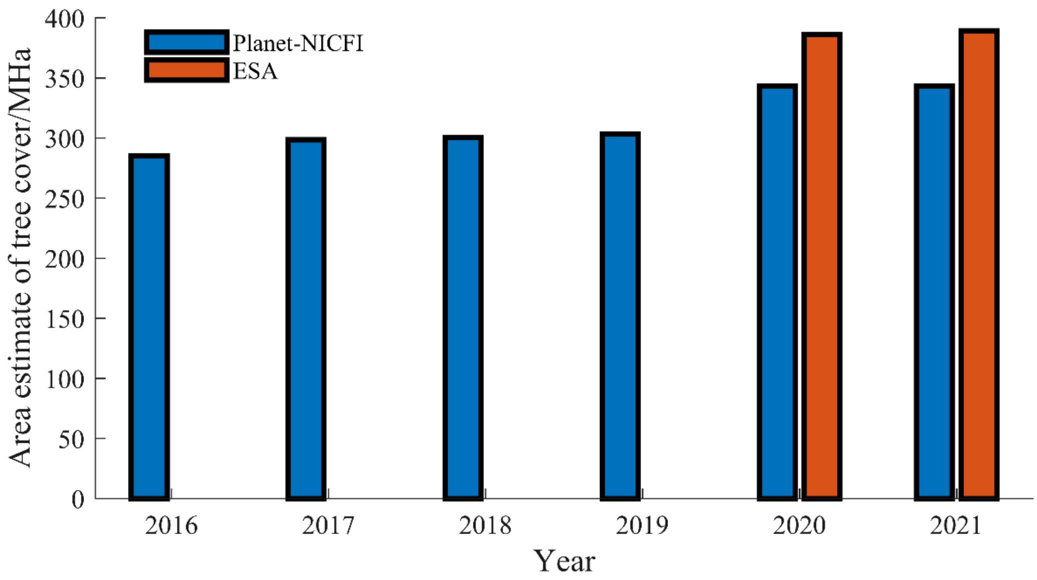

Fig. R3 Area dynamics change of tree cover maps for Planet-NICFI and ESA from 2016 to 2021.

[*Reviewer #2* Comment 4] *4. It remains unclear how the model performed over complex landscapes and regions with isolated trees. Additional information regarding the model's performance in such settings would greatly enhance the manuscript's credibility and applicability to various environments.*

[Response] Thanks a lot for your helpful suggestion.

We have addressed these issues in the algorithms article. Thus, in this study, we mainly report how the data were generated/collected, a thorough evaluation of the time series tree cover map product, the scope and uncertainty of the data, and how to get them, etc.

Specifically, in the algorithms article, we enlarge Planet-NICFI imagery as well as Planet/Sentinel-1 and ESA tree cover maps for four selected focus locations for assessment of built-up fields, dominant croplands in the lowlands, as well as two selected locations in the highlands (Figs. R6-8). We counted conducted the area comparisons of the mapping of new tree cover and ESA LC at six locations (Table R2). In addition, we performed the comparison of pixel-scale fractional cover estimates (Figs. 9-10). Overall, these analyses all show promise for monitoring complex landscapes and regions with isolated trees.

Table R2 Area comparisons of the mapping new forest cover and ESA LC at six locations.

Map scene	Elevation/m	Area/km^2	Total forest area/km^2		Area difference (%)
			Planet/Sentinel-1 LC	ESA LC	
1	182	5.8	4.5	4.6	0.1(3.6)
2	68	136.1	123.1	128.0	4.9(4.0)
3	127	11.5	5.4	5.9	0.5(9.7)
4	36	19.1	9.0	12.4	3.4(36.8)
5	1050	53.7	47.4	45.3	−2.1(−4.4)
6	845	20.0	19.3	19.9	0.6(3.0)

Note: Area difference indicates ESA LC minus Planet/Sentinel-1 LC, and the values in parenthesis express the area difference as a percentage relative to the area of our forest product.

