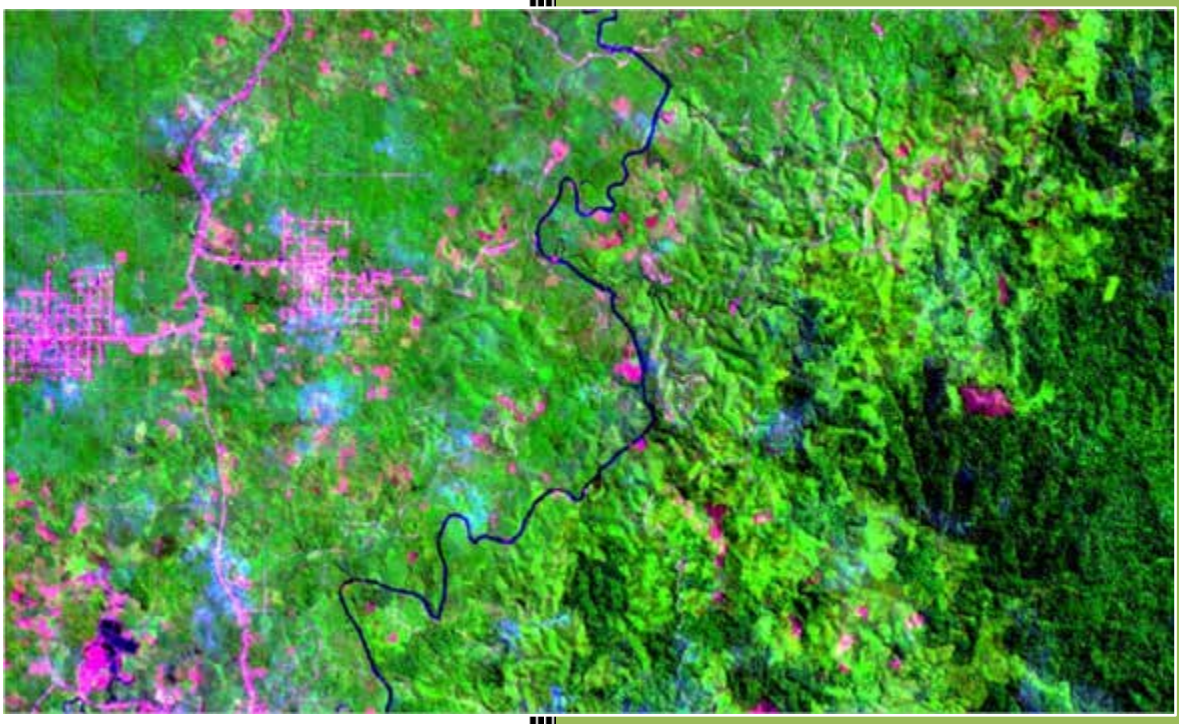
Technical Support for Creating Baseline Analysis for Carbon Stock and Land Cover Change in Samdhana Institute Focal Areas (2015-2020)



Prepared by:

Y. I Ketut Deddy Muliastra
Fransiska Widyastuti,
Gede Aswin Yoga Putra and
Anne Casson

Submitted by:
PT Serasi Kelola Alam (SEKALA)
Jl. Subak Sari, Gg. Mango No.1
Br. Tegalgundul, Ds. Tibubeneng
Kec. Kuta Utara, Kab. Badung
Bali 80361 - Indonesia

Table of Contents

List of Tables iii
List of Figures iii
Acronyms viii
Background 1
Data Collation, Methodology and Management 1
Spatial Data Collated from Various Sources 2
Topographic Map and Digital Elevation Model 3
Forestry Maps 3
Land Administration 3
Oil Palm Concession map 3
Customary Area 4
Peat Maps 4
Other Maps 4
Spatial Data Produced from Processing Satellite Images 4
Land Cover Map 2015 and 2019 5
Tree Cover Loss 6
Forest Fire and Heatmap 9
Above and Below Carbon Stock Estimates 10
Analysis Results for Focal Area 10
The Mukim Lamteuba focal area, Aceh Province 10
The Talang Mamak focal area, Riau Province 15
Ketapang focal area, West Kalimantan 21
Pulang Pisau Focal Area, Central Kalimantan 29
Kapuas Hulu Focal Area 35
Sungai Boh Focal Area 40
Sigi Focal Area 45
Tambrauw Focal Area 49
Manokwari Selatan Focal Area 53
Biak Numfor Focal Area 55
Jayapura Focal Area 58

Summary and Conclusion 64
References 67

List of Tables

Table 1. List of carbon stock estimation for each land cover type. 10
Table 2. Summary spatial analysis for each focal area. 66

List of Figures

Figure 1. Distribution of 11 focal areas of the Samdhana's priority areas. 2
Figure 2. Sentinel 2 images (SWIR, NIR and Blue Band), stacked from March 2019 to beginning April 2020 6
Figure 3. Sentinel 1 images (Band VV, VH and ratio of VV and VH), taken from March 2020 to beginning May 2020 (averaged). 6
Figure 4. Land cover map 2019 produced by KLHK. 6
Figure 5. Land cover map 2020 produced by SEKALA. 6
Figure 6. Landsat 8, results of stacking one year images from March 2017 to beginning April 2018, cloud and shadow were removed and the median value calculated for each pixel. This image represents a 2017 image. 7
Figure 7. Landsat 8, results of stacking one year images from March 2018 to beginning April 2019, cloud removed and the median value calculated for each pixel. This image represents a 2018 image. 7
Figure 8. Both images of 2017 and 2018 (Figure 5 and 6 respectively) was staked in both SWIR band and blue band for the recent year, shows white for no change in open area in both year. This represents built up area, while red in this image shows new clearing in the recent year and light blue represents vegetation growth in the recent year (was cleared in previous year but new vegetation growth in the recent year). 8
Figure 9. Staked Landsat 8 images of Short Infrared Wave and Blue bands in year 2017 and 2018. Pinky red shows forest loss, light green shows vegetation grows and white is no change, usually build up. There are some thin pink colors which are remaining haze. 9
Figure 10. Forest loss in red, according to GFC in 2018, which is change from 2017 to 2018. 9
Figure 11. Deforestation in red, according to KLHK in 2018. 9
Figure 12. Tree covers loss in red, result from SEKALA's analysis, change from 2017 to 2018. 9
Figure 13. Mukim Lamteuba focal area, Aceh Province. 11
Figure 14. Topography of Aceh focal area. 11
Figure 15. Forest land use plan for Aceh focal area. 11
Figure 16. Comparison of land cover in 2015 and 2020 in the Aceh focal area (SEKALA). 12
Figure 17. Annual vegetation loss 2015-2019 for Aceh focal area. 12
Figure 18. Annual vegetation loss 2015-2019 in Aceh focal area (SEKALA) 13
Figure 19. Land cover 2020 in Aceh focal area (SEKALA) 13
Figure 20. Active fires from 2015 to 2019 in Aceh focal area (FIRMS) 13
Figure 21. Active fires from 2015 to mid 2020 in Aceh focal area (FIRMS) 13
Figure 22. Burnt scar 2019 (KLHK). 14
Figure 23. Carbon stock estimation 2020 (SEKALA). 14
Figure 24. Large scale concessions (KLHK, 2019). 14

Figure 25. Moratorium for permits in primary forest and peatland (KLHK, 2019). 14
Figure 26. Existing land titled in Aceh focal area (BPN, 2019) 15
Figure 27. Indicative area as object for agrarian reform in Aceh focal area (BPN, 2019). 15
Figure 28. Talang Mamak focal area, Indragiri Hulu District, Riau Province. 16
Figure 29. Topography of Talang Mamak focal area. 16
Figure 30. Forest land use of Talang Mamak focal area. 16
Figure 31. Comparison between land cover 2015 and 2020 of Talang Mamak focal area. 17
Figure 32. Peat depth in Talang Mamak focal area (WI 2000-2002). 17
Figure 33. Land cover 2020 of Talang Mamak focal area (SEKALA). 17
Figure 34. Vegetation loss 2015-2019 (SEKALA). 18
Figure 35. Vegetation loss at land covers type in Talang Mamak focal area. 18
Figure 36. Distribution of carbon stock estimation in Talang Mamak focal area. 18
Figure 37. Permit moratorium on primary forest and peat in Talang Mamak focal area (KLHK 2019). 18
Figure 38. Large scale concessions in Talang Mamak focal area (Mining from Ministry of Mining and Energy, 2019, Timber plantation from KLHK, 2019, and oil palm concession from GFW, 2019). 19
Figure 39. Community forestry in Talang Mamak focal area (KLHK, 2019). 19
Figure 40. Indicative map of social forestry in the Talang Mamak focal area (KLHK 2019). 20
Figure 41. Land allocated for land reform in Talang Mamak focal area (ATR/BPN 2019). 20
Figure 42. Land titled at Talang Mamak focal area (ATR/BPN 2019). 20
Figure 43. Heatmap of active fires from 2015 to mid 2020 in Talang Mamak focal area (FIRMS). 21
Figure 44. Burn scar map 2015-2019 in Talang Mamak focal area (KLHK). 21
Figure 45. Yearly active fire quantity from 2015 to mid 2020 in Talang Mamak focal area (FIRMS) 21
Figure 46. Yearly burn scar area from 2015 to 2019 in Talang Mamak focal area (KLHK) 21
Figure 47. Ketapang focal area, West Kalimantan Province. 22
Figure 48. Topographic map of Ketapang focal area (Demnas, BIG 2018). 22
Figure 49. Peatland map of Ketapang focal area (Wetlands International, 2000-2002). 22
Figure 50. Land cover map of Ketapang focal area (SEKALA, 2020). 23
Figure 51. Forest estate in Ketapang focal area (SK 733, KLHK 2019). 23
Figure 52. Comparison land covers 2015 and 2020 in Ketapang focal area (SEKALA). 24
Figure 53. Annual vegetation loss 2015-2019 in Ketapang focal area (SEKALA). 24
Figure 54. Total carbon stock estimation in Ketapang focal area. 24
Figure 55. Vegetation loss yearly at land covers type in Ketapang focal area (SEKALA). 25
Figure 56. Moratorium permits on primary forest and peatland in Ketapang focal area (KLHK 2019). 26
Figure 57. Large scale concessions in Ketapang focal area (timber plantation and logging from KLHK (2019) and oil palm from GWC (2019). 26
Figure 58. Social forestry concessions in Ketapang focal area (KLHK 2019). 27
Figure 59. Indicative map for social forestry in Ketapang focal area (KLHK 2019). 27
Figure 60. Land title in Ketapang focal area (ATR/BPN 2019). 28
Figure 61. Mapped customary area in Ketapang (various sources 2019). 28
Figure 62. Annual active fires intensity 2015-2019 in Ketapang focal area (FIRMS). 28
Figure 63. Burnt scar 2015-2019 in Ketapang focal area (KLHK). 28
Figure 64. Land object for agrarian reform in Ketapang focal area (ATR/BPN 2019). 29

Figure 65. Burnt scar map 2015-2019 in Ketapang focal area (KLHK). 29
Figure 66. Pulang Pisau focal area, Central Kalimantan Province. 30
Figure 67. Topography of Pulang Pisau focal area. 30
Figure 68. Forest land use plan in Pulang Pisau focal area (KLHK 2019). 30
Figure 69. Land cover in Pulang Pisau focal area (SEKALA 2020). 31
Figure 70. Peat depth in Pulang Pisau focal area (WI 2000-2002). 31
Figure 71. Permit moratorium on primary forest and peat in Pulang Pisau focal area (KLHK 2019). 32
Figure 72. Carbon stock estimation in Pulang Pisau focal area. 32
Figure 73. Comparison between land cover 2015 and 2020 (SEKALA). 32
Figure 74. Vegetation loss map 2015-2019 in Pulang Pisau focal area (SEKALA). 33
Figure 75. Vegetation loss map 2015-2019 over land cover type in Pulang Pisau focal area (SEKALA). 33
Figure 76. Burnt scar map of Pulang Pisau focal area 2015-2019 (KLHK) 33
Figure 77. Accumulated active fire/hotspot location in Pulang Pisau focal area 2015-mid 2020 (FIRMS). 33
Figure 78. Active fire/hotspot in Pulang Pisau focal area (FIRMS). 34
Figure 79. Burnt scar in Pulang Pisau focal area (KLHK). 34
Figure 80. Large scale concession in Pulang Pisau focal area (GFW 2019). 34
Figure 81. Community forestry and village forest in Pulang Pisau lanscape (KLHK 2019). 34
Figure 82. Indicative for social forestry program in Pulang Pisau focal area (KLHK 2019). 35
Figure 83. Land planned for agrarian reform program in Pulang Pisau focal area (ATR/BPN 2019). 35
Figure 84. Land titled in Pulang Pisau focal area (ATR/BPN 2019). 35
Figure 85. Customary area that already mapped in Pulang Pisau focal area (various sources 2019). 35
Figure 86. Kapuas Hulu focal area, West Kalimantan Province. 36
Figure 87. Topography of Kapuas Hulu focal area (BIG 2018). 36
Figure 88. Forest land use plan (KLHK 2019). 36
Figure 89. Comparison between land cover 2015 and 2020 in Kapuas Hulu focal area (SEKALA). 37
Figure 90. Land cover 2020 at Kapuas Hulu focal area (SEKALA). 37
Figure 91. Peat depth in Kapuas Hulu focal area (WI 2000-2002). 37
Figure 92. Carbon stock estimation in Kapuas Hulu focal area. 38
Figure 93. Vegetation loss 2015-2019 in Kapuas Hulu focal area (SEKALA). 38
Figure 94. Annual vegetation loss 2015-2019 over land cover type in Kapuas Hulu focal area (SEKALA). . 38
Figure 95. Heatmap active fires occurrences 2015-mid2020 in Kapuas Hulu focal area (FIRMS). 39
Figure 96. Permit moratorium on primary forest and peat in Kapuas Hulu focal area (KLHK 2019). 39
Figure 97. Large scale concession in Kapuas Hulu focal area (GFW 2019). 39
Figure 98. Village forest in Kapuas Hulu focal area (KLHK 2019). 39
Figure 99. Indicative map for social forestry program in Kapuas Hulu focal area (KLHK 2019). 40
Figure 100. Land titled in Kapuas Hulu focal area (ATR/BPN 2019). 40
Figure 101. Sungai Boh focal area, Malinau District, North Kalimantan Province. 41
Figure 102. Topography of Sungai Boh focal area (BIG 2018). 41
Figure 103. Forest land use plan (SK 718/2014) in Sungai Boh focal area (KLHK 2019). 41
Figure 104. Land cover 2020 in Sungai Boh focal area (SEKALA). 42
Figure 105. Carbon stock estimation for Sungai Boh focal area 2020. 42
Figure 106. Comparison between 2015 and 2020 land cover of Sungai Boh focal area (SEKALA). 42

Figure 107. Annual vegetation loss 2015-2019 in Sungai Boh focal area (SEKALA). 43
Figure 108. Burnt scar 2015-2019 in Sungai Boh focal area (KLHK). 43
Figure 109. Annual vegetation loss distribution in Sungai Boh focal area (SEKALA). 43
Figure 110. Heatmap of active fires 2015-mid2020 in Sungai Boh focal area (FIRMS). 44
Figure 111. Permit moratorium on primary forest and peat in Sungai Boh focal area (KLHK 2019). 44
Figure 112. Large scale concession in Sungai Boh - logging (KLHK 2019). 44
Figure 113. Indicative map for social forestry program in Sungai Boh focal area (KLHK 2019). 44
Figure 114. Land allocated for agrarian reform in Sungai Boh focal area (ATR/BPN 2019). 45
Figure 115. Land titled in Sungai Boh focal area (ATR/BPN 2019). 45
Figure 116. Sigi focal area, Central Sulawesi Province. 45
Figure 117. Topography of Sigi focal area (BIG 2018). 46
Figure 118. Forest land use plan in Sigi focal area (KLHK 2019). 46
Figure 119. Comparison between 2015 and 2020 land cover (SEKALA). 47
Figure 120. Land cover 2020 of Sigi focal area (SEKALA). 47
Figure 121. Carbon stock estimation 2020 for Sigi focal area. 47
Figure 122. Annual vegetation loss 2015-2019 in Sigi focal area over land cover type (SEKALA). 48
Figure 123. Distribution annual vegetation loss in Sigi focal area (SEKALA). 48
Figure 124. Permit moratorium on primary forest and peat in Sigi focal area (KLHK 2019). 48
Figure 125. Village forest and customary forest in Sigi focal area (KLHK 2019). 48
Figure 126. Indicative map for social forestry program in Sigi focal area (KLHK 2019). 49
Figure 127. Land as object for land reform in Sigi focal area - red arrows (ATR/BPN 2019). 49
Figure 128. Customary area that has been mapped in Sigi focal area (various sources 2019). 49
Figure 129. Land titled in Sigi focal area (ATR/BPN 2019). 49
Figure 130. Tambrauw focal area, West Papua Province. 50
Figure 131. Topography of Tambrauw focal area (BIG 2018). 50
Figure 132. Forest land use in Tambraw focal area (KLHK 2019). 50
Figure 133. Comparison between 2015 and 2020 land cover in Tambraw focal area (SEKALA). 51
Figure 134. Land cover map 2020 of Tambrauw focal area (SEKALA). 51
Figure 135. Distribution of vegetation loss 2015-2019 in Tambrauw focal area (SEKALA). 51
Figure 136. Annual vegetation loss over land cover type in Tambrauw focal area (SEKALA). 51
Figure 137. Permit moratorium on primary forest and peat in Tambrauw focal area (KLHK 2019). 52
Figure 138. Carbon stock estimation in Tambrauw focal area 2020. 52
Figure 139. Indicative map for social forestry program in Tambrauw focal area (KLHK 2019). 53
Figure 140. Land titled in Tambrauw focal area (ATR/BPN 2019). 53
Figure 141. Manokwari Selatan focal area, West Papua Province. 53
Figure 142. Topography of Manokwari Selatan focal area (BIG 2018). 54
Figure 143. Forest land use plan in Manokwari Selatan (KLHK 2019). 54
Figure 144. Land cover 2020 of Manokwari Selatan focal area (SEKALA). 54
Figure 145. Carbon stocks estimation in Manokwari Selatan focal area 2020. 54
Figure 146. Permit moratorium on primary forest and peat in Manokwari Selatan focal area (KLHK 2019). 54
Figure 147. Indicative map of social forestry in Manokwari Selatan focal area (KLHK 2019). 54

Figure 148. Village forest in Manokwari Selatan focal area (KLHK 2019). 55
Figure 149. Biak Numfor focal area, Papua Province. 55
Figure 150. Topography of Biak Numfor focal area (BIG 2018). 56
Figure 151. Forest land use plan in Biak Numfor focal area (KLHK 2019). 56
Figure 152. Land cover 2020 of Biak Numfor focal area (SEKALA). 57
Figure 153. Carbon stock estimation 2020 for Biak Numfor. 57
Figure 154. Annual vegetation loss 2015-2019 over land cover type in Biak Numfor focal area (SEKALA)57
Figure 155. Vegetation loss 2015-2019 in Biak Numfor focal area (SEKALA). 57
Figure 156. Permit moratorium on primary forest and peat in Biak Numfor focal area (KLHK 2019). 58
Figure 157. Village forest in Biak Numfor focal area (KLHK 2019). 58
Figure 158. Land as object for agrarian reform in Biak Numfor focal area (ATR/BPN 2019). 58
Figure 159. Land titled in Biak Numfor focal area (ATR/BPN 2019). 58
Figure 160. Jayapura focal area, Papua Province. 59
Figure 161. Forest land use plan of Jayapura focal area (KLHK 2019). 60
Figure 162. Topography of Jayapura focal area (BIG 2018). 61
Figure 163. Carbon stock estimation in Jayapura focal area 2020. 61
Figure 164. Land cover 2020 for Jayapura focal area (SEKALA). 61
Figure 165. Comparison of land cover 2015 and 2020 in Jayapura focal area (SEKALA). 61
Figure 166. Annual vegetation loss 2015-2019 in Jayapura focal area (SEKALA). 62
Figure 167. Annual vegetation loss 2015-2019 over land cover type in Jayapura focal area (SEKALA)....62
Figure 168. Active fires in Jayapura focal area from 2015 to mid 2020. 62
Figure 169. Burnt scar area (in Hectare) in Jayapura focal area from 2015 to 2019 (KLHK) 62
Figure 170. Active fires distribution map in Jayapura focal area from 2015 to mid 2020 (FIRMS) 62
Figure 171. Burnt scar in Jayapura focal area 2015-2019 (KLHK). 63
Figure 172. Permit moratorium on primary forest and peat in Jayapura focal area (KLHK 2019). 63
Figure 173. Large scale concession - logging, in Jayapura focal area (KLHK 2019). 63
Figure 174. Land titled in Jayapura focal area (ATR/BPN 2019). 63

Acronyms

AMAN	The Indigenous Peoples' Alliance of the Archipelago, *Aliansi Masyarakat Adat Nusantara*
APL	Other land use, *Areal Penggunaan Lain*
ATR/BPN	Agrarian and Spatial Planning/National Land Agency, *Agraria dan Tata Ruang/Badan Pertanahan Nasional*
BIG	Geospatial Information Agency, *Badan Informasi Geospasial*
BPS	Central Statistics Agency, *Badan Pusat Statistik*
BRWA	Ancestral Domain Registration Agency, *Badan Registrasi Wilayah Adat*
CA	Nature Reserve, *Cagar Alam*
CBFM	Community Based Forest Management
DEMNAS	National Digital Elevation Model
FIRMS	Fire Information for Resource Management System
HA	Adat Forest, *Hutan Adat*
HD	Village Forest, *Hutan Desa*
HK	Conversion Forest, *Hutan Konversi*
HKM	Social Forestry, *Hutan Kemasyarakatan*
HL	Protection Forest, *Hutan Lindung*
HTR	Peoples' Plantation Forest, *Hutan Tanaman Rakyat*
HPH	Forest Use Right, *Hak Pengusahaan Hutan*
HPK	Conversion Production Forest, *Hutan Produksi Konversi*
HP	Production Forest, *Hutan Produksi*
HR	Community Forest, *Hutan Rakyat*
HSAW	Forest for Nature and Tourism, *Hutan Suaka Alam dan Wisata*
HPT	Limited Production Forest, *Hutan Produksi Terbatas*
HTI	Industrial Timber Plantation, *Hutan Tanaman Industri*
IPLC	Indigenous People and Local Community
IUPHHK	Forest Plantation Wood Production Permit, *Izin Usaha Pemanfaatan Hasil Hutan Kayu*
JKPP	Community Mapping Network, *Jaringan Kerja Pemetaan Partisipatif*
KLHK	Ministry of Environment and Forestry, *Kementrian Lingkungan Hidup dan Kehutanan*
KSA	Nature Sanctuary Area, *Kawasan Suaka Alam*
KPA	Nature Conservation Area, *Kawasan Pelestarian Alam*
MOF	Ministry of Forestry
MoEF	Ministry of Environment and Forestry
NASA	The National Aeronautics and Space Administration
NGO	Non-Government Organization
NORAD-NIFCI	Norwegian Agency for Development Cooperation- Norway's International Climate and Forest Initiative
RBI	Topographic map, *Rupa Bumi Indonesia*
SK	Decree, *Surat Keputusan*
TM	New Parks, *Taman Baru*
TN	National Park, *Taman Nasional*
TORA	Lands Subjected for Land Reform, *Tanah untuk Objek Reforma Agraria*
TWA	Nature Tourism Park, *Taman Wisata Alam*
UU	Law, *Undang-Undang*
WA	Customary Areas, *Wilayah Adat*
WI	Wetlands International
WWF	World Wildlife Fund

Background

The Samdhana Institute is supporting its partners in 8 focal areas, which are customary areas within the 1) Indragiri Hulu Regency in Riau, 2) Kapuas Hulu Regency in West Kalimantan, 3) Pulang Pisau Regency in Central Kalimantan, 4) Malinau Regency in North Kalimantan, 5) Sigi Regency in Central Sulawesi, 6) Tambrau Regency in West Papua, and 7) Biak Numfor and 8) Jayapura Regency in Papua. This initiative is funded by NORAD-NIFCI project 2016-2020. In addition, the Samdhana Institute is also supporting its partners in 3 other priority areas: 1) Aceh Besar Regency in Aceh, 2) South Manokwari Regency in West Papua and 3) Ketapang Regency in West Kalimantan.

The Samdhana Institute has provided small grants for its partners to work on these areas for strengthening indigenous people and local community (IPLC) rights over land and natural resources through supporting customary mapping, developing sustainable livelihoods from natural resources, and supporting policy developments at the national and regional level for protecting the rights of the IPLC while incentivizing sustainable resource management. Achievements made by the partners are well documented, however, several assessments are required to identify whether the priority areas have suffered from fires, the carbon stock potential for each area; and how land use has changed between 2015 and 2020. Addressing those questions will help the Samdhana Institute to communicate the contribution of the priority areas where Samdhana works to reduce emissions from deforestation and degradation of forest resources due to land use changes. In order to support the Samdhana Institute to assess the priority areas to provide clarity to answer those questions, the SEKALA has developed baseline data on related information and assessed the priority areas using remote sensing and geographic information system technologies.

SEKALA has supported the Samdhana Institute to prepare baseline information for assessing whether the priority areas that has been supported by the institute since 2015 have had an impact on reducing fires and maintaining the carbon stock through avoiding deforestation and degradation of forests by securing indigenous and local community rights over land and natural resources and providing incentives through sustainable resource management. The outcome of this activity is baseline information, which includes current and historical forest cover (2015-present), mapped indigenous and local community's areas, land use plans, concession and biophysical data of a focal area at the Samdhana Institute priority areas collated in the form of GIS geodatabase, and presented on maps and/or pictures for presentations or reporting. In order to maintain interoperability with various geospatial software, the GIS dataset is organized in folders and every data layer is in a shapefile format for vector data, and in geotiff format for raster data. Metadata for each data layer is also provided.

Data Collation, Methodology and Management

Data collation was started by identifying the 11 focal areas geographical scope, accessed from Samdhana and SEKALA's database. The geographical scope is mainly customary areas and village boundaries that have been mapped by Samdhana's partners in the focal area. Customary maps of Talangmamak and Malinau came from SEKALA's database while others came from the Samdhana

database. Geographical scope of Aceh and Ketapang focal area uses administration boundaries (villages for Aceh and district for Ketapang) from BIG's topographic map (2019).

Baseline data was collated for the following 11 focal areas which are Samdhana's priority areas (see Figure 1):

1. Aceh focal area, Aceh Besar Regency, Aceh
2. Indragiri Hulu focal area, Indragiri Hulu Regency, Riau.
3. Ketapang focal area, Ketapang Regency, West Kalimantan
4. Pulang Pisau focal area, Pulang Pisau Regency, Central Kalimantan
5. Kapuas Hulu focal area, Kapuas Hulu Regency, West Kalimantan
6. Malinau focal area, Malinau Regency, North Kalimantan
7. Sigi focal area, Sigi Regency, Central Sulawesi
8. Tambrauw focal area, Tambrauw Regency, West Papua
9. South Manokwari focal area, South Manokwari Regency, West Papua
10. Biak Numfor focal area, Biak Numfor Regency, Papua
11. Jayapura focal area, Jayapura Regency, Papua

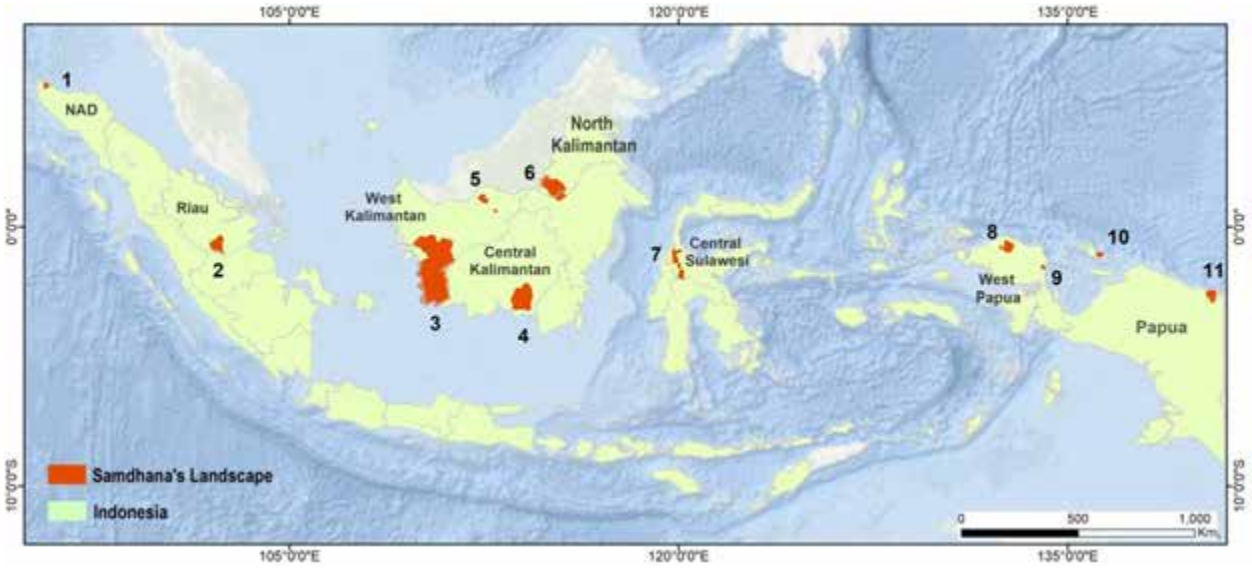


Figure 1. Distribution of 11 focal areas of the Samdhana's priority areas.

Spatial Data Collated from Various Sources

In order to establish the baseline, the following data has been collated from various sources for each focal area:

Topographic Map and Digital Elevation Model

Geospatial Information Agency (BIG) provides Indonesian Topographic Map (RBI) for 1:50,000 scale for all of Indonesia and this information is available for download at their website. BIG also provide National Digital Elevation Modes (DEMNAS - version 1) for land surface modeling with a spatial resolution of 8.3 meters. Both of these datasets is used by the Indonesian government as base maps for thematic mapping activities in Indonesia. The topographic map consists of data on water bodies (river, lake and ocean), contour lines, land cover, administration boundaries and infrastructures. However, in most cases the more frequently changed data in nature, such as land cover, administration boundaries and infrastructure is outdated.

The DEMNAS dataset was generated from various radar data, such as IFSAR (5m resolution), TERRASAR-X (5m resolution) and ALOS PALSAR (11.25m resolution), with additional data from *Masspoints* resulting from stereo-plotting. The spatial resolution of the DEMNAS is 0.27-arcsecond (8.3m resolution), with vertical datum of EGM2008. Both RBI 1:50,000 and DEMNAS were officially released by BIG in 2018. All of this data is used as formal base maps for any mapping activities on that scale. DEMNAS can be analyzed further to produce contour, hillshade, aspect, slope, watershed and other three dimensional analysis.

Forestry Maps

Forestry data (1:250,000 scale) was sourced from the Ministry of Environment and Forestry. It includes data on:

1. Forest estate designation plan (*Kawasan Hutan*). This map shows forest estate designated for the following functions: conservation area, protection forest, limited production forest, production forest, production forest for conversion to non forestry, and other uses (non forestry).
2. Moratorium permits on primary forest and peat land, KLHK, version 4, 2019.
3. Forestry concessionaries, such as timber plantations, logging concessions, and permits related to social forestry, such as community forestry, community industrial forest, village forest, customary forest, and partnership forest.
4. Indicative maps on social forestry.
5. Burn scars area, 2016-2019.
6. Deforestation, 2016-2019.

All of these datasets were collected for every focal area and updated.

Land Administration

Land administration is under the Ministry of Agrarian and Spatial Plan. The recent dataset on land title and indicative land for agrarian reform has been collected from this Ministry.

