

Using Geospatial Technology to Map Potential Biofeedstock Crop Cultivation Zones and Identify Potential Conflict with Areas of High Biodiversity or Ecosystem Service Value

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Sustainable Biofuel Crops Project

- **DoE funded**
- **Multi-component**
 - **Global & regional scale mapping**
 - **Pilot projects - sustainable siting**
 - **Policy development**

- **Global scale component**
 - Mapping process
- **Potential environmental impacts**
 - Global scale
 - Conflict areas
 - Oil palm
- **Environmental impacts**
 - Regional scale
- **Potential opportunities**

At the global scale, and in general terms, where are the areas most suitable for biofeedstock cultivation based on climatic and environmental requirements?



Development of global scale potential biofuel cultivation zone maps for selected biofeedstock crops

- *Jatropha (jatropha curcas)*
- Eucalyptus*
- Sugar cane (*saccharum officinarum*)
- Soy (*glycine max*)
- Switchgrass (*panicum virgatum*)
- Cassava (*manihot esculenta*)
- Oil palm (*elaeis guineensis*)

* Mapping ~4 major species (Eucalyptus globulus, Eucalyptus nitens, Eucalyptus camaldulensis, Eucalyptus grandis)

Data inputs & sources



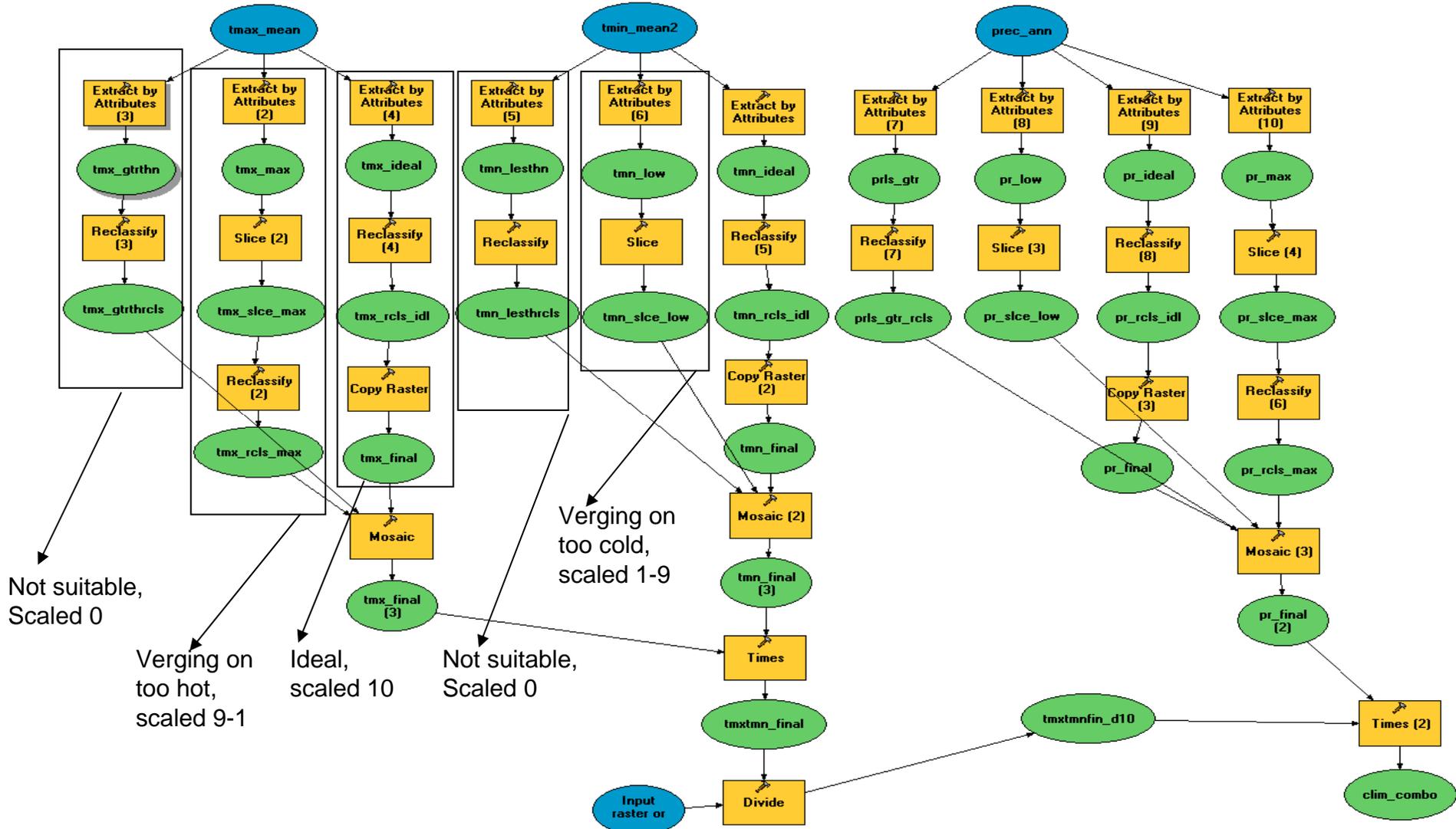
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- **Climatic & environmental crop requirements**
 - FAO Ecocrop database
 - > 2000 species
 - Aim: broad scale/basic information
- **Broad climatic parameters**
 - Hijmans et al. Worldclim current climate data
 - Minimum & maximum temperature requirements
 - Annual precipitation requirements
 - Optimal/absolute
- **Elevational requirements**
 - Resampled SRTM (Hijmans et al.)
- **Latitudinal requirements (Ecocrop)**
- **Soil & terrain**
 - Harmonized World Soil Database (HWSD)
 - Multiple soil parameters
- **Assumptions**
 - 365 day crop cycle
 - Absolute elevational range
 - Absolute latitudinal extent

