Agro-forestry systems: global extent and potential for climate change mitigation

Sistemi agro-forestali: estensione globale e potenzialità per la mitigazione dei cambi climatici

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The Value of Trees on Farm -> AgroForestry

The value of Trees on Farm:

- Support livelihood of rural communities
- Established Carbon stock
- Maintain biodiversity in managed area
- Buffer deforestation

Many types and definition of Agro-Forestry systems, typologies and technologies:

- Spatial and temporal scales
- Plot to landscape,
- Short-rotations to historic
- Cropping - Livestock Based

Estimates based on expert opinion → need for systematic estimates to ensure realistic policy attention

Extent of Trees on Farm

Mapping problem:

- On the ground lost in the definition of agroforestry systems for systematic accounting
- Not easily categorized or classified within traditional agriculture / forestry typologies
- Limited by constraints on field sampling resources

As outcome:

- Current estimates of global extent are partial and highly varying, based on expert opinion and assumptions
- Biomass carbon stocks of trees on farm are often ignored
- IPCC default value of 5t C/ha of biomass for agric land

A potential framework to support systematic accounting of Trees on Farm

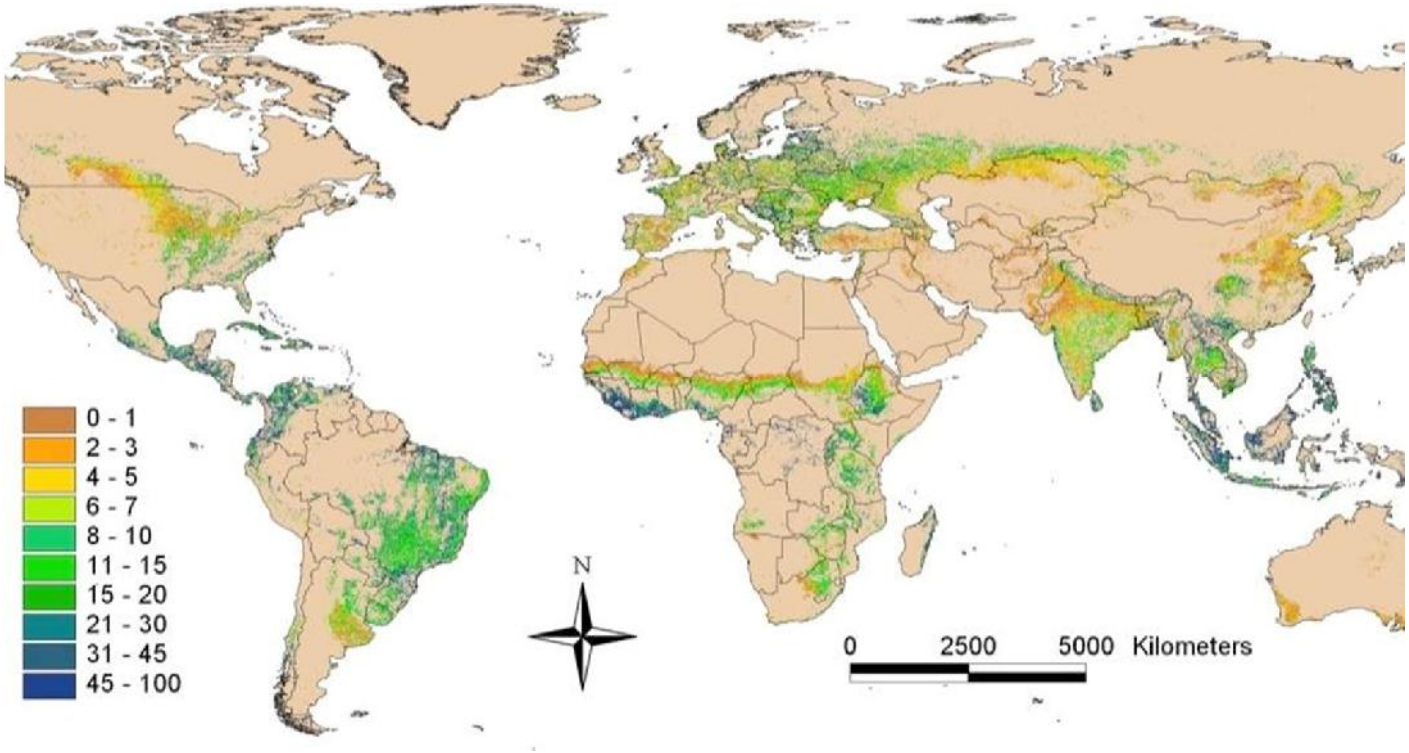
Global Remote Sensing estimates (1 km) of:

- Tree cover % for 2000 and 2010 (Hanson et al 2003)
- Location of agricultural land (GLC 2000)

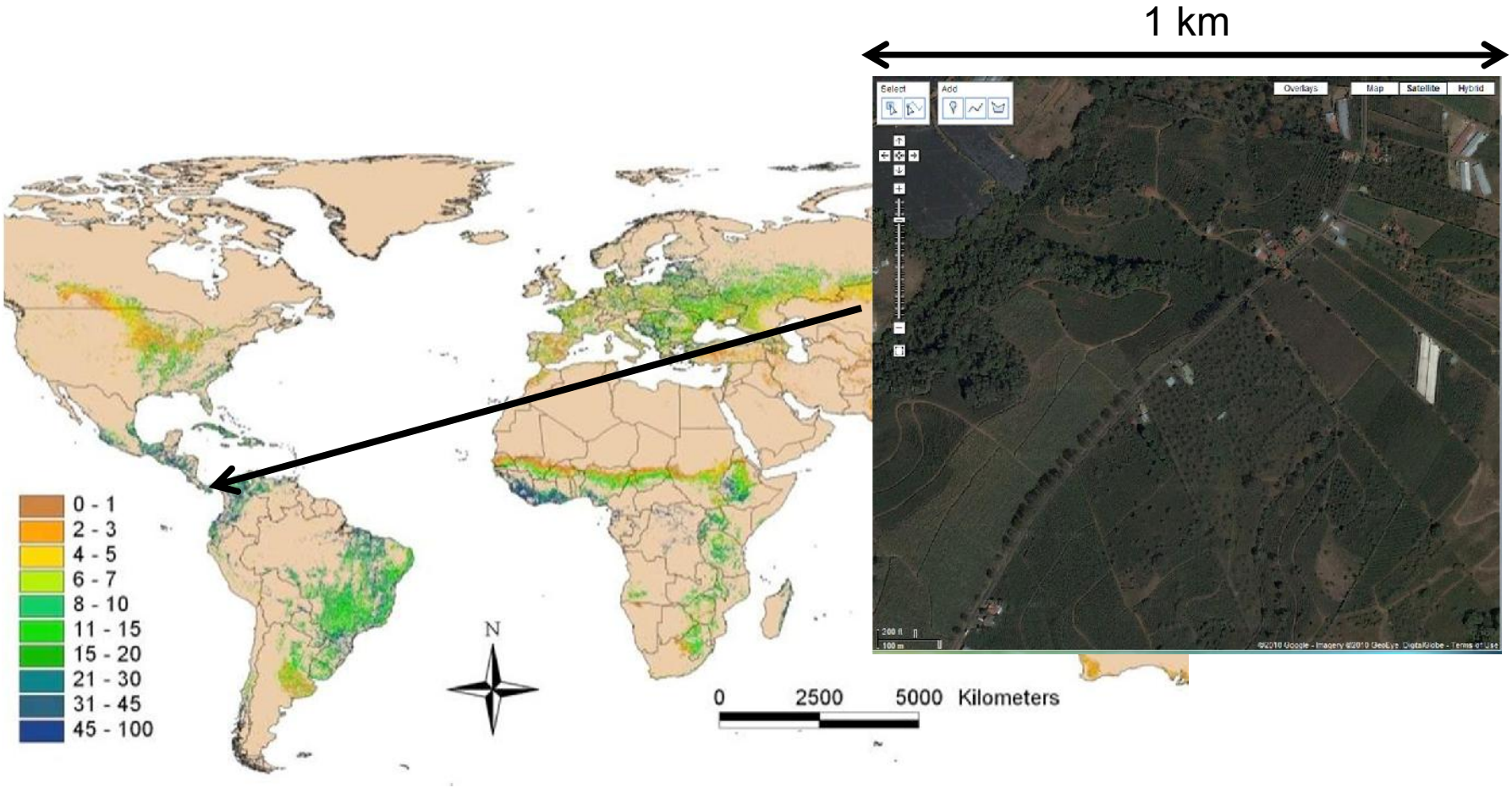
This data structure can define:

- Trees inclusion over agricultural landscape
- Landscape patterns that don’t emerge on the field

Tree cover over LU classified as agriculture



Landscape analysis of trees on farm (1km)

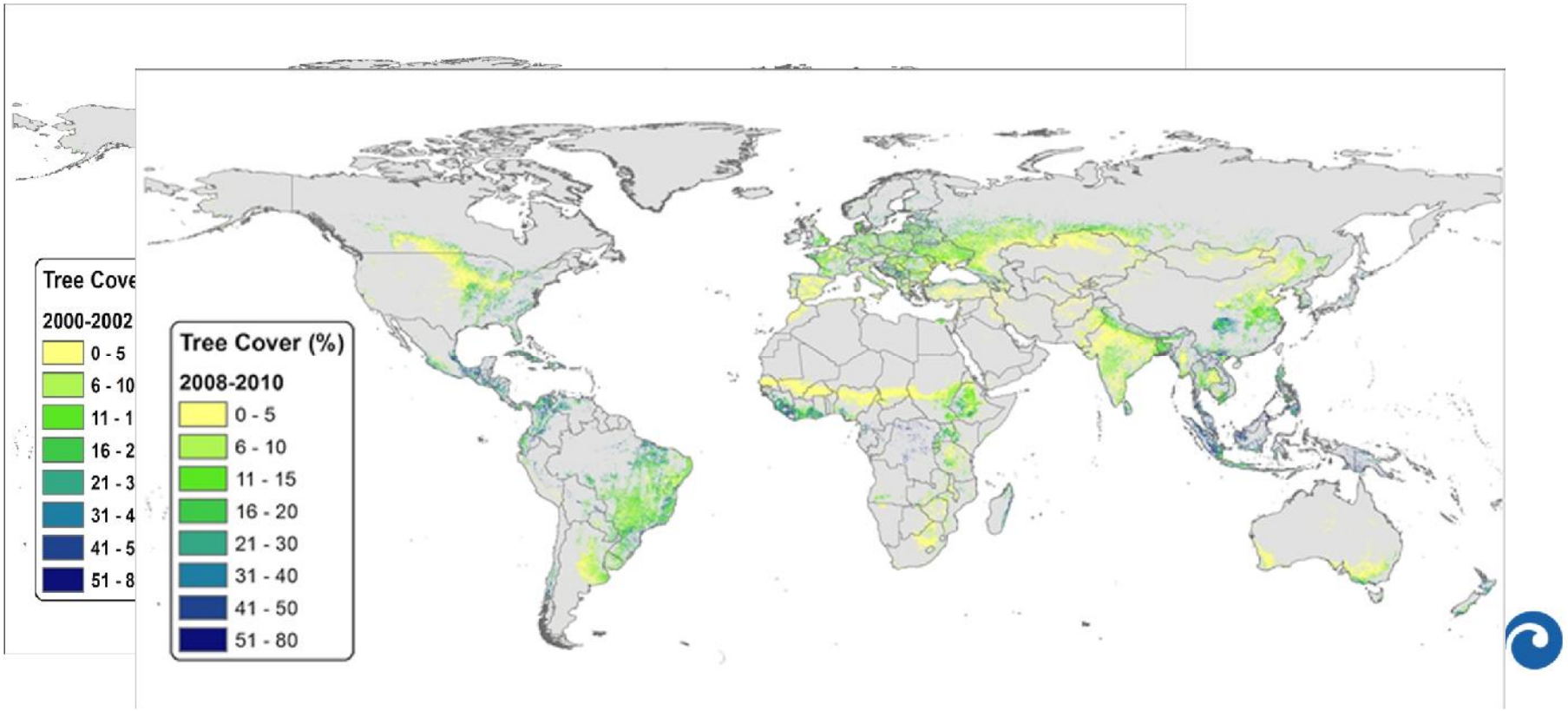


Some health warnings

- Base RS layers are imperfect. A global analysis showing large scale patterns, not necessarily accurate local predictions
- No info on population interactions with the land and trees
- No info on configuration of trees and agricultural land in each pixel

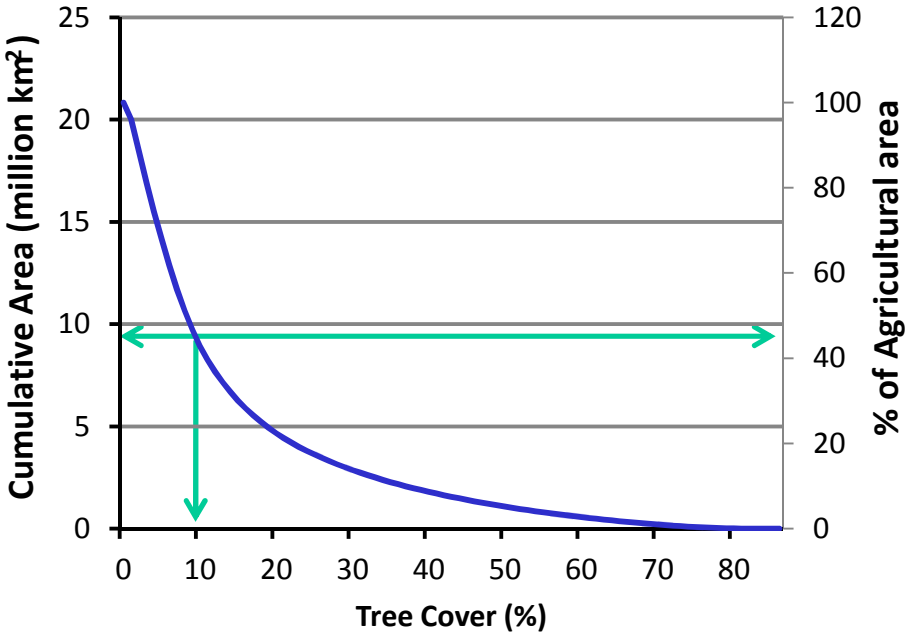
Trees on Agricultural Land: global accounting

- Role of trees on agricultural land at global level, along with recent change trends between 2000 (2000-2002) and 2010 (2008-2010).
- Remote sensing data show that in 2010, 43% of all agricultural land globally had at least 10% tree cover and that this has increased by 2% over the previous ten years.
- Agroforestry systems and tree cover can make an important contribution on agricultural land.



Trees on Agricultural Land: regional accounting

- Role of trees on agricultural land at regional level, along with recent change trends between 2000 (2000-2002) and 2010 (2008-2010).
- Much of Central America's (95%) and Southeast Asian (77%) agriculture has >10% tree cover. Estimates for South American agriculture revealed 53%.
- Significant proportions of land under tree inclusion are also found in Europe and North America (40%), East Asia (32%) and Sub-Saharan Africa (27%).
- South Asia and north Africa show the lowest level.



43% of gal (9.5 M km²) has > 10% tree cover
22% of gal (4.9 M km²) has > 20% tree cover
13% of gal (3.0 M km²) has > 30% tree cover
6% of gal (1.2 M km²) has > 50% tree cover