Oil Palm Concession map

Oil palm concession data is difficult to collect because this data is usually administered at the provincial level. However, the Ministry of Agriculture under the estate crop division has compiled this data and the process is still in progress. In addition, the government has tried to reorganize the permitting system of

this commodity. Therefore, the final update of this map is not openly available. For this activity, the data on large scale oil palm concession was collected the from the Global Forest Watch website[1]. The data was sourced from various sources and date, such as government institution, NGOs and other organization.

Customary Area

SEKALA has compiled customary area spatial data that has been mapped since 2014 until 2019. This data has been sourced from various NGOs who have supported and undertaken customary area mapping in Indonesia. The customary areas found in the 9 focal areas have been extracted from these datasets and some data was also enhanced by Samdhana.

Peat Maps

Peatland maps were sourced from the Ministry of Agriculture (1:250,000) (2012) and from Wetlands International (1:500,000) (2000-2002). This data is relatively old and the Ministry of Agriculture in collaboration with BIG, Peatland Restoration Agency and the Ministry of Environment and Forestry are in the process improving this dataset to a scale of 1:50,000.

Other Maps

Hot spot data was collected from NASA's Fire Information for Resource Management System (FIRMS), from January 2015 until end of April 2020. The global forest change map produced by Global Forest Cover initiative hosted by the Maryland University version 1.7 consisting of tree cover loss and gain from 2000 until 2018 was also utilized. The yearly dataset produced from one year stacking of Landsat images from March previous year to March on the next year. This dataset has been updated annually and will continue to be updated in near future. This version should be used in caution, especially from 2000-2012 (processed from Landsat 7) and 2011 to 2019 (processed using Landsat 5, 7 and 8). The Global Forest Cover Initiative (GFC) has planned to reprocess the data and will produce version 2.0 for those improvement[2].

Spatial Data Produced from Processing Satellite Images

SEKALA has also acquired Landsat 8 satellite and Sentinel 1 images. Landsat 8 images of 2015, 2016, 2017, 2018 and 2019 were collected, while Sentinel 1 images were collected for 2015 and the beginning of 2020. The Landsat 8 image is 30m multispectral images and has been provided by NASA. This data has been corrected for geometrical and atmospheric errors. This image was then cleaned from cloud, cloud shadow and any other cirrus using hundreds of images in one year, with acquisition date from 1 April of previous year to 31 March of the next year. The median value of each pixel was then used for representing each year images. The Sentinel 1 image is a C-Band radar images with 10m resolution. Band vv and vh, and ascending and descending images were collected from 1 January to end of April 2020. All of these images, then averaged to produce images that has less ascending and descending effect. The same period of 2015 was also collected. Removal of the cloud, shadow and cirrus of Landsat

[1] See https://data.globalforestwatch.org/datasets/oil-palm-concessions

[2] See https://earthenginepartners.appspot.com/science-2013-global-forest/download_v1.7.html. Please note during this report written, new update just released from the GFC for 2019 tree cover loss and gain. However, due to limitation of the data, SEKALA will use in house processing to produce tree cover loss and gain.

8 and averaging Sentinel 1 images was done on the Google Earth Engine. All of these images will be used to produce tree cover change from 2015-2020 and recent land cover map. This task is aimed to collate available data and using free available satellite images for analysis. No field work required, therefore, the result of the analysis and the dataset is not being tested in the field yet.

The following section will explain the processing of satellite images to produce yearly tree cover loss, land cover mapping and some example analysis of heatmap of hot spot distribution and carbon stock distribution. This section will also explain the gaps and discrepancies of maps produced from this process with similar maps sourced from other parties.

Land Cover Map 2015 and 2019

The Ministry of Environment and Forestry produced land cover data for the years of 1990, 1996 and every three years since 2000 until 2011 and then every year since 2011 until recently for the year of 2019. The Ministry produced the land cover maps with 23 classes, including: primary and secondary dryland forest, primary and secondary mangrove, secondary and primary swamp forest, forest plantation, and non forest cover consist of savannah, scrub and swamp, dryland farms, irrigated rice farming, estate crop plantations and mining. The map has been created using on screen digitization of Landsat images in combination with interpreter and regional office 'knowledge' in the area. This land cover map production has been standardized since it was launched in 2000. Since then the technology of remote sensing has been improved significantly and the availability of up to date Landsat images and ability of computer technology to process large amounts of data the land cover map at the beginning produced every three years then produced every year.

Even though the land cover map from the KLHK can be accessed, SEKALA developed a new land cover map for this project using combination of Sentinel 1 and Sentinel 2 images for year 2019[3] for flat areas. For mountainous area, Sentinel 2 and Landsat 8 have been used. Sentinel 1 images are radar images which are sensitive to local incident angle, more difficult detecting land cover in high slope area. However, this image can clearly show oil palm plantations and monoculture forest plantations. It also was shown by Jukka (*et al.*, 2016). With spatial resolution 10 to 20 meter compared to Landsat 8 images with 30 meter resolution, more detailed land cover can be mapped. Landsat 8 and Sentinel 2 is multispectral images, consist of several bands that useful to see different types of land cover by certain combination of three different bands. Land cover 2015 produced using Sentinel 1 and Landsat 8 images, due to lack of availability of Sentinel 2 images during those year. Figure 2 shows Sentinel 2 images in composite of Band SWIR, NIR and Blue, to penetrate hazy image and better distinction of bare land and vegetation. Figure 3 shows Sentinel 1, which is dual polarization C-Band of radar images, in composite of VV, VH and ratio of VV and VH. This image shows oil palm clearly in pinky purple colour.

[3] The land cover 2019 produced based on up to date Sentinel 1 image (April to May 2020) and one year atmospheric and geometric corrected Sentinel 2 images (from March 2019 to beginning April 2020), where more than a hundred images was stacked and cloud removed using cloud and cirrus bands that provided by the Copernicus and analyzed pixel by pixel; the median number calculated for each pixel to produce relatively cloud and shadow clean image. Similar process was also conducted for year 2015 cloud removal Landsat 8 images (stacked from March 2015 to April 2016).

Preprocessing images was done through Google Earth Engine and classification process conducted on the desktop using supervised classification, random forest method. Land cover types of the KLHK have been chosen to compare the result and also to make it easier to calculate carbon stock using standardized land cover types. Rationalization process has been done manually to enhance the final product by removing noises from remaining haze that can mislead the classification process. Figure 4 and 5 shows the different of land cover map produced by the KLHK and SEKALA. When the images are compared, many detailed features have been missed out from the KLHK forest cover map.

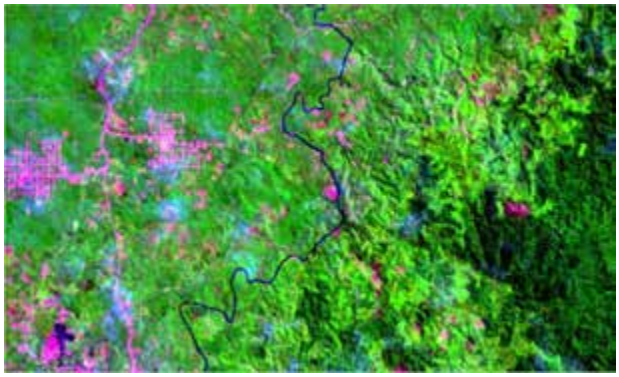


Figure 2. Sentinel 2 images (SWIR, NIR and Blue Band), stacked from March 2019 to beginning April 2020.

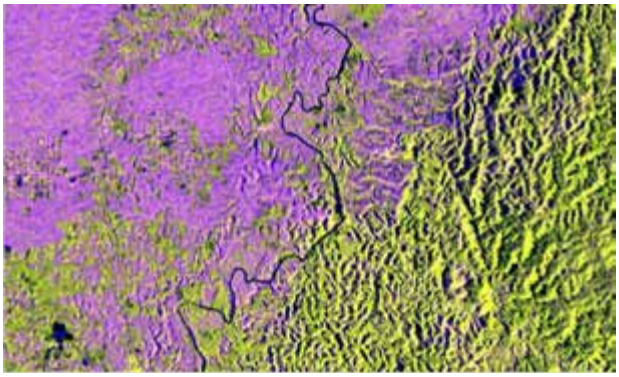


Figure 3. Sentinel 1 images (Band VV, VH and ratio of VV and VH), taken from March 2020 to beginning May 2020 (averaged).

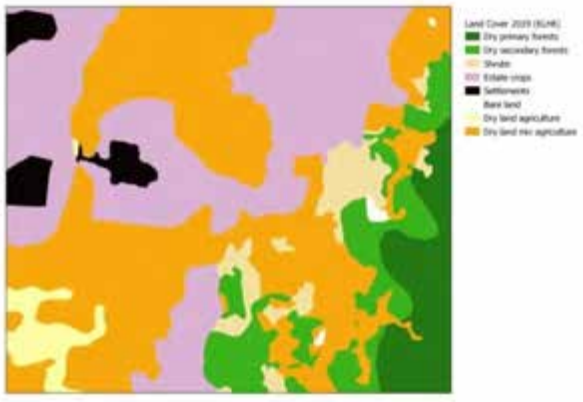


Figure 4. Land cover map 2019 produced by KLHK.

Figure 5. Land cover map 2020 produced by SEKALA.

Tree Cover Loss

There are significant differences between the deforestation dataset from the Ministry of Environment and Forestry (MoEF) and tree cover loss from GFC/Maryland University. The MoEF defined deforestation as the changes of land cover from forest to non forest, this include inside the industrial forest plantation[4]. The MoEF defines natural forest deforestation to refers to deforestation that not including harvesting inside industrial forest plantation. The GFC used automatic methods to process Landsat 5, 7

[4] See http://appgis.menlhk.go.id/appgis/download.aspx?status=view&filename=Deforestasi%202017-2018.pdf&fileFullName=E:%5Cwebgisapp%5CDownload%5C1.2.%20Buku%20DEFORESTASI%5CDeforestasi%202017-2018.pdf

and 8 images for correcting atmospheric error and removing clouds and shadows in cloud and using global sampling to produce yearly global forest loss and gain since 2000. While the MoEF produced deforestation data by calculating the difference between recent and older land cover maps. Both of these data has been collected and assessed the accuracy and the consistency. GFC maps are more consistent and show cumulative change since 2000; however, some forest loss areas are missed out and some mistake where forest loss occurs at estate crops. Land clearing for oil palm replanting is also identified as forest loss due to the baseline is year 2000, therefore oil palm plantation that already exists in 2000 still identified as forest.

In order to improve understanding on land cover dynamics, SEKALA created land cover maps for 2015 as a baseline and then using yearly cloud and shadow free Landsat 8 images to map tree cover change (loss and gain) for every year, since 2015 for this assignment. Using this approach, land clearing activities in any land cover types can be mapped on a yearly basis. A rationalization process was also implemented to improve the map by removing remaining haze and removing vegetation change due to natural processes (such as seasonal flood). The change on the map only shows anthropogenic changes (from human activities) only. Figure 6 shows a cloud and shadow free Landsat 8 image for 2017 and Figure 7 shows a cloud and shadow free Landsat 8 image for 2018. Even though the majority of cloud and shadow has been removed, some thin haze and small cloud and shadow appear on the image. Figure 8 shows staking both 2017 and 2018 images to highlight changes in both images.

Figure 6. Landsat 8, results of stacking one year images from March 2017 to beginning April 2018, cloud and shadow were removed and the median value calculated for each pixel. This image represents a 2017 image.

Figure 7. Landsat 8, results of stacking one year images from March 2018 to beginning April 2019, cloud removed and the median value calculated for each pixel. This image represents a 2018 image.

Figure 8. Both images of 2017 and 2018 (Figure 5 and 6 respectively) was staked in both SWIR band and blue band for the recent year, shows white for no change in open area in both year. This represents built up area, while red in this image shows new clearing in the recent year and light blue represents vegetation growth in the recent year (was cleared in previous year but new vegetation growth in the recent year).

Figure 10, 11 and 12 below shows the different deforestation data of the MoEF, forest loss of GFC and tree cover loss of SEKALA respectively in the Talang Mamak focal area.

Figure 9. Staked Landsat 8 images of Short Infrared Wave and Blue bands in year 2017 and 2018. Pinky red shows forest loss, light green shows vegetation grows and white is no change, usually build up. There are some thin pink colors which are remaining haze.

Figure 10. Forest loss in red, according to GFC in 2018, which is change from 2017 to 2018.

Figure 11. Deforestation in red, according to KLHK in 2018.

Figure 12. Tree covers loss in red, result from SEKALA's analysis, change from 2017 to 2018.

Forest Fire and Heatmap

Forest fires data collated from Fire Information for Resource Management System (FIRMS)[5] for active fire data/thermal hotspot location and from the Ministry of Forestry and Environment for yearly burnt scar areas. FIRMS provide almost real time data for every three hours that produced from MODIS NRT (Terra and Aqua) and VIIRS active fire products. Yearly burnt scar data developed by the Ministry of Forestry and Environment using one year active fire data (hotspot) overlaid on Landsat 7 or 8, then digitized manually. Verification has also applied to improve this data (Endarwati *et al.* 2015).

Burnt scar data is useful to estimate area that has been burnt in a certain year. In the future, a better approach to map burnt scars is using normalized burn ratio (NBR), however, for this assignment the burnt scar data from the Ministry of Environment and Forestry is used. Active fire data/thermal hotspot location is useful to detect high frequency of thermal hotspot locations in a certain time period using heatmap analysis; therefore the fire cause and impact can be better understood.

[5] See FIRMS website at https://firms.modaps.eosdis.nasa.gov/

Above and Below Carbon Stock Estimates

Estimation of carbon stocks combines above and below ground carbon stocks to produce an estimate of the total carbon stocks contained in Indonesia's forests and soils. Only one dataset is available for below ground (peat) carbon stocks, i.e. Wetlands International (2000-2002), while for above ground carbon stocks using data on each land cover type compiled by SatGas REDD+ (2012) using National Forest Inventory and various study compiled in Krisnawati *et al.* (2012) and Agus *et al*. (2012) (Table 1).

Table 1. List of carbon stock estimation for each land cover type.

No	Land cover type	Ton/Ha of C
1	Primary dryland forest	246.98
2	Secondary dryland forest	218.74
3	Primary swamp forest	250.45
4	Primary mangrove	222.38
5	Secondary swamp forest	206.05
6	Secondary mangrove	191.35
7	Industrial forest plantation	58.00
8	Estate crops	86.85
9	Shrubs	25.68
10	Swampy shrubs	25.68
11	Dryland farming	12.85
12	Dryland farming mixed with shrubs	15.25
13	Ricefield	6.00
14	Settlement	1.20
15	Transmigration area	12.00

Analysis Results for Focal Area

The Mukim Lamteuba focal area, Aceh Province

Samdhana's focal area in Aceh the Mukim Lamteuba community area, which consists of 8 villages, i.e. Ateuk, Blang Tingkeum, Lam Apeng, Lambada, Lampantee, Lamteuba Droe, Meurah and Pulo (Figure 13). Samdhana supported Yayasan Rumpun Bambu Indonesia (YRBI) to work in this area in 2019. This focal area is located at Seulimeum sub-district of Aceh Besar District with a total area of 17,811 Ha. The total population of this focal area is 6,006 people (BPS, 2019) with a population density of 0.34 people/Ha. The majority of the focal area is upland with altitude between 200 and 500m (12,019 ha; 67%). The remaining land is mountainous area with altitude of more than 500m (4,523 ha; 25%) and lowland area with altitude below 200m (1,269 ha; 7%) (Figure 14).

Figure 13. Mukim Lamteuba focal area, Aceh Province.

According to the Ministry of Environment and Forestry (KLHK) regulation SK No. 580, 2018 on forest area designation (updated in 2019), the majority of the focal area (8,990 Ha; 50.47%) has been classified as production forest and non-forest land (8,167 Ha; 45.85%) land allocated for other uses and lying outside the forest estate. Only around 3.51% (625 Ha) of the total land area in the focal area has been classified as nature reserve (625 Ha; 3.51%) (Figure 15).

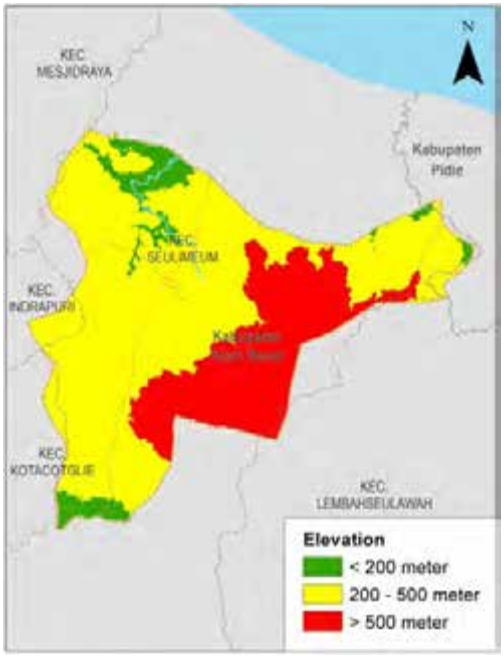


Figure 14. Topography of Aceh focal area.

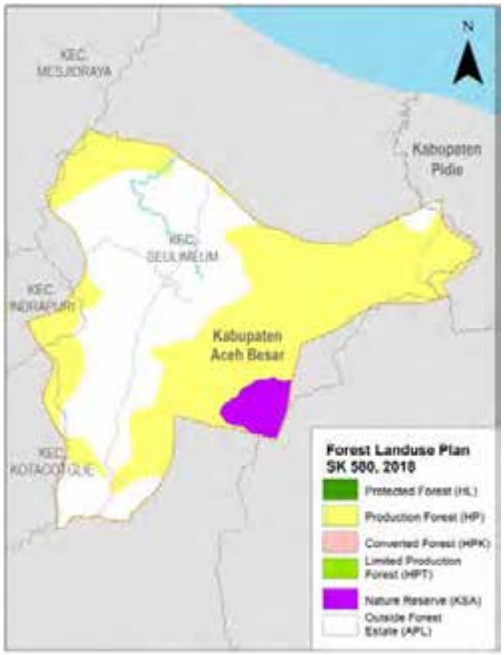


Figure 15. Forest land use plan for Aceh focal area.

Land cover analysis carried out by SEKALA using satellite images of Radar Sentinel 1-2020 and Sentinel-2 2020 revealed that the majority of Aceh's focal area land cover is shrubs (8,232 Ha; 46.2%) and secondary dryland forest (4,718 Ha; 26.48%). Together these two land types account for 72.68% of the focal area's total land cover. Other significant land cover detected is savanna (1,535 Ha; 8.6%), dryland and mixed agriculture (1,275 Ha; 7.16%). Only 1.2% of the total land area was determined to be oil palm

plantation (214 Ha). The remaining 10.3% is barren land, settlement and rice field. No primary dryland forest was detected (Figure 19).

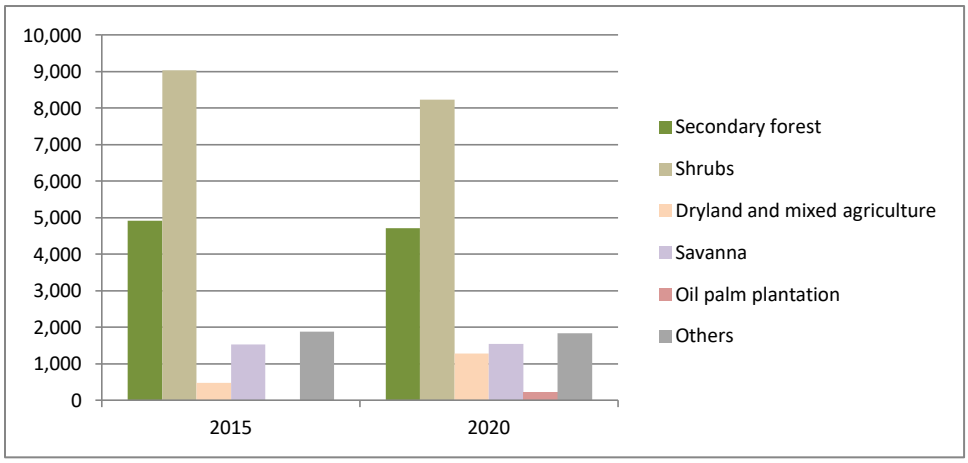


Figure 16. Comparison of land cover in 2015 and 2020 in the Aceh focal area (SEKALA).

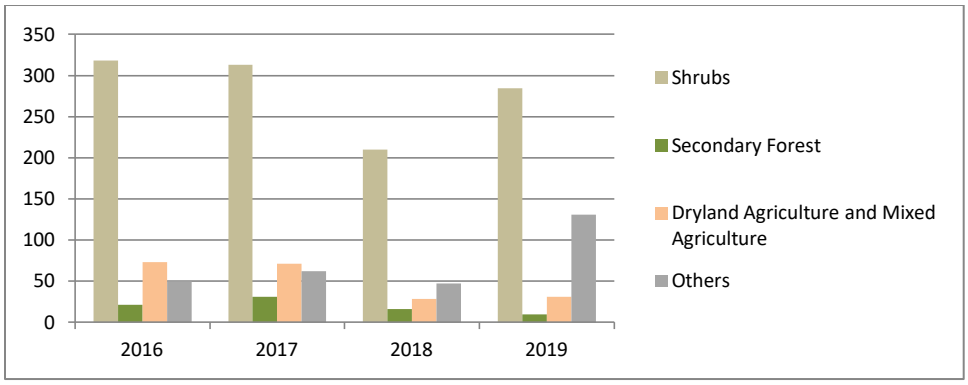


Figure 17. Annual vegetation loss 2015-2019 for Aceh focal area.

Analysis of the 2015 land cover map conducted by SEKALA (using satellite images of Radar Sentinel 1-2015 and Landsat 8, 2015) in comparison to the land cover map 2020 suggests that deforestation in the last five years in this focal area has been relatively small, only 202 Ha, detected by the reduction of secondary forest. Land clearing was mainly identified in shrubs (Figure 16 and Figure 17). The analysis reveals land clearing (vegetation loss) due to conversion for agriculture as shown by the increased area of dryland and mixed agriculture by 803 Ha in the last five years. The clearing activities mainly took place in upland and lowland areas (Figure 18).

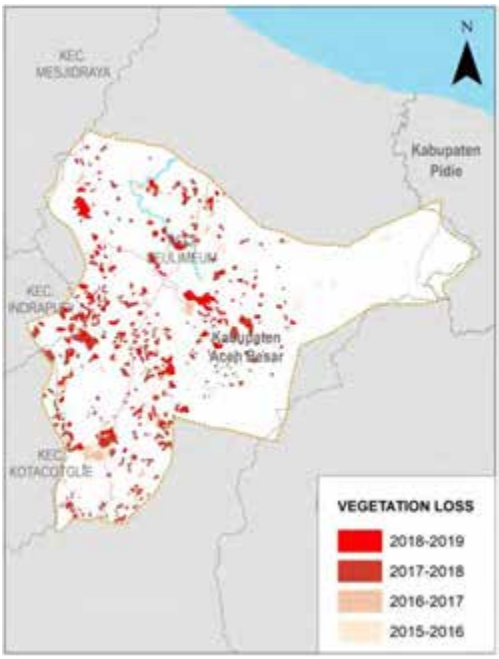


Figure 18. Annual vegetation loss 2015-2019 in Aceh focal area (SEKALA)

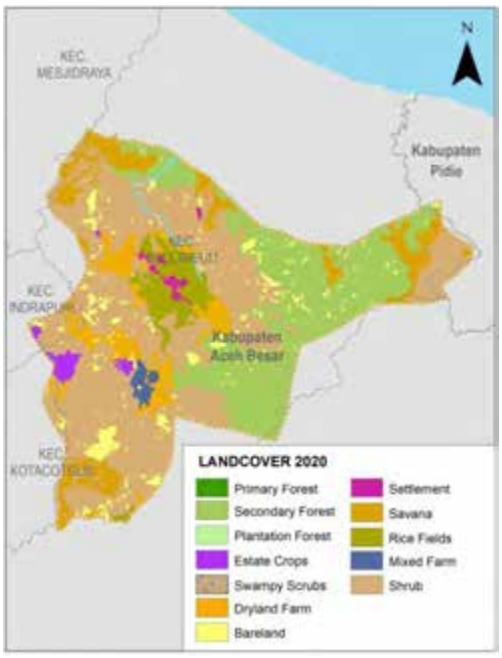


Figure 19. Land cover 2020 in Aceh focal area (SEKALA)

According to KLHK, burn scars were only identified in 2019, which is only 24 Ha. However, the active fire data from FIRMS from 2015 to mid 2020 shows that fires occur every year with the highest number of hot spots being detected in 2016 (Figure 20 and 21). This might relate to traditional farming practices and land clearing activities for bigger developments, such as oil palm.

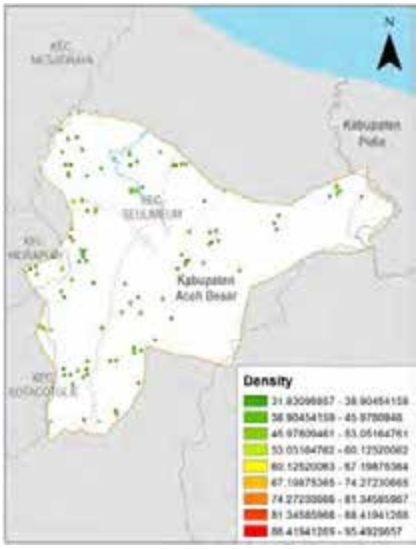


Figure 20. Active fires from 2015 to 2019 in Aceh focal area (FIRMS)

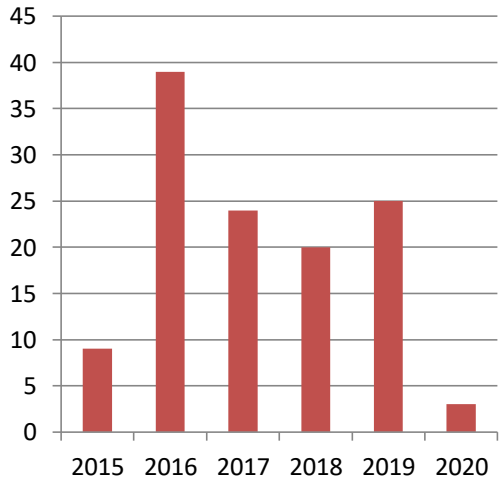


Figure 21. Active fires from 2015 to mid 2020 in Aceh focal area (FIRMS)

The analysis of carbon stocks produced an estimate of the total carbon stocks contained in the forests and soils of the focal area. The analysis shows that the focal area has a total carbon stock in 2020 of around 0.00134 GtC and that all of this carbon is located in above ground forests (mainly secondary

dryland forest and shrub). In comparison with carbon stocks in 2015 (0.00137 GtC), the loss of the carbon stocks in the last five years on this focal area is very small (less than 0.00003 GtC).

Figure 22. Burnt scar 2019 (KLHK).

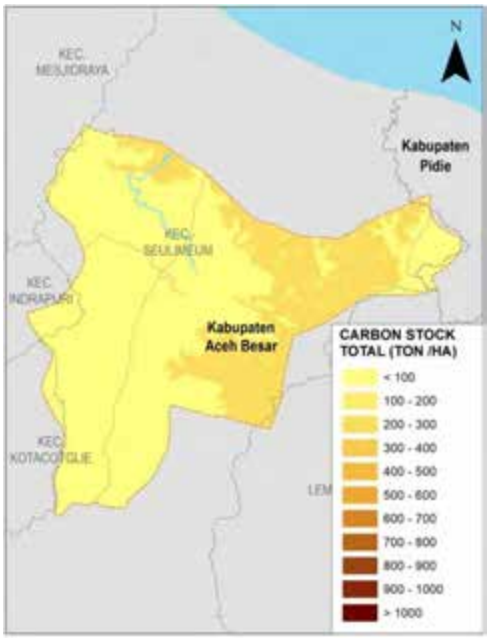


Figure 23. Carbon stock estimation 2020 (SEKALA).

Land use concessions have primarily only been issued for one industrial timber plantation in the Mukim Lamteuba focal area, PT Aceh Nusa Indrapuri (9,112 Ha) (Figure 24). According to the new moratorium map released by KLHK, 625 Ha of Nature Reserve in Aceh has been protected from conversion (Figure 25).

Figure 24. Large scale concessions (KLHK, 2019).

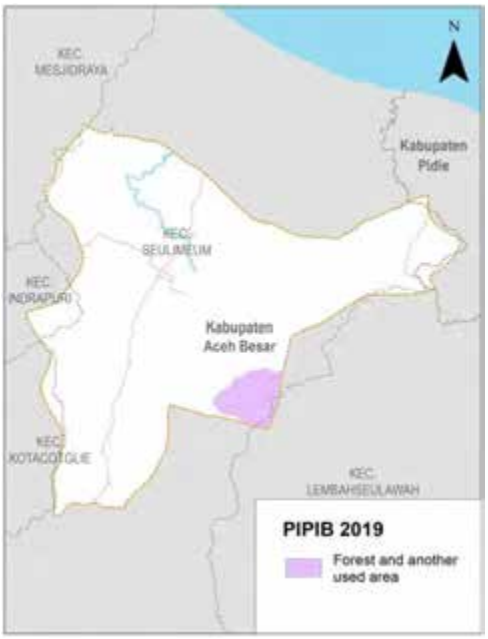


Figure 25. Moratorium for permits in primary forest and peatland (KLHK, 2019).

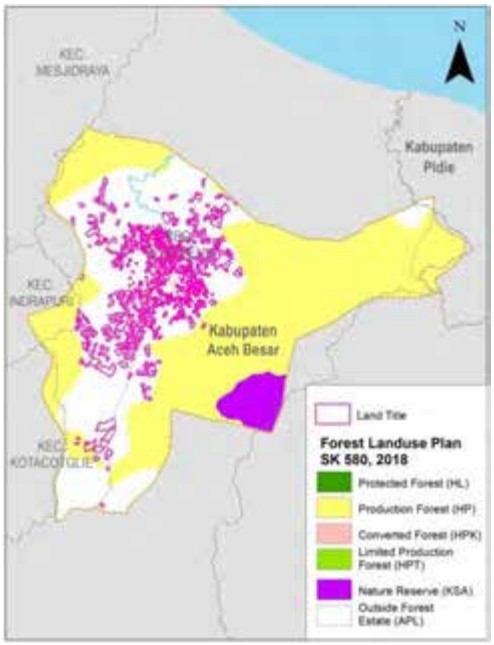


Figure 26. Existing land titled in Aceh focal area (BPN, 2019)

Figure 27. Indicative area as object for agrarian reform in Aceh focal area (BPN, 2019).

According to the Ministry of Agraria and Spatial Planning (ATR/BPN), around 1,295 Ha of land in the focal area has been titled (Figure 26) and around 617 Ha has been allocated for land reform programs and this land will be released from the forest estate (Figure 27).

The Talang Mamak focal area, Riau Province

The Talang Mamak customary area is located in the Indragiri Hulu District of Riau Province. Samdhana supported Kaoem Talapak from 2018 to 2019 to map the customary areas (totaling 194,549 ha) claimed by the Talang Mamak community in this area (Figure 28). The area covers 76 villages with a combined population of 239,384 people (PODES, 2016) and a population density of 1.23 people per hectare. DEMNAS data from BIG (2018) indicates that around 89.9% (173,654 Ha) of the Talang Mamak total area is lowland and relatively flat, however, 9.5% of Talang Mamak focal area's area is upland (18,269 Ha) and 0.7% of Talang Mamak focal area's area is mountainous area (1,272 Ha). Mountainous and upland areas are primary found in the southern and eastern part of the focal area (Figure 29).

Figure 28. Talang Mamak focal area, Indragiri Hulu District, Riau Province.

According to KLHK's forest area designation (SK 903/2018, updated in 2019), the total area of forest area (*kawasan hutan*) is 120,831 Ha, around 62.1% of the total focal area. Around 38,228 Ha (19.6% of the focal area) has been allocated for limited production forest, 27,617 Ha (13.2% of the focal area) was allocated for national park, 25,100 Ha (12.9% of the focal area) was allocated as convertible production forest, 11.8% of the focal area (22,926 Ha) was allocated for production forest and around 8,957 Ha (4.6%) was allocated for protected forest.