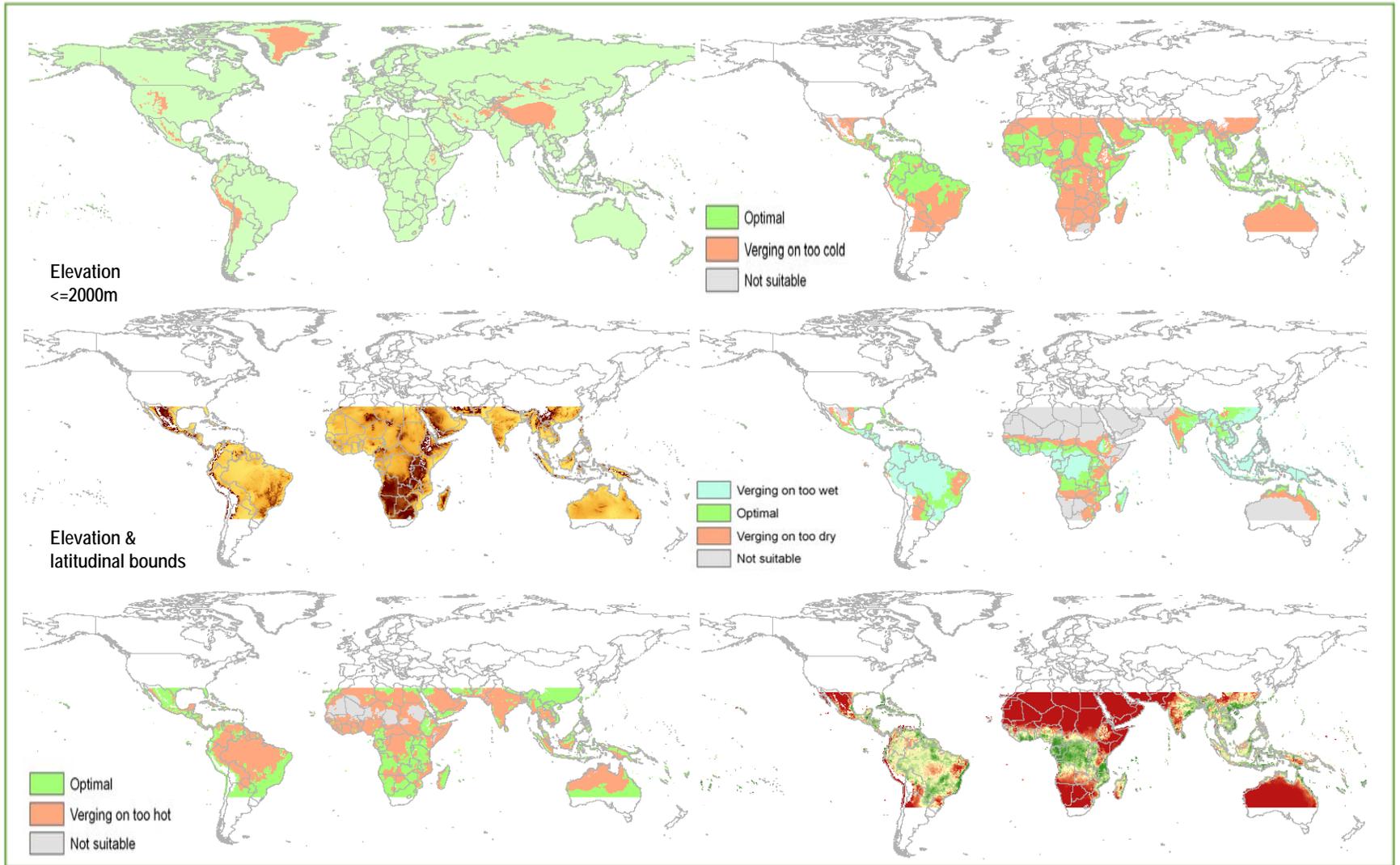
Database of crop requirements (climatic & environmental variables)