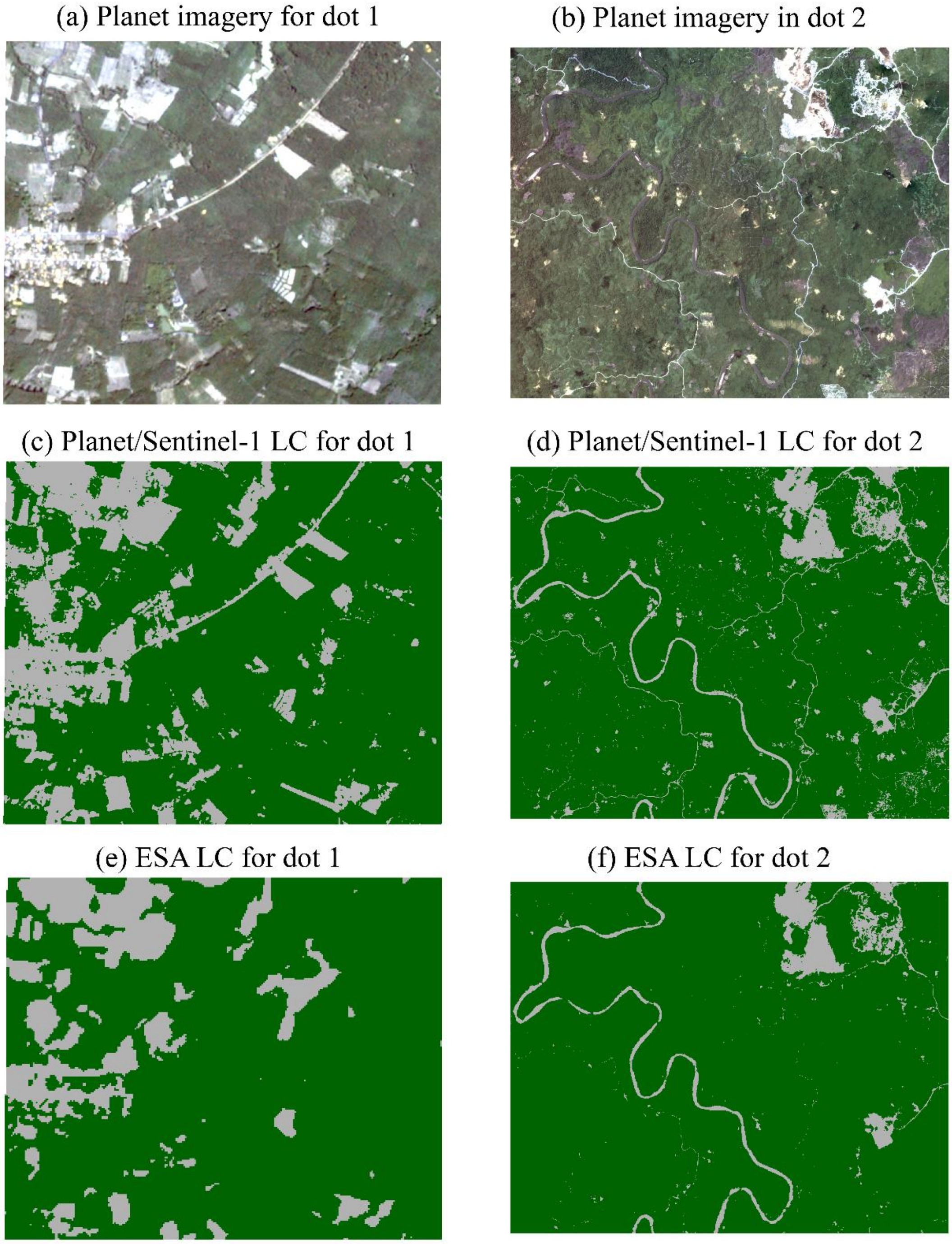

Fig. R6 Enlarged Planet imagery as well as Planet/Sentinel-1 and ESA forest maps for two selected focus locations for assessment of built-up fields in the lowlands. (a) and (b), (c) and (d), and (e) and (f) indicate Planet imageries, Planet/Sentinel-1 forest map (this study), and ESA forest maps for focus points 1 and 2 in Fig. 4, respectively.