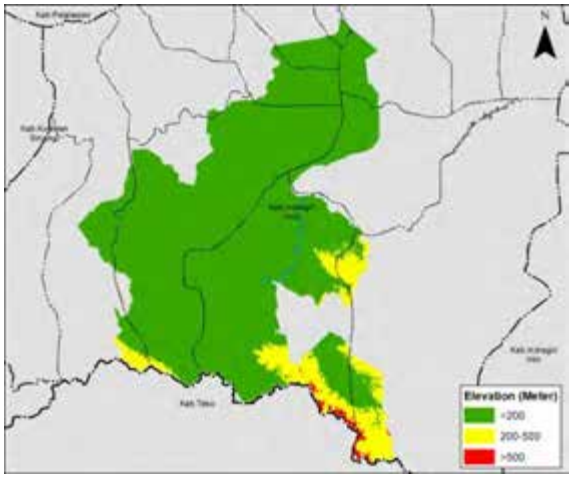


Figure 29. Topography of Talang Mamak focal area.

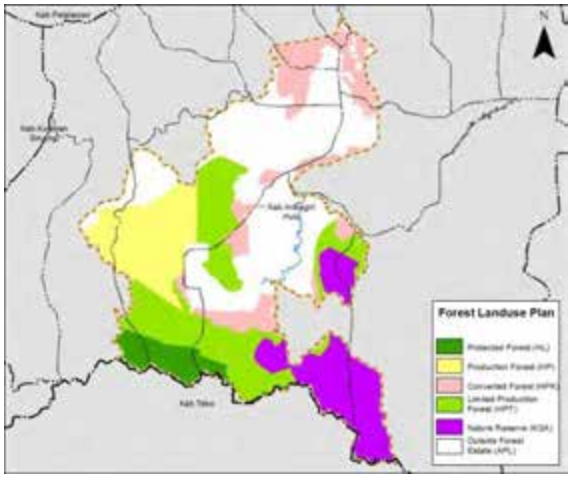


Figure 30. Forest land use of Talang Mamak focal area.

Analysis of land cover conducted by SEKALA in the area indicates that 91,497 Ha (47% of the focal area) was covered by oil palm plantation in mid 2020. The other large land covering in this area is dryland and mixed agriculture (24.2% or 47,177 Ha). Around 13,093 Ha (6.7%) of the area is barren land and 25,899 Ha (13.3%) of the area is secondary forest. Only 2,069 Ha (1.1%) of the area is primary forest and only

5,367 Ha (2.8%) is forest plantation. The remaining 4.9% of the focal area is shrubs and settlements (Figure 33).

Land cover change analysis conducted by SEKALA between 2015 and 2020 reveals that around 21,120 Ha of the primary and secondary forest in the area has been deforested in the last five years (Figure 31)[6]. It also suggests that there has been a significant increase in the oil palm plantation area of around 30,577 Ha and dryland and mixed agriculture (around 40,487 Ha).

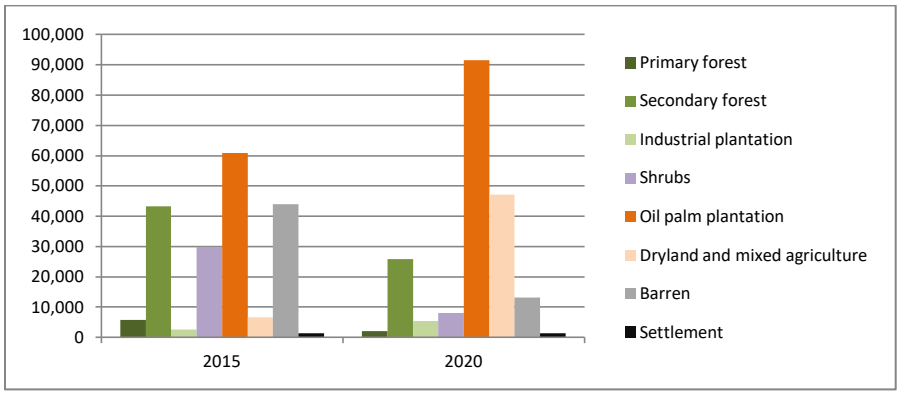


Figure 31. Comparison between land cover 2015 and 2020 of Talang Mamak focal area.

Yearly vegetation loss from 2015 to 2019 using Landsat 8 images analysed by SEKALA suggests that most deforestation occurred between 2015 and 2017, and then deforestation decreased between 2017 and 2019 (Figure 34 and 35). Vegetation loss inside estate crops suggests that land clearing for replanting oil palm is taking place and vegetation loss inside plantation forest indicates timber harvesting activities.

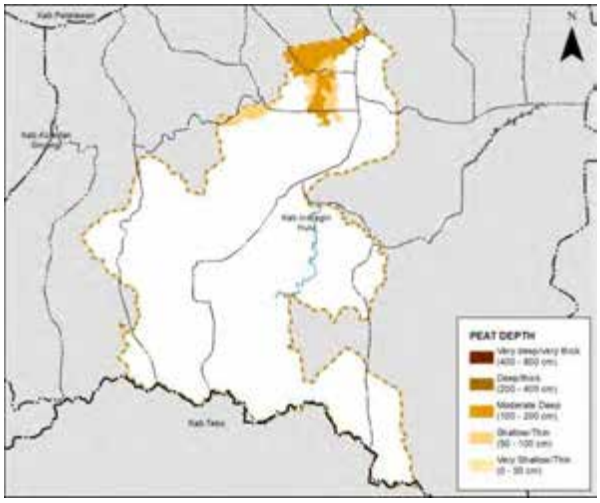


Figure 32. Peat depth in Talang Mamak focal area (WI 2000-2002).

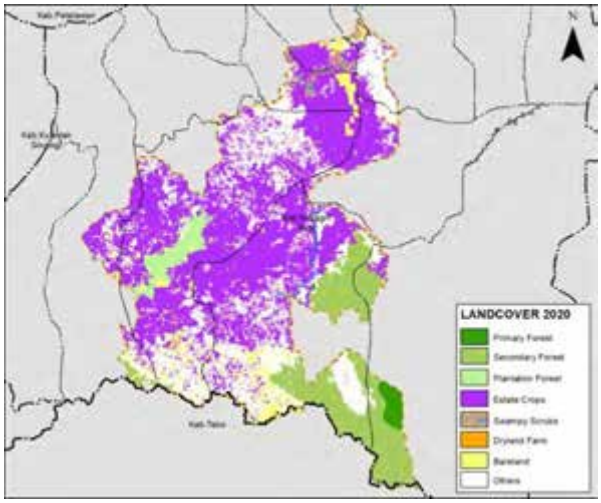


Figure 33. Land cover 2020 of Talang Mamak focal area (SEKALA).

According to Wetlands International (2000-2002) data, there is around 31,603 Ha of peat soil in the area. Most of these peat soils, around 6,050 Ha, are very shallow (0-50cm). Around 3,905 Ha is shallow

[6] Deforestation is defined as the conversion of natural forest, i.e. primary and secondary forest into other land cover types.

or thin with 50-100 cm depth, and the rest around 5,846 Ha is moderate with 100-200m depth (Figure 32).

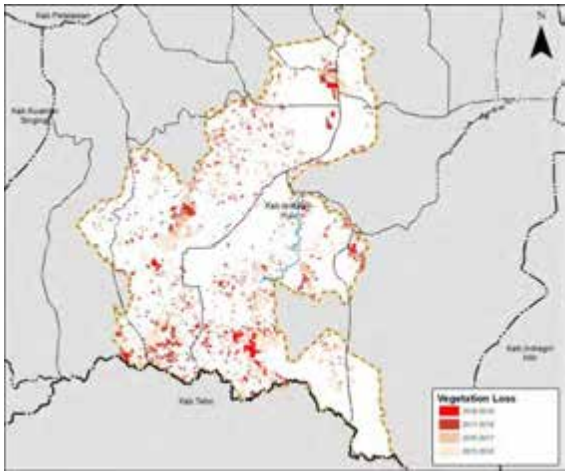


Figure 34. Vegetation loss 2015-2019 (SEKALA).

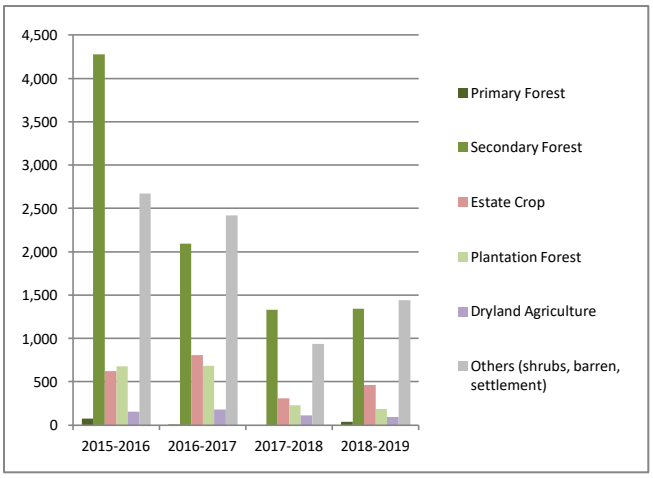


Figure 35. Vegetation loss at land covers type in Talang Mamak focal area.

Estimates are available for the two major carbon pools in the Talang Mamak focal area - peat soils and above ground biomass. Using land cover (mid 2020) produced by SEKALA and Wetlands International data on peat to analyze a total above and below ground carbon stock of around 0.045 GtC, and around 64.7% of this carbon is located in the peatland and 35.3% is located in above-ground forests (mainly secondary and primary dryland forest). The majority of the areas carbon stocks are located in the northern part of the focal area where mainly peatland is located (Figure 36). Analysis by comparing total carbon stock estimation using land cover 2015 and 2020 (ignoring below ground carbon pool), suggests that there has been around 0.0012 GtC loss in the last five years.

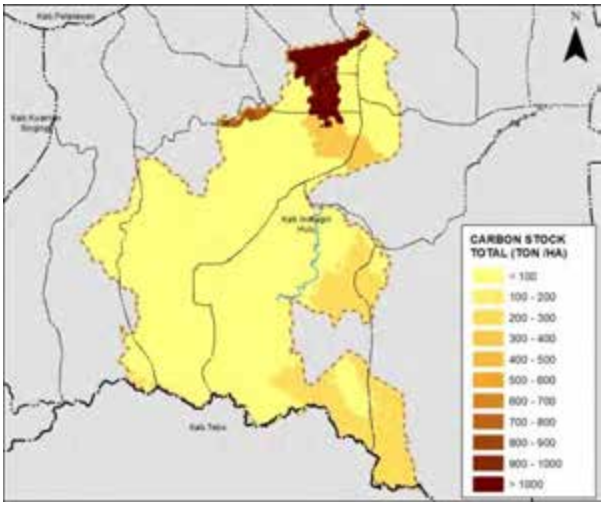


Figure 36. Distribution of carbon stock estimation in Talang Mamak focal area.

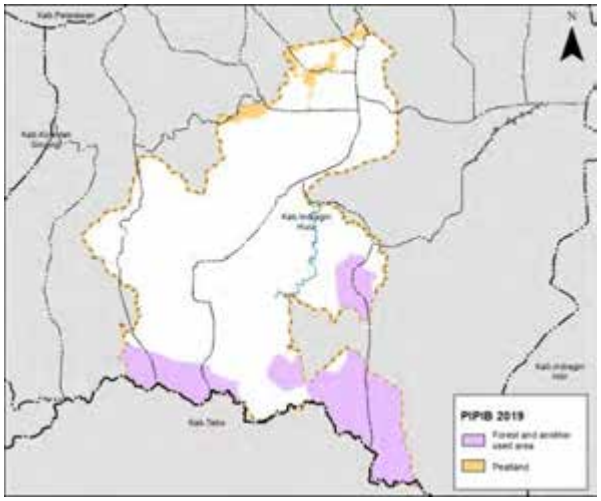


Figure 37. Permit moratorium on primary forest and peat in Talang Mamak focal area (KLHK 2019).

According to the moratorium on converting primary forest and peatland data from KLHK (2019), around

38,741 Ha of the focal area is currently protected from conversion. Of this land, 3,806 Ha is peatland, 420 Ha is classified as primary dryland forest and 34,516 Ha is classified as forest area that needs special attention for protection, such as protected forest and conservation area (Figure 37).

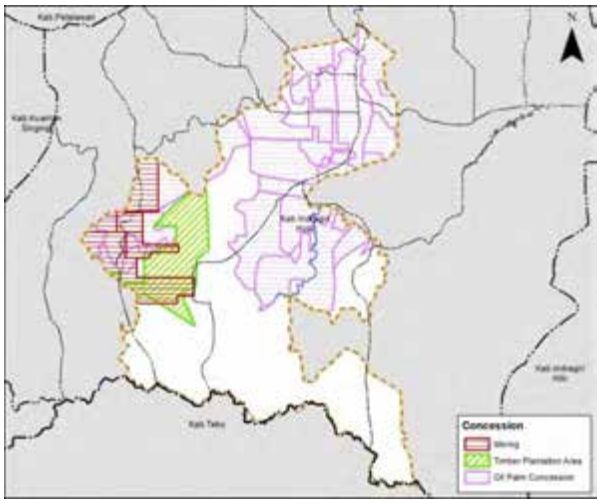


Figure 38. Large scale concessions in Talang Mamak focal area (Mining from Ministry of Mining and Energy, 2019, Timber plantation from KLHK, 2019, and oil palm concession from GFW, 2019).

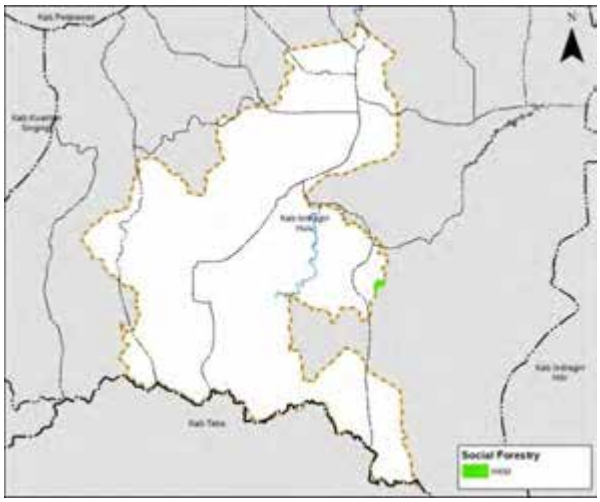


Figure 39. Community forestry in Talang Mamak focal area (KLHK, 2019).

Land use concessions have primarily been issued for large scale oil palm plantation (138,054 Ha), mining and timber plantation concessions (13,486 Ha) in the Talang Mamak area. No active logging concession currently exists in the area to date (Figure 38).

Only 1,909 Ha of land has been issued for community forestry (Figure 39), however, an indicative map for the social forestry program of KLHK (2019) shows 4,891 Ha has been reserved and 3,903 Ha has been identified as potency to allocate community based forest management in Talang Mamak focal area (Figure 40). According to ATR/BPN (2019), 31,525 Ha of land in the focal area has been allocated for agrarian reform. In the future this land will be titled and some will be excluded from the forest estate. This land is located in convertible production forest 23,340 Ha, in production forest 3,779 Ha, in limited production forest 2,019 Ha, and in other land uses 2,387 Ha (Figure 41). This land reform program will add the number of land titled, which is now around 46,716 Ha from the total land of the Talang Mamak focal area (Figure 42).

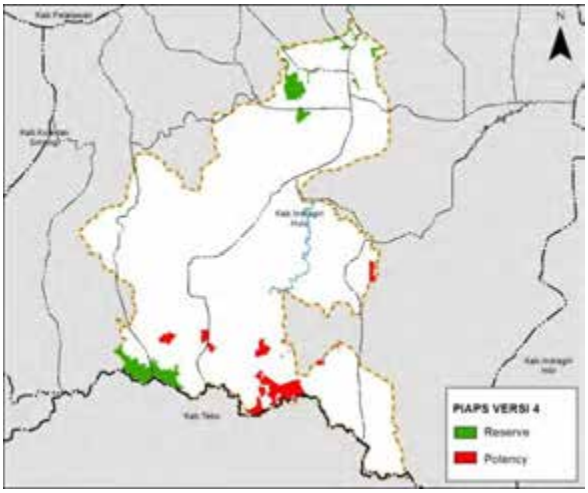


Figure 40. Indicative map of social forestry in the Talang Mamak focal area (KLHK 2019).

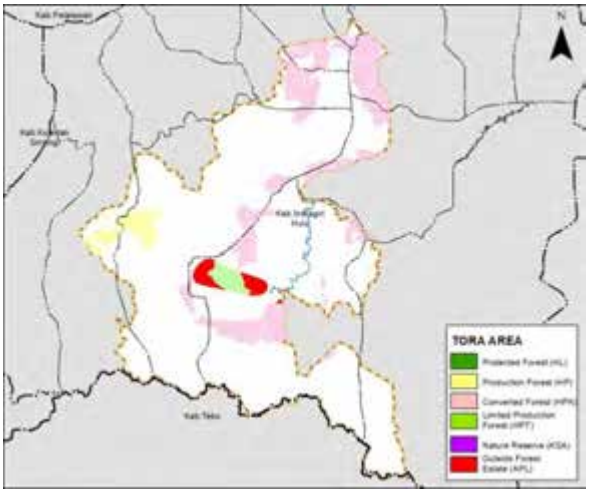


Figure 41. Land allocated for land reform in Talang Mamak focal area (ATR/BPN 2019).

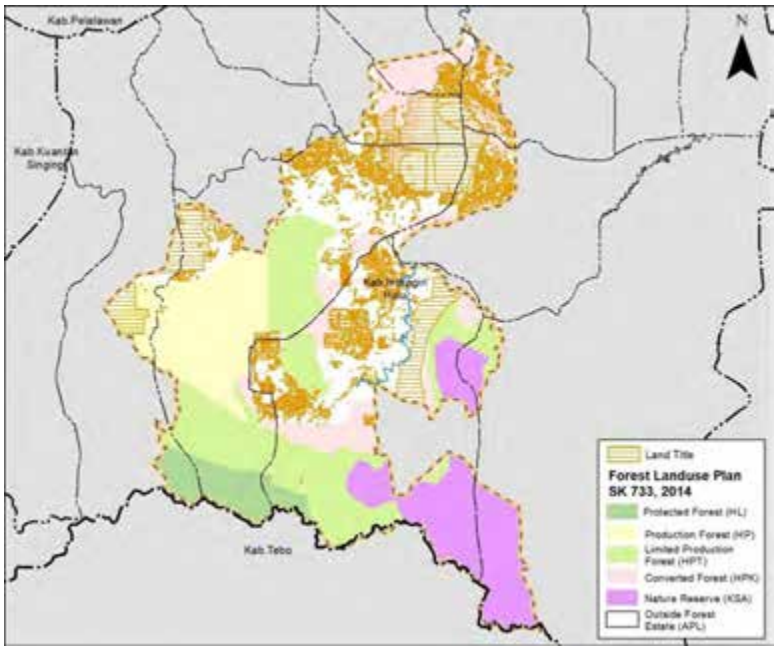


Figure 42. Land titled at Talang Mamak focal area (ATR/BPN 2019).

Analysis of active fires sourced from FIRMS reveals that the highest number of fires hotspots occurred in 2015. The fire heatmap (Figure 43) suggests that the southern part of the focal area has had the highest frequency of fire occurrences in the last five years. According to KLHK's burn scar map (Figure 44), most of area that burnt was also in the southern part of the focal area. Figure 45 and 46 presents hotspot and burnt scar history between 2015 and 2019. It suggests that the highest quantity and the largest area burnt occurred in 2015.

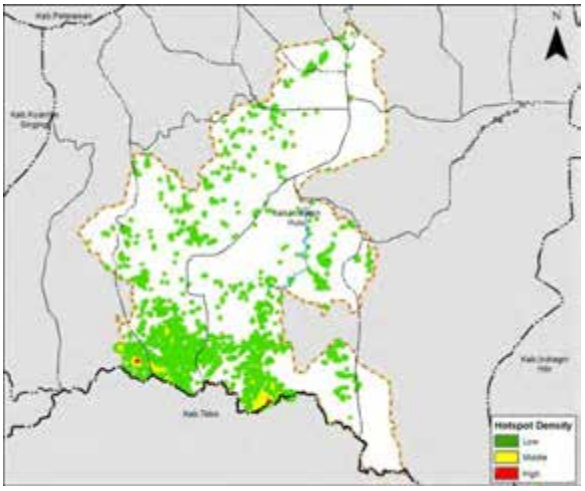


Figure 43. Heatmap of active fires from 2015 to mid 2020 in Talang Mamak focal area (FIRMS).

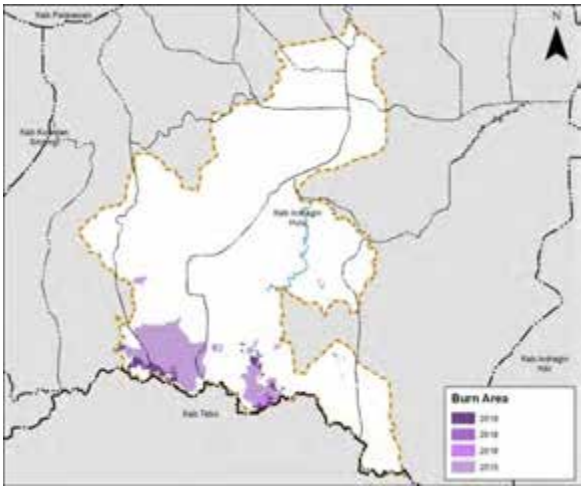


Figure 44. Burn scar map 2015-2019 in Talang Mamak focal area (KLHK).

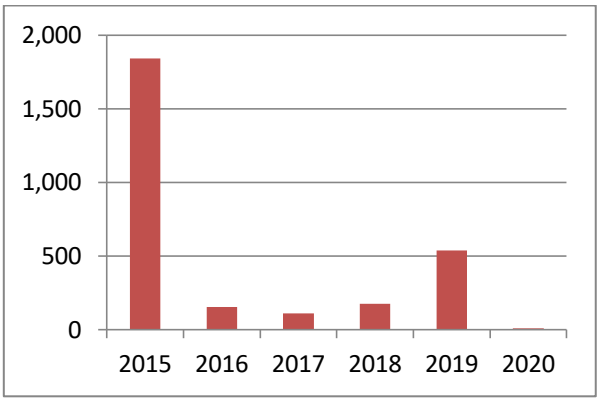


Figure 45. Yearly active fire quantity from 2015 to mid 2020 in Talang Mamak focal area (FIRMS)

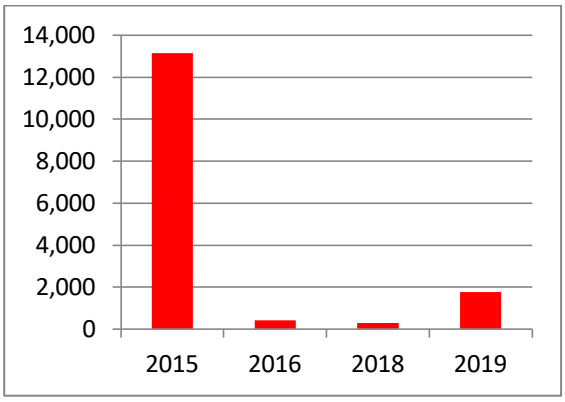


Figure 46. Yearly burn scar area from 2015 to 2019 in Talang Mamak focal area (KLHK)

Ketapang focal area, West Kalimantan

The Ketapang focal area covers the entire Ketapang Regency, where Samdhana supported the Pancur Kasih Foundation to facilitate discussion on local government regulations that can provide recognition of land rights for indigenous peoples. This regency is located in West Kalimantan Province (Figure 47) with an area of 3,012,741 Ha, where the majority of its area (2,638,963 Ha / 87.59%) is lowland with an altitude of up to 200 m above sea level, only 9.22% (277,925 Ha) of the district is upland area with an altitude from 200 to 500m. Only 3.13% (around 94,315 Ha) of the district is mountainous with an altitude higher than 500m. The mountainous areas are primarily located in the eastern part of the focal area (Figure 48).

Figure 47. Ketapang focal area, West Kalimantan Province.

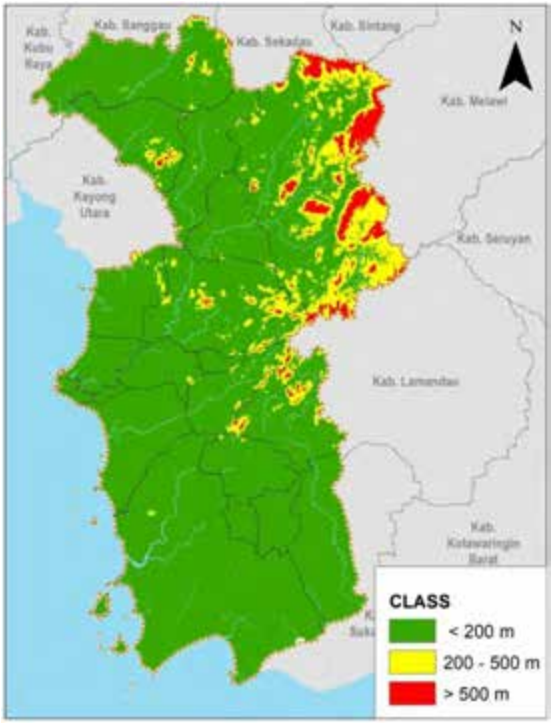


Figure 48. Topographic map of Ketapang focal area (Demnas, BIG 2018).

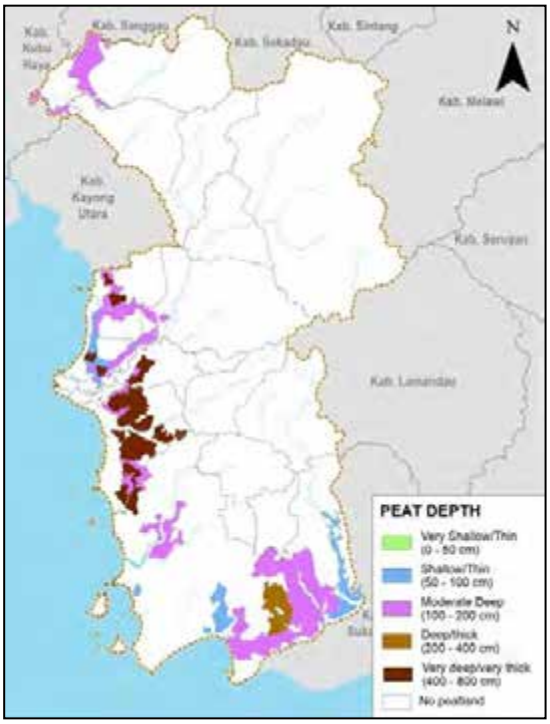


Figure 49. Peatland map of Ketapang focal area (Wetlands International, 2000-2002).

The focal area is divided into twenty sub-districts (*Kecamatan*) and 235 villages. The total number of people living in this focal area is around 512,783 people. Delta Pawan is the sub-district that has the highest number of people and this is also the capital of the Ketapang district (BPS 2019).

According to KLHK's forest designation map (SK 733/2014, updated 2019), the total forest area is 1,768,599 Ha, around 58.7% of the total focal area. Around 627,786 Ha (20.84% of the focal area) has

been allocated for limited production forest, 597,619 Ha (19.84% of the focal area) was allocated for production forest, 307,103 Ha (10.19% of the focal area) was allocated for protected forest, and only 166,442 Ha (5.5% of the focal area) was allocated for conservation (nature reserve and national park) (Figure 51).

According to Wetlands International data (2002), there is 294,497 Ha (10% of the total area of the focal area) of peat land in Ketapang district. This peat is divided into four categories: shallow/thin (50 - 100 cm), moderate (100-200 cm), deep/thick (200-400 cm) and very deep (400-800 cm). The majority of Ketapang's peat land (67%) is classified as moderate (197,807 Ha) and this peatland can primarily be found along the western and southern part of the focal area. An additional 46,385 Ha has been classified as shallow/thin peat, 20,765 Ha as deep/thick peat and 75,926 Ha as very deep peat (Figure 49).

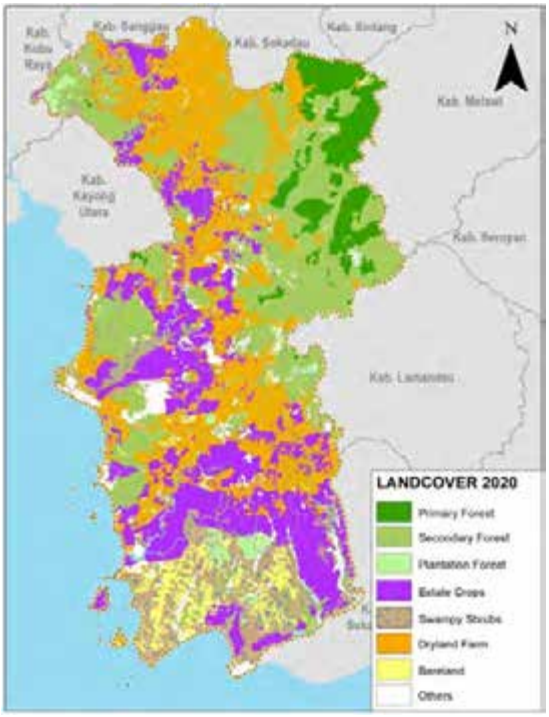


Figure 50. Land cover map of Ketapang focal area (SEKALA, 2020).

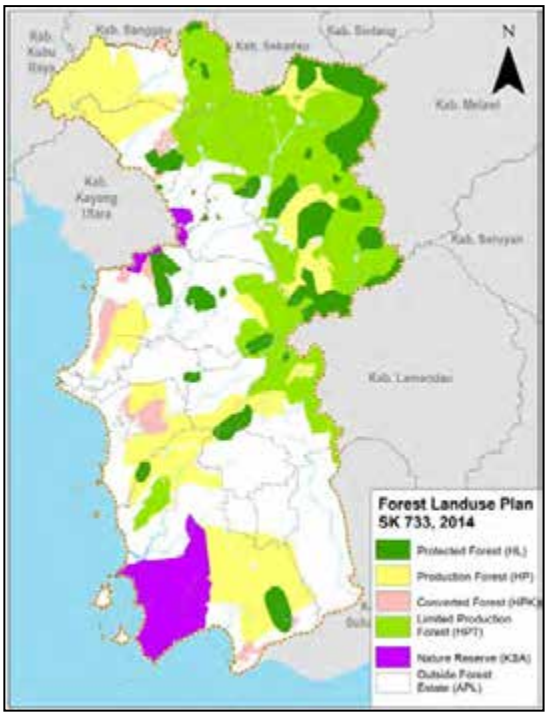


Figure 51. Forest estate in Ketapang focal area (SK 733, KLHK 2019).

Land cover analysis carried out by SEKALA using Sentinel 1 and 2 satellite images 2020 (Figure 50) revealed that the majority of Ketapang's land cover is dryland agriculture (816,279 Ha; 27.1%) and secondary dry forest (791,920 Ha; 26.3%). Together these two land covers account for 53.4% of Ketapang's total land cover. Other significant land cover detected is oil palm plantation (612,030 Ha; 20.3%) and swampy shrubs (283,682 Ha; 9.42%). Only 203,482 Ha (6.8%) was determined to be primary dry forest and 39,570 Ha (1.3%) was determined to be plantation forest. Barren land and swampy shrubs at the southern part of the focal area is related to sandy soils (*Spodosols*) that strongly acid and poor in plant nutrients, usually this kind of soil has a strong association with heat forest (*kerangas*) vegetation (Mackinnon *et al.* 1996), like shrubs.