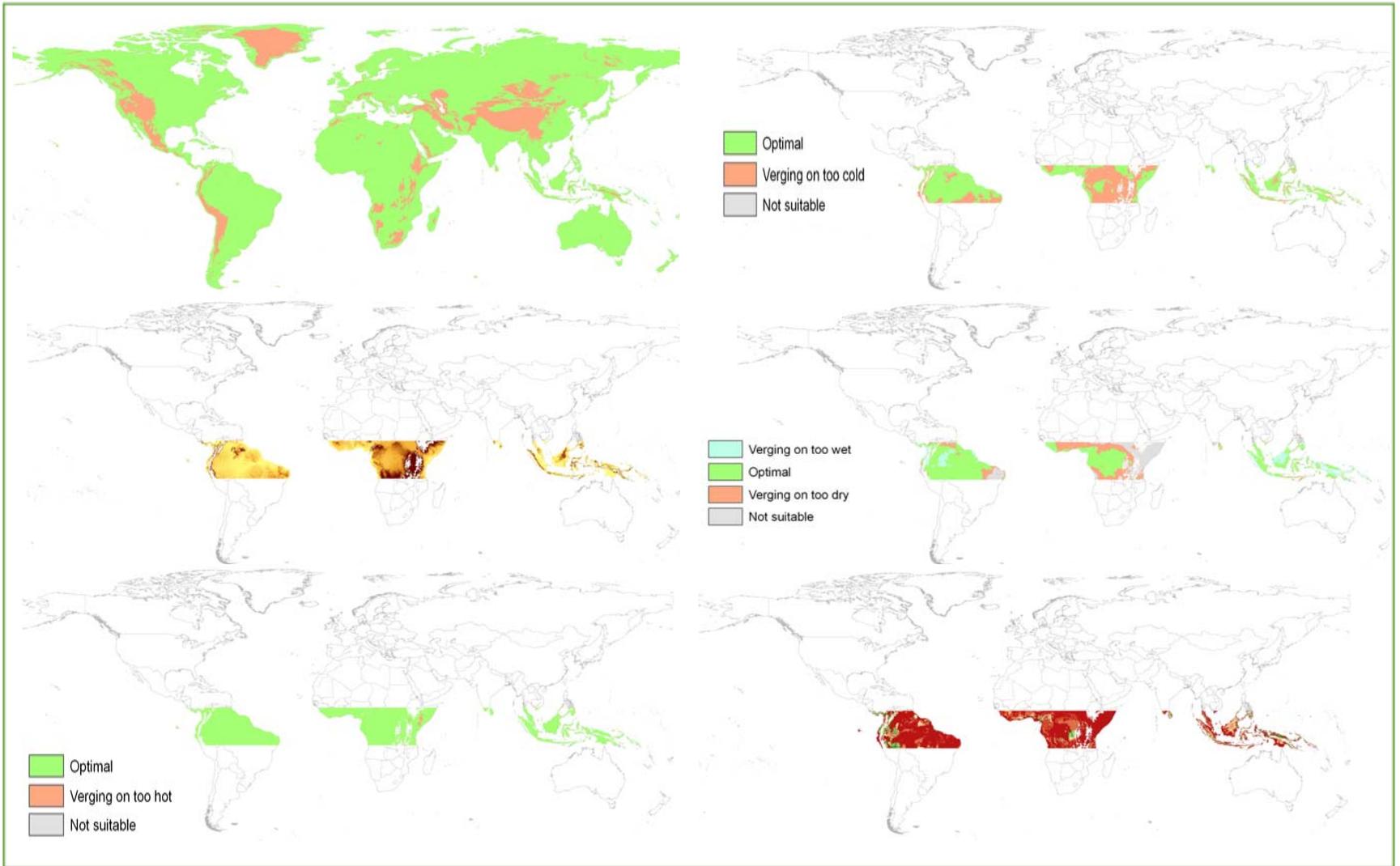


Common Name	Cassava (manihot esculenta)	Jatropha (jatropha curcas)	Oil Palm (elaeis guineensis)	Soybean (glycine max)	Switchgrass (panicum virgatum)	Sugar Cane (saccharum officinarum)
Temperature Optimal Min (dC)	20	11	20	20	17	24
Temperature Optimal Max (dC)	29	28	35	33	32	37
Temperature Absolute Min (dC)	10	7	12	10	6	15
Temperature Absolute Max (dC)	35	36	38	38	36	41
Rainfall Optimal Min (annual mm)	1000	500	1500	600	500	1500
Rainfall Optimal Max (annual mm)	1500	1500	3000	1500	1100	2000
Rainfall Absolute Min (annual mm)	500	300	1000	450	350	1000
Rainfall Absolute Max (annual mm)	5000	2000	8000	1800	2700	5000
Latitude Min (S) (absolute)	30d	28, 30d	10d	47d	-	35d
Latitude Max (N) (absolute)	30d	30d	20d	52d	-	35d
Altitude Range (m)	2000	1600	1300	3000	-	1600



Processing Stream





Refinement of climate zones based on soil attribute information



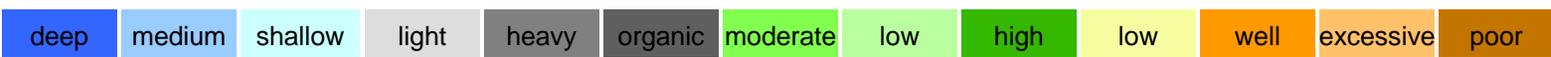
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- **Incorporation of soil attributes**
- **Harmonized World Soil Database**
 - Topsoil PH
 - Soil depth
 - Topsoil texture
 - Subsoil fertility
 - Topsoil salinity
 - Drainage

Soil attribute requirements for selected biofeedstock crops



Ecocrop variable	Cassava		Oil Palm		Jatropha		Soy		Sugarcane		Switch grass		E. globulus		E. nitens		E. camaldulensis		E. grandis	
	Opt	Abs	Opt	Abs	Opt.	Abs	Opt	Abs	Opt	Abs	Opt	Abs	Opt	Abs	Opt	Abs	Opt	Abs	Opt	Abs
Soil PH	5.5-8	4-9	4.5-6	3.2-8	5.5-7.5	5-8	5.5-6.5	4.5-8.4	5-8	4.5-9	6-7	4.9-8.2	5.5-6.5	5-7.5	6-6.5	5.5-7.5	5-7	4.5-8	5.5-6.5	5-7.5
Soil depth	medium	shallow	deep	medium	deep	deep	medium	shallow	deep	medium	medium	shallow	deep	shallow	deep	medium	deep	shallow	deep	medium
Soil texture	light	heavy	heavy	light	light	light	light	heavy	NL	NL	heavy	heavy	light	heavy	heavy	heavy	light	heavy	light	heavy
Soil fertility	moderate	moderate	high	moderate	moderate	moderate	high	moderate	high	moderate	moderate	moderate	high	moderate	high	moderate	moderate	moderate	moderate	moderate
Soil salinity	low	low	low	low	low	low	low	excessive	low	excessive	low	low	low	low	low	low	low	excessive	low	low
Soil drainage	well	well	well	well	well	well	well	poor	NL	NL	well	excessive	well	well	well	well	well	well	well	well