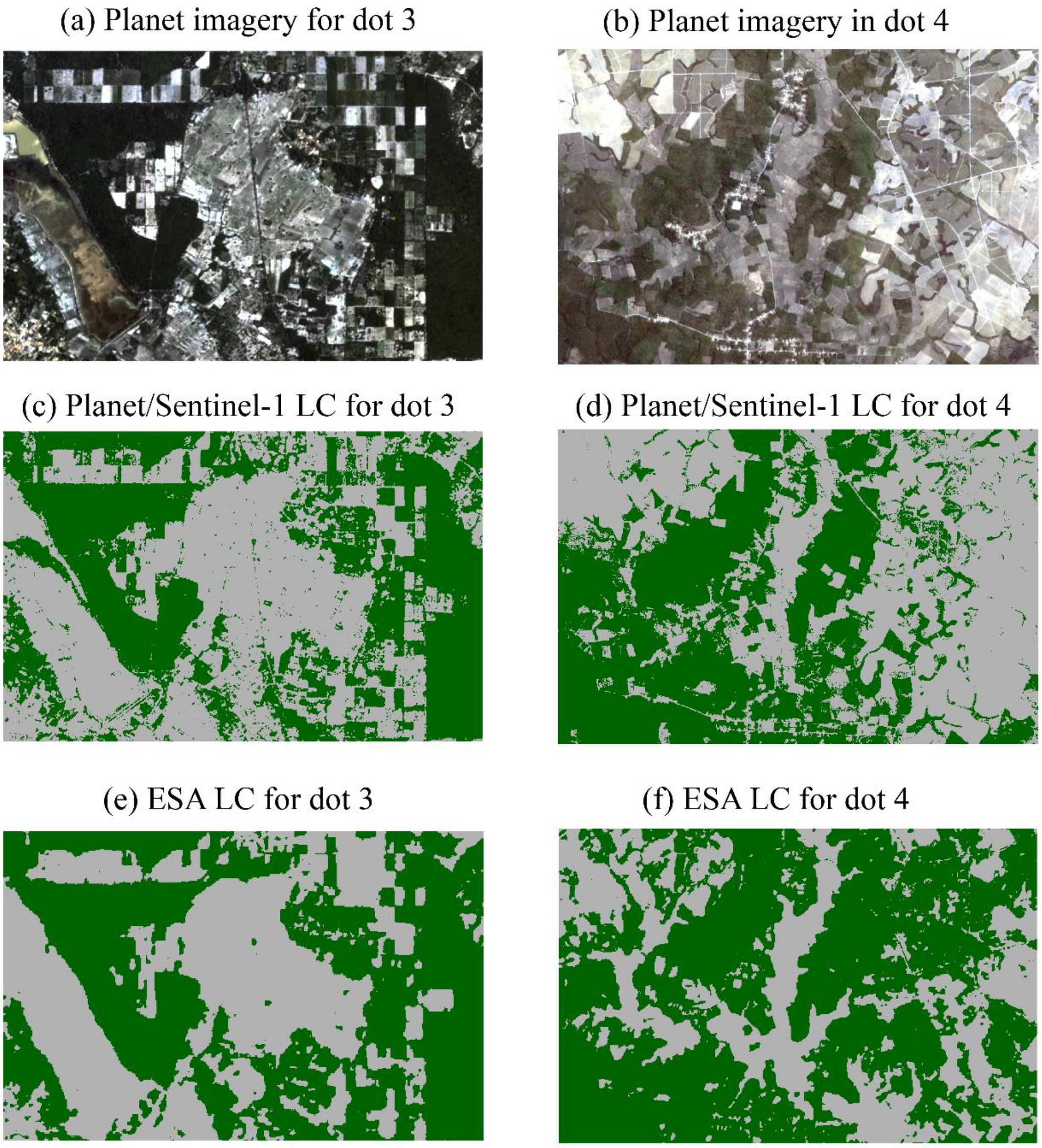

Fig. R7 Same as Figure 6, but for assessment of dominant croplands in the lowlands.