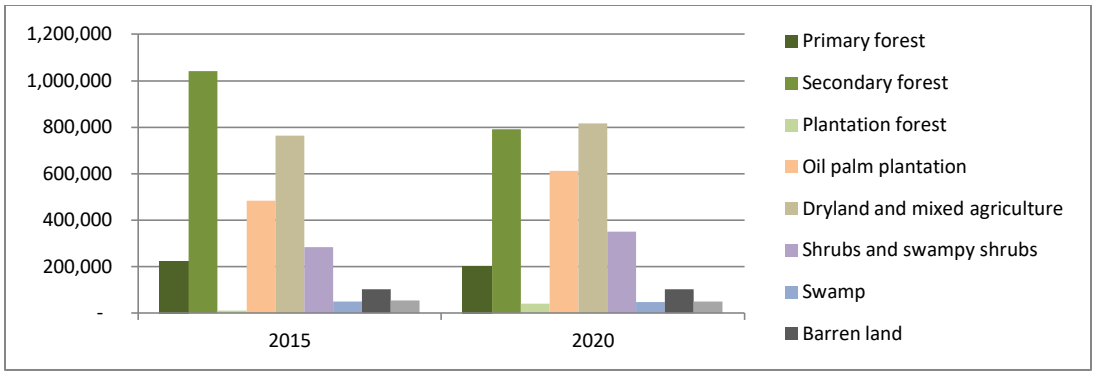


Figure 52. Comparison land covers 2015 and 2020 in Ketapang focal area (SEKALA).

Comparison between land covers in 2015 (analyzed by SEKALA using Landsat 8 and Sentinel 1 data for year 2015) and land covers in 2020 above, suggests that 269,485 Ha of land was deforested between 2015-mid 2020. During this time, (19,150 Ha) of primary forest and (250,335 Ha) of secondary forest was converted to other types of land cover (Figure 52). The majority of this deforestation occurred in 2015-2016 (47,313 Ha). During the 2016-2018 period, deforestation has been reduced significantly from 10,688 Ha during 2016-2017 to 4,707 Ha during 2017-2018. However, deforestation increased again during 2018-2019 (22,667 Ha) (Figure 55).

In addition, land cover change analysis revealed an increase in oil palm plantation area by 128,988 Ha in this focal area in the last five years (Figure 52). Yearly vegetation loss analysis (Figure 55) also suggests that vegetation loss in oil palm plantations might strongly relate to replanting oil palm at the existing plantation.

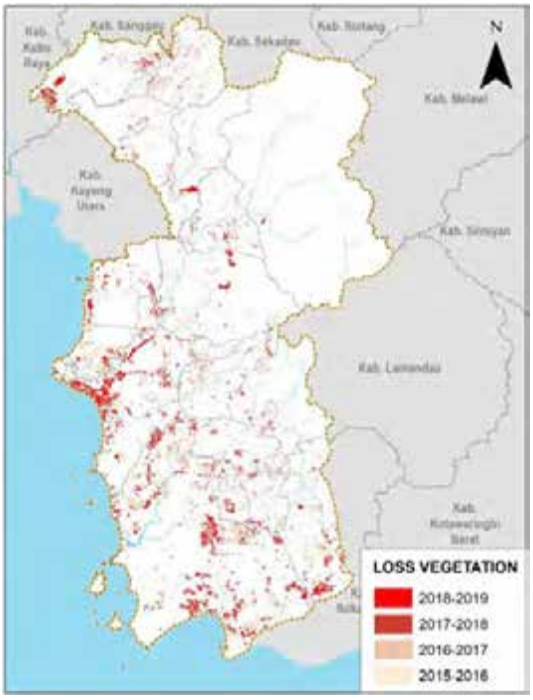


Figure 53. Annual vegetation loss 2015-2019 in Ketapang focal area (SEKALA).

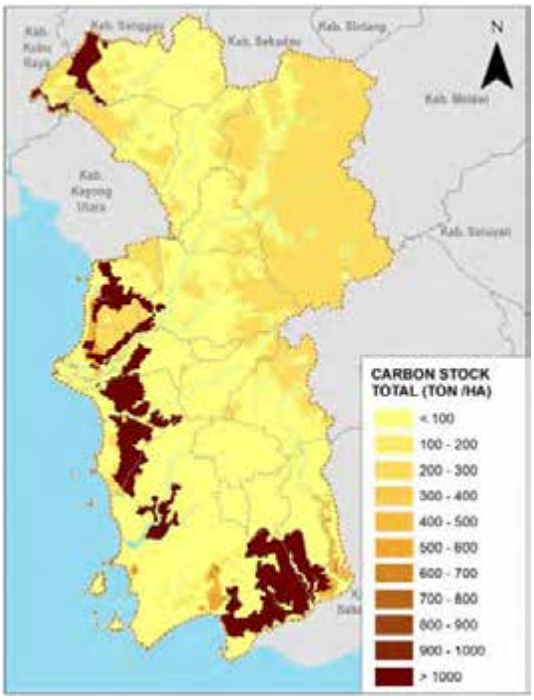


Figure 54. Total carbon stock estimation in Ketapang focal area.

Carbon pools in peat soils and above ground biomass using land cover (2020) produced by SEKALA and Wetlands International (2002) carbon stock data on peat have been analysed to produce an above and below ground carbon stock of around 0.96 GtC. Around 94% of this carbon is located in the focal area's peatland and only 6% is located in above-ground forests, which is mainly primary and secondary forests. The majority of the focal area's carbon stocks are located in the eastern and southern part of the Ketapang focal area, where the peatland is mainly located (Figure 54). Comparison of total carbon stock in 2015 and 2020 has revealed around 0.042 GtC was lost in the last five years.

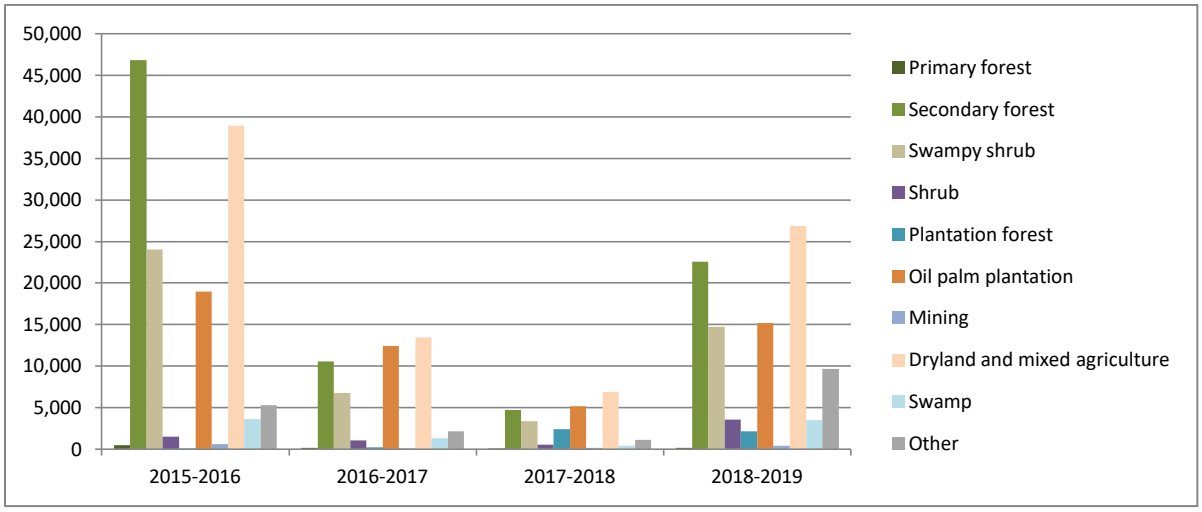


Figure 55. Vegetation loss yearly at land covers type in Ketapang focal area (SEKALA).

Land use concessions have been issued for timber plantations (629,725 Ha), logging (431,124 Ha) and oil palm plantations (1,048,921 Ha) in the Ketapang focal area (Figure 57). The Moratorium on converting primary forest and peatland (KLHK 2019) suggests that around 539,324 Ha of the focal area is currently protected from conversion. Around 9,475 Ha of this land is primary forest, around 55,705 Ha is peatland, and 474,144 Ha is classified as forest area that need special attention for protection, such as conservation area and protected forest (Figure 56).

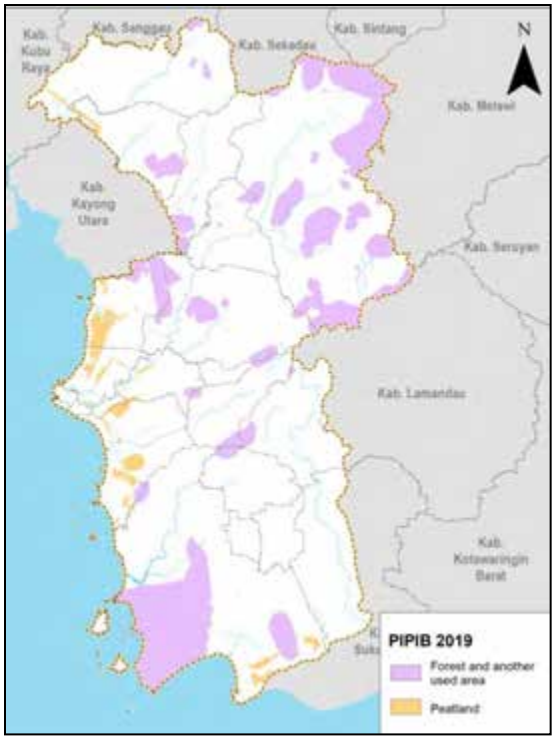


Figure 56. Moratorium permits on primary forest and peatland in Ketapang focal area (KLHK 2019).

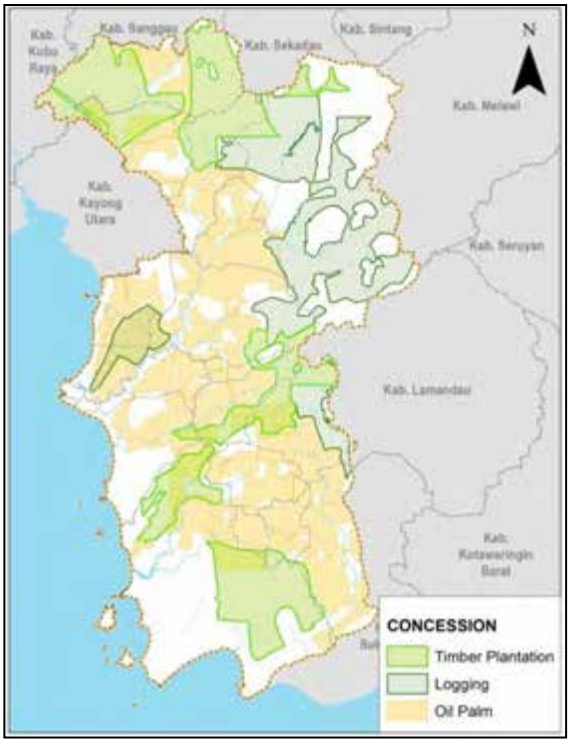


Figure 57. Large scale concessions in Ketapang focal area (timber plantation and logging from KLHK (2019) and oil palm from GWC (2019).

Around 38,191 Ha of village forest and 3,816 Ha of community forestry have been issued in this focal area. The KLHK (2019) has also allocated 1,913,327 Ha as indicative areas for a social forestry program. The indicative map (Figure 59) shows 965,727 Ha has been reserved for social forestry and 947,600 have been identified as having potential for social forestry.

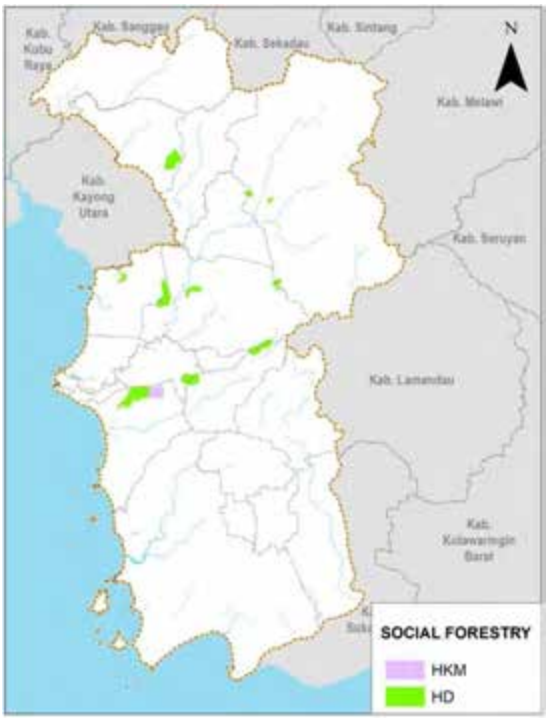


Figure 58. Social forestry concessions in Ketapang focal area (KLHK 2019).

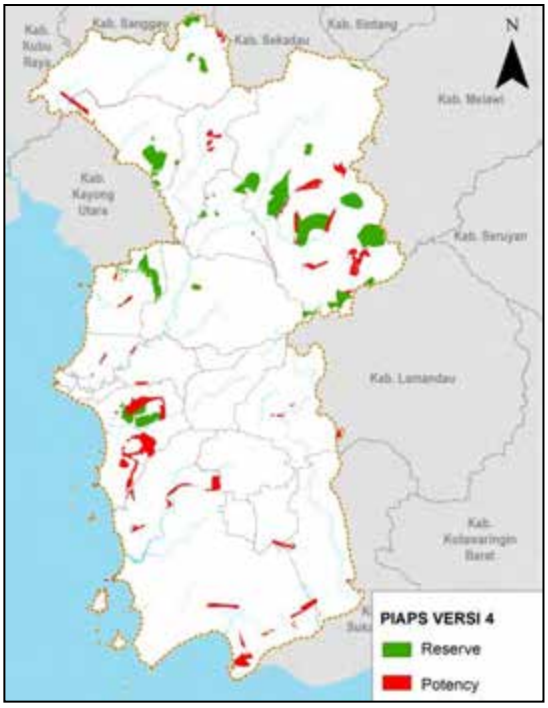


Figure 59. Indicative map for social forestry in Ketapang focal area (KLHK 2019).

According to ATR/BPN, 146,036 Ha of land in this focal area has been assigned for agrarian reform (Figure 64). This land will be titled and the land that currently falls inside the forest area will be released for non forestry uses. Recently this land has been used by the local community, but it has not been titled yet. Around 114,747 Ha of this land is located outside the forest area, 691 Ha in protected forest, 2,828 Ha in production forest, 25,005 Ha in convertible production forest, 108 Ha in limited production forest, and 2,537 Ha in conservation area. This land reform program will increase the area of land titled in Ketapang focal area, which is currently 695,178 Ha (Figure 60).

Some civil society organizations (such as AMAN, JKPP and Pancur Kasih) have worked directly or indirectly on the issue of customary community rights and have mapped large areas of customary land in the Ketapang focal area. Around 836,142 Ha customary territory has been mapped in this focal area (Figure 61).

Fire history analysis suggests that the highest intensity of fires occurred in 2015 with 26,500 active fires detected by FIRMS during this year. KLHK's burnt scar map reveals in 2015, 46,765 Ha of land was burnt in the Ketapang focal area. The number of active fires detected by FIRMS in 2016 until 2018 is much less then in 2015, however, active fires increased in 2019 to around 21,000 active fires (Figure 62). KLHK data suggests the highest number of land cover area burnt in 2019 was around 91,378 Ha (Figure 63). Burning is usually associated with land clearing activities as shown in Figure 53 and 55. Most of these fires and land clearing occurred in the southern and western part of the focal area.

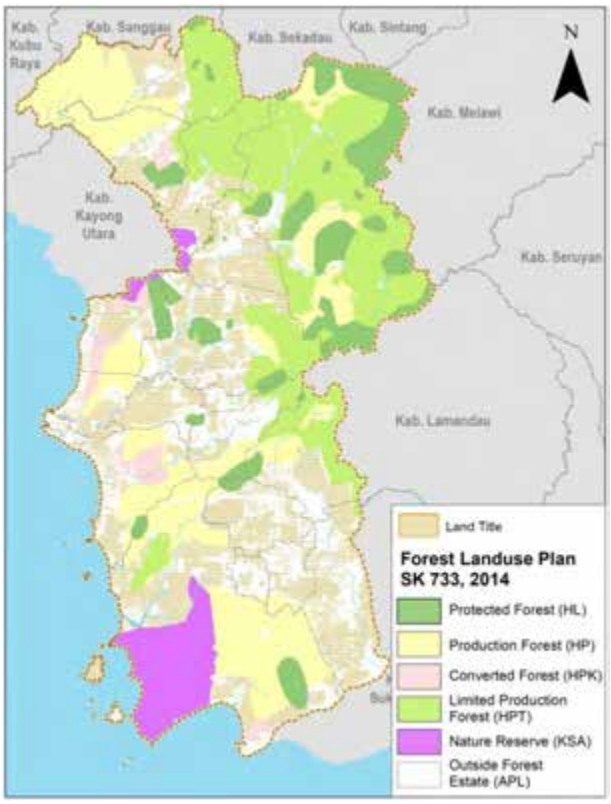


Figure 60. Land title in Ketapang focal area (ATR/BPN 2019).

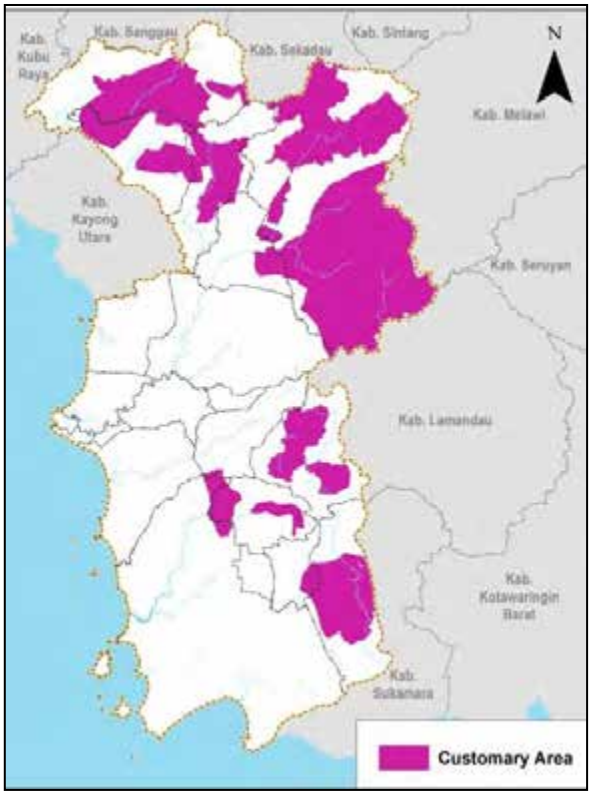


Figure 61. Mapped customary area in Ketapang (various sources 2019).

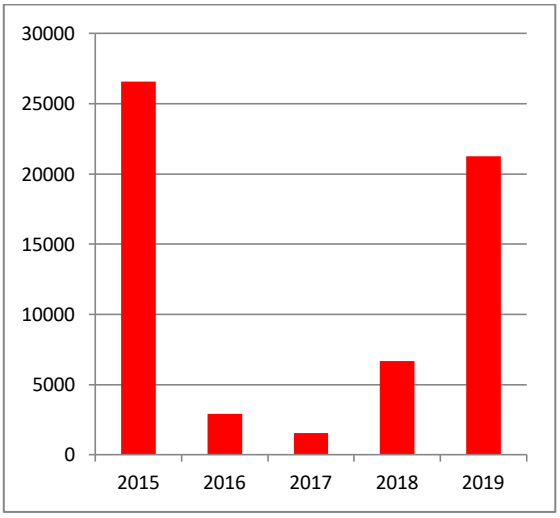


Figure 62. Annual active fires intensity 2015-2019 in Ketapang focal area (FIRMS).

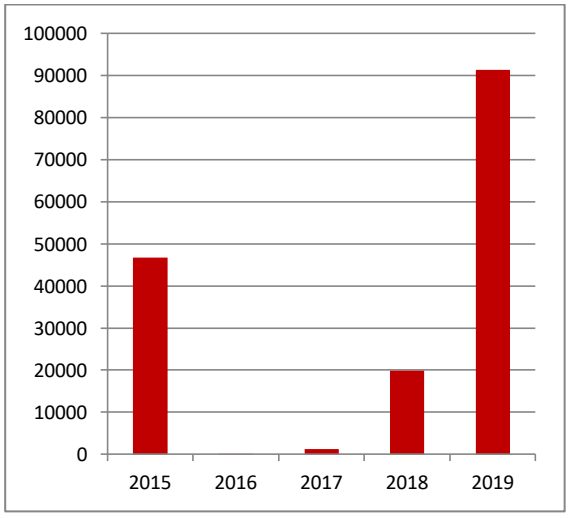


Figure 63. Burnt scar 2015-2019 in Ketapang focal area (KLHK).

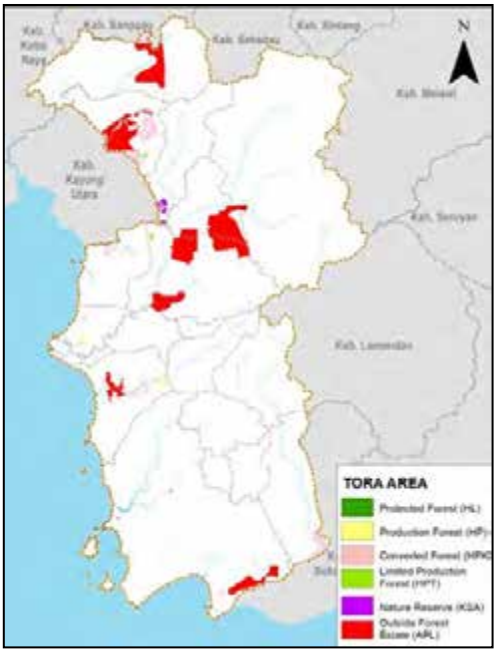


Figure 64. Land object for agrarian reform in Ketapang focal area (ATR/BPN 2019).

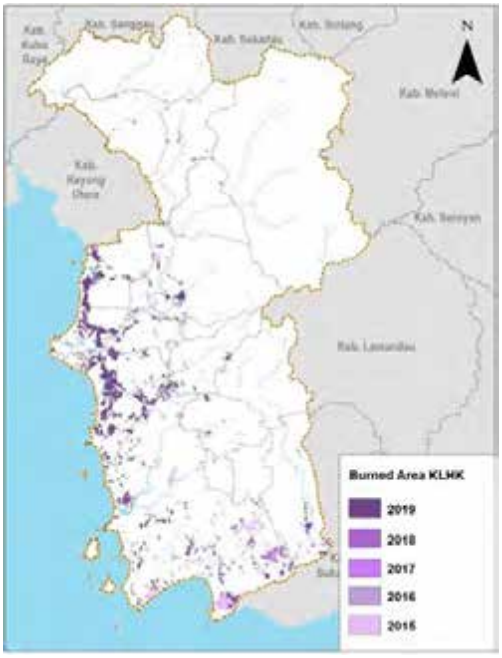


Figure 65. Burnt scar map 2015-2019 in Ketapang focal area (KLHK).

Pulang Pisau Focal Area, Central Kalimantan

The Pulang Pisau focal area is located in Pulang Pisau District, Central Kalimantan Province (Figure 66). In total, the focal area covers 40 villages. It includes four villages in Jabiren Raya Sub-district (namely Tanjung Taruna, Pilang, Henda and Garung), four villages in Kahayan Hilir Sub-district (namely Gohong, Kelurahan Kalawa, Mantaren 1, and Buntoi), and one village in Sebangau Kuala Sub-district (namely Paduran Sebangau) where Samdhana supported Pokker SHK to work in these villages for village boundary mapping. It also covers 16 villages in Pandih Batu Sub-district (namely Talio Hulu, Talio Muara, Pangkoh Sari, Kantan Dalam, Kantan Muara, Kantang Atas, Mulyasari, Karya Bersama, Dandang, Talio, Pangkoh Hulu, Pangkoh Hilir, Sanggang, Pantik, Belanti Siam and Gadabung), and 15 villages in Maliku Sub-district (namely Sei Baru Tewu, Kanamit, Purwodadi, Wono Agung, Kanamit Barat, Kanamit Jaya, Grantung, Sidodadi, Badirih, Tahai Baru, Tahai Jaya, Maliku Baru, Maliku Mulya, Gandang, and Gandang Barat) where Samdhana supported Yayasan Bentang Borneo from 2016 to 2017 for village boundary mapping. The total focal area is 585,297 Ha and the area has a total population of around 415,258 people (BPS, 2016). The highest populated villages are Mitin and Pulang Pisau which reach 40 thousand people. On average, the density of population in this focal area is 0.7 people per hectare.

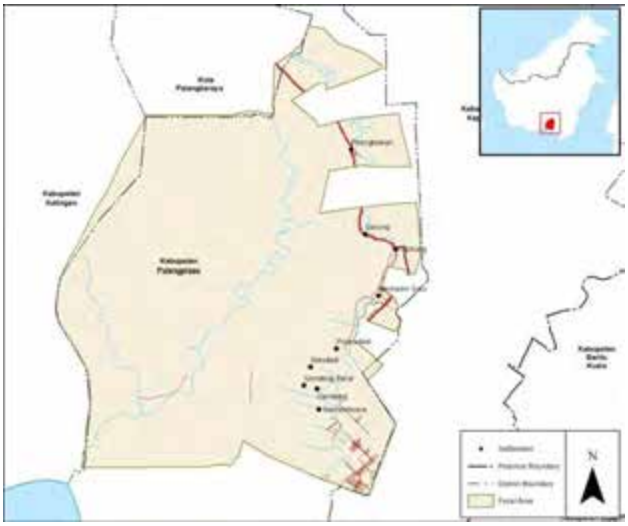


Figure 66. Pulang Pisau focal area, Central Kalimantan Province.

The focal area is predominantly lowland area with an elevation less than 200m above mean sea level. According to KLHK's forest designation map (SK 529/2012, updated in 2019), the majority of the focal area is forest area (79.4%). Around 219,497 Ha (37.5% of the total area of the focal area) is Sebangau National Park, 122,888 Ha (21% of the focal area) is allocated for production forest, 111,285 Ha (19%) is allocated for protected forest, 7,981 Ha is (1.4% of the focal area) is allocated for limited production forest and 3,252 Ha (0.6% of the focal area) is allocated for convertible production forest (Figure 68).

According to KLHK (2020) data, the moratorium on converting peatland and primary forest protects 416,937 Ha in this focal area. Around 85,583 Ha of this land is peatland and 331,354 Ha of this land is conservation and protected forest (Figure 71).

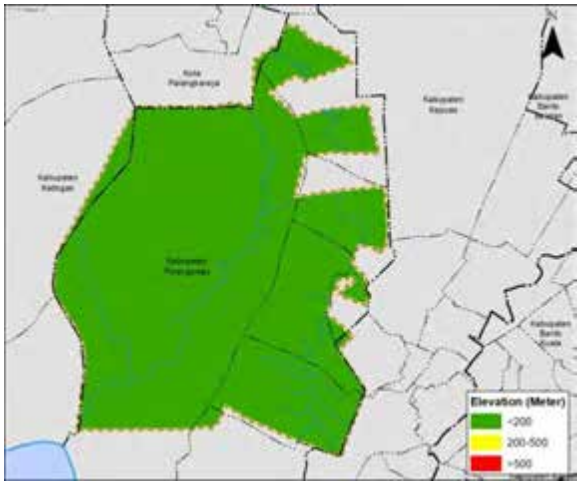


Figure 67. Topography of Pulang Pisau focal area.

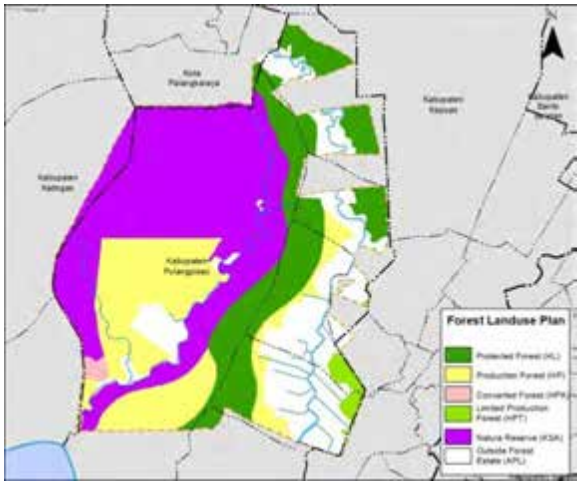


Figure 68. Forest land use plan in Pulang Pisau focal area (KLHK 2019).

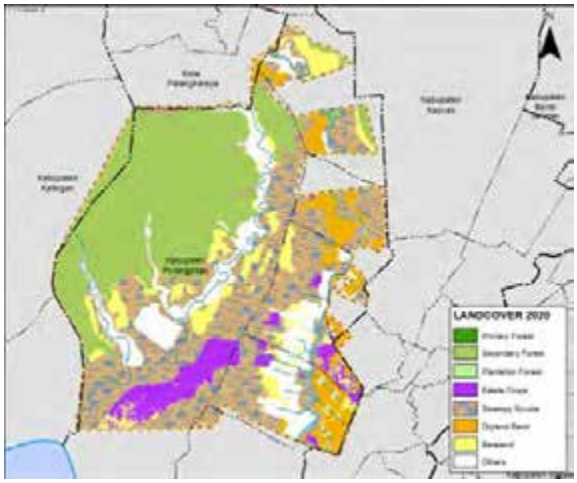


Figure 69. Land cover in Pulang Pisau focal area (SEKALA 2020).

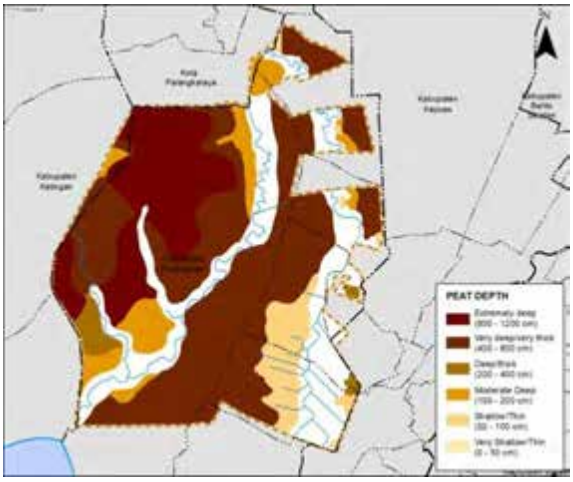


Figure 70. Peat depth in Pulang Pisau focal area (WI 2000-2002).

Land cover analysis for 2020 conducted by SEKALA shows the majority of the focal area is swampy shrubs (198,081 Ha; 33.84%) and secondary swamp forest (189,974 Ha; 32.45%). Another large land cover is dry and mixed agriculture (69.873 Ha; 11.9%). Another 2,696 Ha (1.02%) of shrubs, 32,841 Ha (5.6%) of oil palm plantation, 33,957 Ha (5.8%) of swamp, 46,986 Ha (8%) of barren land, and 4,889 (0.8%) of settlement (Figure 69) were detected in the area.

According to Wetlands International (2002), the majority area of the focal area is peat soil (313,824 Ha), and this can be found in 54% of the focal area total area. The majority of this peat, around 116,657 Ha, is very deep (400-600cm). Around 104,698 Ha is extremely deep (800-1200cm), 12,638 Ha is deep (200-400cm), 43,508 Ha is moderate deep (100-200cm), and 36,323 Ha is shallow (5-100cm) (Figure 70). Current estimate on total carbon pools in this focal area using 2020 land cover data for above ground carbon stocks and Wetlands International (2002) for below ground carbon stocks suggest that the total carbon pool in this focal area is around 2.24 GtC. The below ground carbon pool is 2.19 GtC, which is around 97.8% of the total carbon pool in this focal area and only 0.05 (2.2%) of this carbon is located above ground. Comparison of total carbon stock in 2015 and 2020 has revealed around 0.01 GtC was lost in the last five years.

Land cover change analysis using 2015 and 2020 data from SEKALA suggest there has been significant conversion of secondary forest in this focal area. Around 63,300 Ha of secondary forest has been converted into other land cover. It also suggests a reduction of dry and mixed agriculture in the last five years (of 47,103 Ha). Oil palm plantation area was also decreased by 3,023 ha. However, barren land increased by 46,974 ha and swamp land increased by 16,972 ha in the 2020 land cover data (Figure 73).