depth



salinity



drainage



ph



fertility



texture

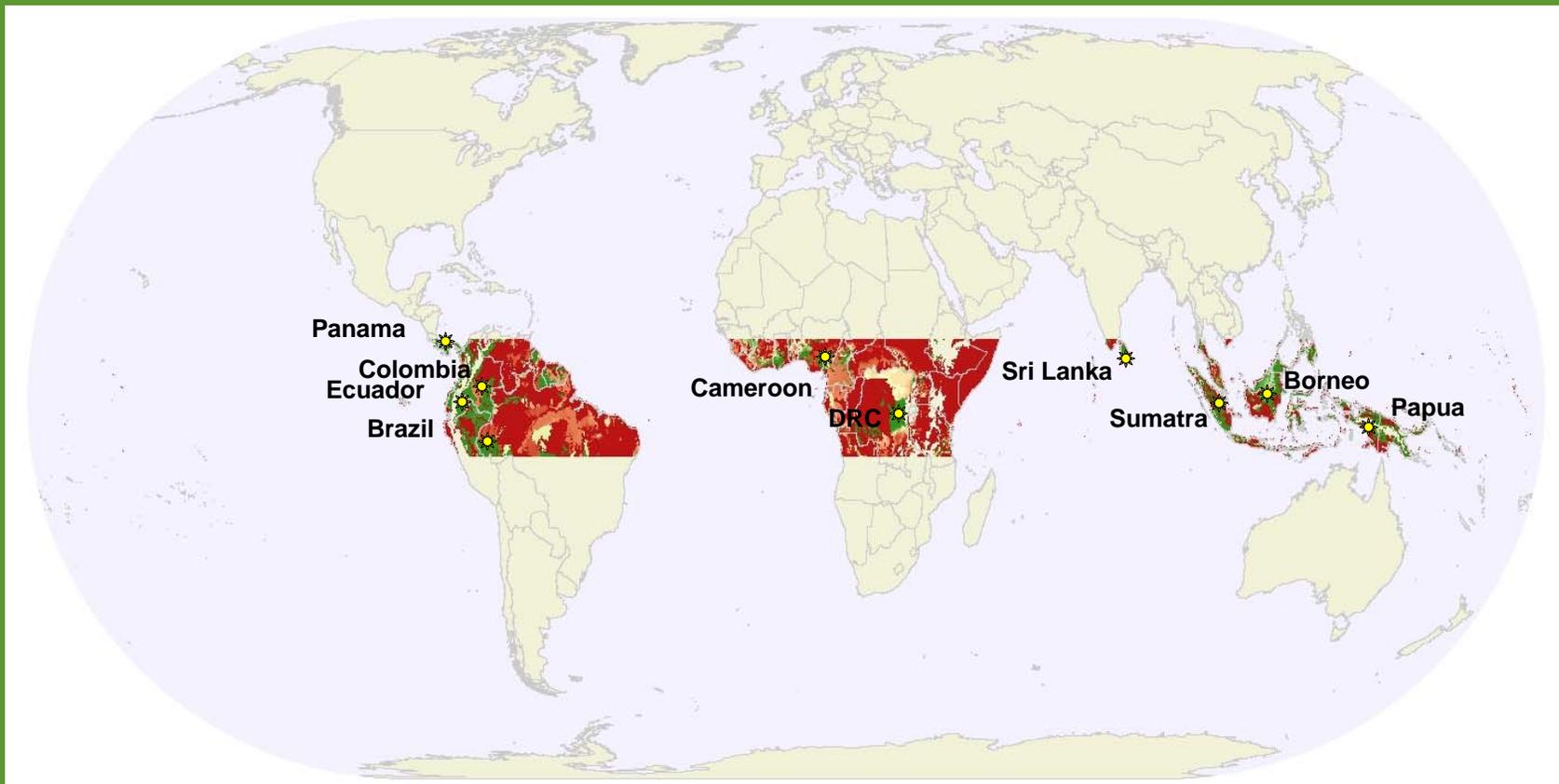


Oil palm soil requirements

Potential cultivation zone for oil palm



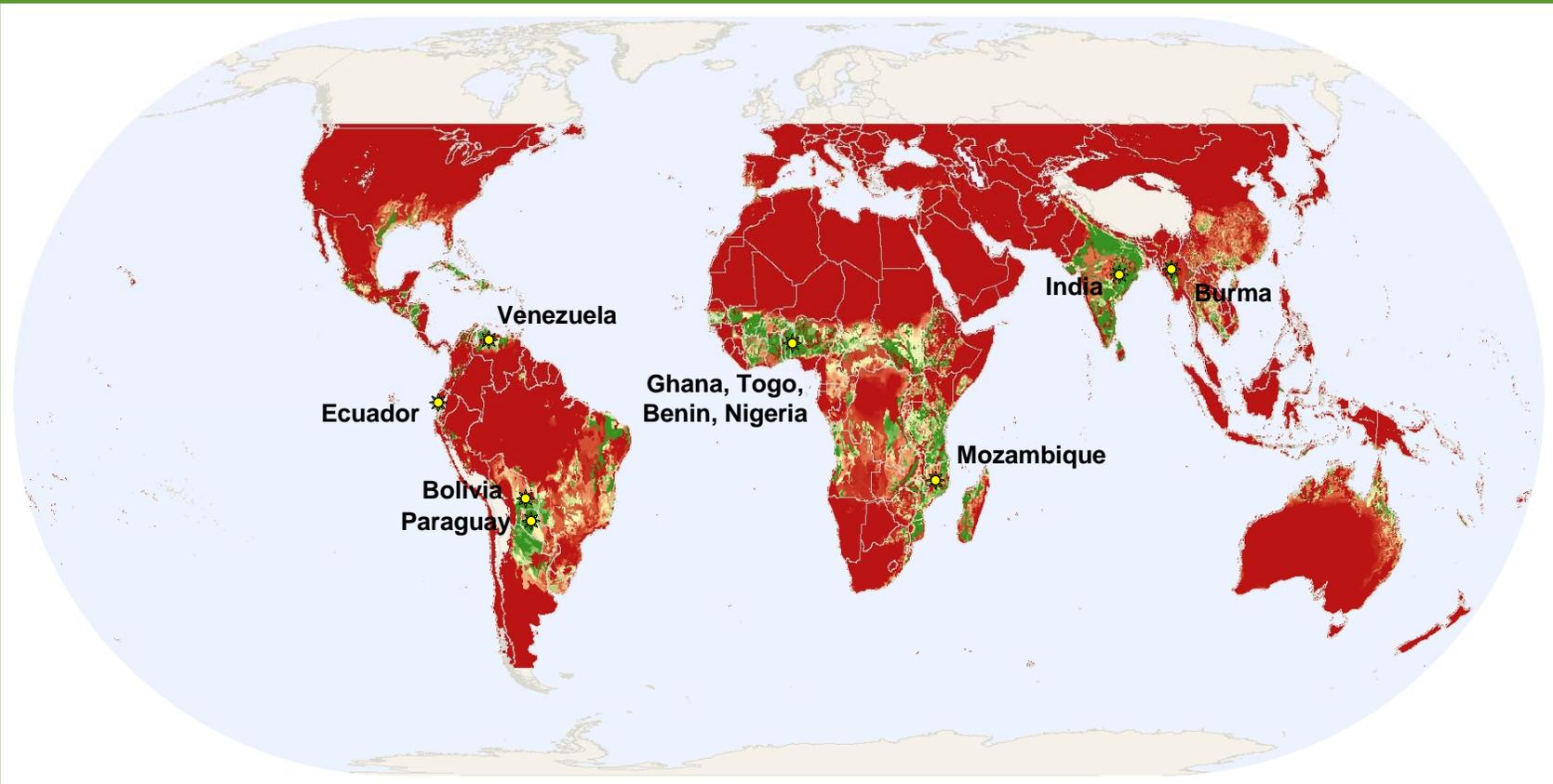
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Potential cultivation zone for soy



