1. **Supplementary material**

**SM A: Full list of criteria used to construct the bio-physical suitability map**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Criterion | Unit/description | Suit. Class 5 (Perfect) | Suit. Class 4 (High) | Suit. Class 3 (Suitable) | Suit. Class 2 (Moderate) | Suit. Class 1 (Marginal) | Suit. Class 0 (Not suitable) | Dataset used |
| Climate | **Annual Precipitation**  | mm/m2 | 2000-2500 | 1750 - 2000 | 1500 - 1750 | 1250 - 1500 | 1000 - 1250 | <1000 | WorldClim (Hijmans et al., 2005) |
| 2000-2500 | 2500-2875 | 2875-3250 | 3250 -3625 | 3625-4000 | >4000 |
| **Annual Precipitation on well-drained soils** | mm/m2 | <4000 | 4000- 4250 | 4250 - 4500 | 4500 - 4750 | 4750 - 5000 | >5000 |
| **Number of dry months**  | monthly precipitation <100 mm/m2 | 0 | 1 | 2 | 3 | 4-5 | 0 |
| **Average Annual Temperature**  | ° Celsius | 24.0 – 33.0 | 21.6 – 24.0 | 20.4 - 21.6 | 19.2 - 20.4 | 18.0 - 19.2 | <18.0 |
| 24.0 – 33.0 | 33.0 - 34.0 | 34.0 - 35.0 | 35.0 - 36.0 | 36.0 - 38.0 | >38 |
| Soil | **Pre dominant soil texture type** | Soil texture classification | Clay loamSandy clay loamSilty clay loam | Sandy loamSilt loamSilt  | Loam | Clay (heavy)Loamy sand | Sand |  | HWSD (Nachtergaele et al., 2012) |
| **Other problematic site features** | Permanently waterlogged zones considered unsuitable | - |  |  |  |  | Wetlands | MODIS (Friedl et al., 2010) |
| Topography | **Slope** | Sloping degrees | 0 – 25 |  |  |  |  |  | NASA SRTM (NASA, 2010) |
| **Elevation** | Meters | 0-1500 |  |  |  |  |  |

**SM B: Suitability maps for each bio-physical criterion: (a) Average annual temperature, (b) temperature of the coldest month, (c), annual precipitation, (d) length of the dry season, (e) soil, (f) elevation, (g) slope.**

|  |  |  |
| --- | --- | --- |
| (a) | (b) |  |
| (c) | (d) |

|  |
| --- |
| (e) |

|  |  |
| --- | --- |
| (f) | (g) |

**SM C: Review of criteria used for construction of oil palm suitability maps.**

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| --- | --- | --- | --- | --- |
| Source | Study region | Climate | Topography | Soil |
|  |  | Rainfall | Temperature | Seasonality indicator | Water deficiency | Solar radiation | Wind speed | Elevation a.s.l. | Slope | Soil type | Soil depth | Soil drainage | Soil texture | Soil fertility | Soil erosion risk | Level of the water table | Other soil property |
| Latin America |
| Ramalho Filho et al., 2010 | LegalAmazon /Brazil | X | X | X |  | X |  |  | X |  | X | X | X | X | X |  |  |
| Yui & Yeh, 2013 | Pará State /Brazil | X | X |  |  |  |  |  | X |  |  | X | X |  |  |  |  |
| Gutiérrez-Vélez et al., 2011 | Peru |  |  |  |  |  |  | X | X |  |  |  |  |  |  |  |  |
| Inter-American Development Bank, 2012 | Colombia | X | X |  |  | X | X |  | X |  | X | X | X |  |  |  |  |
| Fernandez Vargas, 2010 | Nicaragua | X | X | X |  | X |  | X |  |  | X | X |  |  |  | X |  |
| INIFAP, 2008 | Mexico | X |  |  |  |  |  | X | X |  |  |  | X |  |  |  |  |
| Africa |
| Wyrley-Birch et al, 1982 | South-West Cameroon |  |  |  |  | X | X |  |  |  |  | X |  |  |  |  | X |
| Feintrenie ,2014 | Republic of Congo | X | X |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Asia |
| Mantel et al., 2007 | Kalimantan /Indonesia  | X | X |  |  | X | X | X | X |  |  |  |  |  |  |  | X |
| Harris et al., 2013 | Indonesia,Malaysia,PapuaNew-Guinea | X | X |  |  |  |  | X | X | X |  |  |  |  |  |  |  |
| Gingold et al., 2012 | Kalimantan and Papua/ Indonesia | X |  |  |  |  |  | X | X | X | X | X |  | X |  |  |  |
| Global |
| van Velthuizen et al., 2007 | Global | X | X | X | X |  |  |  | X |  | X | X | X |  |  |  | X |
| Stickler et al., 2007 | Global | X | X | X |  |  |  |  |  |  |  |  |  |  |  |  | X |