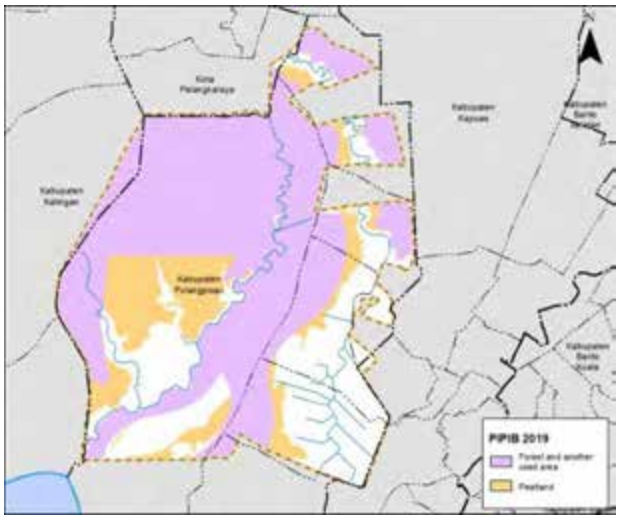


Figure 71. Permit moratorium on primary forest and peat in Pulang Pisau focal area (KLHK 2019).

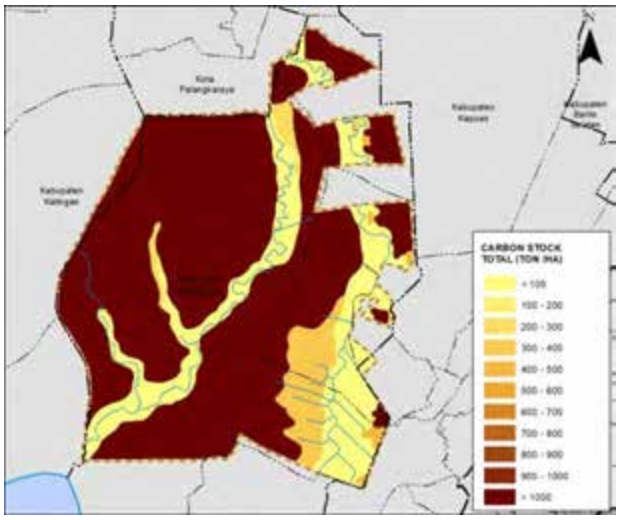


Figure 72. Carbon stock estimation in Pulang Pisau focal area.

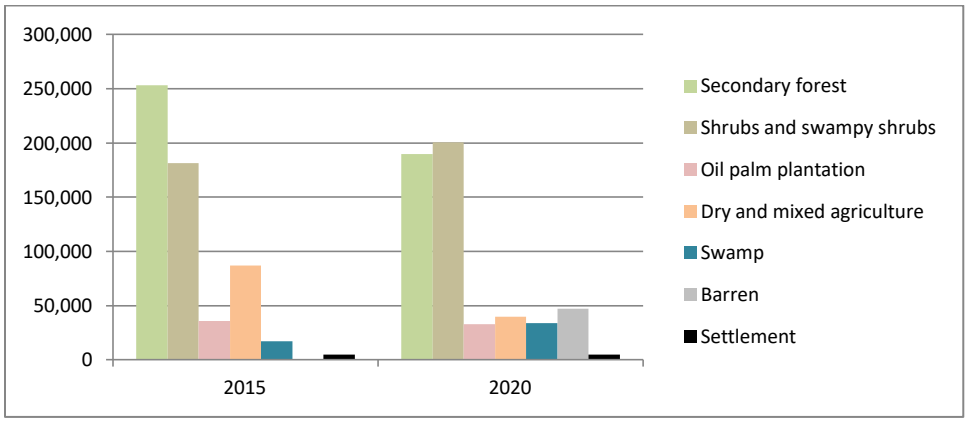


Figure 73. Comparison between land cover 2015 and 2020 (SEKALA).

According to vegetation loss analysis conducted by SEKALA, the majority of secondary forest was cleared in 2015 to 2016 (37,189 Ha). During this period, shrubs and dryland & mixed agriculture area was also largely cleared by 12,419 Ha and 6,098 Ha respectively. The clearance occurred along the main rivers on shallow peat. Between 2016 and 2019, a relatively small amount of land clearing occurred in in oil palm plantation, shrubs and dryland & mixed agriculture area. This land clearing occurred mainly in southern part of the focal area.

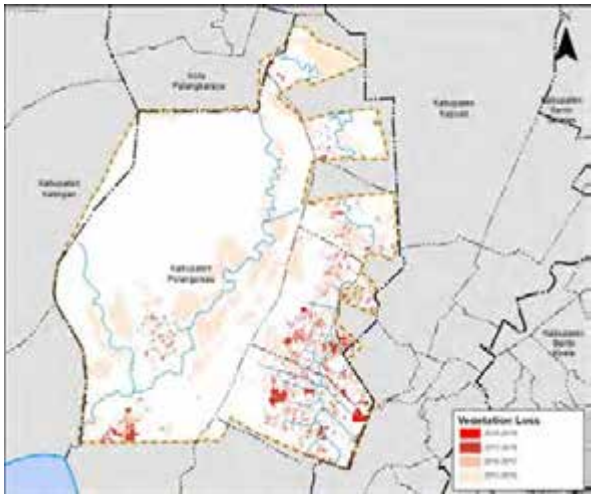


Figure 74. Vegetation loss map 2015-2019 in Pulang Pisau focal area (SEKALA).

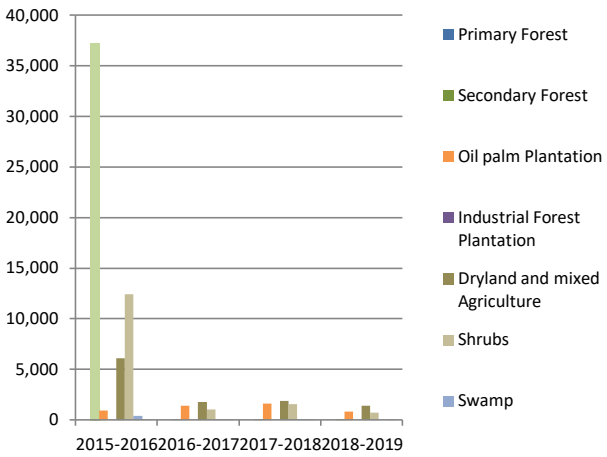


Figure 75. Vegetation loss map 2015-2019 over land cover type in Pulang Pisau focal area (SEKALA).

The land clearing trend from 2015 to 2019 has a similar pattern with burn scars and the active fires occurrences (Figure 75, 78 and 79). According to KLHK data, there was 149,583 Ha of land burned in 2015 and this decreased in the next two year. However, the burn scar detected increased in 2018 and reached 46,165 Ha in 2019 (Figure 79). The heatmap analysis (Figure 77) shows the concentration of active fires (red indicate high density and yellow for moderate density) in five years occurred mainly in the eastern and southern part of the focal area. This area is mainly closed to settlement, main roads and rivers.

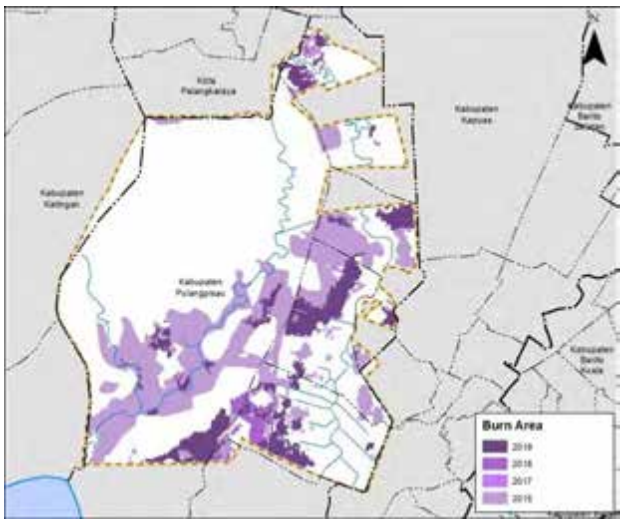


Figure 76. Burnt scar map of Pulang Pisau focal area 2015-2019 (KLHK)

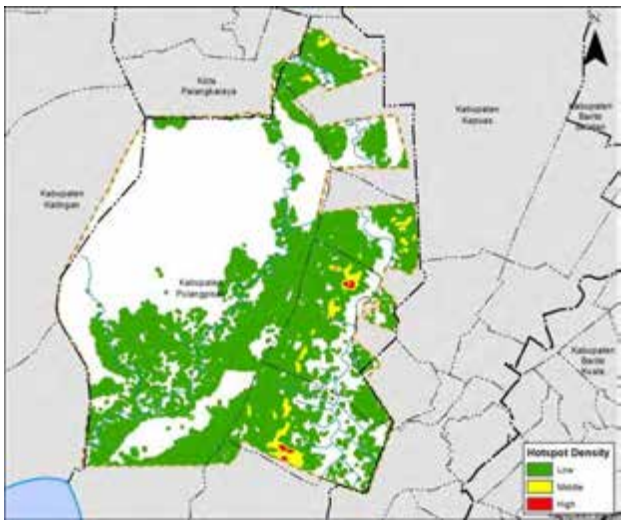


Figure 77. Accumulated active fire/hotspot location in Pulang Pisau focal area 2015-mid 2020 (FIRMS).

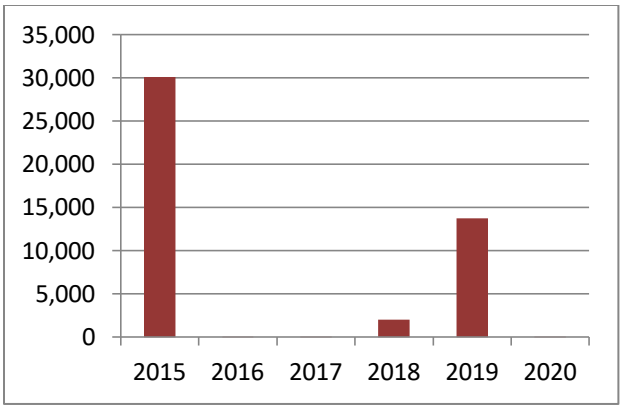


Figure 78. Active fire/hotspot in Pulang Pisau focal area (FIRMS).

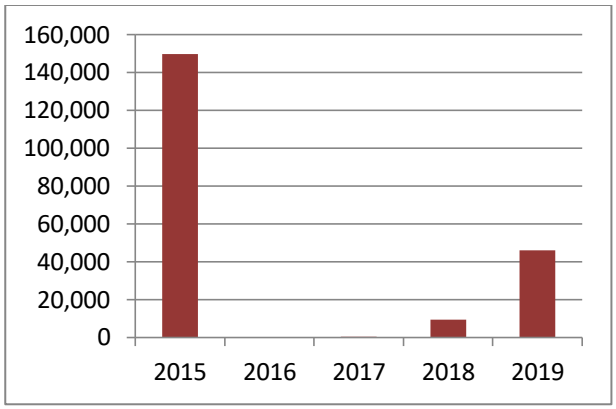


Figure 79. Burnt scar in Pulang Pisau focal area (KLHK).

According to Global Forest Watch, 2019, there was around 105,277 ha of large-scale oil palm plantations in this focal area in 2019. (Figure 80). According to KLHK (2019), around 30,254 Ha of Village Forest and 1,629 Ha of Community Forest Plantation has been issued, which is mainly in eastern part of the focal area (Figure 81). In addition, KLHK has allocated 85,496 Ha as indicative area for social forestry. Around 12,377 Ha has been classified as having potential for social forestry and 73,119 Ha has been classified as reserve for social forestry in this focal area (Figure 82).

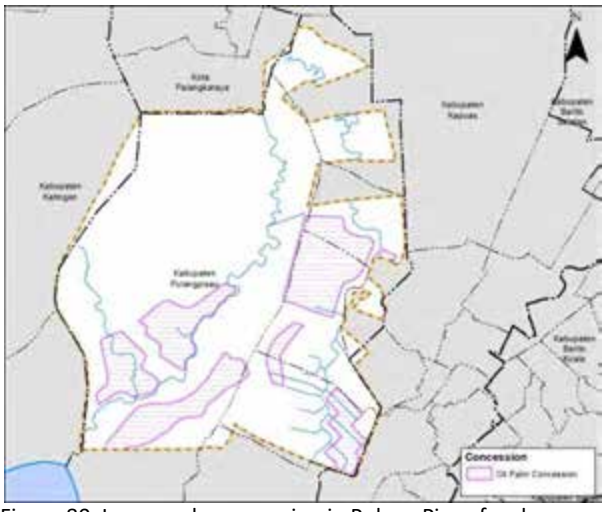


Figure 80. Large scale concession in Pulang Pisau focal area (GFW 2019).

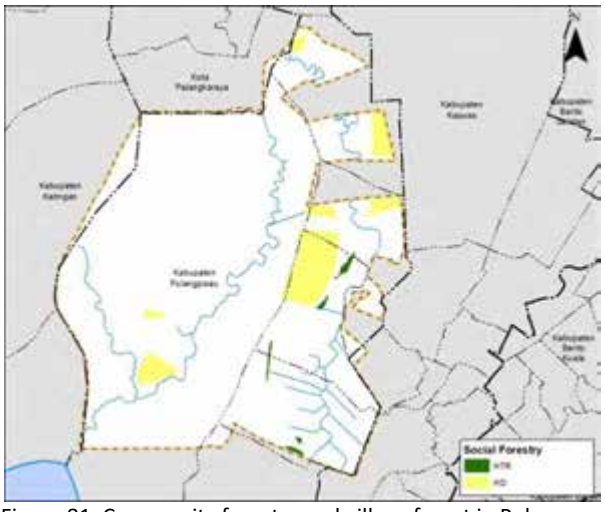


Figure 81. Community forestry and village forest in Pulang Pisau lanscape (KLHK 2019).

According to ATR/BPN data (2019), around 19,629 Ha of land in this focal area has been titled (Figure 84). ATR/BPN has also planned to title around 1,595 Ha of land as part of TORA (land object for agrarian reform) program in this focal area. This land is 400 Ha in protection forest, 799 Ha in production forest, 390 Ha in limited production forest, and 5 Ha in convertible production forest (Figure 83). In addition, according to database collated by SEKALA from various sources (2019), around 275,011 Ha of customary area in this focal area has been mapped (Figure 85).

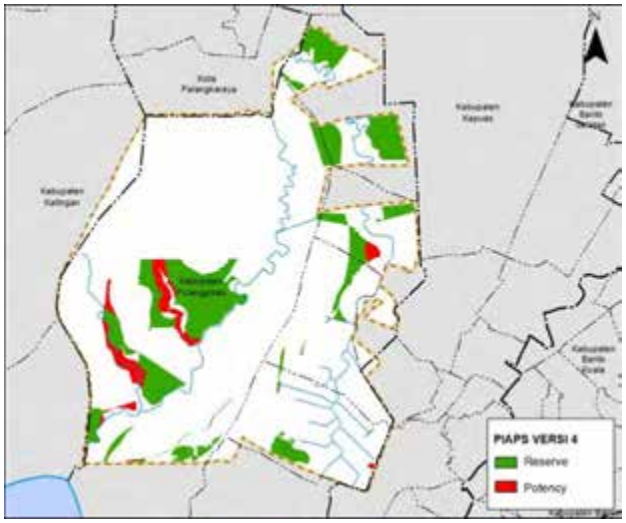


Figure 82. Indicative for social forestry program in Pulang Pisau focal area (KLHK 2019).

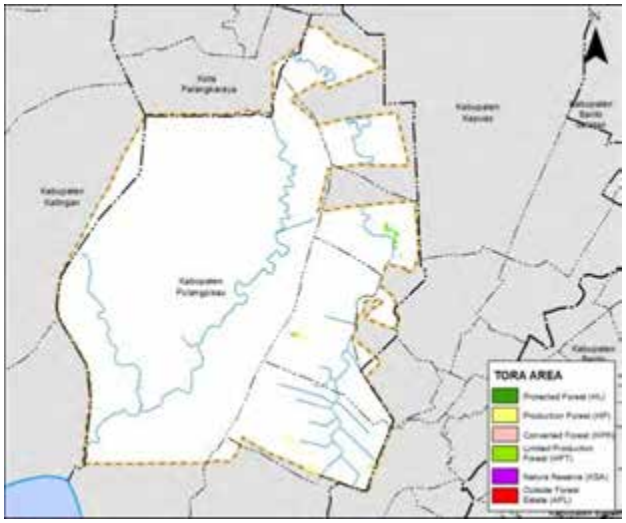


Figure 83. Land planned for agrarian reform program in Pulang Pisau focal area (ATR/BPN 2019).

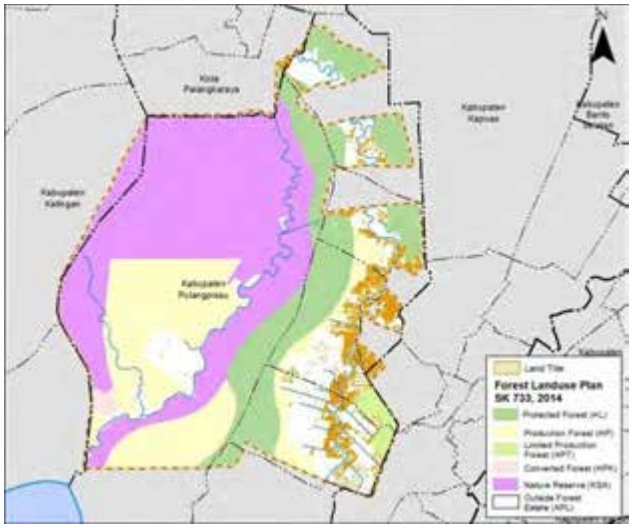


Figure 84. Land titled in Pulang Pisau focal area (ATR/BPN 2019).

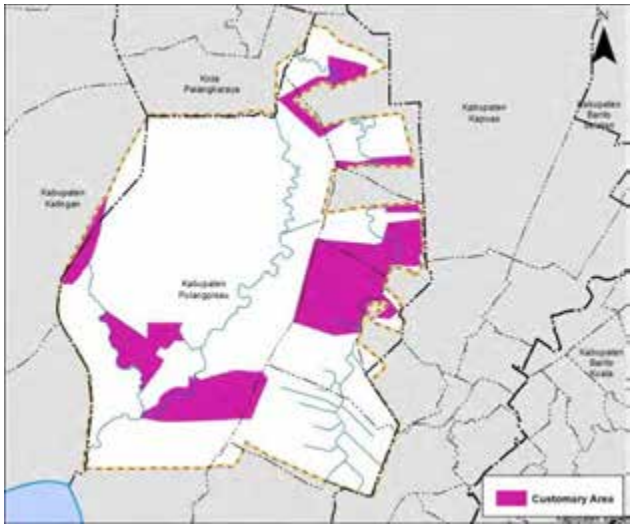


Figure 85. Customary area that already mapped in Pulang Pisau focal area (various sources 2019).

Kapuas Hulu Focal Area

The Kapuas Hulu focal area covers Ketemanggungan Embaloh Hulu in Embaloh Hulu and Embaloh Hilir sub-district and Ketemanggungan Dayak Kalis (Nanga Danau Village, Rantau Kalis Village and Nanga Tubuk Village) in Kalis sub-district, Kapuas Hulu District of West Kalimantan (Figure 86). Samdhana supported Lanting Borneo to work in Ketemanggungan Embaloh from 2016 to 2017 and in Ketemanggungan Dayak Kalis in 2018. The focal area is 41,024 Ha and the number of people living in this

focal area according to BPS (2016) is 17,864 people. Therefore the population density is around 0.44 people per hectare.

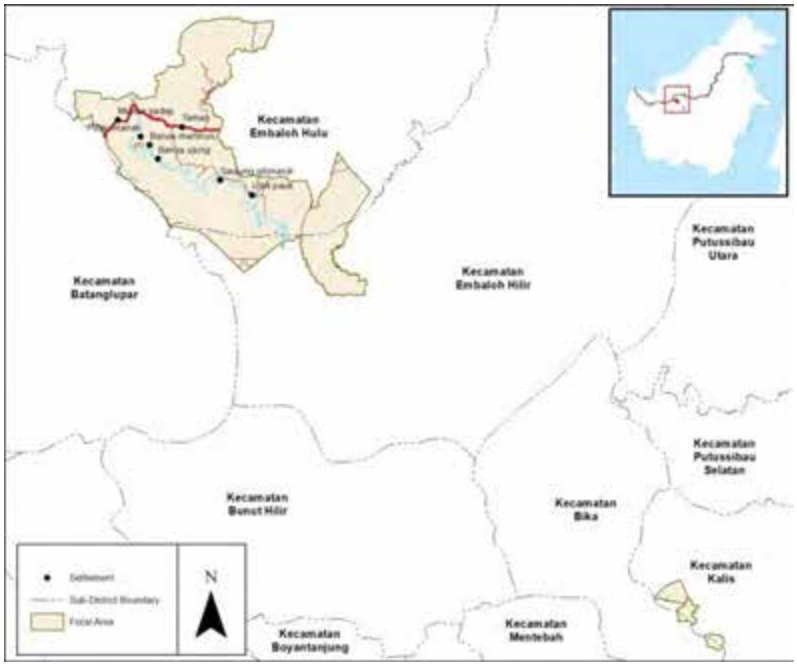


Figure 86. Kapuas Hulu focal area, West Kalimantan Province.

According to BIG (2018), the majority (36,987 Ha; 90%) the area of this focal area is lowland (below 200m altitude). Around 3,885 Ha (9%) is upland with an elevation of 200-500m above mean sea level. Only 146 Ha (0.36%) is mountainous area (more than 500m altitude) Figure (87).

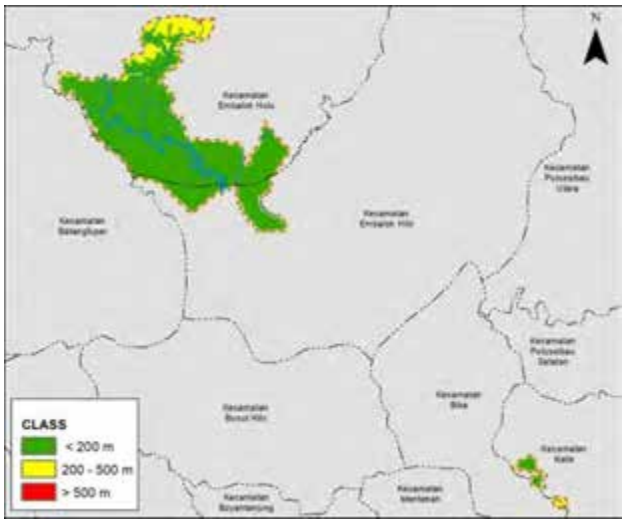


Figure 87. Topography of Kapuas Hulu focal area (BIG 2018).

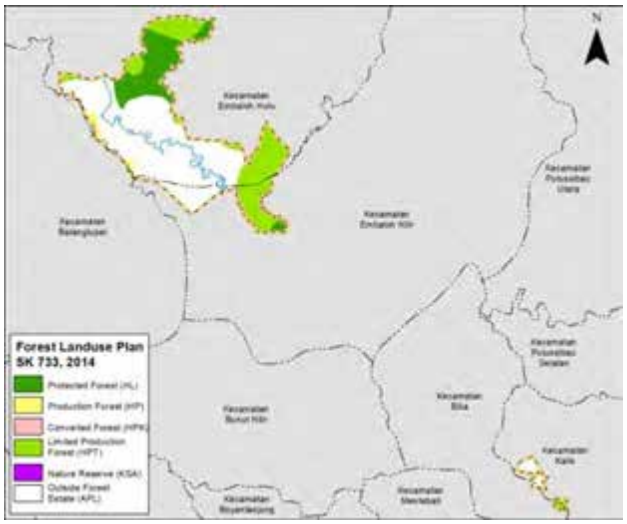


Figure 88. Forest land use plan (KLHK 2019).

According to KLHK's forest area designation (SK No. 733/2014, updated in 2019), around 17,746 Ha (43.3%) of the focal area total area has been allocated for forest area. Around 9,986 Ha (24.3% 2% of the

focal area) has been allocated for limited production forest, 6,920 Ha (16.9% 2% of the focal area) has been allocated for protection forest and 841 Ha (2% of the focal area) has been allocated for production forest (Figure 88).

Land cover analysis for year 2020 conducted by SEKALA reveals majority (27,686 Ha; 67.5%) of the total area of the focal area is secondary forest. Around 6,057 Ha (14.8% of the focal area) is primary forest, 4,168 Ha (10.2% of the focal area total area) is dryland and mixed agriculture and 1,900 Ha (4.6% of the focal area total area) is shrubs (Figure 90). Land cover change analysis for 2015 and 2020, suggests that in five years only 1,916 Ha of primary forest has been converted, and it reveals the increase around 1,975 Ha of secondary forest. While dryland and mixed agriculture and shrubs were relatively stable (Figure 89).

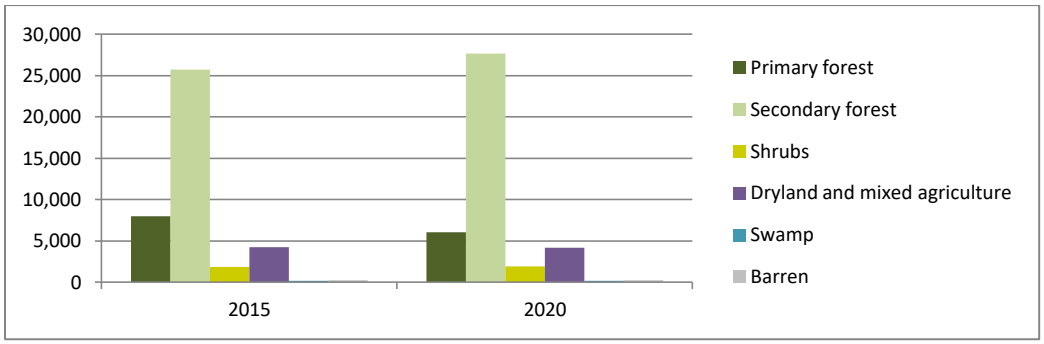


Figure 89. Comparison between land cover 2015 and 2020 in Kapuas Hulu focal area (SEKALA).

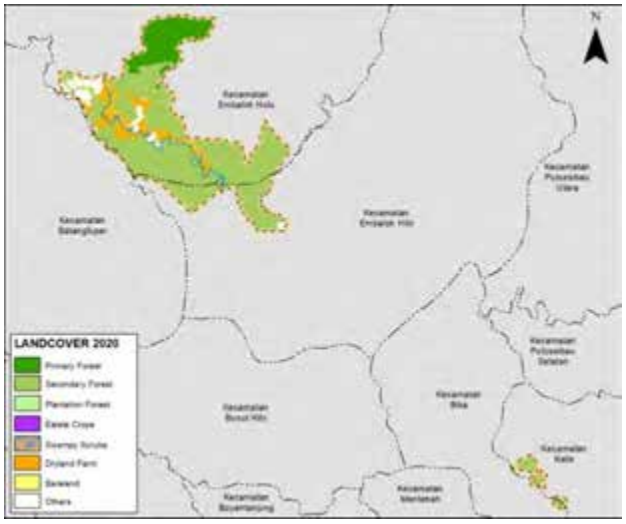


Figure 90. Land cover 2020 at Kapuas Hulu focal area (SEKALA).

Figure 91. Peat depth in Kapuas Hulu focal area (WI 2000-2002).

According to Wetlands International (2002), the focal area has 18,931 Ha of peat soil, where the majority of this peat (9,145 Ha) is less then 5cm deep and is classified as very shallow. Around 6,114 Ha is classified as shallow with 50-100cm deep, 1,609 Ha is classified as moderate deep with 100-200cm

deep and 2,063 Ha is classified as deep with 200-400cm deep (Figure 91). According to WI (2002), the total carbon stock for the below ground carbon in this focal area is only 0.01 GtC. In combination with above ground carbon stock calculated from land cover 2020, the total current above ground carbon stocks is 0.007 GtC. Therefore the total carbon stock (above and below ground) of this focal area is 0.017 GtC. Figure 92 shows the distribution of carbon stock per hectares in this focal area. Carbon loss during 2015-2020 is estimated to be relatively small, around 0.00004 GtC.

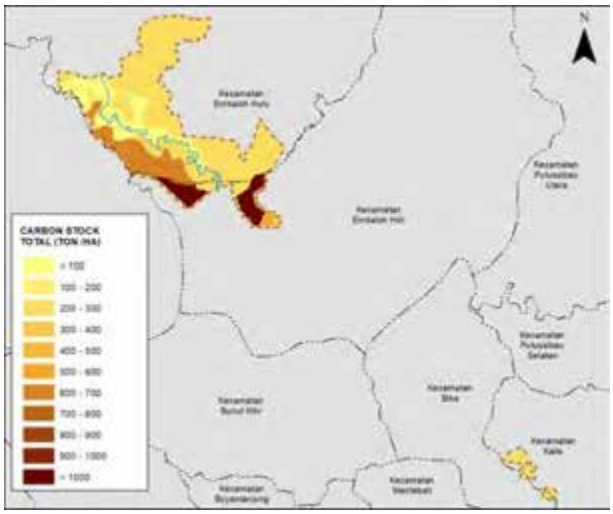


Figure 92. Carbon stock estimation in Kapuas Hulu focal area.

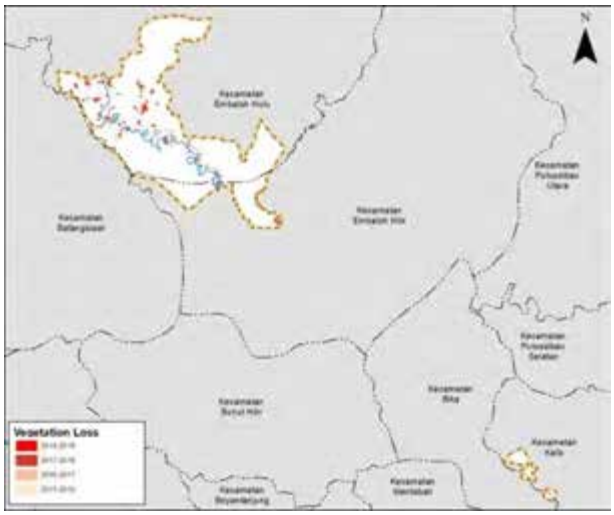


Figure 93. Vegetation loss 2015-2019 in Kapuas Hulu focal area (SEKALA).

Analysis of annual vegetation loss 2015-2020 carried out by SEKALA revealed that a relatively small amount of land clearing occurred annually in this focal area and this mostly happened in secondary forests, shrubs and dryland agriculture. The land clearing activities increased in 2017-2018 but dropped in 2018-2019 (Figure 93 and 94).

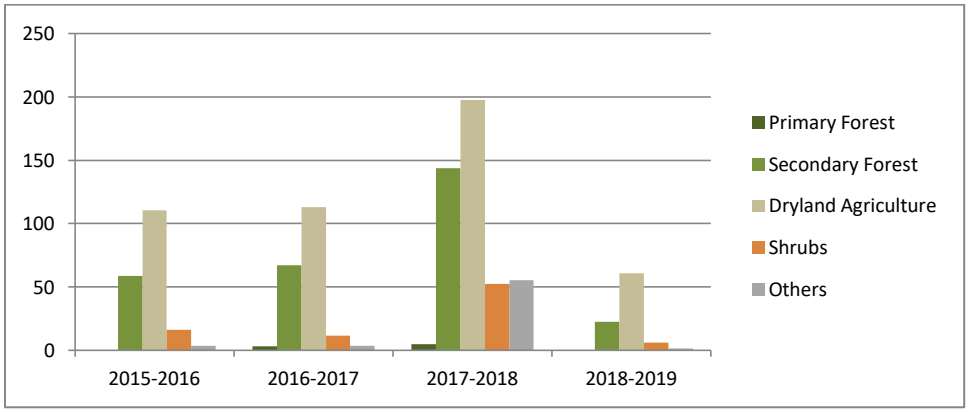


Figure 94. Annual vegetation loss 2015-2019 over land cover type in Kapuas Hulu focal area (SEKALA).