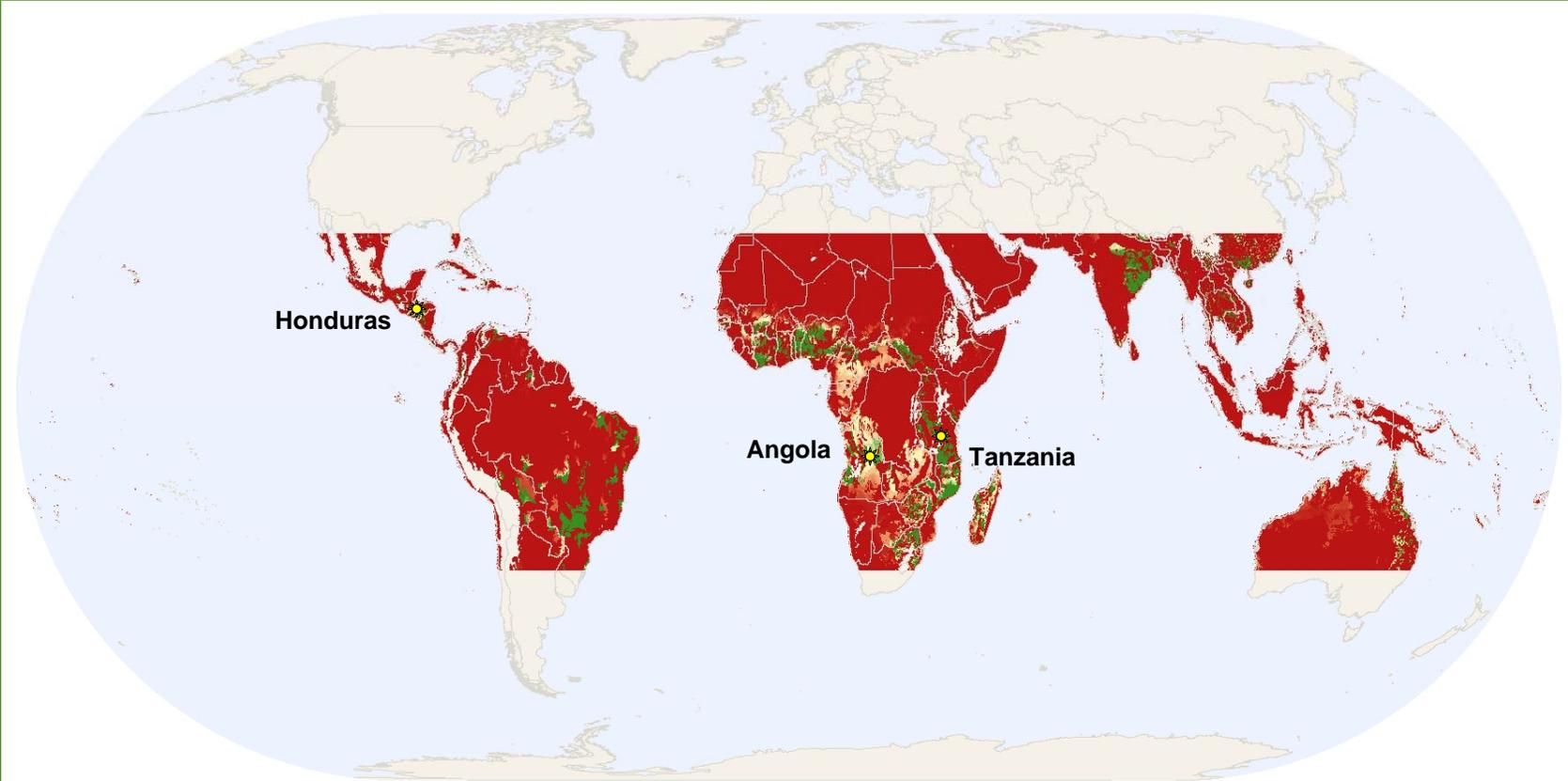
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Potential cultivation zone for jatropha