**SM D: Available land (green) and other suitable land (dark yellow) for the twelve countries harboring the most available land. Note the scale-break between Brazil and the other countries.**



**SM E: Available land per country and suitability class.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Highly suitable area | Other suitable area  | Urban | PA's | Cropland & pasture | Palm concessions | Logging Concessions | Biodiversity priority | IFL | AGB >100t | Peatlands | Potentially available |
| Brazil | 110.27 | 306.70 | 0.52 | 222.80 | 361.89 | 0 | 0 | 9.17 | 227.06 | 321.32 | 0 | 43.36 |
| DRC | 58.28 | 108.67 | 0.27 | 22.45 | 154.26 | 0.00 | 14.04 | 6.22 | 62.06 | 122.31 | 14.04 | 38.86 |
| Indonesia | 60.72 | 87.34 | 1.21 | 16.23 | 114.95 | 14.09 | 24.91 | 22.33 | 25.96 | 111.38 | 24.91 | 18.19 |
| Colombia | 28.49 | 53.44 | 0.19 | 11.26 | 69.51 | 0 | 0 | 6.29 | 32.69 | 57.78 | 0 | 21.09 |
| Peru | 27.01 | 34.74 | 0.08 | 27.50 | 60.82 | 0 | 0 | 15.95 | 48.40 | 60.48 | 0 | 0.26 |
| Venezuela | 7.62 | 38.01 | 0.04 | 30.23 | 39.78 | 0 | 0 | 7.99 | 24.97 | 34.06 | 0 | 5.89 |
| Cameroon | 1.36 | 29.79 | 0.08 | 4.04 | 29.10 | 0.39 | 7.56 | 3.30 | 5.15 | 24.99 | 7.56 | 5.51 |
| Bolivia | 1.18 | 29.90 | 0.01 | 9.03 | 29.88 | 0 | 0 | 5.59 | 8.82 | 25.41 | 0 | 3.65 |
| Malaysia | 13.73 | 15.19 | 0.51 | 5.77 | 24.18 | 0 | 0 | 5.42 | 1.57 | 25.27 | 0 | 2.15 |
| PNG | 10.55 | 18.19 | 0.03 | 0.48 | 27.69 | 0 | 0 | 2.10 | 10.11 | 23.61 | 0 | 3.78 |
| Congo | 0.34 | 28.22 | 0.03 | 9.29 | 25.68 | 0.04 | 12.91 | 0 | 12.10 | 19.64 | 12.91 | 6.31 |
| CAR | 0.82 | 24.41 | 0.02 | 2.75 | 24.58 | 0 | 3.44 | 0 | 0.87 | 15.68 | 3.44 | 8.91 |
| Gabon | 2.64 | 20.48 | 0.03 | 4.57 | 21.78 | 0.08 | 6.24 | 1.00 | 8.71 | 20.87 | 6.24 | 1.62 |
| Philippines | 2.22 | 20.28 | 0.48 | 3.32 | 11.42 | 0 | 0 | 8.29 | 0.25 | 11.57 | 0 | 5.77 |
| Nigeria | 0.28 | 19.99 | 0.45 | 3.26 | 11.19 | 0 | 0 | 0.53 | 0.28 | 5.17 | 0 | 11.88 |
| Cote d'Ivoire | 0.37 | 17.09 | 0.16 | 4.94 | 10.84 | 0 | 0 | 2.50 | 0.45 | 5.76 | 0 | 8.46 |
| Guyana | 4.54 | 10.22 | 0.02 | 0.62 | 14.39 | 0 | 0 | 0.87 | 10.37 | 13.95 | 0 | 0.41 |
| Suriname | 8.90 | 4.75 | 0.02 | 2.11 | 13.48 | 0 | 0 | 0 | 10.44 | 13.02 | 0 | 0.20 |
| Ghana | 0.00 | 11.91 | 0.13 | 2.37 | 5.80 | 0 | 0 | 0 | 0 | 3.10 | 0 | 7.16 |