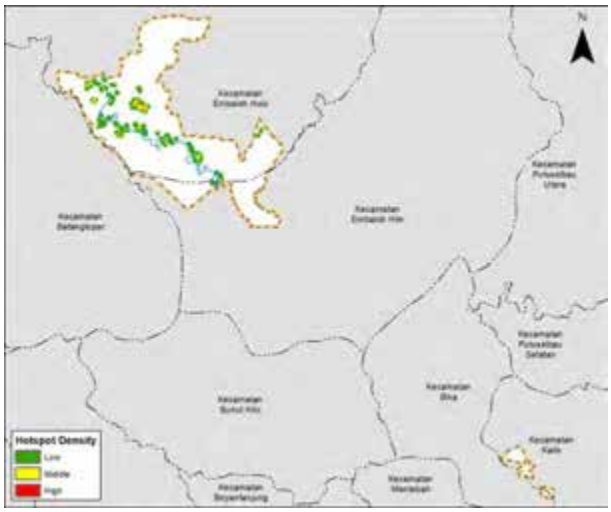


Figure 95. Heatmap active fires occurrences 2015-mid2020 in Kapuas Hulu focal area (FIRMS).

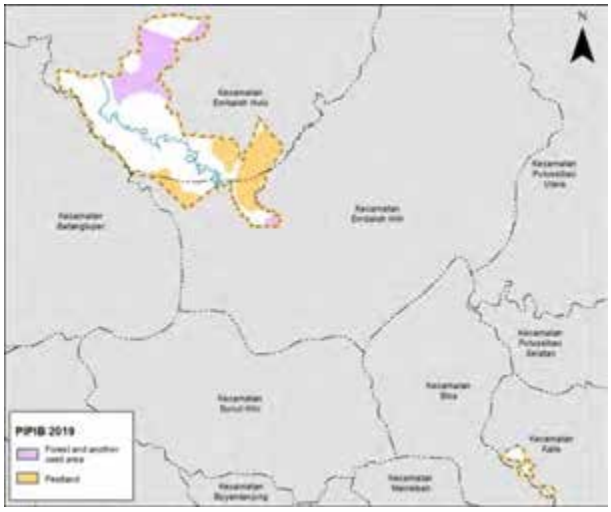


Figure 96. Permit moratorium on primary forest and peat in Kapuas Hulu focal area (KLHK 2019).

According to KLHK (2020) data, the moratorium on converting peatland and primary forest protects 14, 348 Ha of this focal area. Around 7,432 Ha of this land is peat, 6,895 Ha of this land is protected forest and 21 Ha of this land is primary forest.

Heatmap analysis (Figure 95) in the focal area shows that the occurrence of fires during 2015-2020 was concentrated along the main rivers in the focal areas. According to KLHK (2019), no burn scars occurred in this area during this time period. Only oil palm concession (19,942 Ha) is the largest land use concession that has been issued in the focal area (Figure 97) according to GFW data (2019). The oil palm development in this focal area may be in the early stages of development as no oil palm was detected in the 2020 land cover analysis. According to KLHK (2019), 12,489 Ha has been issued for Village Forest in this focal area (Figure 98).

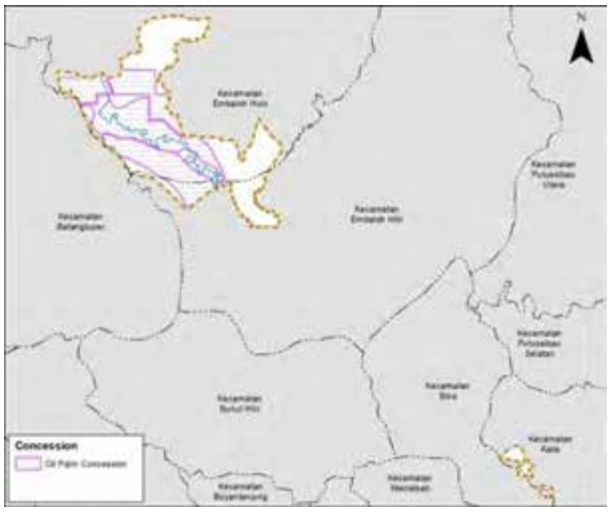


Figure 97. Large scale concession in Kapuas Hulu focal area (GFW 2019).

Figure 98. Village forest in Kapuas Hulu focal area (KLHK 2019).

KLHK has allocated 1,433 Ha of forest area in this focal area for social forestry. Around 601 Ha has been allocated as reserve for social forestry and 832 Ha has been allocated as having potential for social forestry (Figure 99). According to ATR/BPN, 4,976 Ha of land in this focal area has been titled (Figure 100).

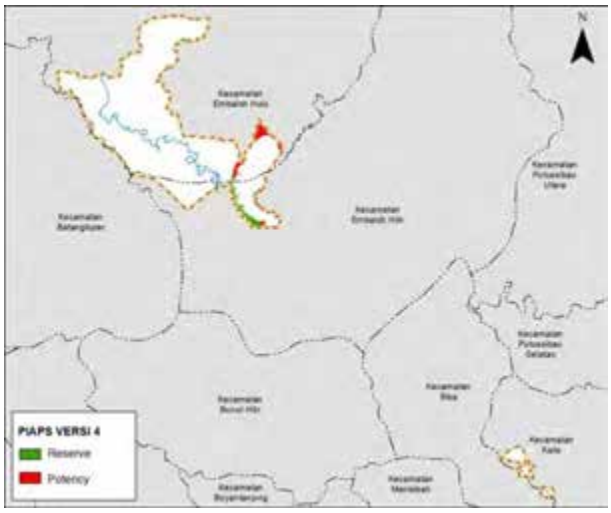


Figure 99. Indicative map for social forestry program in Kapuas Hulu focal area (KLHK 2019).

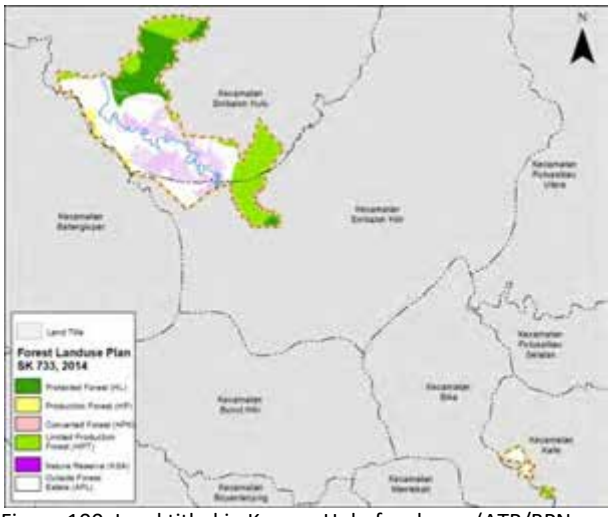


Figure 100. Land titled in Kapuas Hulu focal area (ATR/BPN 2019).

Sungai Boh Focal Area

The Apau Kayan customary area can be found in the Sungai Boh focal area in Malinau District, North Kalimantan (Figure 101). The focal area includes six villages in Sungai Boh Sub-district, namely Agung Baru, Datah Baru, Long Lebusan, Long Top, Long Mahak and Mahak Baru, and five villages in Kayan Selatan Sub-district, i.e. Lidung Payau, Long Uro, Bakung Metulang, Long Ampong and Sungai Barang. Samdhana supported JKPP from 2016 to 2018 to map this customary area. The total area of the focal area is 526,633 Ha and the total number of people living in the area is 50,610 people (BPS, 2016). The population density is around 0,096 people per hectares. The majority of the land in this focal area is mountainous (498,398 Ha; 94.63% of the focal area total area) with more than 500m altitude. Around 28,071 Ha (5.33% of the focal area) is upland with an elevation between 200 and 500m. Only 209 Ha (0.04% of the focal area) is lowland with an elevation below 200m (Figure 102). There is no peat soil in this focal area.

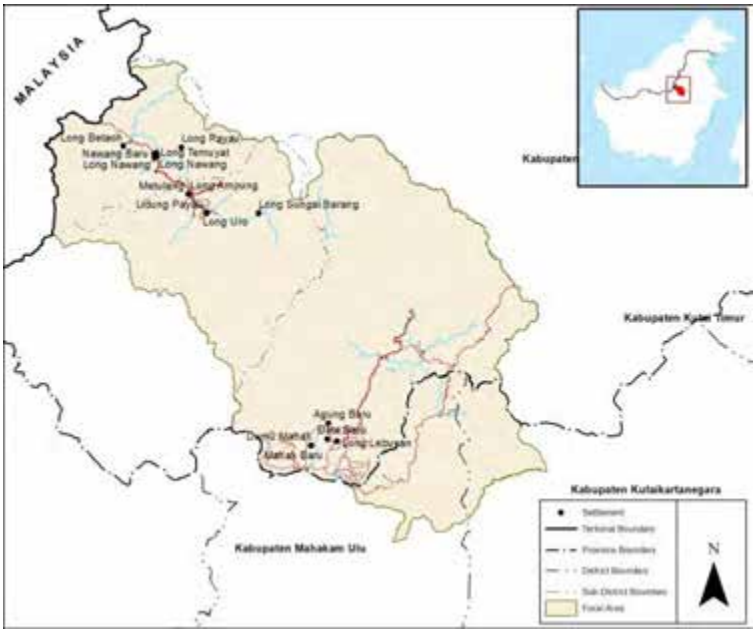


Figure 101. Sungai Boh focal area, Malinau District, North Kalimantan Province.

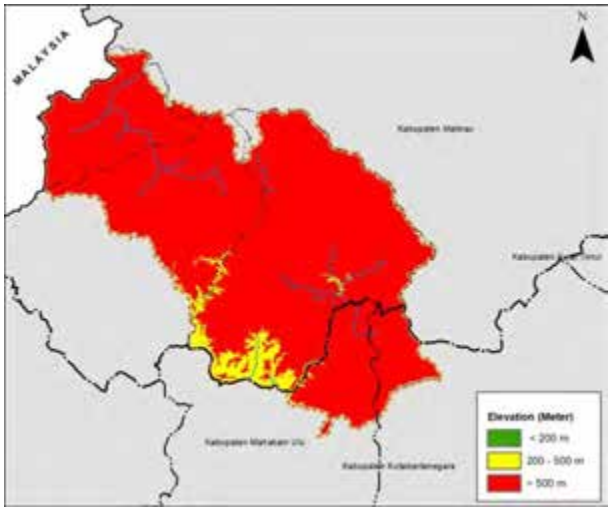


Figure 102. Topography of Sungai Boh focal area (BIG 2018).

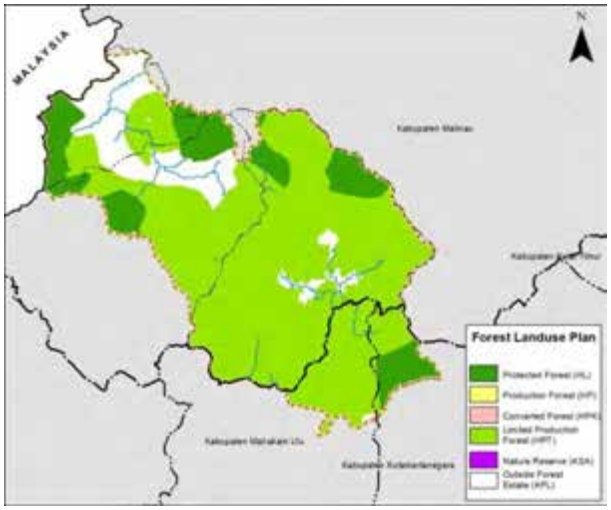


Figure 103. Forest land use plan (SK 718/2014) in Sungai Boh focal area (KLHK 2019).

According to KLHK's forest area designation (SK 718/2014), the total forest area is 458,986 Ha, which is 87.1% of the focal area. The majority (374,635 Ha) has been allocated for limited production forest. Around 83,903 Ha is allocated for protected forest, and only 448 Ha (0.1%) has been allocated for conversion. The remaining 67,025 Ha (12.7% of the focal area total area) has been allocated for other land uses (Figure 103).

According to land cover analysis 2020 carried out by SEKALA (Figure 104), the dominant land cover is primary forest (499,823 Ha; 94.9%), while the rest is mixed dryland agriculture (24,425 Ha; 4.64%),

shrubs (627 Ha; 0.12%), barren land (115 Ha; 0.02%) and settlement (358 Ha; 0.07%). Land cover change analysis between 2015 and 2020 conducted by SEKALA reveals around 10 thousand hectare of primary forest has been converted into mixed dryland agriculture in the last five years (Figure 106).

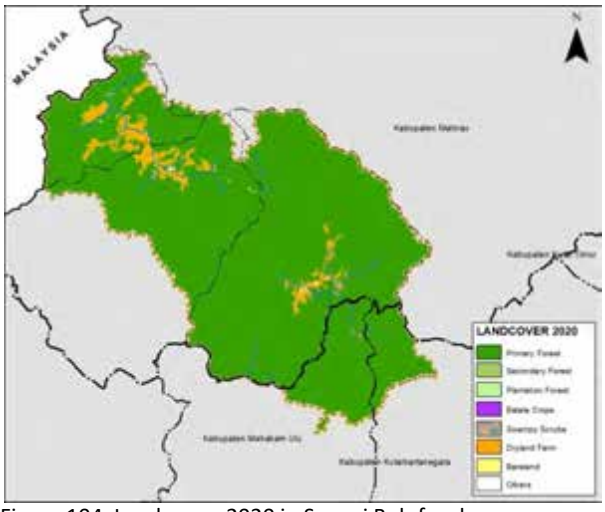


Figure 104. Land cover 2020 in Sungai Boh focal area (SEKALA).

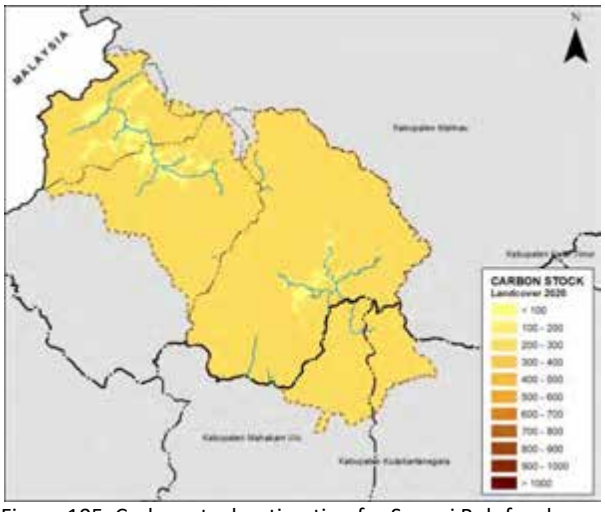


Figure 105. Carbon stock estimation for Sungai Boh focal area 2020.

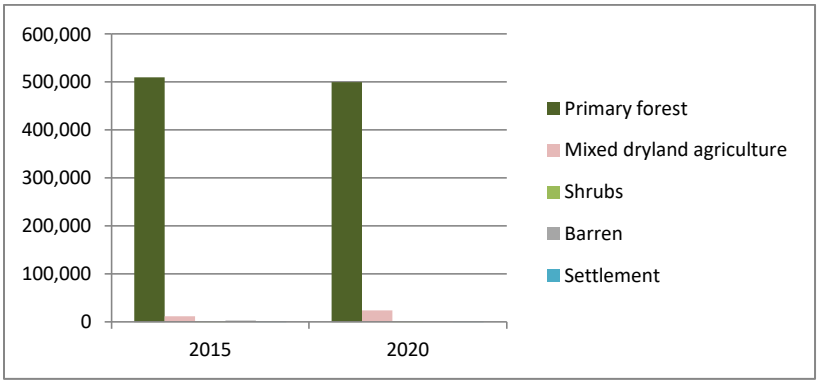


Figure 106. Comparison between 2015 and 2020 land cover of Sungai Boh focal area (SEKALA).

Estimates on carbon pools is only available for above ground biomass. Using land cover map (2020) produced by SEKALA, the total above ground carbon stock in this focal area is 0.12 GtC and change analysis of land cover between 2015 and 2020 reveals the change of biomass in the last five years is around 0.002 GtC. Figure 105 shows the distribution of the carbon stocks in tonnes per hectare.

Annual vegetation loss analysis carried out by SEKALA shows most clearing occurred in primary forest and mixed dryland agriculture in an irregular way. However, the land clearing was much lower in the period of 2018-2019 (Figure 107). This focal area is isolated and transport to this area is only by plane. Land clearing is likely to have been caused by traditional shifting cultivation practices and logging. Land clearing has mainly occurred along the rivers (Figure 109).

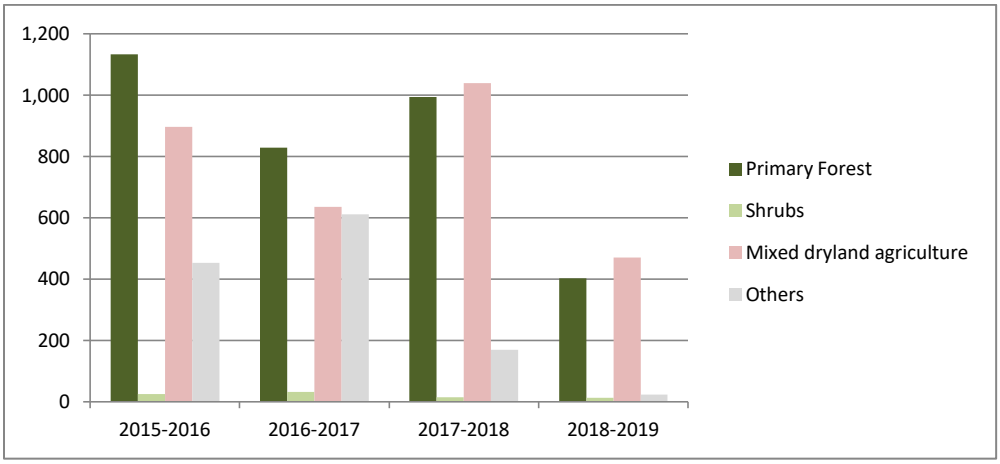


Figure 107. Annual vegetation loss 2015-2019 in Sungai Boh focal area (SEKALA).

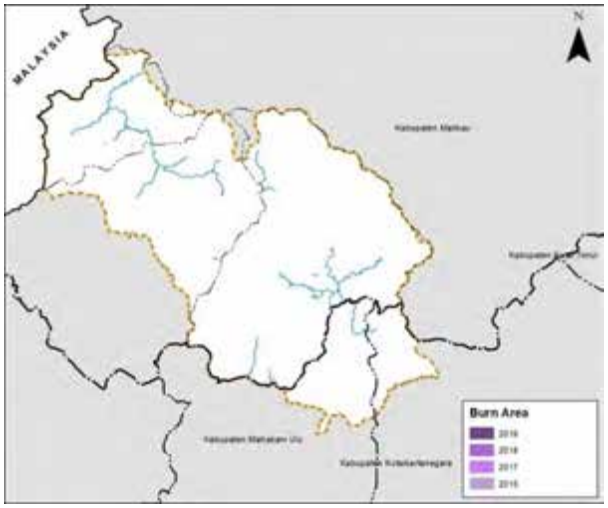


Figure 108. Burnt scar 2015-2019 in Sungai Boh focal area (KLHK).

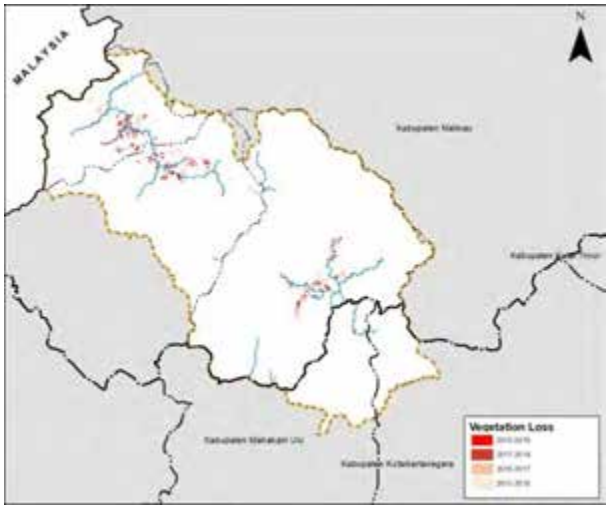


Figure 109. Annual vegetation loss distribution in Sungai Boh focal area (SEKALA).

According to KLHK's burn scar map (2015-2019), only 245 Ha of land has burned in this focal area in the last five years. Heatmap analysis shows the high intensity of active fires is along the rivers (Figure 110). This pattern is in line with the vegetation loss distribution (Figure 109).

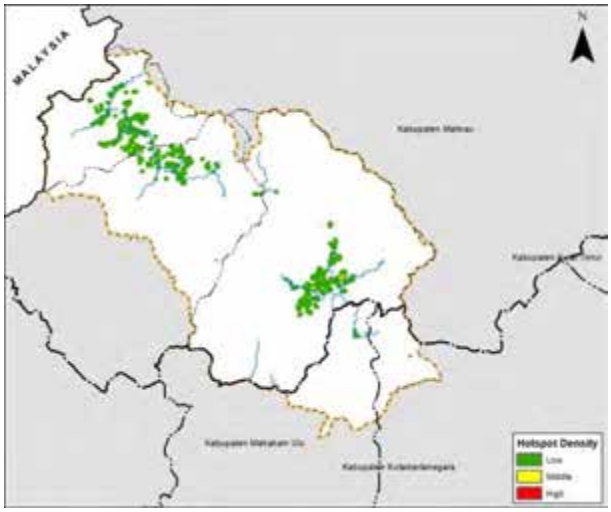


Figure 110. Heatmap of active fires 2015-mid2020 in Sungai Boh focal area (FIRMS).

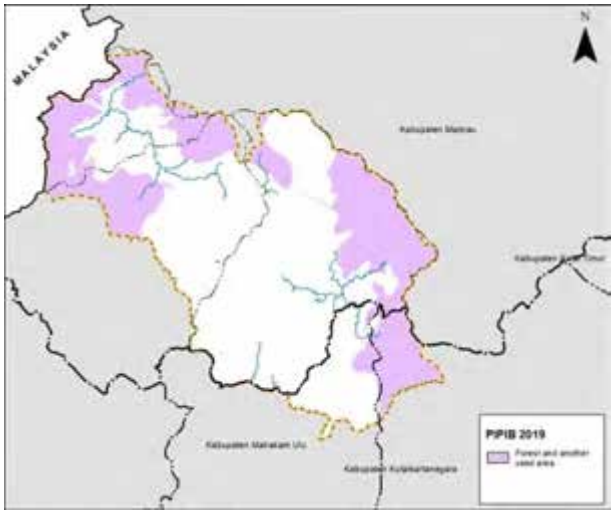


Figure 111. Permit moratorium on primary forest and peat in Sungai Boh focal area (KLHK 2019).

The KLHK's moratorium on converting peatland and primary forest (2020) suggests 181,237 Ha (34.4) of this focal area is protected from conversion (Figure 111). Of this land, 97,576 Ha is primary forest and 83,661 Ha is protected forest. The KLHK also released an indicative map on social forestry (2019); it suggests 16,843 Ha will be considered for social forestry. Of this land, 2,276 Ha has been classified as a reserve for social forestry and 14,567 Ha has been classified as having potential for social forestry (Figure 113). In addition, logging is the only large-scale land use in this focal area. Around 291,769 Ha or 55.4% of the total area has been allocated for logging in this focal area (Figure 112).

Figure 112. Large scale concession in Sungai Boh - logging (KLHK 2019).

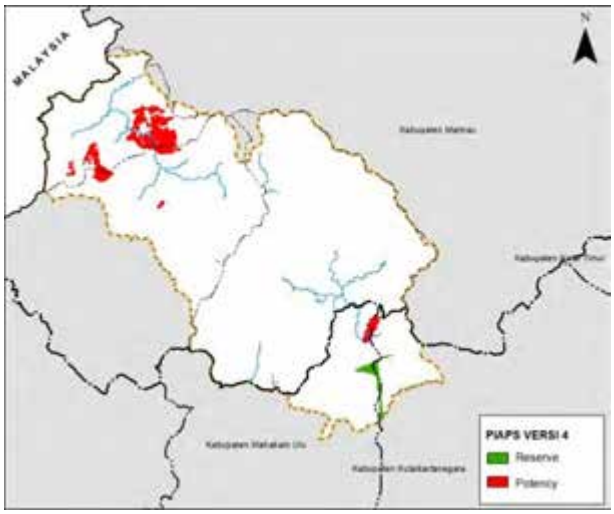


Figure 113. Indicative map for social forestry program in Sungai Boh focal area (KLHK 2019).

According to the ATR/BPN data (2019), only 79 Ha of land has been titled. The ministry is also planning to allocate 3,055 Ha of land in this focal area for land reform (Figure 114).

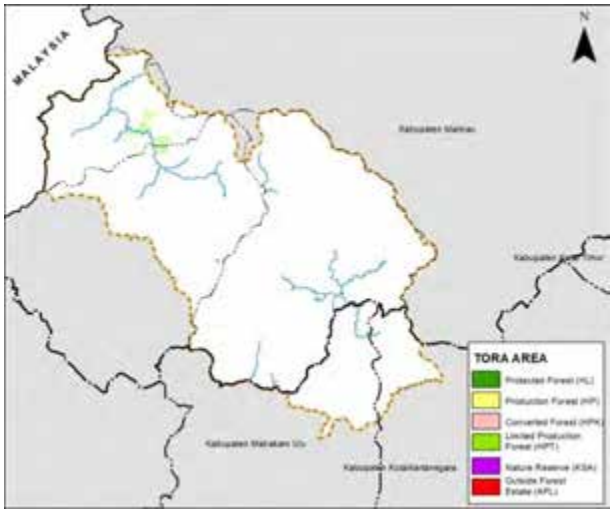


Figure 114. Land allocated for agrarian reform in Sungai Boh focal area (ATR/BPN 2019).

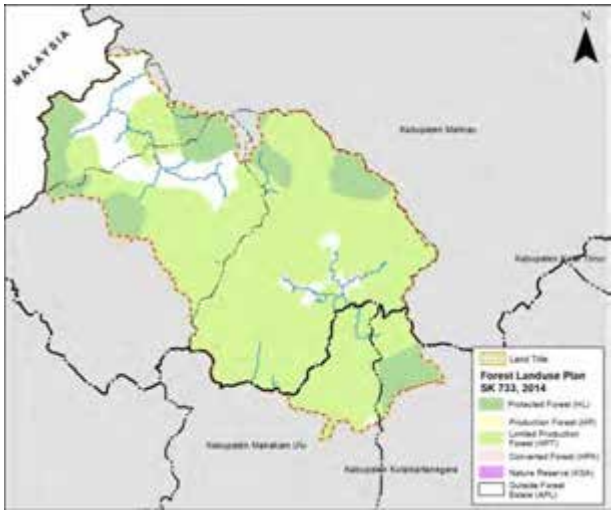


Figure 115. Land titled in Sungai Boh focal area (ATR/BPN 2019).

Sigi Focal Area

The Sigi focal area covers 16 villages in Kulawi Selatan, Dolo Selatan, Kulawi, Kinovaro, Dolo, Sigi Biromaru, Dolo Barat and Kinovaro Sub-district (Figure 116). Samdhana supported Aman Sulawesi Tengah to conduct boundary mapping of one village in Kulawi Selatan in 2016, three villages in Dolo Selatan and one village (Mataue Village) in Kulawi Sub-district from 2017 to 2018. It also supported BANTAYA to map Marena Village in Kulawi Sub-district from 2016 to 2018. Moreover, Samdhana supported Yayasan Pendidikan Rakyat (YPR) to map the village boundary for Kayumpia Village in Kinovaro Sub-district, Waturalele Village in Dolo Sub-district, and Pombewe-Rarangunau Village in Sigi Biromaru Sub-district from 2016 to 2017. In addition, Samdhana also supported Yayasan Tanah Merdeka to conduct village boundary mapping in Dolo Barat Sub-district (Kalukutinggu, Balaroa Pewunu, Sibonu) and in Kinovaro Sub-district (Uwemanje, Pobolobia, Daenggune and Balane) in 2018.

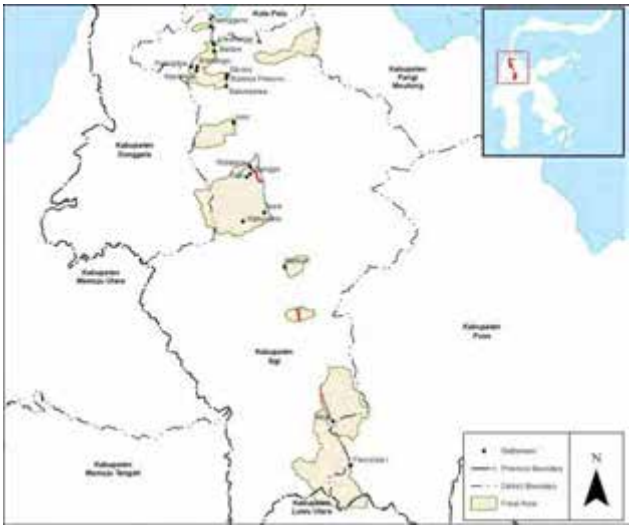


Figure 116. Sigi focal area, Central Sulawesi Province.

The focal area covers 78,102 Ha of land and the population is around 274,345 (BPS 2016); therefore the population density is 3.5 people per hectare. The majority (67,531 Ha; 86.46%) of the focal area is mountainous area with more than 500m altitude. Around 6,849 Ha (8.77%) is upland with an elevation between 200 and 500m above mean sea level, and around 3,722 Ha (4.77%) is in lowland with an altitude less than 200m (Figure 117). No peatland is found in this focal area.

According to KLHK's forest area designation map (SK 869/2014, updated 2019), the majority this focal area has been allocated as protected forest (43,707 Ha; 56%). Around 14,510 Ha (18.5%) has been allocated for conservation area, 3,164 Ha (4.1%) has been allocated for limited production forest and 16,721 Ha (21.4%) has been allocated for other land uses of non forest area (Figure 118). Land covers analysis (2020) carried out by SEKALA reveals the majority of the focal area is primary forest (43,728 Ha; 56%) and secondary forest (18,874 Ha; 24.2%). Around 8,230 Ha (10.5%) is dryland and mixed agriculture, and the rest (9.3%) is shrubs, rice field, settlement, barren land and water body (Figure 120). Land cover change analysis between 2015 and 2020 conducted by SEKALA suggests minor changes to the focal area. The focal area has lost 1,375 Ha of primary and secondary forest in the last five years. The total above ground carbon stock for this focal area is estimated to be 0.015 GtC and the loss of the carbon stocks in the last five years is 0.00034 GtC. The distribution of carbon stock in tonnes per hectare is presented in Figure 121.

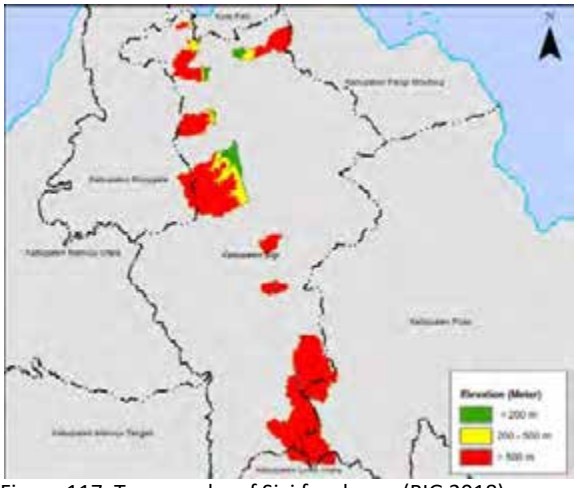


Figure 117. Topography of Sigi focal area (BIG 2018).