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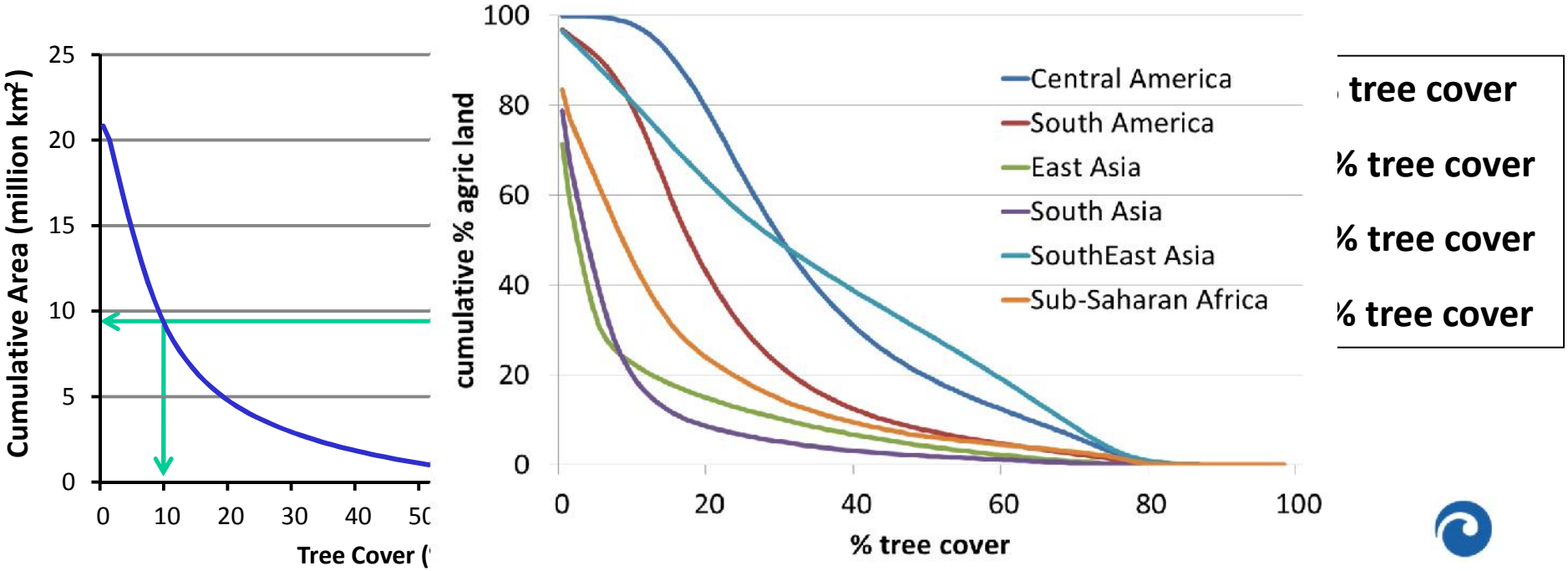
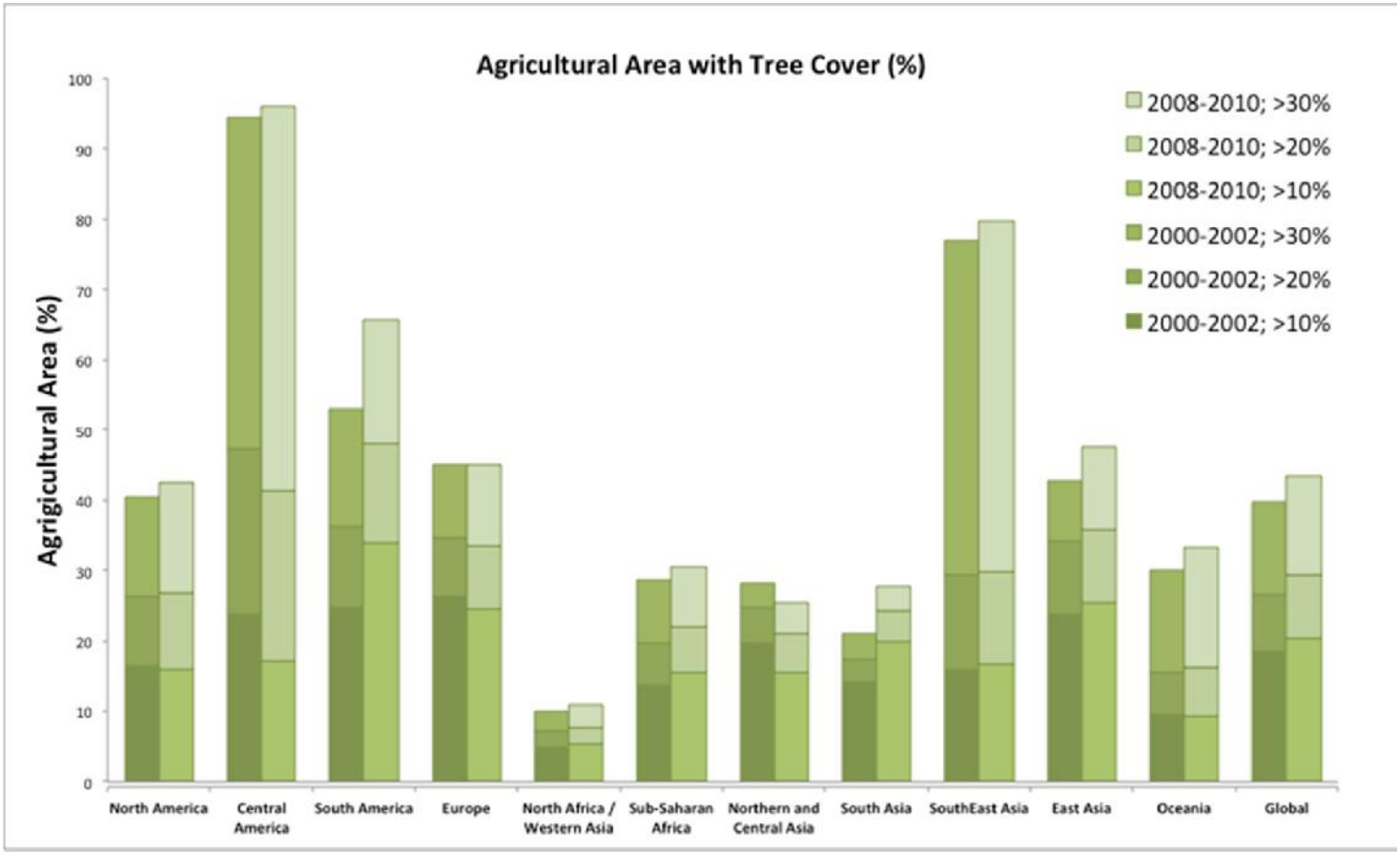


