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CLASlite
Sensing Technology For Forest & Agriculture

Research Report (Unpublished Data)

0103-GC

Leuser Ecosystem Deforestation 2013-2022 (10, 5 and 1 year analysis)

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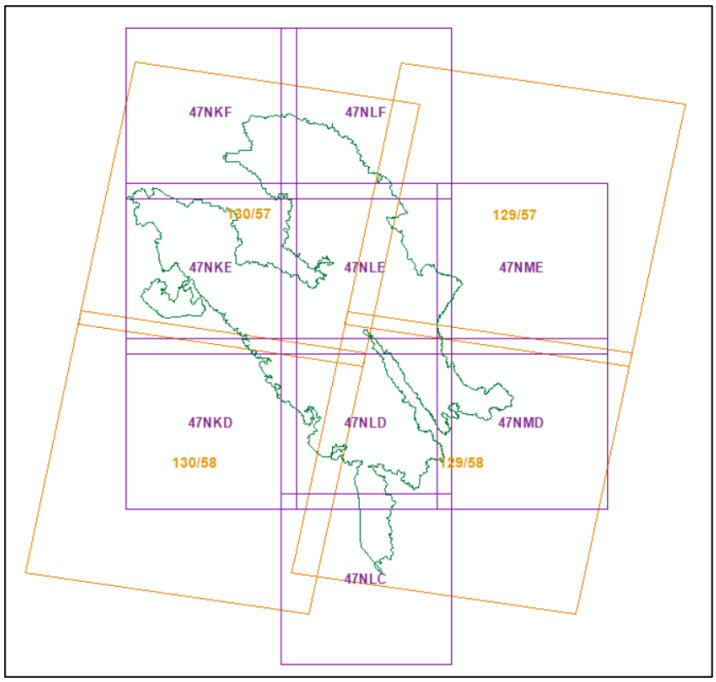
10, 5 and 1 year deforestation analysis of the Leuser Ecosystem in Indonesia with CLASlite revealed a loss of forest 507.67 Km², 424.70 Km² and 227.60 Km², respectively during these periods. Majority of the deforestation occurred in the past 10 years along the forest borders, followed by a shift into intrinsic areas in the past 5 and 1 years. Particular areas that are susceptible to continued deforestation are identified.

Leuser Ecosystem, a Forestal area on the island of Sumatra in Indonesia, it has around 2.6 Million hectares. Its diverse landscape includes lowland and montane rainforests, nine rivers, three lakes, and over 185,000 hectares of carbon-rich peatlands. One of the last remaining intact rainforests in all of Indonesia, it is a crucial source of clean drinking water and agricultural livelihoods for over four million people. For Global Conservation[1], i-Cultiver has monitored the Forestal Area through the CLASlite software to determine deforestation for the years 2013, 2017, 2021 and 2022. The satellite data available to process the timeline was Landsat-8 from NASA and Sentinel-2 from ESA. The Path/Row total for processing data is 13 images, four images for Landsat and nine images for Sentinel-2 (Fig.1)

Figure 1. Leuser Ecosystem (green), Landsat-8 path/row (orange), Sentinel-2 path/row (purple). Total processed data by CLASlite.



Results

10 Years: CLASlite can map deforestation, total loss of forest cover. To analyze ten years of forest loss, we selected images from years 2013 and 2021. The results show **507.67 km²** of deforestation. Figure 2 shows the forest cover loss in yellow. Majority of loss occurred at forest edges.

5 Years: The percentage cloud cover for 2017 is less than 2022. The total forest cover loss since 2017 until 2022 mapped with CLASlite is **424.70 km²**. Figure 3 shows the forest cover loss in yellow. We can see shift towards internal forest loss in the past 5 years, beyond the edges.

1 *Year:* The total forest cover loss mapped with CLASlites since 2021 until 2022 is **227.60 km²**. Figure 4 shows the forest cover loss in yellow.

Conclusion

Deforestation shown in yellow (Figs. 2, 3 and 4) appears to shift from forest edges in the 10 year analysis to internal areas in the forest in past 5 and 1 year analysis. This means that major deforestation occurred in the past 10 years along the borders (yellow, Figure 2), followed by intrinsic areas in the past 5 and 1 years (yellow, Figures 3 and 4). Particular areas that are susceptible to continued deforestation are the regions (in yellow) present in both 5 and 1 year analysis (Figures 3 and 4), along the south-central divide and the North-West areas of the Leuser Ecosystem.

[1] https://globalconservation.org/projects/leuser-national-park-indonesia/

Figure 2. Deforestation 2013-2021 map.