| Ecuador | 3.05 | 7.15 | 0.01 | 3.40 | 8.97 | 0 | 0 | 2.69 | 4.15 | 9.20 | 0 | 0.54 |
| South Sudan | 0.00 | 10.09 | 0.00 | 1.35 | 9.91 | 0 | 0 | 0 | 0 | 2.09 | 0 | 6.81 |
| Liberia | 5.92 | 3.27 | 0.02 | 1.19 | 8.79 | 0.53 | 0 | 8.43 | 0.47 | 8.71 | 0 | 0.17 |
| Viet Nam | 0.16 | 8.66 | 0.10 | 1.31 | 3.73 | 0 | 0 | 0.16 | 0.05 | 3.45 | 0 | 1.61 |
| Thailand | 1.75 | 6.73 | 0.09 | 1.80 | 3.20 | 0 | 0 | 0 | 0.48 | 5.03 | 0 | 2.28 |
| Nicaragua | 4.54 | 3.44 | 0.01 | 4.05 | 4.55 | 0 | 0 | 0 | 0.95 | 6.78 | 0 | 0.68 |
| Uganda | 0.00 | 7.31 | 0.05 | 0.64 | 3.14 | 0 | 0 | 0.00 | 0 | 0.51 | 0 | 6.09 |
| French Guiana | 5.25 | 1.95 | 0.01 | 4.11 | 7.18 | 0 | 0 | 0 | 6.10 | 7.10 | 0 | 0.03 |
| Mexico | 1.70 | 4.86 | 0.04 | 0.90 | 2.66 | 0 | 0 | 0.00 | 0.30 | 3.46 | 0 | 1.91 |
| Panama | 0.99 | 5.34 | 0.02 | 1.80 | 4.35 | 0 | 0 | 0.49 | 1.19 | 3.78 | 0 | 2.08 |
| Cambodia | 0.10 | 5.60 | 0.00 | 1.78 | 2.80 | 0 | 0 | 0 | 0 | 2.08 | 0 | 1.08 |
| Sierra Leone | 0.28 | 5.29 | 0.03 | 0.46 | 4.47 | 0 | 0 | 0.76 | 0 | 2.76 | 0 | 2.41 |
| Guatemala | 0.71 | 4.38 | 0.01 | 2.44 | 3.44 | 0.07 | 0 | 0.00 | 0.35 | 3.46 | 0 | 0.77 |
| Madagascar | 1.65 | 3.04 | 0.00 | 0.44 | 1.92 | 0 | 0 | 4.67 | 0.16 | 2.55 | 0 | 0.01 |
| Honduras | 0.88 | 3.78 | 0.01 | 2.03 | 3.66 | 0 | 0 | 0.08 | 0.63 | 3.73 | 0 | 0.70 |
| India | 0.06 | 3.81 | 0.06 | 0.76 | 2.95 | 0 | 0 | 1.30 | 0.07 | 2.77 | 0 | 0.58 |
| Angola | 0.00 | 3.79 | 0.00 | 0.00 | 3.69 | 0 | 0 | 0 | 0 | 1.26 | 0 | 2.52 |
| Costa Rica | 0.65 | 3.01 | 0.00 | 1.12 | 1.95 | 0 | 0 | 0.05 | 0.03 | 2.34 | 0 | 0.88 |
| Sri Lanka | 0.36 | 2.20 | 0.07 | 0.48 | 1.28 | 0 | 0 | 1.25 | 0 | 1.80 | 0 | 0.17 |
| Equatorial Guinea | 0.54 | 1.97 | 0.00 | 0.55 | 2.47 | 0 | 0.70 | 0.00 | 0.37 | 2.45 | 0.70 | 0.01 |
| Solomon Islands | 0.83 | 1.30 | 0.01 | 0.03 | 2.10 | 0 | 0 | 1.64 | 0.61 | 0.15 | 0 | 0.40 |
| Dominican Republic | 0.23 | 1.80 | 0.00 | 0.22 | 0.74 | 0 | 0 | 1.60 | 0 | 1.17 | 0 | 0.09 |
| Guinea | 0.17 | 1.80 | 0.00 | 0.14 | 1.67 | 0 | 0 | 0.52 | 0 | 0.51 | 0 | 1.24 |
| Myanmar | 0.00 | 1.82 | 0.00 | 0.42 | 1.48 | 0 | 0 | 0 | 0.33 | 1.30 | 0 | 0.37 |
| Belize | 0.13 | 1.52 | 0.00 | 0.65 | 1.45 | 0 | 0 | 0 | 0.35 | 1.36 | 0 | 0.22 |
| Fiji | 0.58 | 0.92 | 0.00 | 0.03 | 1.17 | 0 | 0 | 1.49 | 0 | 0 | 0 | 0.01 |
| Togo | 0.00 | 1.45 | 0.01 | 0.14 | 0.76 | 0 | 0 | 0 | 0 | 0.11 | 0 | 1.14 |