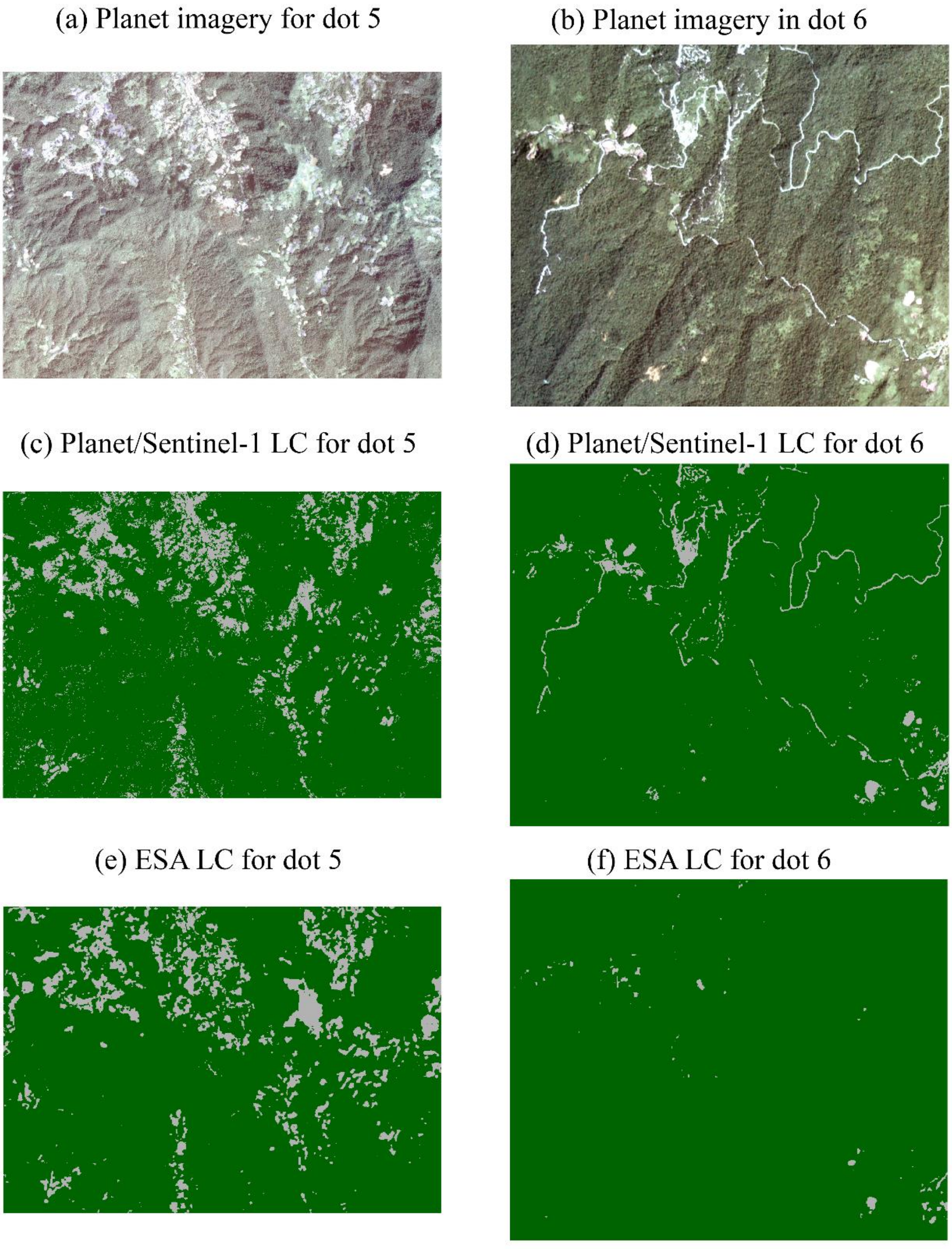

Fig. R8 Same as Figure 6, but for assessment of forest extent in the highlands with elevations above 300 m.