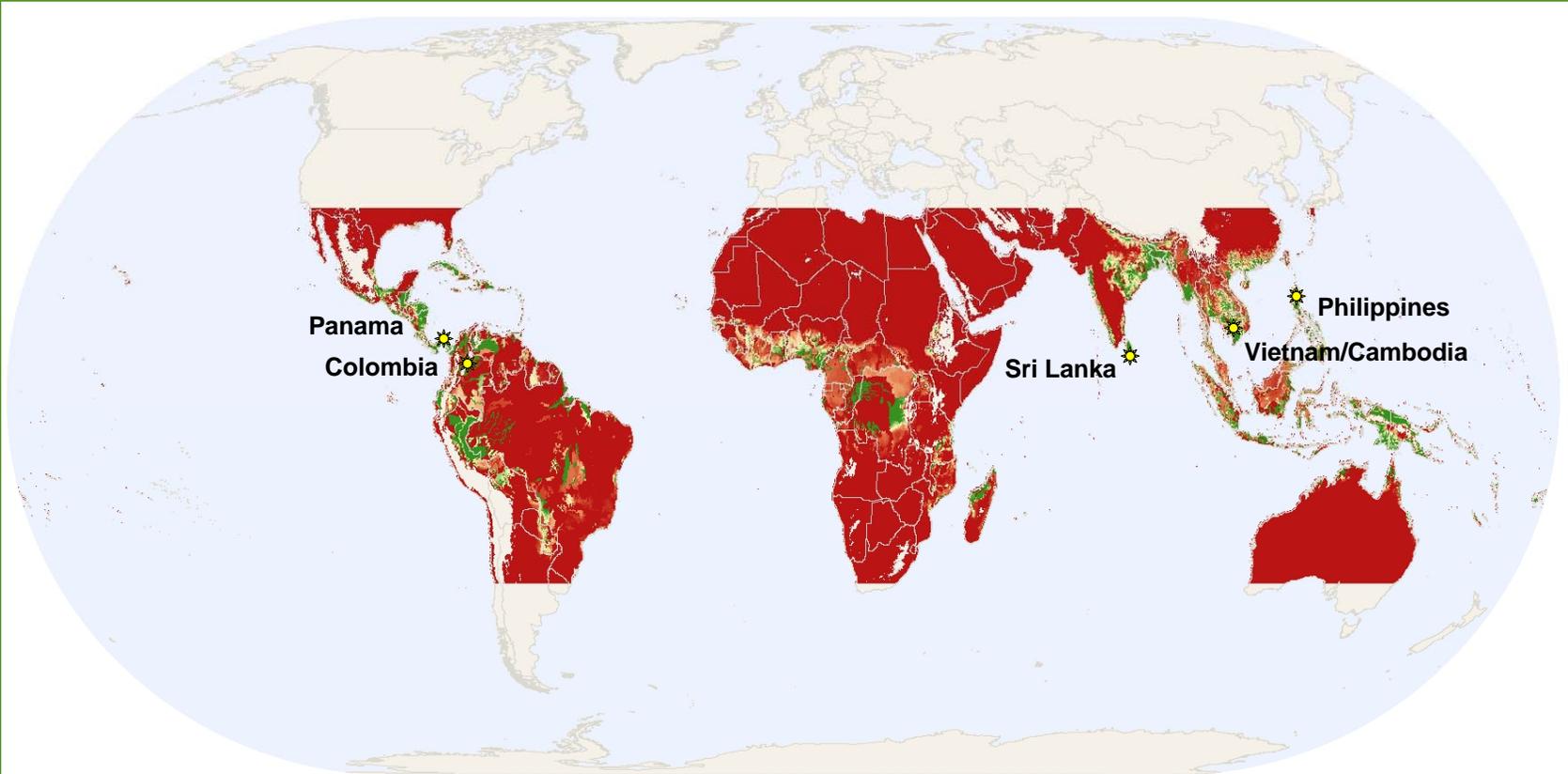
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Potential cultivation zone for sugar cane



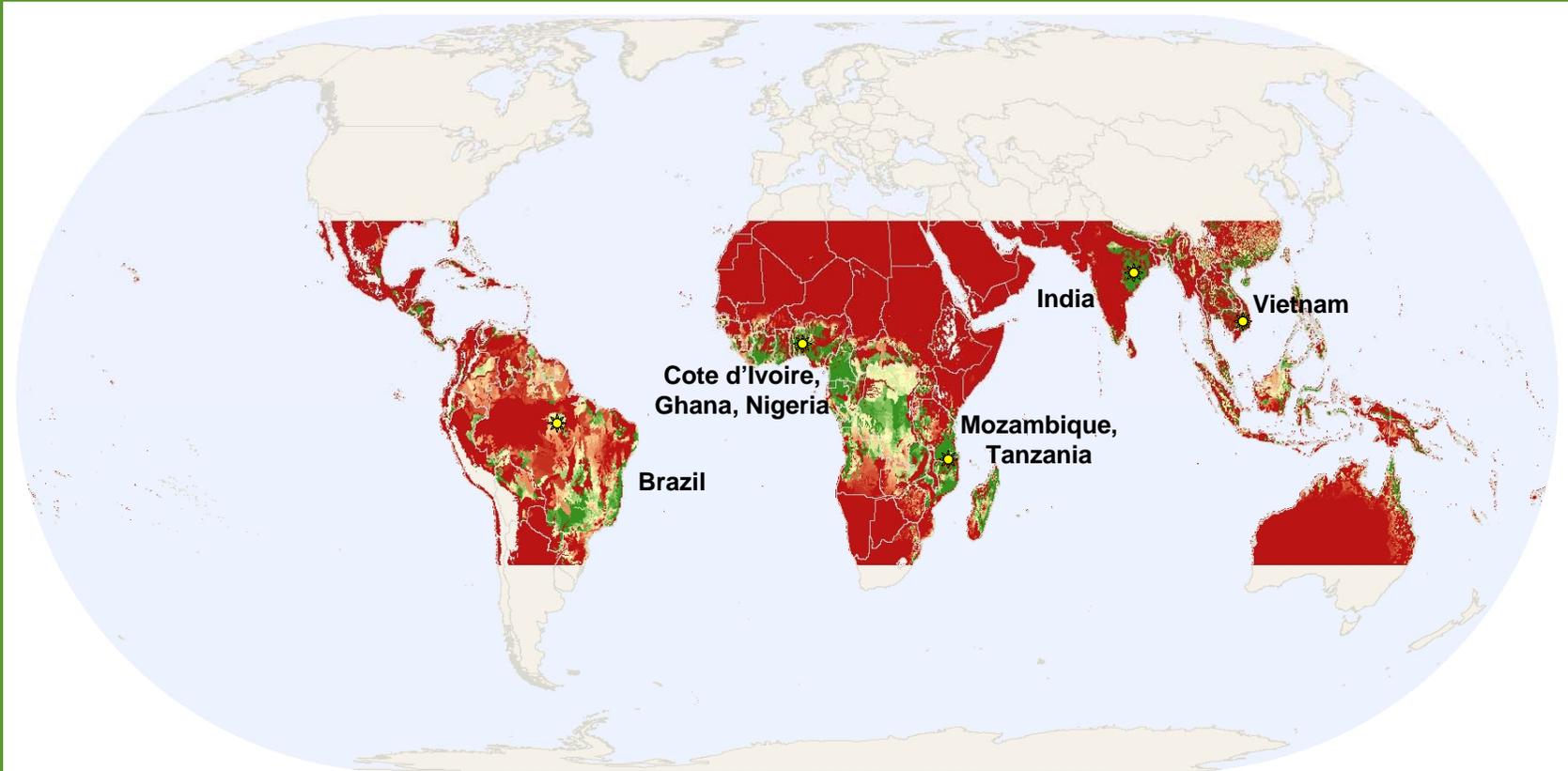
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Potential cultivation zone for cassava