Change in Amount of Agricultural Area with Tree Cover

From 2000 to 2010



- Almost all regions increased the amount of land with at least 10% tree cover
- South America showed the largest increase
- Only North and Central Asia decreased area
- South Asia increased from 21% to 28%, East Asia from 40% to 48%
- Central America increased to 96% of all agricultural land with at least 10% tree cover

Above and Below Ground Biomass Carbon on Agricultural Land

CDIAC

New IPCC Tier-1 Global Biomass Carbon Map for the Year 2000

Submitted to ORNL-CDIAC by Aaron Ruesch and Holly K. Gibbs*

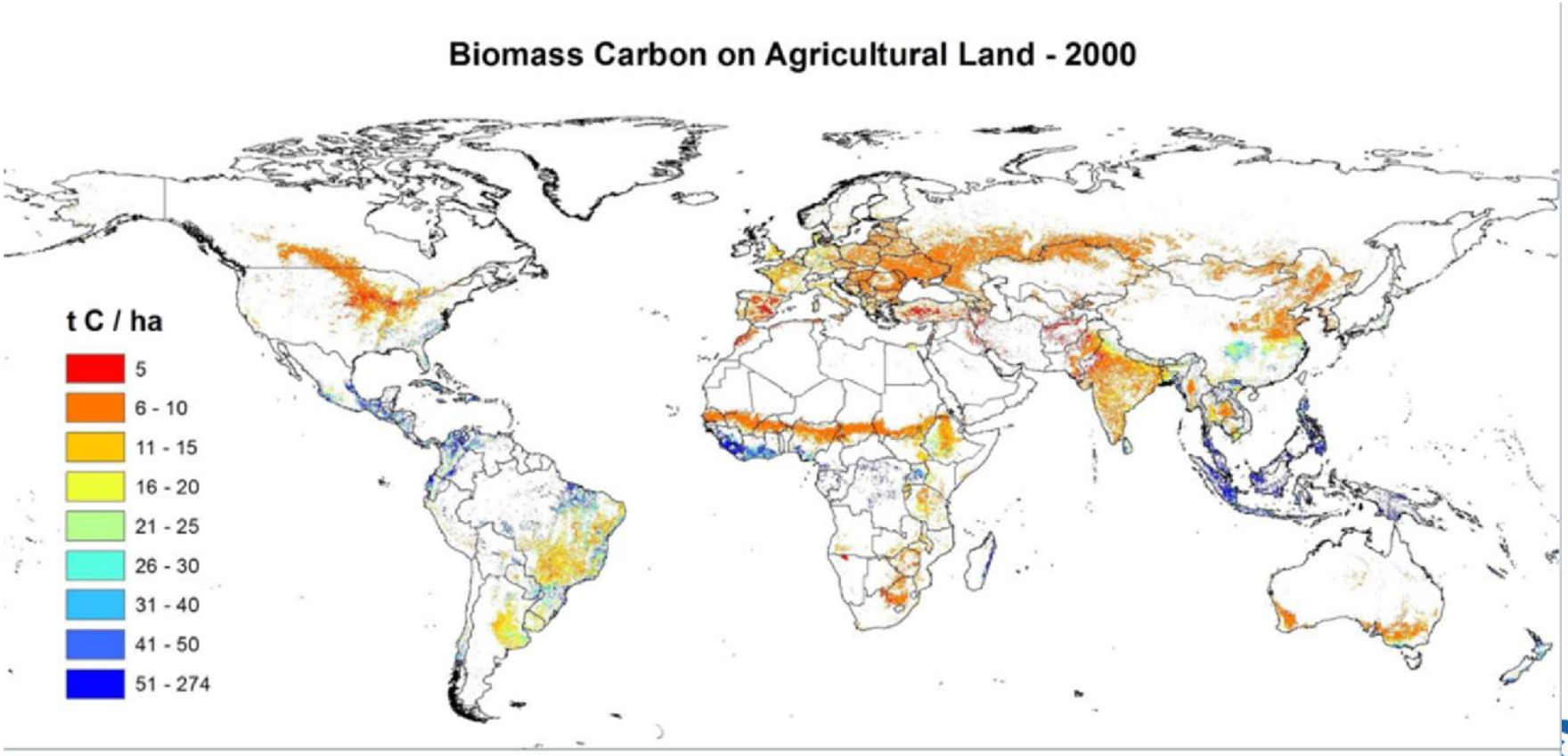
- IPCC Tier-1 Global Biomass Carbon Map
  - Ruesch and Gibbs (2008)
- Stratification into 124 carbon zones by bio-climatic region
- Specific carbon estimate for each landuse type within each continent/region
- Agricultural land estimated with low value (5 tC / ha)
- Tree cover (agroforestry) component missing from this map, and from global and national carbon budgets

Combine Tree Cover Analysis with the CDIAC Biomass Carbon Map

- **If agric. land 0% tree cover, then: biomass = 5 tC/ha (IPCC Tier-1 value)**
- **If agric. land had 100% tree cover, then: biomass = mixed forest type**
- **from 0 to 100 % tree cover then:**
  Biomass carbon increases linearly i.e., from 5 tC/ha to value of mixed forest