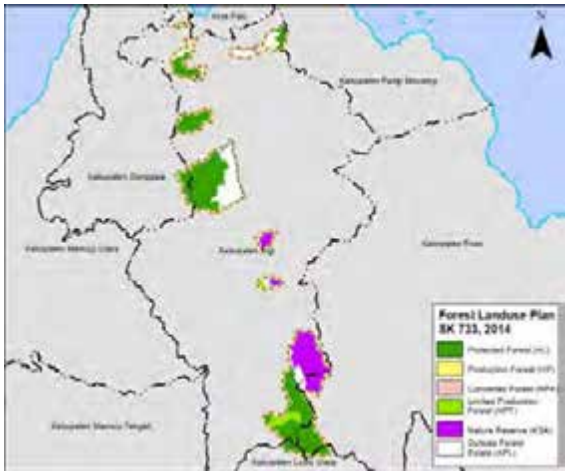


Figure 118. Forest land use plan in Sigi focal area (KLHK 2019).

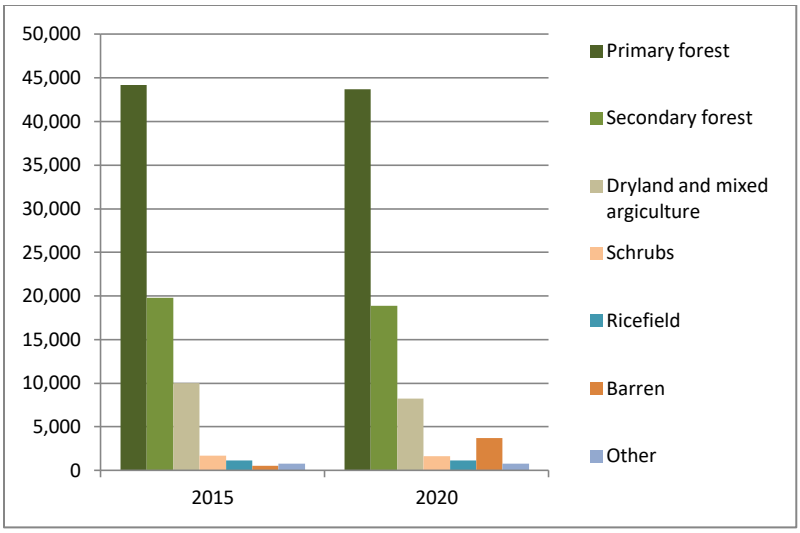


Figure 119. Comparison between 2015 and 2020 land cover (SEKALA).

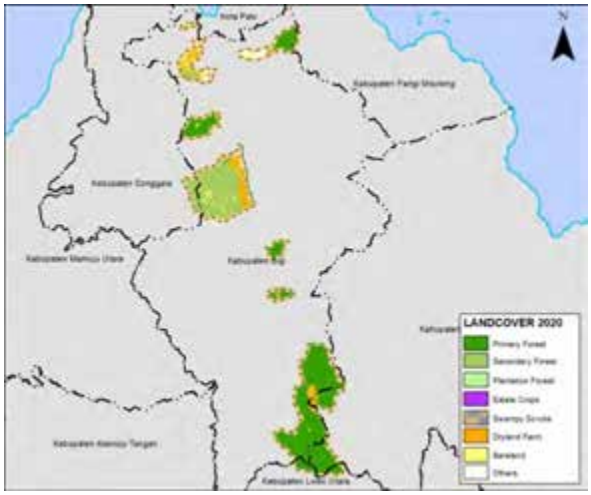


Figure 120. Land cover 2020 of Sigi focal area (SEKALA).

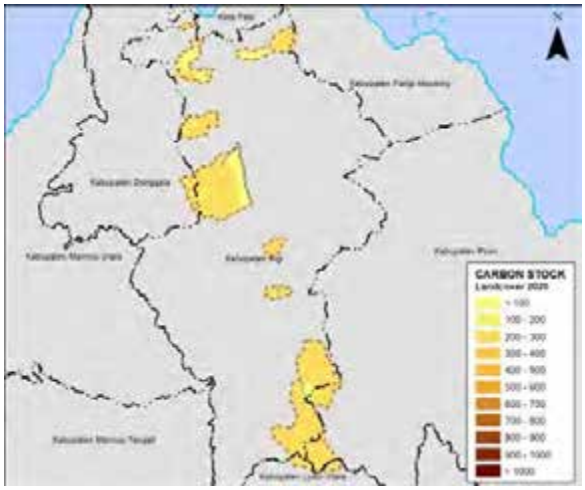


Figure 121. Carbon stock estimation 2020 for Sigi focal area.

Annual vegetation loss 2015-2020 carried out by SEKALA reveals that deforestation (loss of primary and secondary forest) annually has been below 400 hectares per year, however, deforestation significantly increased in 2018-2019 to almost 1,400 Ha. Most of the land clearing activities occurred in the middle of the focal area, in Bangga Village (Figure 122 and 123).

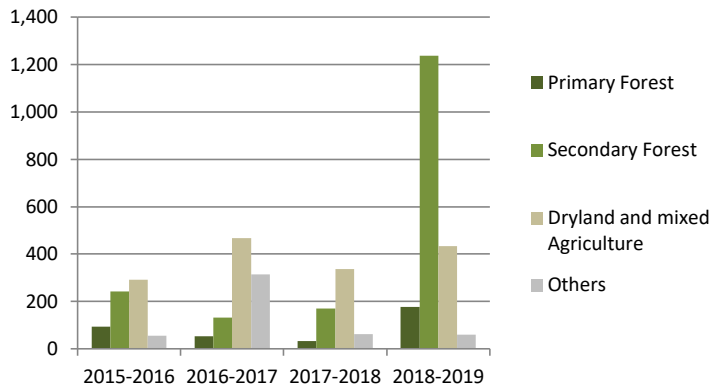


Figure 122. Annual vegetation loss 2015-2019 in Sigi focal area over land cover type (SEKALA).

Figure 123. Distribution annual vegetation loss in Sigi focal area (SEKALA).

KLHK's moratorium on converting primary forest and peatland suggests around 58,736 Ha is protected from conversion (Figure 124). Of this land, 58,257 Ha is conservation area and 479 Ha is primary forest. There are no large scale concessions in this focal area. Only one Village Forest (Walatana Village, 1,275 Ha) and one Customary Forest (MHA Kulawi, 755 Ha) have been issued in this focal area (Figure 125).

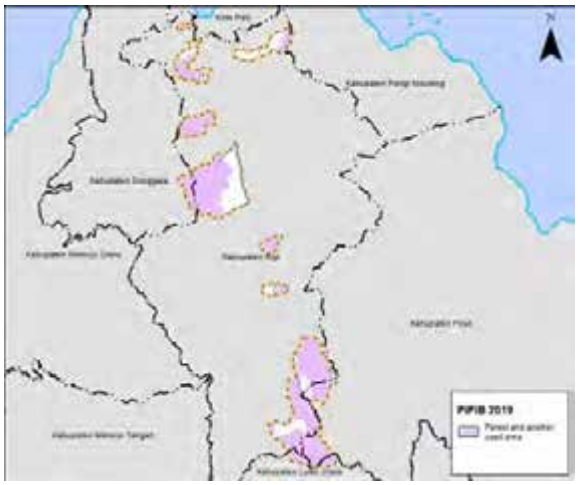


Figure 124. Permit moratorium on primary forest and peat in Sigi focal area (KLHK 2019).

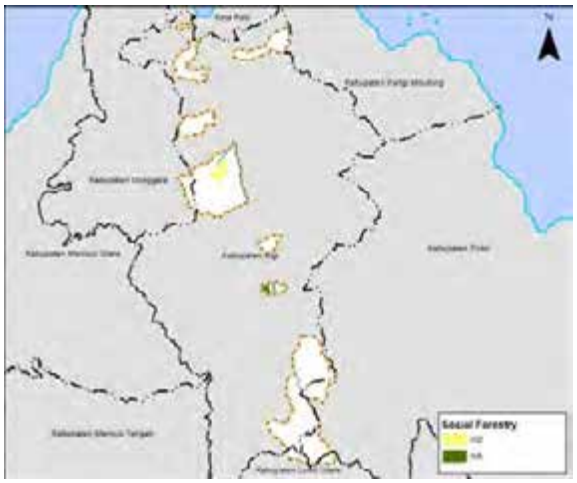


Figure 125. Village forest and customary forest in Sigi focal area (KLHK 2019).

According to KLHK's indicative map for social forestry, 200 Ha has been reserved for social forestry, which is in Pombewe Village (red arrow in Figure 126). The ATR/BPN has titled around 1,176 Ha of land in this focal area (Figure 129) and has allocated 26 hectare of land in Wisolo and Moa Village for a land reform program (red arrows in Figure 127). In addition, around 38,193 Ha of customary area in the focal area has been mapped by several NGOs (Figure 128).

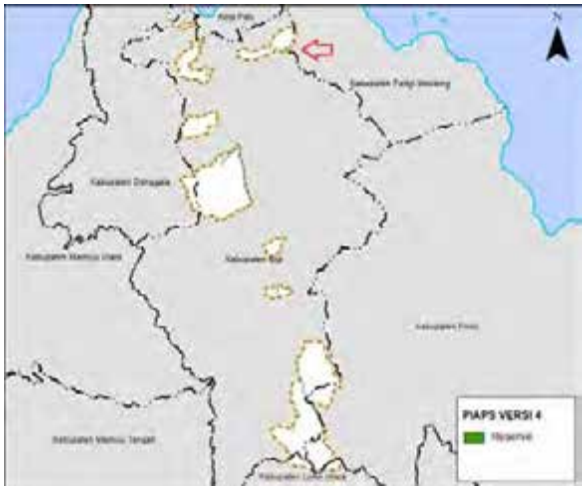


Figure 126. Indicative map for social forestry program in Sigi focal area (KLHK 2019).

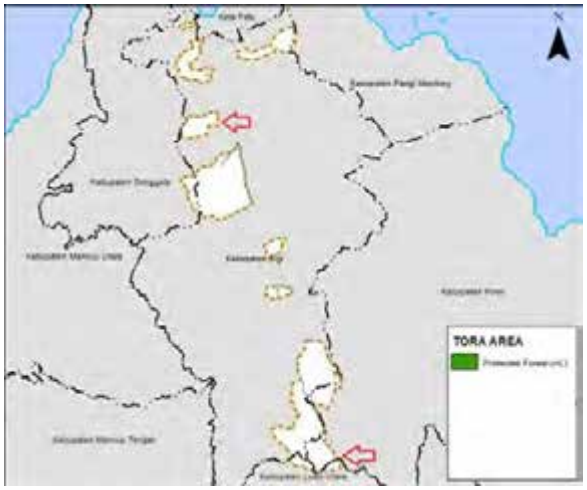


Figure 127. Land as object for land reform in Sigi focal area - red arrows (ATR/BPN 2019).

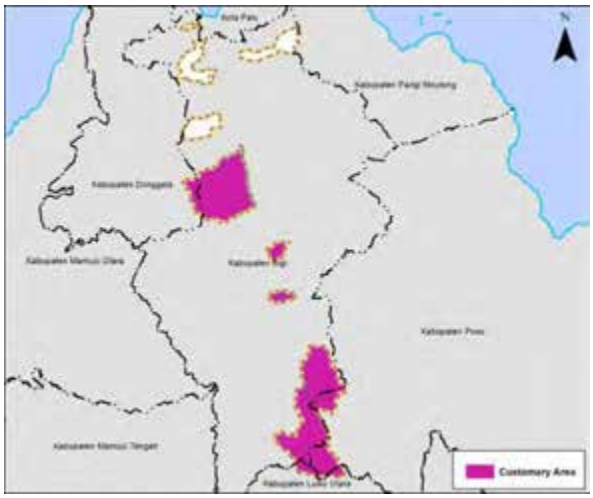


Figure 128. Customary area that has been mapped in Sigi focal area (various sources 2019).

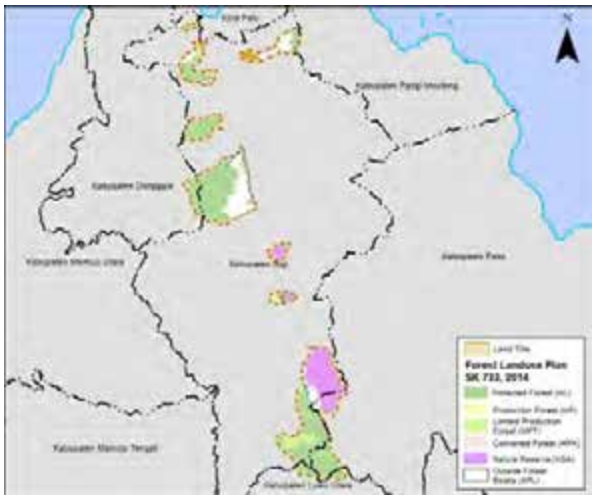


Figure 129. Land titled in Sigi focal area (ATR/BPN 2019).

Tambrauw Focal Area

The Tambrauw focal area is a customary area for the Marga Wabia and Marga Yessa in Miyah Sub-district, and Marga Baasakof and Marga Tafii in Fef Sub-district of Tambrauw District, West Papua (Figure 130). Samdhana supported Aka Wuon from 2017-2018 to conduct community mapping in Fef Sub-district and Marswanath to conduct community mapping in Miyah Sub-district. The total area of the focal area is 110,703 Ha, around 105,595 (95.4%) is mountainous area and 5,108 Ha (4.6%) is upland (Figure 131). The total number of population in this focal area is 4,786 people (BPS 2016) and the population density is 0.04 people/Ha.

Figure 130. Tambrauw focal area, West Papua Province.

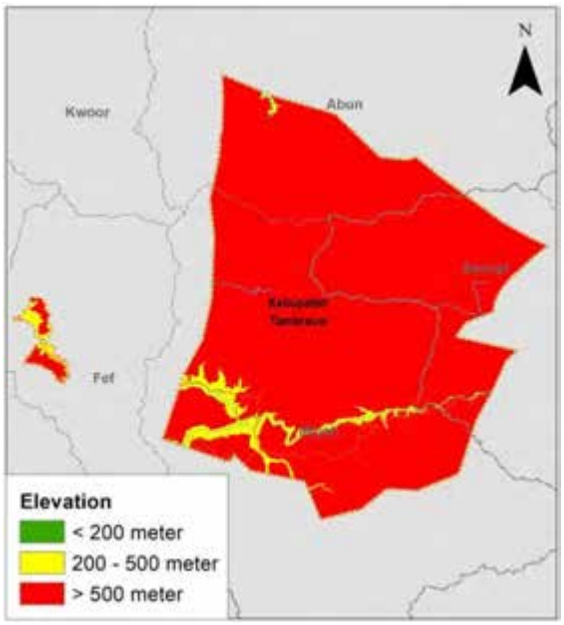


Figure 131. Topography of Tambrauw focal area (BIG 2018).

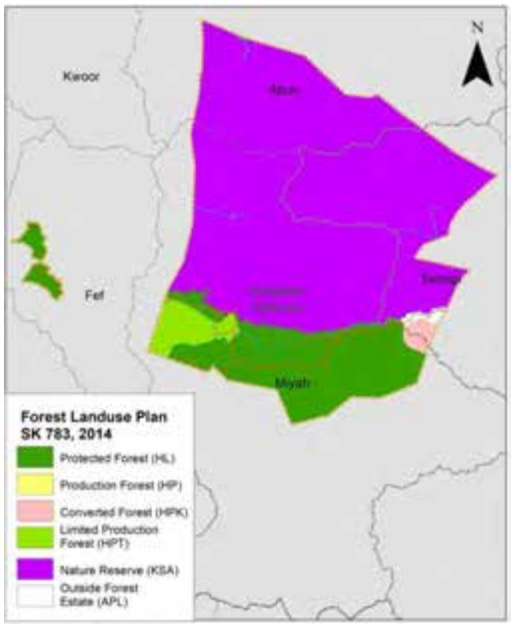


Figure 132. Forest land use in Tambraw focal area (KLHK 2019).

There is no lowland in this focal area. According to KLHK (SK 783/2014, updated 2019), the majority (82,910 Ha; 74.9%) of the focal area is allocated for conservation area, around 22,402 Ha (20.2%) is allocated for protected forest, 1,079 Ha (1%) is allocated for convertible production forest, and 3,551 Ha (3.2%) is allocated for limited production forest. Only 504 Ha (0.5%) of this area is allocated for other land uses (Figure 132).

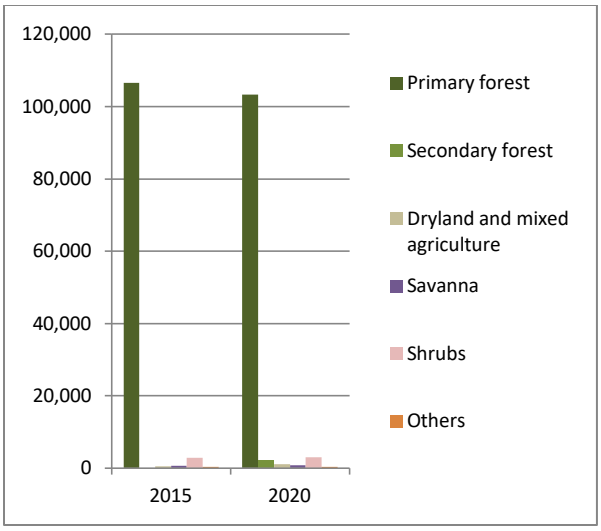


Figure 133. Comparison between 2015 and 2020 land cover in Tambraw focal area (SEKALA).

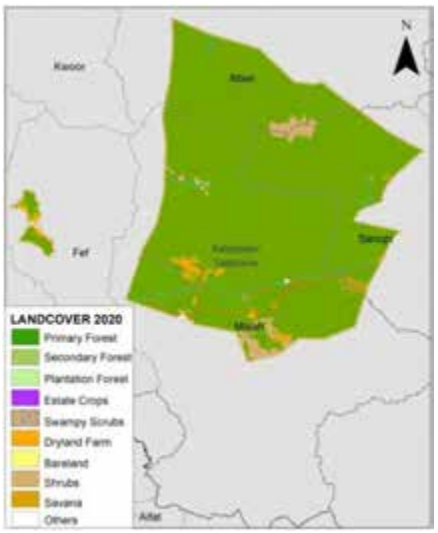


Figure 134. Land cover map 2020 of Tambrauw focal area (SEKALA).

Land cover analysis 2020 conducted by SEKALA shows the majority land cover is primary forest (103,330 Ha; 93.4%). Other land cover on this focal area is secondary forest (2,038 Ha; 1.8%), dryland and mixed agriculture (1,146 Ha; 1%), savanna (727; 0.7%), shrubs (3,052 Ha; 2.8%) and others (301 Ha; 0.3%) (Figure 134).

Figure 135. Distribution of vegetation loss 2015-2019 in Tambrauw focal area (SEKALA).

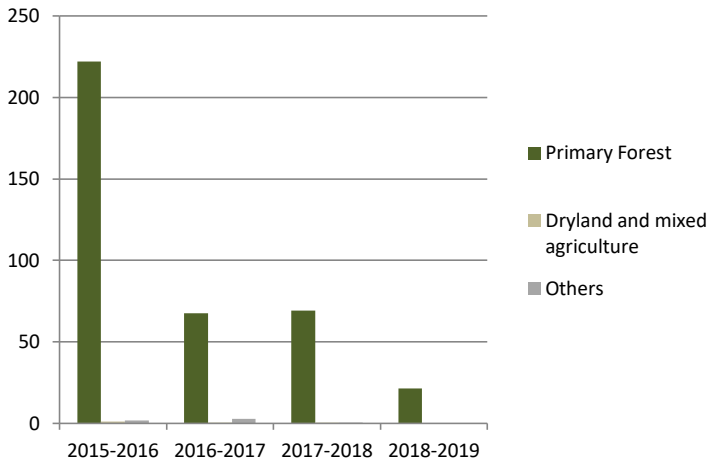


Figure 136. Annual vegetation loss over land cover type in Tambrauw focal area (SEKALA).

Land cover change 2015-2020 analysis carried out by SEKALA shows not many changes to the focal area in the last five years. Around 3,278 Ha primary forests have been reduced and 2,038 Ha secondary forests have been increased during the last five years (Figure 133). Annual vegetation loss analysis

conducted by SEKALA for 2015 to 2019 suggests that land clearing of primary forest has declined since 2015, from 222 Ha in 2015 to 22 Ha in 2019 (Figure 135 and 136).

Figure 137. Permit moratorium on primary forest and peat in Tambrauw focal area (KLHK 2019).

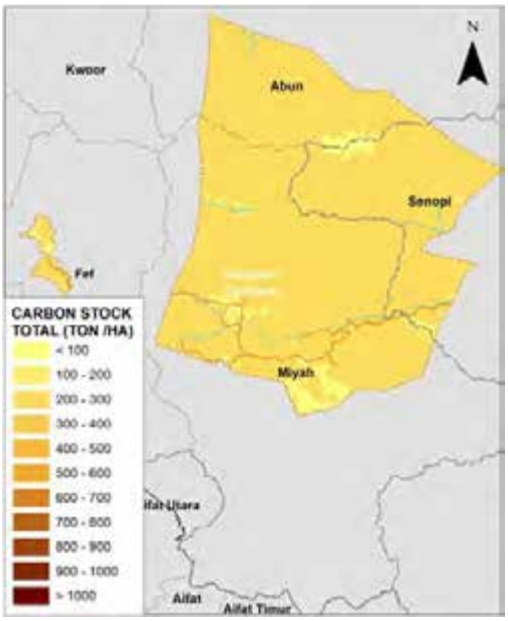


Figure 138. Carbon stock estimation in Tambrauw focal area 2020.

According to the moratorium on converting primary forest and peatland, the majority of in this focal area (108,593 Ha; 98%) is protected from conversion (Figure 137) because it is primary forest. It is estimated that there is around 0.026 GtC in the focal area. Considering the land cover change between 2015 and 2020, only around 0.0003 GtC of carbon stock has been lost during the last five years.

According to KLHK's indicative map for social forestry, 840 Ha has identified as having potential for social forest (Figure 139). No land reform has been planned for this focal area and only 17 Ha of land in this focal area has been titled (Figure 140).

Figure 139. Indicative map for social forestry program in Tambrauw focal area (KLHK 2019).

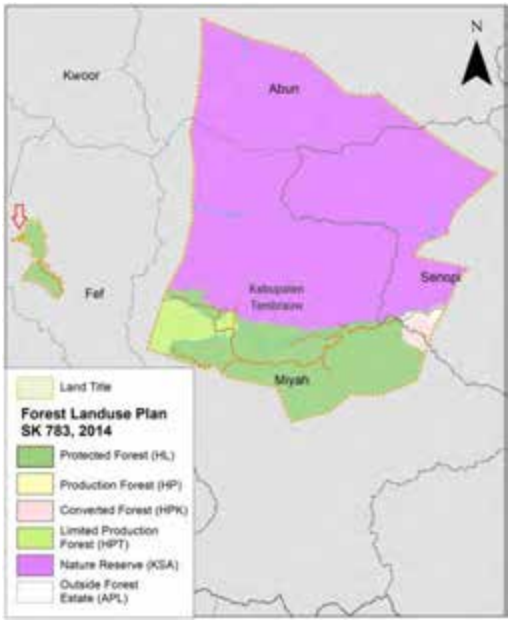


Figure 140. Land titled in Tambrauw focal area (ATR/BPN 2019).

Manokwari Selatan Focal Area

The Manokwari Selatan focal area is a village, called Kampung Siwi in Manokwari Selatan District of West Papua Province (Figure 141). Samdhana funded Mnukwar to conduct boundary mapping activities in this focal area in 2019. The focal area is located in two sub-districts: Momiwaren and Nenny. The focal area is quite small; its total area is only 7,206 Ha. Around 2,175 people live in this focal area and it has a population density 0.3 people per hectare (BPS 2016). Around 3,675 Ha (51%) of the focal area is mountainous, 2,493 Ha (34.59%) is upland, and only 1,039 Ha (14.41%) is lowland (Figure 142).

Figure 141. Manokwari Selatan focal area, West Papua Province.

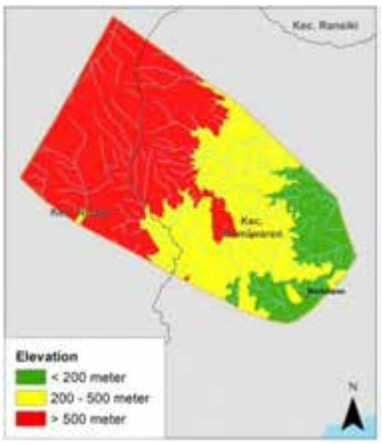


Figure 142. Topography of Manokwari Selatan focal area (BIG 2018).

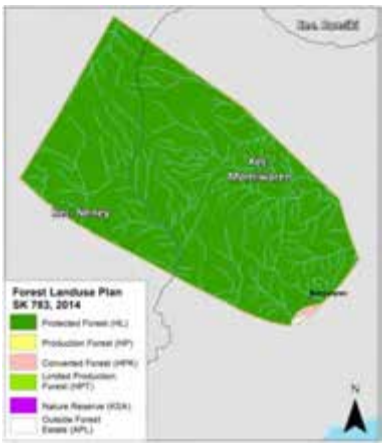


Figure 143. Forest land use plan in Manokwari Selatan (KLHK 2019).

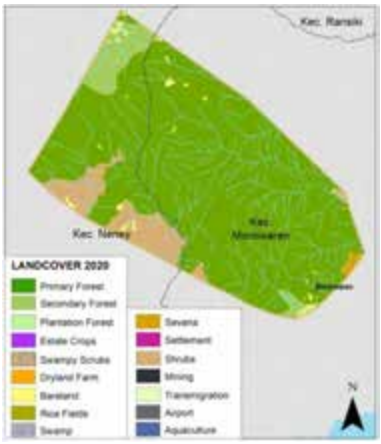


Figure 144. Land cover 2020 of Manokwari Selatan focal area (SEKALA).

According to KLHK's forest area designation map (SK 783/2014, updated in 2019), the majority (7,174 Ha; 99.6%) of this focal area is allocated for protected forest. Only 23 Ha (0.3% of the total area of the focal area) is allocated for production forest. Only 9 Ha (0.1% of the total area of the focal area) is allocated for other land uses (Figure 143). Land cover 2020 analysis conducted by SEKALA suggests that the majority of the focal area (6,099 Ha or 84.6% of the total area of the focal area) is primary forest. Around 405 Ha (5.6%) of the focal area is secondary forest, 593 Ha (8.2%) of the focal area is shrubs, 75 ha (1%) of the focal area is barren land, and 35 Ha (0.5%) of the focal area is savanna (Figure 144). Land cover change analysis for 2015 and 2020 carried out by SEKALA reveals only 362 Ha of primary forest has been converted in the last five years; but secondary forest has increased in number by around 330 Ha. SEKALA has estimated that the total carbon pool in this focal area is only 0.0016 GtC. Figure 145 shows the carbon stock distribution in tonne per hectare. In the last five years, the carbon stock loss in this focal area was only 0.000018 GtC.

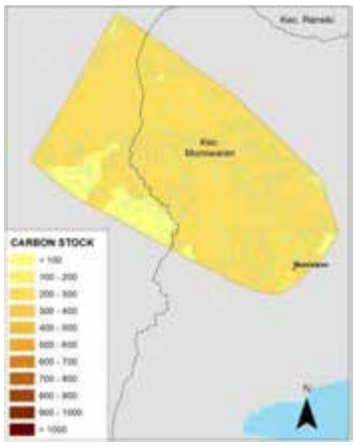


Figure 145. Carbon stocks estimation in Manokwari Selatan focal area 2020.

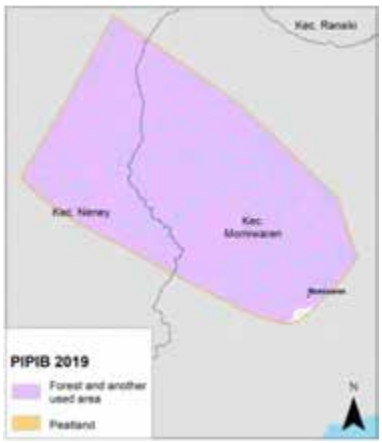


Figure 146. Permit moratorium on primary forest and peat in Manokwari Selatan focal area (KLHK 2019).

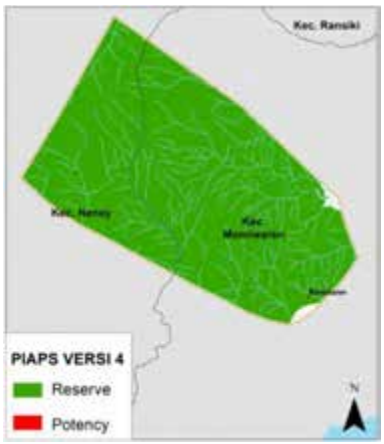


Figure 147. Indicative map of social forestry in Manokwari Selatan focal area (KLHK 2019).

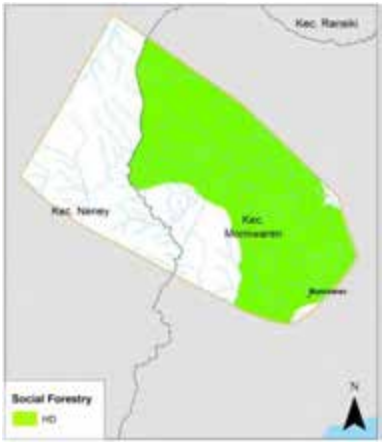


Figure 148. Village forest in Manokwari Selatan focal area (KLHK 2019).

According to the moratorium on converting primary forest and peatland data from KLHK (2019), around 7,183 Ha is protected from conversion due to primary forest (Figure 146). KLHK has allocated 6,982 Ha of this focal area for social forestry (Figure 147). In addition, KLHK has issued 7,657 Ha of this focal area for Village Forestry in Siwi Village and Kampung Demini Village.

Biak Numfor Focal Area

The Biak Numfor focal area encompasses the three customary areas of Auwr Kampung Sepse, Auwr Kampung Imdi and Auwr Kampung Soon in Biak Timur Sub-district, and two customary areas of Auwr Kampung Sauweri and Auwr Kampung Makmakerbo in Oridek Sub-district of Biak Numfor District in Papua Province (Figure 149). Samdhana supported Rumsram to conduct community mapping in this focal area from 2016 to 2018. The total area of this focal area is 18,370 Ha and 7,772 people live in the area. The population density of this focal area is 4.25 people per hectare. According to BIG (2018), the majority (18,157 Ha; 98.84%) of the focal area is lowland and only 213 Ha (1.16%) of this focal area is upland (Figure 150).

Figure 149. Biak Numfor focal area, Papua Province.

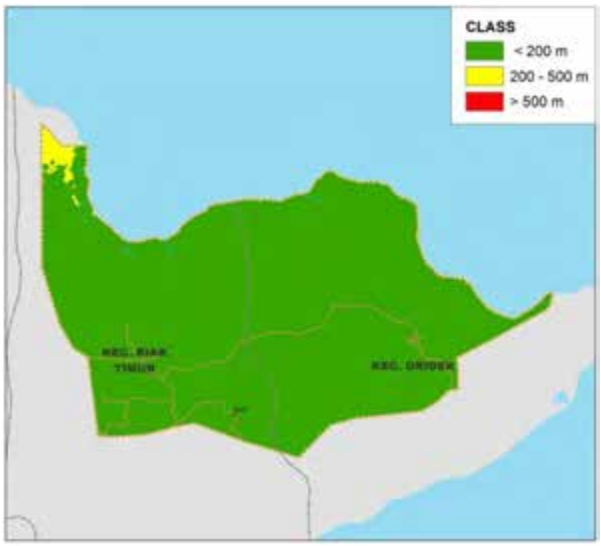


Figure 150. Topography of Biak Numfor focal area (BIG 2018).