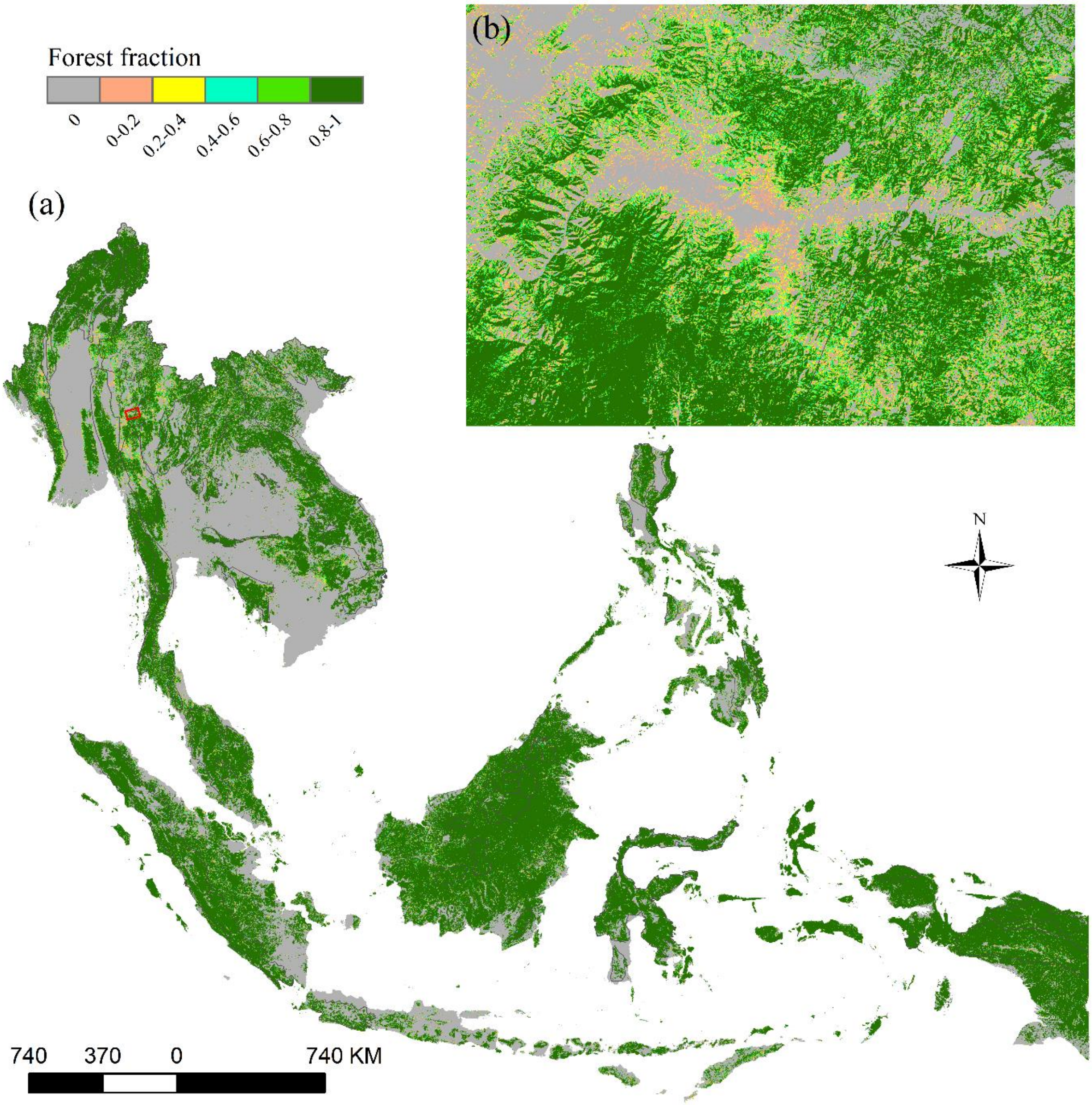

Fig. R9 Spatial distribution of forest cover fraction maps from Globeland30 in the SEA area (a). The mapped 4.77 m Planet/Sentinel-1 LC product was aggregated into cells of Globeland30 and represented as the forest fraction (percentage) of the cell. (b) zoom in for the selected location of (a).