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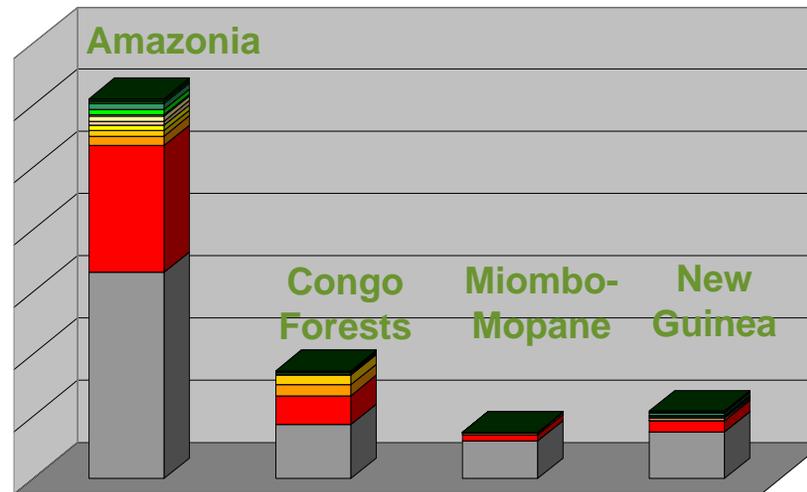
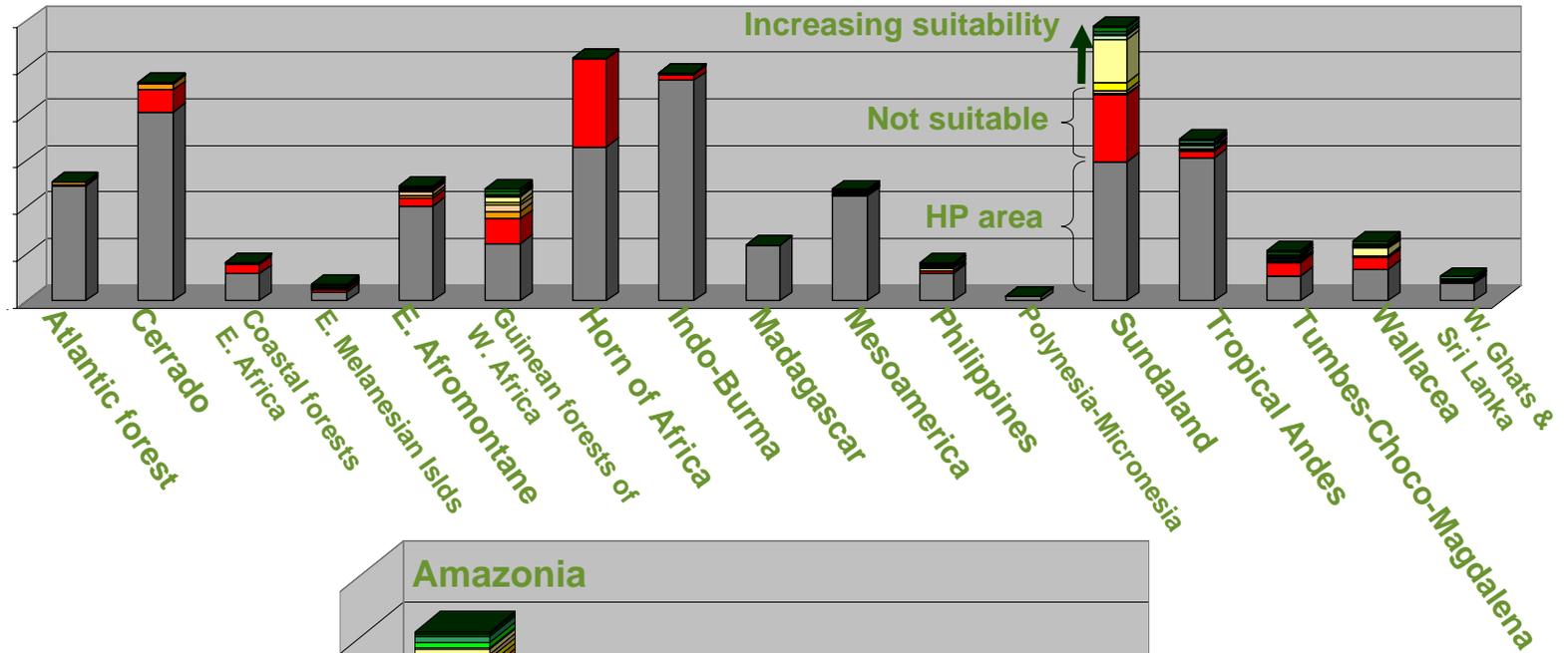


How do these potential cultivation zones intersect with areas of high biodiversity or ecosystem service value?