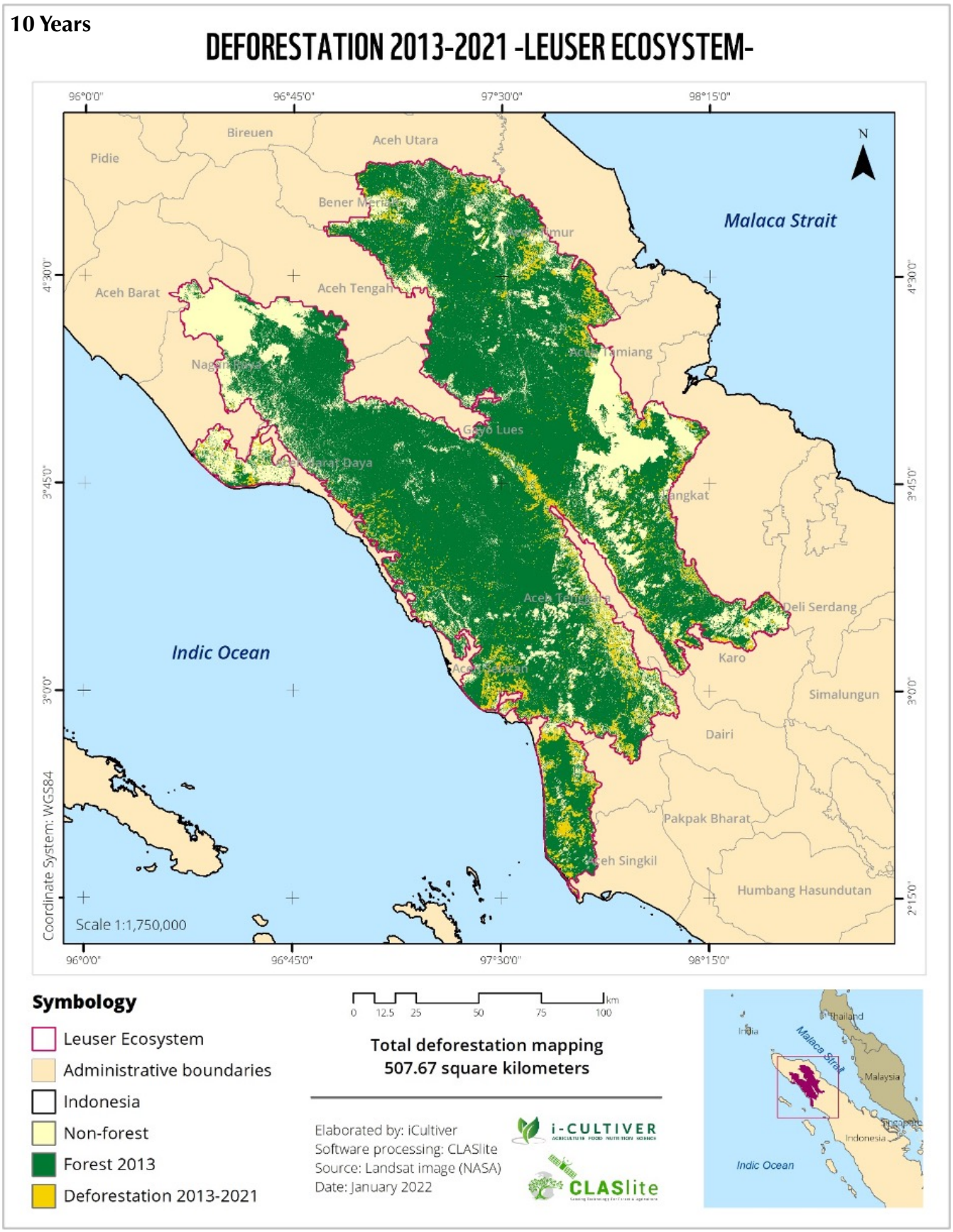


Figure 3. Deforestation 2017-2022 map.