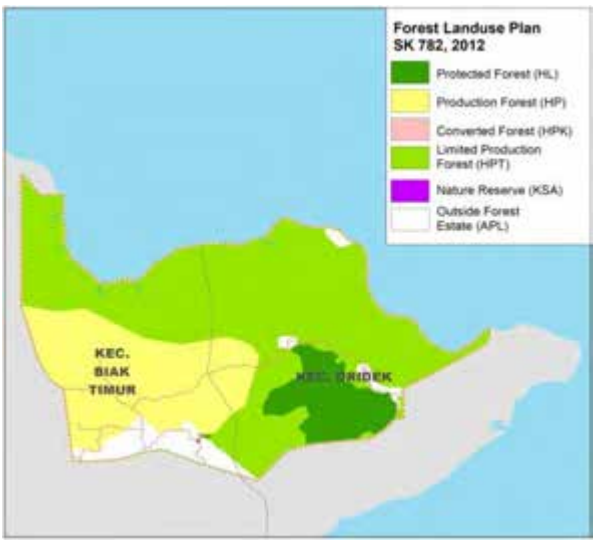


Figure 151. Forest land use plan in Biak Numfor focal area (KLHK 2019).

According to KLHK's forest area designation map (SK 782/2012, updated in 2019), around 10,446 Ha (58.86%) is allocated for limited production forest, 4,944 Ha (26.91%) is allocated for production forest, and 1,728 Ha (9.4%) is allocated for protected forest. Only 1,221 Ha (6.65%) of this focal area is allocated for other land uses (Figure 151). Analysis of the current land cover (2020) shows the majority (12,536 Ha; 68.2%) of the focal area is primary forest and around 4,527 Ha (24.6%) is secondary forest (Figure 152). Other land cover in this focal area is dryland and mixed agriculture (630 Ha; 3.4% of the total focal area), barren land (606 Ha; 3.3% of the focal area) and others (72 Ha; 0.4% of the focal area). The estimated carbon stock of this focal area is around 0.0041 GtC. Only about 0.00018 GtC has been lost in the last five based 2015 and 2020 land cover analysis. The land cover change for 2015 and 2020 suggest there was 1,466 Ha of primary forest has been reduced and 798 Ha of secondary forest have been increased in the last five years.

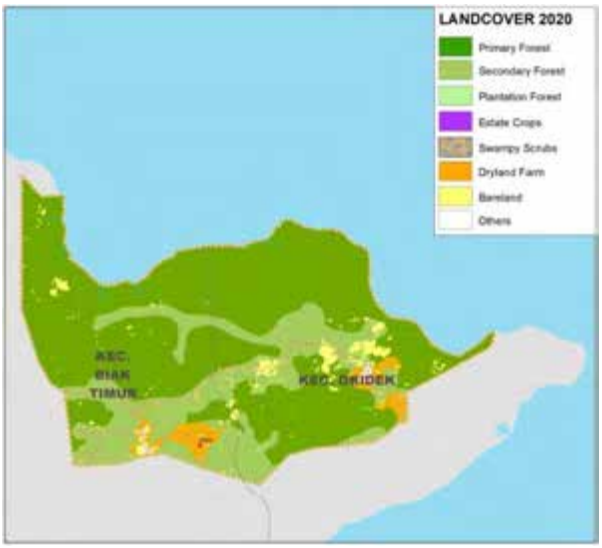


Figure 152. Land cover 2020 of Biak Numfor focal area (SEKALA).

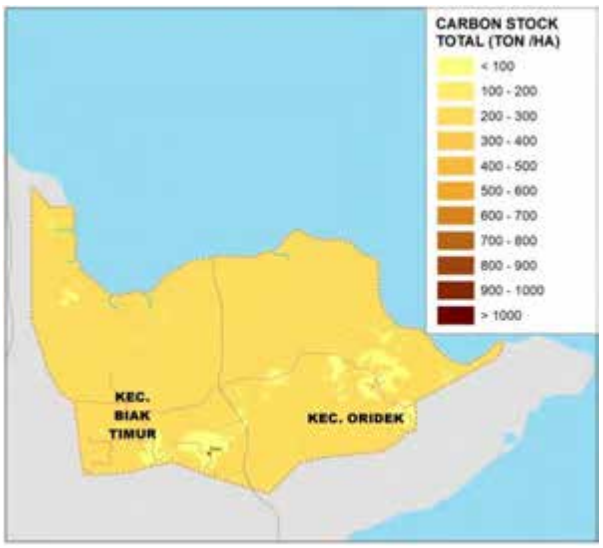


Figure 153. Carbon stock estimation 2020 for Biak Numfor.

Analysis on annual vegetation loss conducted by SEKALA suggests annual vegetation loss is irregular and relatively small. The highest deforestation is only 28 Ha in 2017-2018 and the rest is below that number (Figure 154).

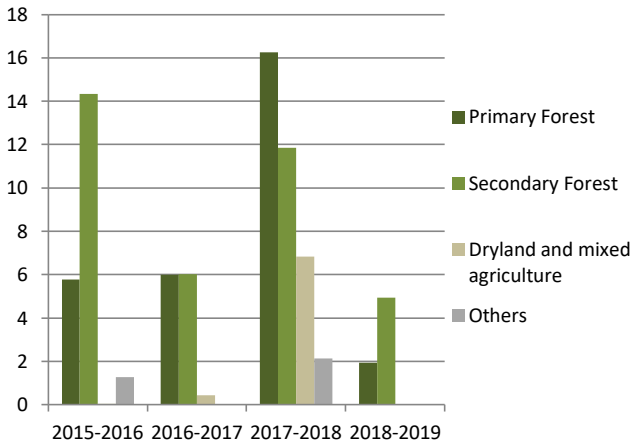


Figure 154. Annual vegetation loss 2015-2019 over land cover type in Biak Numfor focal area (SEKALA)

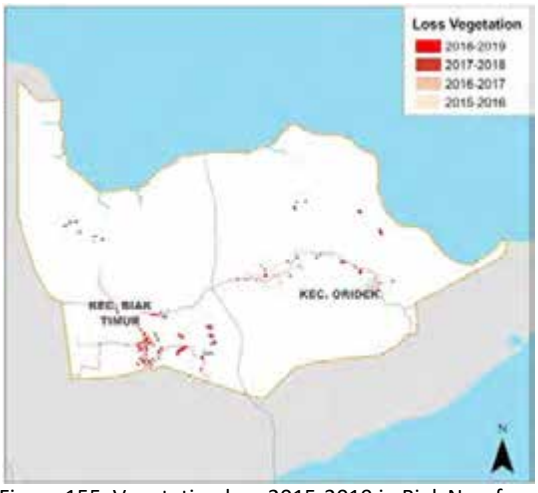


Figure 155. Vegetation loss 2015-2019 in Biak Numfor focal area (SEKALA).

The most recent moratorium on converting primary forest and peatland (KLHK 2019) determined that 12,978 Ha of this focal area is protected from conversion. Of this land, around 11,250 Ha is primary forest and 1,728 Ha is protected forest (Figure 156). According to data from KLHK (2019), around 611 Ha of Village Forest has been issued in this focal area, however, there are no available plans for social forestry in this focal area (Figure 157). According to ATR/BPN (2019), around 91 Ha of land has been

allocated in this focal area for agrarian reform (Figure 158) and up to date 124 Ha of land in this focal area has been titled (Figure 159).

Figure 156. Permit moratorium on primary forest and peat in Biak Numfor focal area (KLHK 2019).

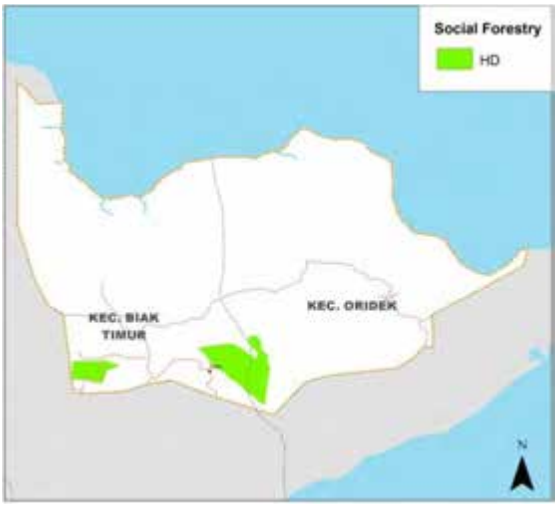


Figure 157. Village forest in Biak Numfor focal area (KLHK 2019).

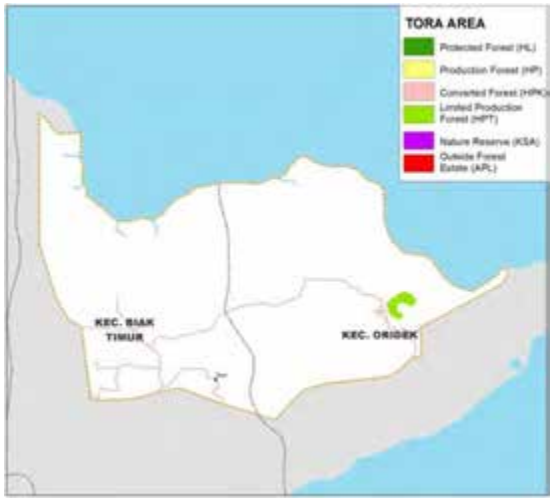


Figure 158. Land as object for agrarian reform in Biak Numfor focal area (ATR/BPN 2019).

Figure 159. Land titled in Biak Numfor focal area (ATR/BPN 2019).

Jayapura Focal Area

The Jayapura focal area covers 16 villages in Sentani Timur Sub-district of Jayapura District, Papua (Figure 160). Samdhana supported JKPP to conduct village boundary mapping in this focal area in 2019. The focal area covers 79,223 Ha and there are around 374,678 people living in the area. The population density is 4.7 people per hectare. According to BIG (2018), around 54,597 Ha (68.92%) of the focal area

is lowland, including Sentani Lake (Figure 162). Around 17,184 Ha (21.69%) of the focal area is upland and 7,441 Ha (9.39%) of the focal area is mountainous area. According to KLHK's forest area designation map (SK 782/2012, updated in 2019), around 12,312 Ha (15.5%) of the focal area is allocated for limited production forest, 11,755 Ha (14.8%) of the focal area is allocated for nature reserve, 8,461 Ha (10.7%) of the focal area is allocated for production forest, 7,146 Ha (9%) of the focal area is allocated for convertible production forest and 652 Ha (0.8%) of the focal area is allocated for protected forest. Around 30,007 Ha (37.9%) of the focal area is allocated for other land uses (Figure 161).

Figure 160. Jayapura focal area, Papua Province.

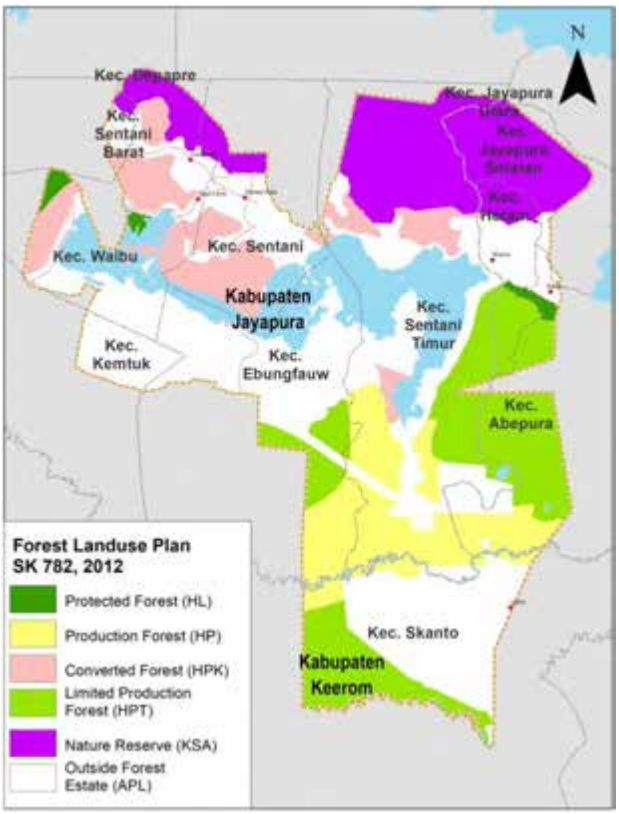


Figure 161. Forest land use plan of Jayapura focal area (KLHK 2019).

Land cover analysis conducted by SEKALA suggests that 11,411 Ha (14.4%) of the focal area is primary forest and around 31,540 Ha (39.8%) is secondary forest. Other land cover is shrubs (6,570 Ha; 8.3%), oil palm plantation (237 Ha; 0.3%), dryland and mixed agriculture (5,904 Ha; 7.5%), savanna (7,805 Ha; 9.9%), barren land (1,276 Ha; 1.6%) and others (14,480 Ha; 18.3%) which is settlement, airport, transmigration area and water body (Figure 164). Land cover change analysis between 2015 and 2020 shows that deforestation in this focal area has been around 2,614 Ha in the last five years (Figure 165).

The estimated above ground carbon stock of this focal area is 0.01 GtC. The carbon stock change analysis using land cover 2015 and 2020 (produced by SEKALA) concluded that around 0.00052 GtC has been lost from land cover change. Figure 163 shows the current distribution of carbon stock in this focal area.

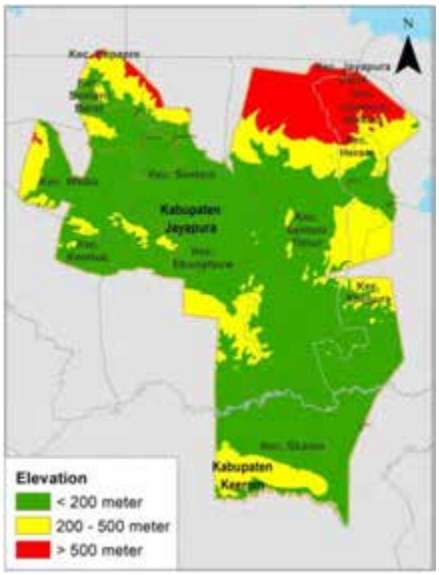


Figure 162. Topography of Jayapura focal area (BIG 2018).

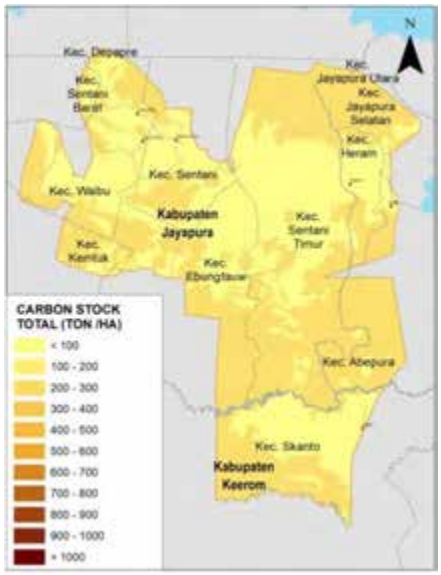


Figure 163. Carbon stock estimation in Jayapura focal area 2020.

Analysis on annual vegetation loss 2015-2019 carried out by SEKALA reveals the highest primary and secondary forest conversion occurred in 2016 when 347 Ha of secondary forest was lost and 14 Ha of primary forest was converted to other land uses (Figure 167).

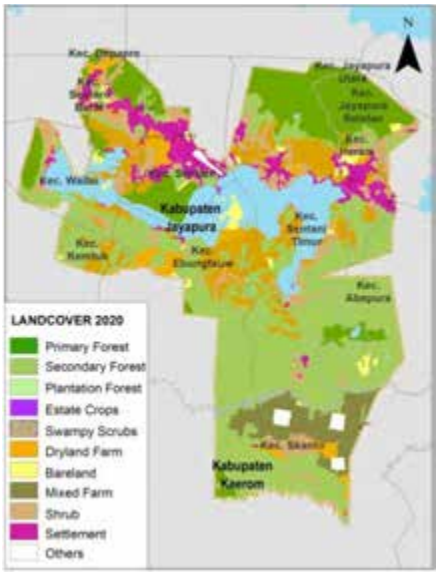


Figure 164. Land cover 2020 for Jayapura focal area (SEKALA).

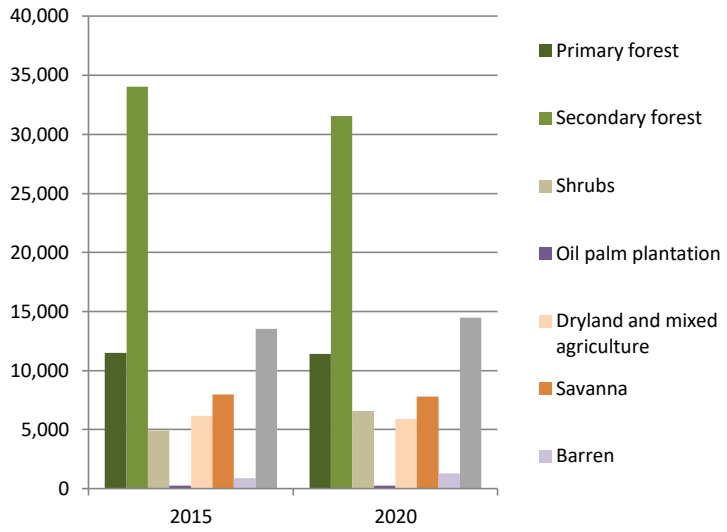


Figure 165. Comparison of land cover 2015 and 2020 in Jayapura focal area (SEKALA).

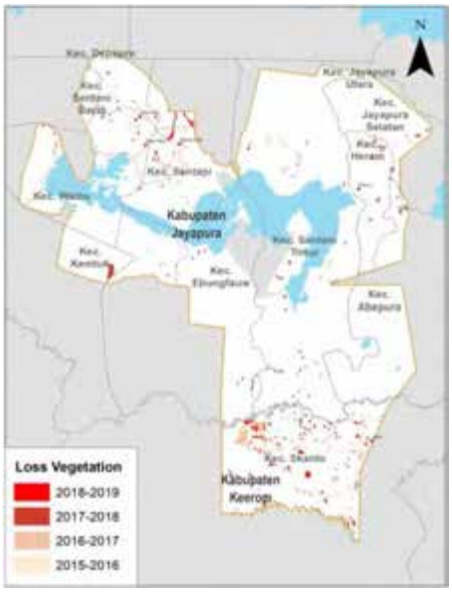


Figure 166. Annual vegetation loss 2015-2019 in Jayapura focal area (SEKALA).

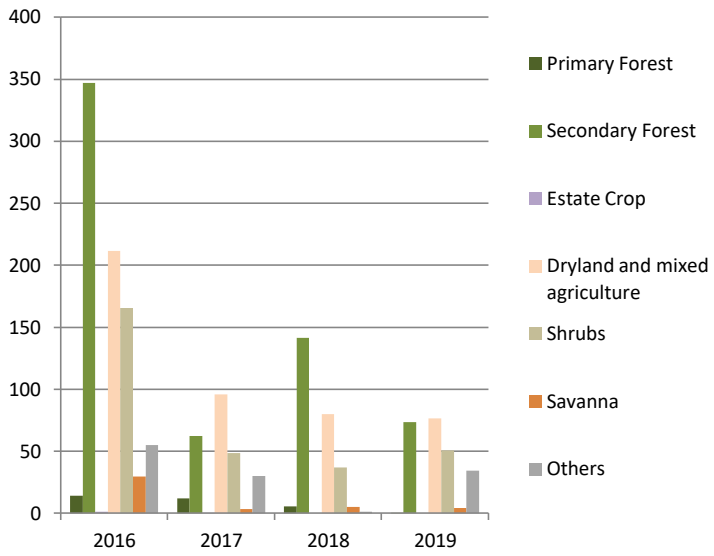


Figure 167. Annual vegetation loss 2015-2019 over land cover type in Jayapura focal area (SEKALA).

Active fires analysis using data from FIRMS shows fires occurred every year (Figure 168) in the area and was mainly located around the lake (Figure 170). According to KLHK data the largest burn scar occurred when 350 Ha was burnt (Figure 169) around the lake (Figure 171).

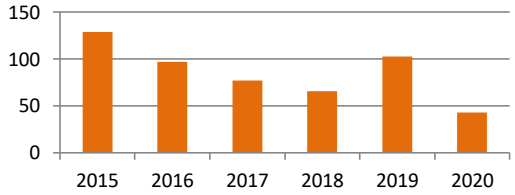


Figure 168. Active fires in Jayapura focal area from 2015 to mid 2020.

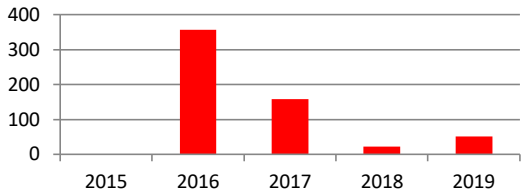


Figure 169. Burnt scar area (in Hectare) in Jayapura focal area from 2015 to 2019 (KLHK)

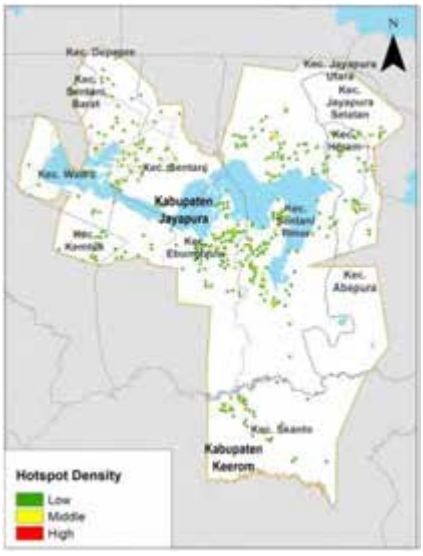


Figure 170. Active fires distribution map in Jayapura focal area from 2015 to mid 2020 (FIRMS)

According to KLHK (2020), the total area protected by the moratorium on converting primary forest and peatland is about 14,689 Ha. Of this, around 1,053 Ha is primary forest and 1,239 Ha is peatland[7] and 12,398 Ha is nature reserve and protected forest (Figure 172). There is no plan for social forestry and agrarian reform in this focal area, however, 3,296 Ha of land has been titled, according to ATR/BPN (2019), see Figure 174. In addition, only one large-scale logging concession is operating in this focal area, i.e. PT Hanurata Unit Jayapura (3,875 Ha), see Figure 173.

Figure 171. Burnt scar in Jayapura focal area 2015-2019 (KLHK).

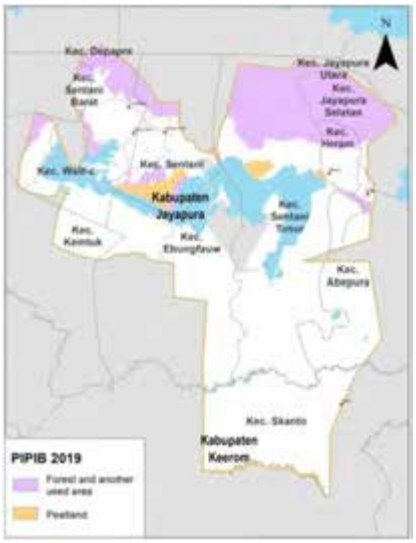


Figure 172. Permit moratorium on primary forest and peat in Jayapura focal area (KLHK 2019).

Figure 173. Large scale concession - logging, in Jayapura focal area (KLHK 2019).

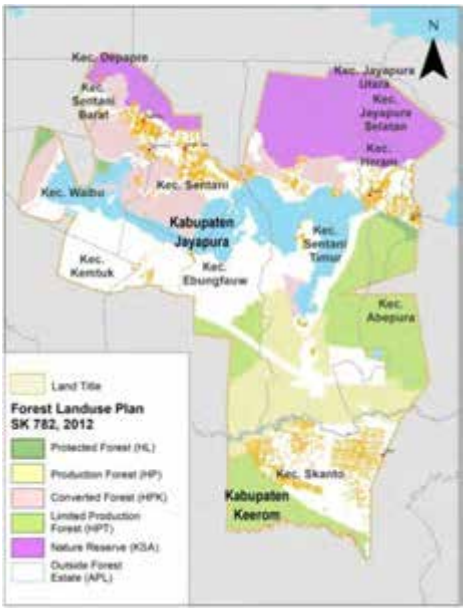


Figure 174. Land titled in Jayapura focal area (ATR/BPN 2019).

[7] KLHK has different version of peatland map. This report is using peatland data from Wetlands International due to has complete peatland classes and estimation of carbon content for every class.

Summary and Conclusion

Data compilation and satellite image interpretation has been used to analyze the current condition of customary rights, fires and deforestation in 11 focal areas supported by Samdhana. Most of the datasets have been updated and structured into folders with shapefile and geotiff file format to increase interoperability when using this data with different software. Metadata has been attached at every shapefile to guide the user.

Analysis of land cover and annual vegetation loss is useful to understand the current condition and history of change in the focal areas. New technology has been utilized to improve the accuracy of the analysis. In addition, the vegetation loss analysis suggests better understanding on historical land cover dynamics. By mapping annual vegetation loss, SEKALA was able to detect loss in every land cover type and compare to a certain year as a base. In this report, land cover for 2015 was used as a baseline and vegetation loss for every land cover type was used to present deforestation more accurately. This issue has been highlight by KLHK in response to global forest change data[8]. Summary of the spatial analysis for every focal area is presented in Table 2 below.

NGOs who supported by Samdhana, were working at 11 focal areas with two geographical units, i.e. village and customary area, to map village boundaries and customary areas. These activities were undertaken to support conflict resolution, land right security and recognition. However, the data suggests that several challenges were faced in every focal area.

Firstly, in areas where customary areas have been mapped, the majority of the customary area has been allocated for large scale development; or it has been allocated as conservation area or protected forest. In addition, outside forest area, many lands have been titled. This situation is particularly notable in the lowland and upland of Sumatra and Kalimantan Island. It is not yet prominent in southern Indonesia, especially in Papua and West Papua Province. However, KLHK have allocated more land for social forestry in Sumatra and Kalimantan than in Papua and West Papua. ATR/BPN has also allocated more land in Sumatra and Kalimantan for agrarian reform. This is likely to be due to the fact that land conflicts area more prominent 'high pressure' areas with rapid development in Sumatra and Kalimantan compare to 'low pressure' areas in Papua and West Papua. The 'high pressure' area will limit options to advocate the local community to secure their access to their land and natural resources and in the future. The 'low pressure' area will give more option for local community to secure their land and natural resources especially in lowland and upland, however, soon this become 'high pressure' due to the government plan to speed up infrastructure development in Papua and West Papua.

Secondly, social forestry especially Customary Forest and Village Forest is an opportunity for local community (including customary community) to access land and/or use inside forest area, however, the area that has been allocated is much smaller than the customary area that have been mapped. Land is titled for private use, not communal use. The ATR/BPN has released Ministerial Regulation No. 18/2019 on Guidance on Customary Land Administration that cancels communal rights because it contradicted

[8] https://www.mongabay.co.id/2014/07/22/tanggapan-terhadap-tulisan-angka-deforestasi-belinda-kajian-ilmiah-bermuatan-politis/

other regulation. This might be a challenge, however, it also provides opportunities to register customary areas or land into the land administration system without titling it as private property. This needs to be thought through in the future.

Finally, in order to make community maps useful, other spatial data is needed in order to conduct further analysis to better understand the area and make the advocacy work more strategic. However, ability to access data and conduct analysis still needs to be developed in the future.

Table 2. Summary spatial analysis for each focal area.

No	Description	Aceh	Talang Mamak	Ketapang	Pulang Pisau	Kapuas Hulu	Sungai Boh	Sigi	Tambrauw	Manokwari Selatan	Biak Numfor	Jayapura
1	Area (Ha)	17,811	194,549	3,012,741	585,297	41,024	526,633	78,102	110,703	7,206	18,370	79,223
2	Lowland (%)	7	89.9	87.6	100	90	0.04	4.8	-	14.4	98.8	68.9
3	Upland (%)	67	9.5	9.2	-	9	5.3	8.8	4.6	34.6	1.2	21.7
4	Mountain (%)	25	0.7	3.1	-	0.4	94.6	86.5	95.4	51.0	-	9.4
5	Population (People)	6,006	239,384	512,783	415,258	17,864	50,610	274,345	4,786	2,175	7,772	374,678
6	Pop. Density (People/Ha)	0.34	1.23	0.17	0.70	0.44	0.10	3.50	0.04	0.30	4.25	4.70
7	Primary forest (%)	-	1.10	6.80	-	14.80	94.90	56.00	93.40	84.60	68.20	14.40
8	Secondary forest (%)	26.5	13.30	26.30	32.46	67.50	-	24.20	1.80	5.60	24.60	39.80
9	Other land cover (%)	73.5	85.60	66.90	67.54	17.70	5.10	19.80	4.80	9.80	7.20	45.80
10	Carbon pool (GtC)	0.00134	0.0450	0.9600	2.2400	0.0100	0.1200	0.0150	0.0260	0.0016	0.0041	0.0100
11	Carbon loss (GtC)*	0.00003	0.0012	0.0420	0.0100	0.00004	0.0020	0.00034	0.00030	0.000018	0.00018	0.00052
12	Deforestation (Ha)**	202	21,120	269,485	63,300	-	10,000	1,375	1,240	32	670	2,614
13	Burnt scar (Ha)***	24	15,636	159,328	205,283	-	245	7	-	-	-	588
14	Forest area (%)	54	62	59	79.4	43.3	87.1	78.6	99.5	99.9	93.3	62
15	Other land uses (%)	46	38	41	20.6	56.7	12.9	21.4	0.5	0.1	6.7	38
16	Peat (%)	-	16	10	54	46	-	-	-	-	-	-
17	Large scale concession (Ha)	9,112	151,541	2,109,770	105,277	19,942	291,769	-	-	-	-	3,875
18	CBFM (Ha)	-	1,909	42,007	31,883	12,489	-	2,030	-	7,657	611	-
19	Moratorium (Ha)	625	38,741	539,324	416,937	14, 348	181,237	58,257	108,593	7,183	12,978	14,689
20	Indicative social forestry (Ha)	-	8,794	1,913,327	85,496	1,433	16,843	200	840	6,982	-	-
21	TORA (Ha)	617	31,525	146,036	1,595	-	3,055	26	-	-	91	-
22	Land titled (Ha)	1,295	47,716	695,178	19,629	4,976	79	1,176	17	-	124	3,296
23	Mapped customary area (%)	-	100	28	47	100	100	49	100	-	100	100

Note: * Carbon pool loss from 2015 to present (mid 2020)
** Total deforestation from 2015 to present (mid 2020)
*** Accumulated burnt scar from 2015 to 2019.

References

Agus, F, Maswar, and Dariah, A. 2012. GHG Emissions Calculation Method in Peatlands and Agricultural Land Resources Ministry of Agriculture, Center for Agricultural Land Resources Ministry of Agriculture, Training materials BAU Baseline Calculation for Local Government. Bandung 21-25 May 2012.

Endarwati, Purwanto, J., Nugroho, S., and Ruandha A.S. 2017. Identification of Forest and Land Burnt Scar Area using Semi Automatic Analysis of Landsat Satellite Imagery, Ministry of Forestry and Enviornment, National Geomantic Seminar 2017: Innovation for Providing Geospatial Information Technology for Sustainable Development, Geospatial Information Agency (BIG), Cibinong.

Jukka Miettinen, Soo Chin Liew and Leong Keong Kwoh, 2016. Usability of Sentinel-1 Dual Polarization C-Band Data for Plantation Detection in Insular Southeast Asia, Centre for Remote Imaging, Sensing and Processing National University of Singapore.

Krisnawati, H., Adinugroho, C. & Imanuddin, R. (2012). Monograph: Allometric Models for Estimating Aboveground Tree Biomass at Various Forest Ecosystem Types in Indonesia. Research and Development Center for Conservation and Rehabilitation, Forestry Research and Development Agency, Bogor.

MacKinnon, K., Hatta, G., Hali, H., and Mangal A. 1996. The Ecology of Kalimantan, Indonesian Borneo, Periplus Editions (HK) Ltd., Hong Kong, China.