- **Incorporation of additional spatial data**
 - Hotspots
 - Wilderness areas
 - World's database on protected areas (WDPA)*
 - Key Biodiversity Areas (KBAs)*
 - Alliance for Zero Extinction (AZE) sites*
 - Forest, woodland, grassland
 - Hydrology

*at the regional scale



At the regional scale – an example of current & potential expansion in one area

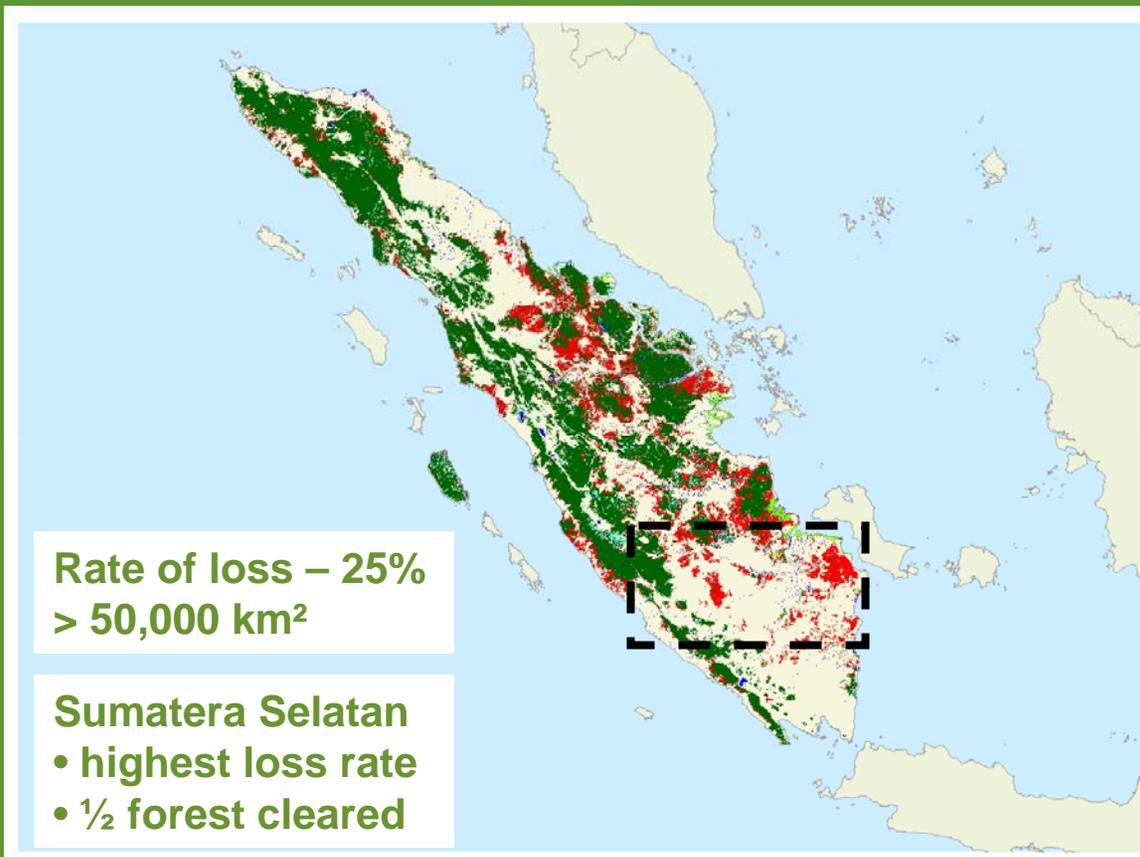


- **Sundaland Biodiversity Hotspot**
- **Indonesia**
 - one of largest oil palm producers (43%, 2006)
- **Sumatra – Sundaland Biodiversity Hotspot**
 - 248 species, IUCN *threatened*
- **Conservation International**
 - Baseline forest cover/change mapping – hotspots
 - Collaboration:
 - WCS – Indonesia
 - CI – Indonesia
 - 1990 – 2000

1990-2000



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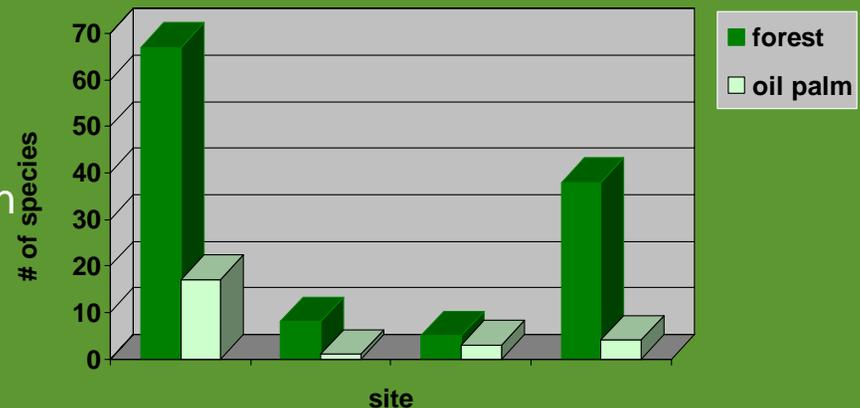


CABS-CI
CI-Indonesia
WCS-Indonesia

It's not just deforestation!



- **Conflict areas**
- **Transformation process**
 - forest into oil palm plantations
 - Danielsen et al. (2008):
 - Forest conversion impacts
 - Jamba province
 - # of years required to regain Carbon
 - 75 – 93 years (forest cleared by logging/fire)
 - 692 years (peatland forest)
 - Impacts on fauna
 - < # of species
 - > # of generalists



Studies cited:
Danielsen & Heegaard 1995
Scott et al., 2004
Maddox et al., 2007

How can the data be used?



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- **4 primary avenues:**
 - **1st level, coarse-scale assessment**
 - **Government guidance**
 - assessment of origins
 - land use planning
 - **Incorporation into certification programs**
 - **Identification - potential conflict areas requiring finer scale analyses**

Beyond the *no-go* areas, what options are available?



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- Potential opportunities
 - Identify additional areas
 - Degraded/idle lands
 - Minimize negative effects
 - Caveats
 - Identification difficulties
 - Lack of adequate data
 - Definition inconsistencies
 - Costs involved (extra inputs required, infrastructure)
 - Collaboration – definition/methodology
- At-risk areas
 - reduced incentive - expansion in areas yielding high negative impacts
 - Certification
 - Assessment of origins
 - Engage governments (multiple levels)
- Potential-risk areas
 - sustainably develop biofeedstock cultivation – expansion yields minimal negative impacts

Thank you

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