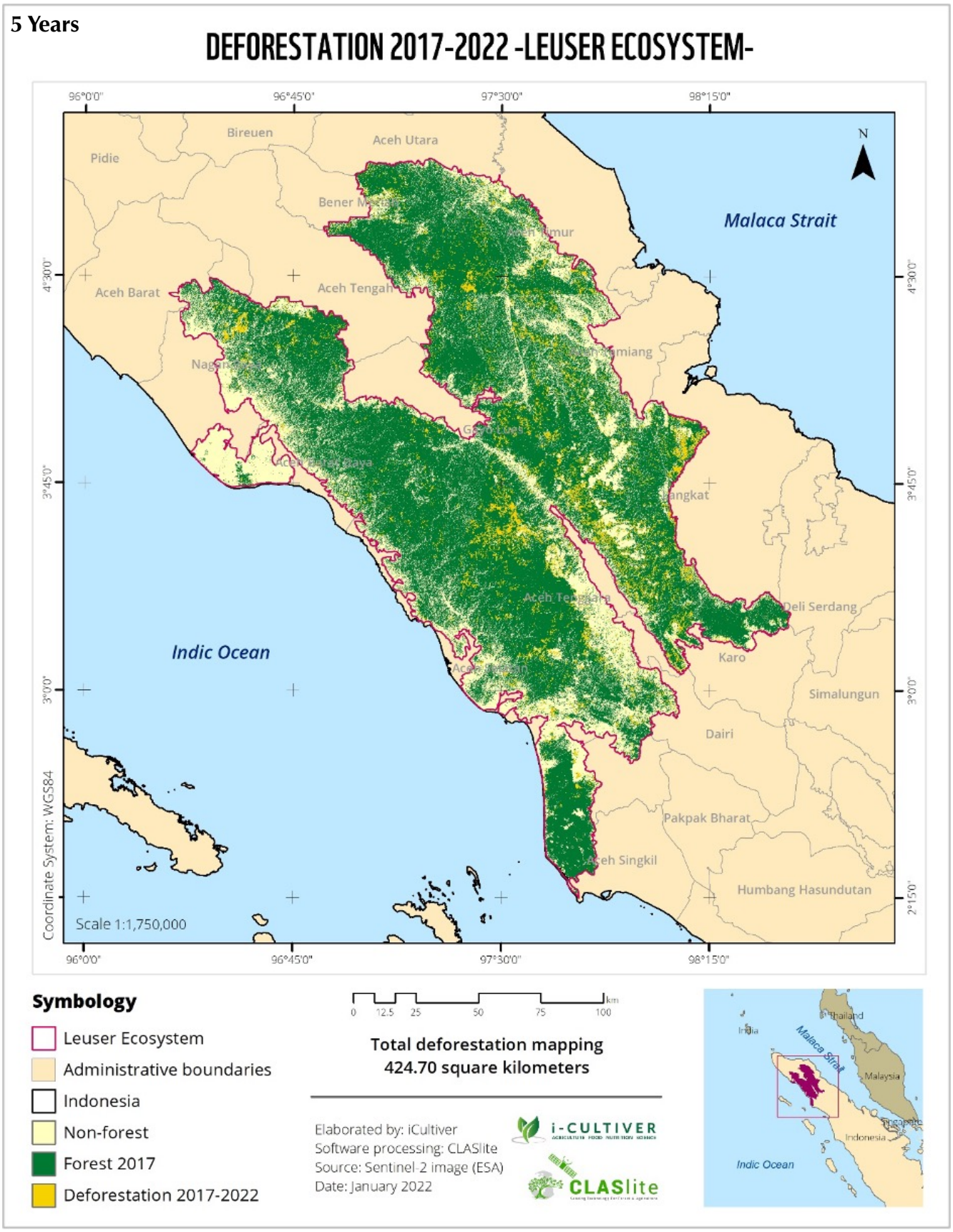
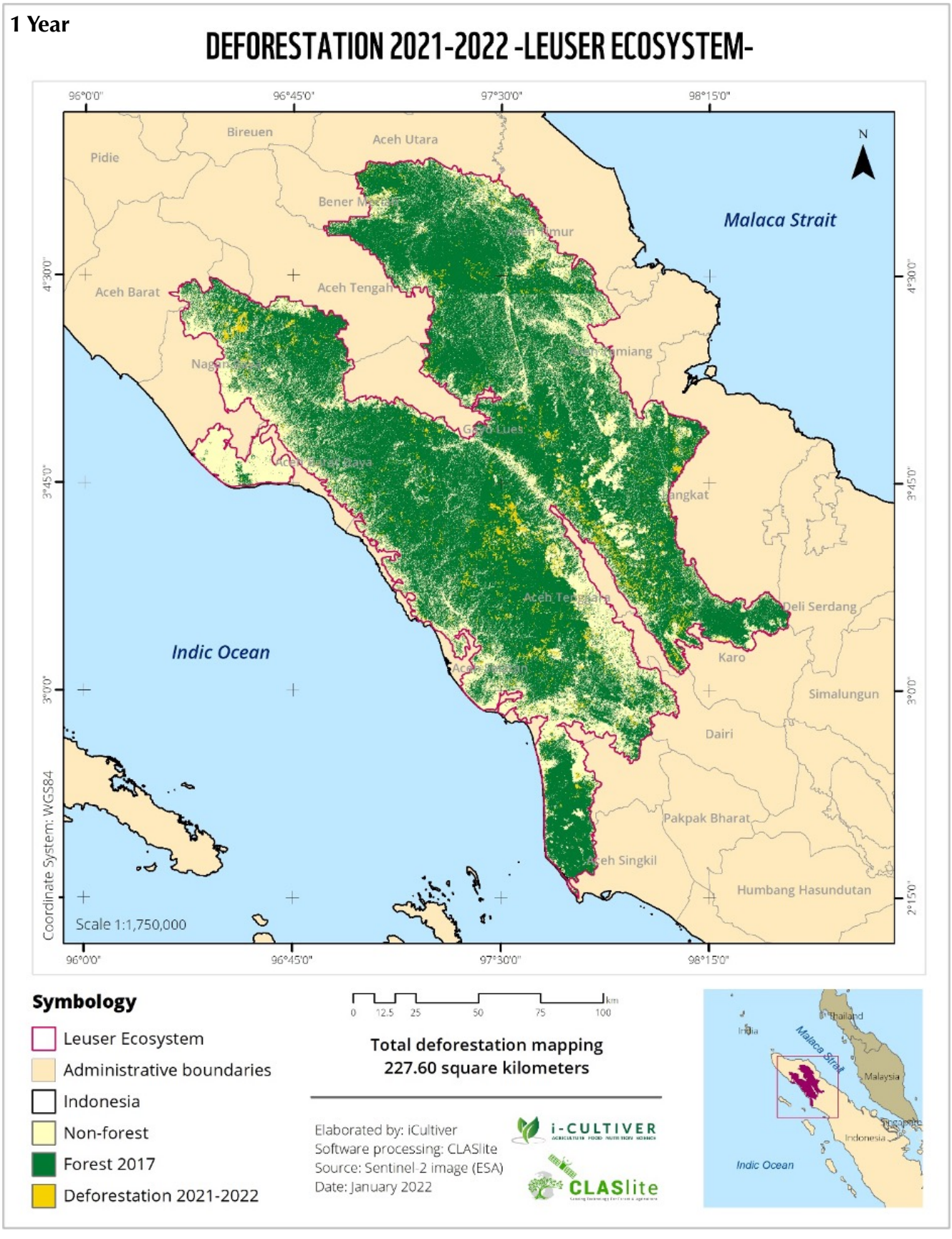