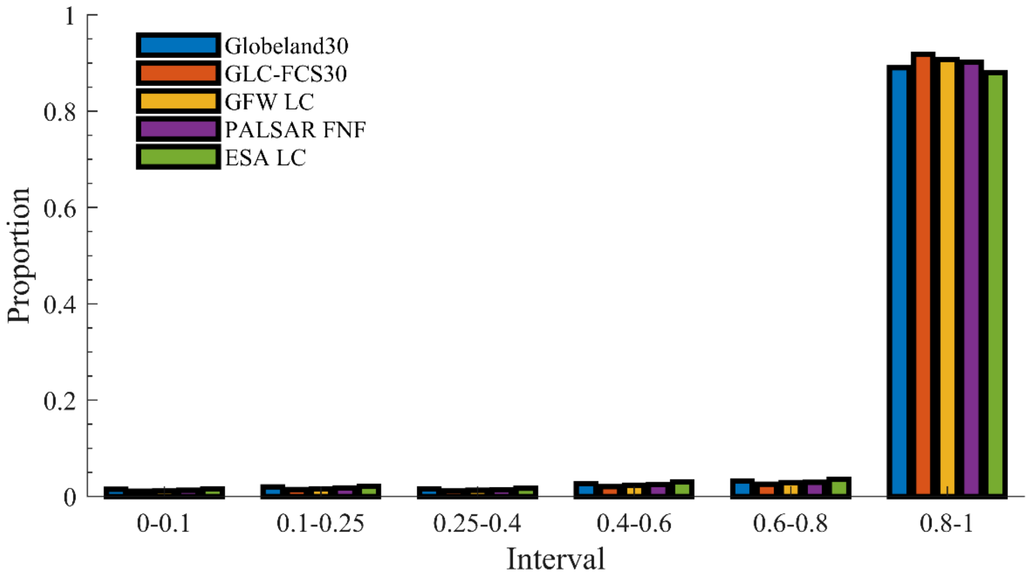

Fig. R10 The proportion of forest cover for each map within the interval of 0-0.1, 0.1-0.25, 0.25-0.4, 0.4-0.6, 0.6-0.8, and 0.8-1.

[*Reviewer #2* Comment 5] *5. To differentiate this manuscript from the unpublished work of Yang et al. (2023), it is important to highlight the distinguishing features. Providing a clear outline of the unique contributions and methodologies employed in this manuscript compared to Yang et al.'s work will help readers understand the specific advancements and insights presented in each study.*

[Response] Thanks a lot for your nice suggestion!

In our algorithms paper, our research question is “the degree to which such high-resolution imagery can mitigate this problem (i.e., “rounding” errors), and thereby improve large-area forest cover maps, is largely unexplored.”. In answering this central question, our study achieves two things that we believe are novel. First, we identify one of the main sources of uncertainty in remotely sensed forest cover estimates, which is the “rounding” error resulting from isolated trees and residual tree clumps outside of dense forests that arises when coarser resolution imagery is used to map forests. Second, we demonstrate that using higher resolution PlanetScope imagery can help to minimize such errors, as the potential applications of PlanetScope data for forest cover mapping have not yet been fully explored. Beyond demonstrating the value of PlanetScope for addressing this issue, we show that PlanetScope on its own does not fully resolve the problem, rather, the best results are achieved by combining high-resolution optical (PlanetScope) and high-medium resolution active remote sensing (Sentinel-1). We explore how this combined methodology addresses the rounding error issue by comparing forest cover estimates derived from our resulting forest cover maps with those from existing forest cover products at ~5 m, 10 m, 25 m, and 30 m resolutions, comparing estimates at the country-level, between mountain and lowland forests, and at the pixel level. We further calculated the proportions of forest cover fraction maps.

In our data description paper, our research question is “the availability of precise high-resolution tree cover map products remains inadequate due to the inherent limitations of mapping techniques utilizing medium-to-coarse resolution satellite imagery, such as Landsat and Sentinel-2 imagery.”. Thus, we have generated an annual tree cover map product at a resolution of 4.77 m for Southeast Asia (SEA) for the years 2016-2021 by integrating Planet-Norway’s International Climate & Forests Initiative (NICFI) imagery and Sentinel-1 Synthetic Aperture Radar data. We have also collected time-series tree cover/non-tree cover labels to further assess the accuracy of our Planet-NICFI tree cover map products during 2016-2021. Additionally, compared our mapped Planet-NICFI tree cover map with two state-of-art fine-scale tree cover map products (FROM-GLC10, ESA WorldCover 2020 and 2021). Thus, We have successfully generated the first accurate and high-resolution time-series tree cover map product for SEA by combining optical and SAR satellite observations.

We have carefully checked them and differentiated the two papers.