| Haiti | 0.10 | 1.27 | 0.00 | 0.00 | 0.10 | 0 | 0 | 1.01 | 0 | 0.39 | 0 | 0.18 |
| Benin | 0.00 | 1.04 | 0.00 | 0.09 | 0.56 | 0 | 0 | 0 | 0 | 0.00 | 0 | 0.88 |
| Timor-Leste | 0.00 | 1.01 | 0.00 | 0.13 | 0.51 | 0 | 0 | 0 | 0 | 0.36 | 0 | 0.52 |
| United Republic of Tanzania | 0.00 | 0.92 | 0.00 | 0.15 | 0.59 | 0 | 0 | 0.00 | 0 | 0.07 | 0 | 0.61 |
| Cuba | 0.00 | 0.92 | 0.00 | 0.17 | 0.52 | 0 | 0 | 0.61 | 0 | 0.53 | 0 | 0.11 |
| Vanuatu | 0.25 | 0.62 | 0.00 | 0.04 | 0.82 | 0 | 0 | 0 | 0.04 | 0 | 0 | 0.78 |
| Jamaica | 0.07 | 0.75 | 0.00 | 0.08 | 0.52 | 0 | 0 | 0.04 | 0 | 0.51 | 0 | 0.24 |
| Paraguay | 0.00 | 0.81 | 0.00 | 0.00 | 0.75 | 0 | 0 | 0 | 0 | 0.43 | 0 | 0.37 |
| Bangladesh | 0.00 | 0.76 | 0.00 | 0.04 | 0.53 | 0 | 0 | 0 | 0 | 0.51 | 0 | 0.12 |
| China | 0.00 | 0.71 | 0.01 | 0.02 | 0.21 | 0 | 0 | 0.03 | 0 | 0.08 | 0 | 0.43 |
| Puerto Rico | 0.09 | 0.57 | 0.08 | 0.03 | 0.36 | 0 | 0 | 0.62 | 0 | 0.43 | 0 | 0.02 |
| New Caledonia | 0.02 | 0.58 | 0.00 | 0.26 | 0.55 | 0 | 0 | 0.42 | 0 | 0 | 0 | 0.16 |
| Ethiopia | 0.00 | 0.60 | 0.00 | 0.15 | 0.40 | 0 | 0 | 0 | 0 | 0.10 | 0 | 0.27 |
| Brunei Darussalam | 0.44 | 0.10 | 0.00 | 0.23 | 0.52 | 0 | 0 | 0 | 0.19 | 0.50 | 0 | 0.02 |

**SM F: National objectives for oil palm planting area and available land for sustainable expansion.**

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| --- | --- | --- | --- |
| Country | Acreage objective | Available land [ha] | Source |
| Indonesia | 18 Mha  | 18.2Mha | The Jakarta Post (2009) |
| Cameroon | Increase of 0.05 Mha ha in addition to the currently existing 0.160 Mha[[1]](#footnote-1) | 5.51 Mha | Palm oil strategy of Cameroon, forthcoming; Hoyle and Levang, (2012) |
| Republic of Congo | 0.1 Mha | 6.3 Mha | INDC of the Republic of Congo (Ministry of forest economy and sustainable development (MEFD, 2014; Republic of Congo, 2015) |

**SM G: Comparison of this suitability map with the GAEZ product. Green - agreement between both products; Orange – disagreement where the GAEZ product is present only; Yellow – disagreement where our product is present only.**

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1. Note: The estimate of 160,000 ha of current planting area in Hoyle and Levang (2012) differs significantly from FAO (2014). [↑](#footnote-ref-1)