Figure 4. Deforestation 2021-2022 map.



Materials and Methods

The timeline of ten years (2013-2021) was analyzed with Landsat-8 satellite from NASA, the images were downloading from Earth Explorer (Table 1). Although the location had several clouds during the year, we could find images with less than 20% cloud cover (Fig.5).

For five-year (2017-2022) and one year (2021-2022) analysis, we used CLASlite with Sentinel-2 images from ESA. The images were downloaded from ESA Hub (Table 2). Although the location had several clouds during the year, we were able to find usable images. The timeline 2017-2022 (five years) was processed in CLASlite with the natural color mosaics of Sentinel-2 (Fig. 6).

For 2021-2022 (one year) we processed CLASlite with the natural color mosaics of Sentinel-2 (Fig. 7). The percentage cloud cover for 2021 is similar to 2022.

Table 1. Downloaded Landsat-8 images 2013 and 2021.

Name	Sensor	Path/Row	Date
LC08_L1TP_129057_20130623_20170504_01_T1	Landsat-8	129/57	23/06/2013
LC08_L1TP_129057_20210309_20210317_01_T1	Landsat-8	129/57	9/03/2021
LC08_L1TP_129058_20130607_20170504_01_T1	Landsat-8	129/58	7/06/2013
LC08_L1TP_129058_20211003_20211013_01_T1	Landsat-8	129/58	3/10/2021
LC08_L1TP_130058_20140225_20170425_01_T1	Landsat-8	130/58	25/02/2014
LC08_L1TP_130058_20210212_20210304_01_T1	Landsat-8	130/58	12/02/2021
LC08_L1TP_130057_20130918_20170502_01_T1	Landsat-8	130/57	18/11/2013
LC08_L1TP_130057_20140804_20170420_01_T1	Landsat-8	130/57	4/08/2014
LC08_L1TP_130057_20210228_20210311_01_T1	Landsat-8	130/57	28/02/2021

Figure 5. Landsat-8 image mosaics, first image 2013 and second image 2021.

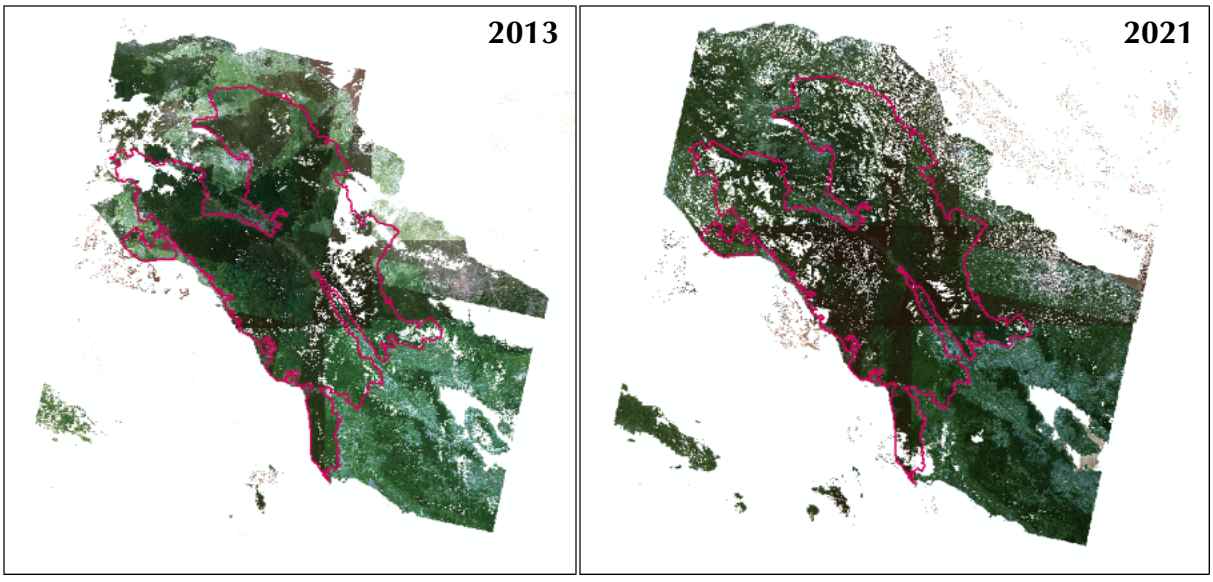
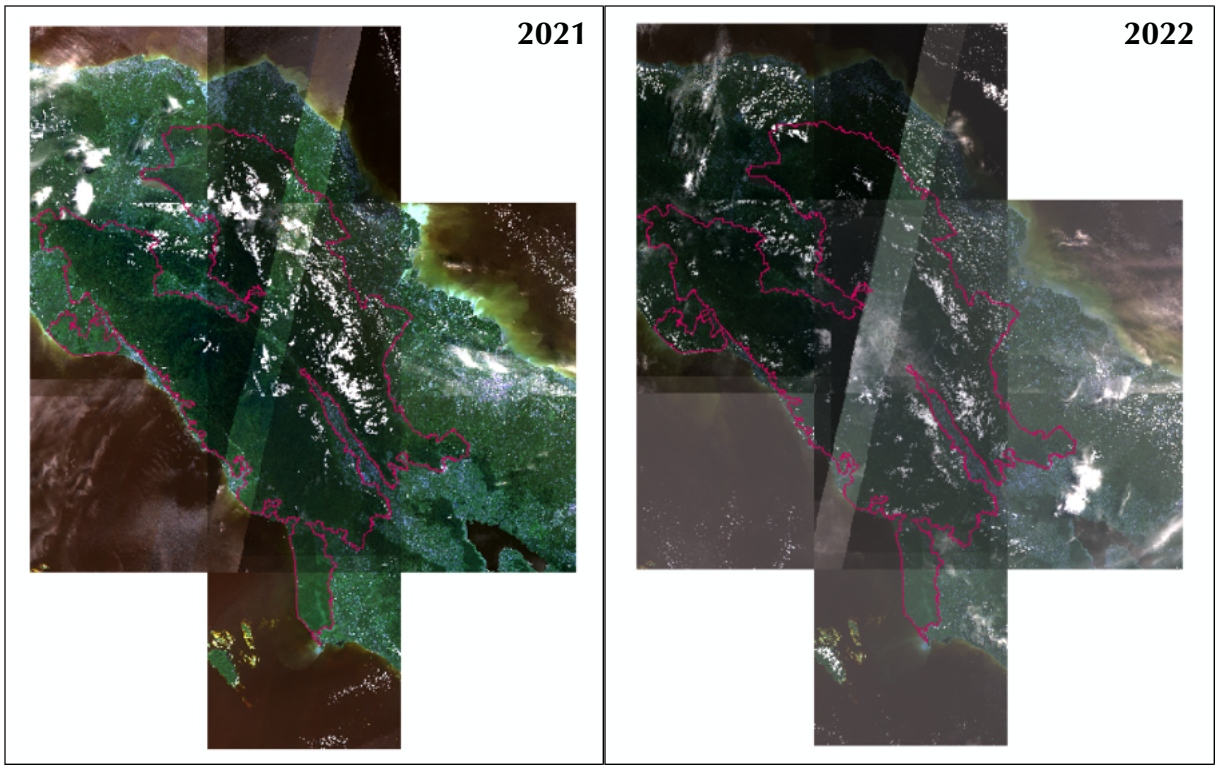


Table 2. Downloaded Sentinel-2 images 2017, 2021 and 2022

Name	Sensor	ID	Fecha
S2A_MSIL1C_20171017T034731_N0205_R104_T47NKD_20171017T040104	Sentinel-2A	T47NKD	17/10/2017
S2A_MSIL1C_20210718T034541_N0301_R104_T47NKD_20210718T063457	Sentinel-2A	T47NKD	18/07/2021
S2A_MSIL1C_20220613T034551_N0400_R104_T47NKD_20220613T060129	Sentinel-2A	T47NKD	13/06/2022
S2A_MSIL1C_20171017T034731_N0205_R104_T47NKE_20171017T040104	Sentinel-2A	T47NKE	17/10/2017
S2A_MSIL1C_20200224T034731_N0209_R104_T47NKE_20200224T065126	Sentinel-2A	T47NKE	24/02/2020
S2A_MSIL1C_20210310T034551_N0209_R104_T47NKE_20210310T064855	Sentinel-2A	T47NKE	10/03/2021
S2A_MSIL1C_20210529T034541_N0300_R104_T47NKE_20210529T063621	Sentinel-2A	T47NKE	29/05/2021
S2A_MSIL1C_20171017T034731_N0205_R104_T47NKF_20171017T040104	Sentinel-2A	T47NKF	17/10/2017
S2B_MSIL1C_20200608T034539_N0209_R104_T47NKF_20200608T080700	Sentinel-2B	T47NKF	8/06/2020
S2A_MSIL1C_20210718T034541_N0301_R104_T47NKF_20210718T063457	Sentinel-2A	T47NKF	18/07/2021
S2A_MSIL1C_20180201T033951_N0206_R061_T47NLC_20180201T090202	Sentinel-2A	T47NLC	1/02/2018
S2A_MSIL1C_20200221T033751_N0209_R061_T47NLC_20200221T070031	Sentinel-2A	T47NLC	21/02/2020
S2A_MSIL1C_20220312T033541_N0400_R061_T47NLC_20220312T061836	Sentinel-2A	T47NLC	12/03/2022
S2B_MSIL1C_20171019T033729_N0205_R061_T47NLD_20171019T034744	Sentinel-2B	T47NLD-E	19/10/2017
S2A_MSIL1C_20211003T033601_N0301_R061_T47NLD_20211003T073918	Sentinel-2A	T47NLD-E	3/10/2021
S2A_MSIL1C_20220312T033541_N0400_R061_T47NLD_20220312T061836	Sentinel-2A	T47NLD-E	12/03/2022
S2A_MSIL1C_20220720T033551_N0400_R061_T47NLD_20220720T055331	Sentinel-2A	T47NLD-E	20/07/2022
S2A_MSIL1C_20171017T034731_N0205_R104_T47NLD_20171017T040104	Sentinel-2A	T47NLD-W	17/10/2017
S2A_MSIL1C_20210718T034541_N0301_R104_T47NLD_20210718T063457	Sentinel-2A	T47NLD-W	18/07/2021
S2B_MSIL1C_20220718T034539_N0400_R104_T47NLD_20220718T060842	Sentinel-2B	T47NLD-W	18/07/2022
S2B_MSIL1C_20171019T033729_N0205_R061_T47NLE_20171019T034744	Sentinel-2B	T47NLE-E	19/10/2017
S2B_MSIL1C_20200715T033539_N0209_R061_T47NLE_20200715T081431	Sentinel-2B	T47NLE-E	15/07/2020
S2A_MSIL1C_20220630T033551_N0400_R061_T47NLE_20220630T072519	Sentinel-2A	T47NLE-E	30/06/2022
S2A_MSIL1C_20220720T033551_N0400_R061_T47NLE_20220720T055331	Sentinel-2A	T47NLE-E	20/07/2022
S2A_MSIL1C_20171017T034731_N0205_R104_T47NLE_20171017T040104	Sentinel-2A	T47NLE-W	17/10/2017
S2B_MSIL1C_20210524T034539_N0300_R104_T47NLE_20210524T063532	Sentinel-2B	T47NLE-W	24/05/2021
S2A_MSIL1C_20220213T034851_N0400_R104_T47NLE_20220213T054203	Sentinel-2A	T47NLE-W	13/02/2022
S2B_MSIL1C_20171019T033729_N0205_R061_T47NLF_20171019T034744	Sentinel-2B	T47NLF-E	19/10/2017
S2B_MSIL1C_20210630T033539_N0300_R061_T47NLF_20210630T071530	Sentinel-2B	T47NLF-E	30/06/2021
S2A_MSIL1C_20220312T033541_N0400_R061_T47NLF_20220312T061836	Sentinel-2A	T47NLF-E	12/03/2022
S2A_MSIL1C_20171017T034731_N0205_R104_T47NLF_20171017T040104	Sentinel-2A	T47NLF-W	17/10/2017
S2A_MSIL1C_20200214T034841_N0209_R104_T47NLF_20200214T065354	Sentinel-2A	T47NLF-W	14/02/2020
S2A_MSIL1C_20210529T034541_N0300_R104_T47NLF_20210529T063621	Sentinel-2A	T47NLF-W	29/05/2021
S2B_MSIL1C_20171019T033729_N0205_R061_T47NMD_20171019T034744	Sentinel-2B	T47NMD	19/10/2017
S2B_MSIL1C_20210630T033539_N0300_R061_T47NMD_20210630T071530	Sentinel-2B	T47NMD	30/06/2021
S2A_MSIL1C_20220720T033551_N0400_R061_T47NMD_20220720T055331	Sentinel-2A	T47NMD	20/07/2022
S2B_MSIL1C_20170731T033539_N0208_R061_T47NME_20191219T150011	Sentinel-2B	T47NME	31/07/2017
S2B_MSIL1C_20210121T034049_N0209_R061_T47NME_20210121T061453	Sentinel-2B	T47NME	21/01/2021
S2B_MSIL1C_20220715T033539_N0400_R061_T47NME_20220715T060005	Sentinel-2B	T47NME	15/07/2022

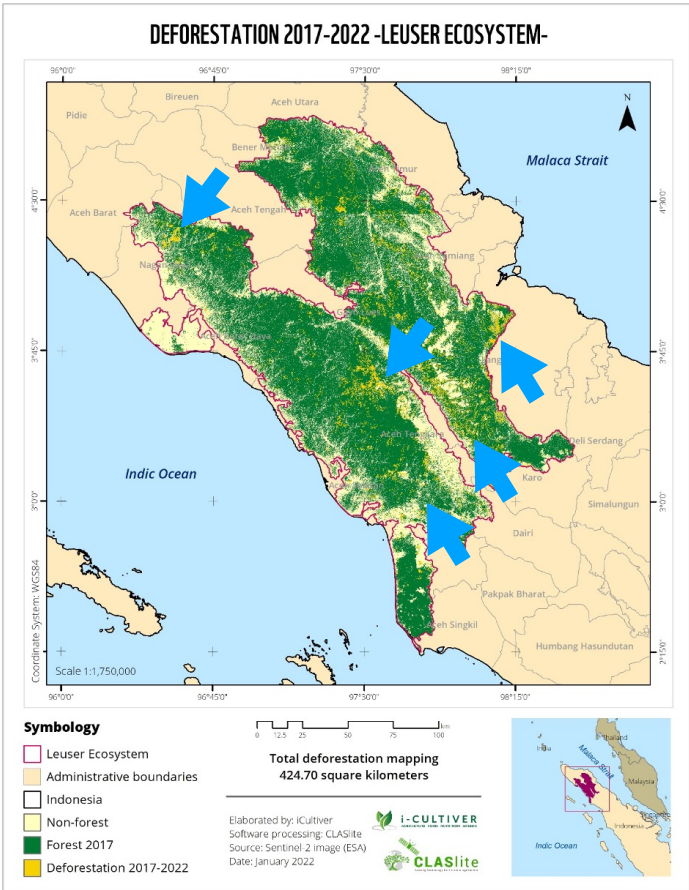
Figure 6. Sentinel-2 image mosaics, first image 2017 and second image 2022.

Figure 7. Sentinel-2 image mosaics, first image 2021 and second image 2022.

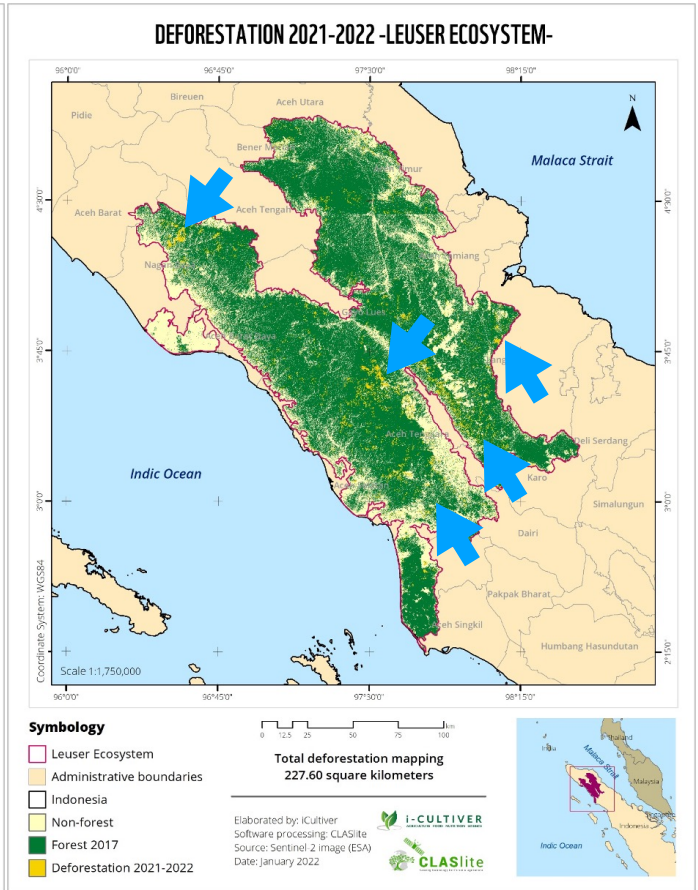


Areas most susceptible to continued deforestation

5 Year



1 Year



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About i-Cultiver:

Consortium of multidisciplinary professionals working together to improve agriculture, nutrition and conservation through advanced research and technology.
Mission: To bring technical solutions for modernizing agriculture, food systems and resource conservation to improve the human condition and its impact on our planet.
For more information, visit https://i-cultiver.com/

APPENDIX

Figure 2. Deforestation 2013-2021 map.

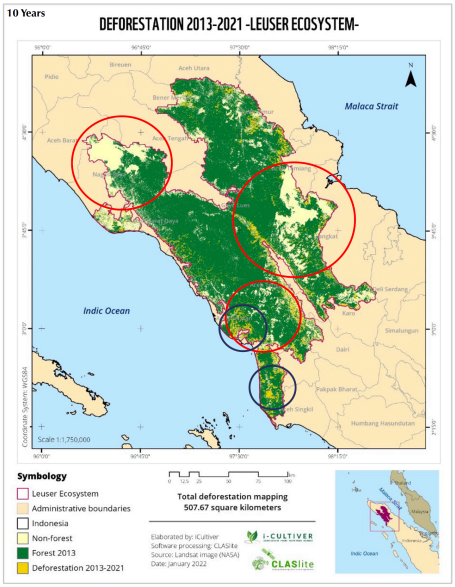


Figure 3. Deforestation 2017-2022 map.

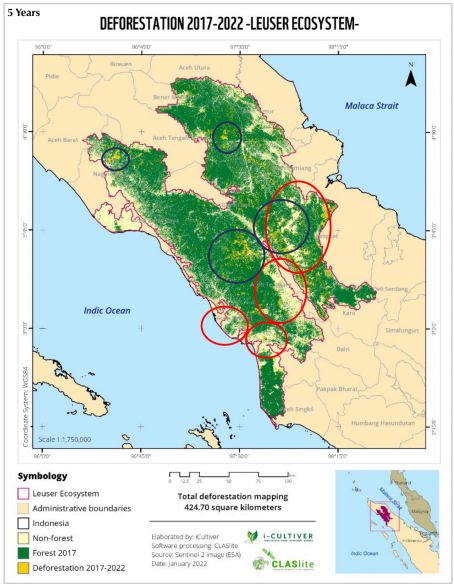
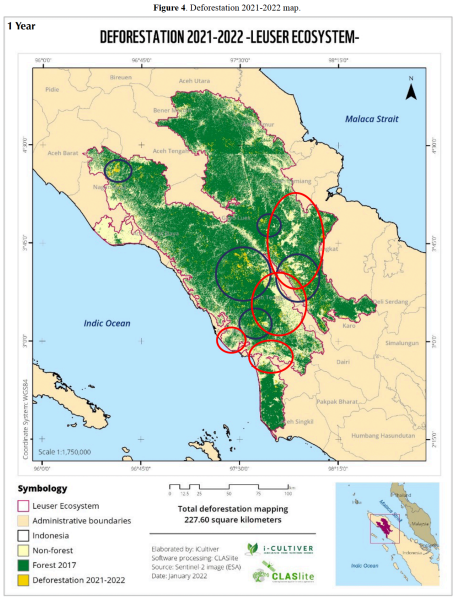


Figure 4. Deforestation 2021-2022 map.



NOTE to Reader (Agung Dwinurcahya)

1. Some areas covered by clouds were classified as non-forest class because they could not be distinguished between "cloud cover" and "non forest". These areas need to be checked for masking in future analysis.

2. Areas in several locations that should still be forest are considered to be no longer forest (shown above, circled in red)
   - 2013 - 2021 map :
     - Aceh Tamiang, Langkat, Nagan Raya, Aceh Selatan, Aceh Timur
   - 2017 - 2022 map :
     - Aceh Tamiang, Langkat, Aceh Tenggara, Aceh Selatan
   - 2021 - 2022 map :
     - Aceh Tamiang, Langkat, Aceh Tenggara, Aceh Selatan

   NB: Some of these locations exist because there are several areas with "No Data values". No Data values are due to Clouds and Shadows. Comparison of outlines in these areas with "National Land Uses Map" from the locations will improve the results in the future. We will work closely with the Administration on the ground to develop better analysis for these areas.

3. Some of the deforestation results are inaccurate (shown above, circled in blue)
   - 2013 - 2021 map :
     - Aceh Selatan and Aceh Singkil
   - 2017 - 2022 map :
     - Aceh Tengah, Aceh Tenggara, Nagan Raya
   - 2021 - 2022 map :
     - Aceh Tenggara, Nagan Raya

   NB: The deforestation results in the blue circled areas need to be validated for precision with information on the ground for Aceh Selatan, Aceh Singkil and others to improve the accuracy of deforestation analysis.