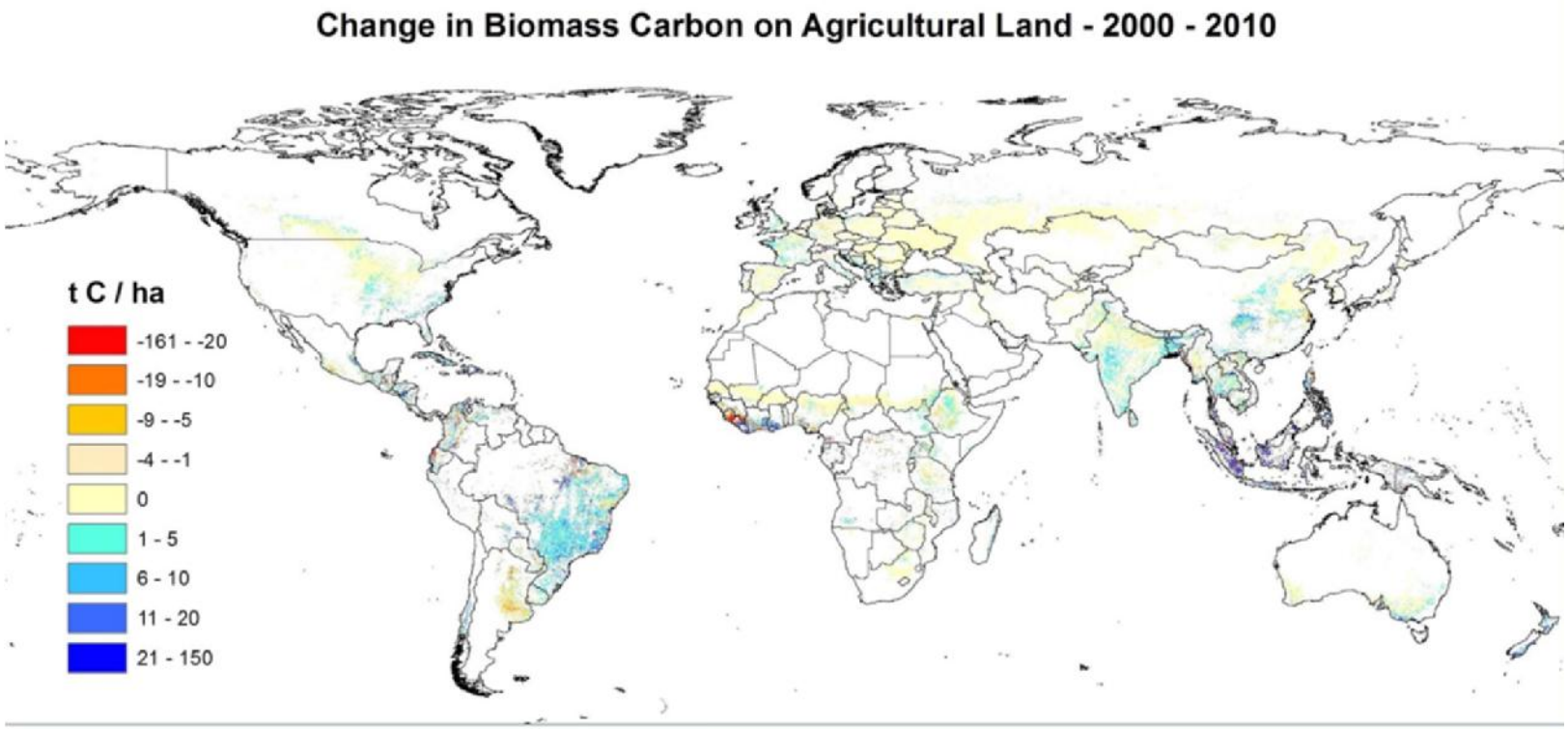
Carbon on Agricultural Land: The contribution of agroforestry to global and national carbon budgets

- Combining geographically and bioclimatically stratified IPCC Tier 1 default estimates of carbon storage with this tree cover analysis, we estimated 45.3 GtC on agricultural land globally, with trees contributing >75%.
- Albeit small to carbon in soils (~2500 GtC), biomass carbon on agricultural land deserves attention both for its mitigation potential and its adaptation benefits.



Carbon on Agricultural Land: The contribution of agroforestry to global and national carbon budgets

- Between 2000 and 2010 tree cover increased by 3.7%, resulting in an increase of >2 GtC (or 4.6%) of biomass carbon. On average, globally, biomass carbon increased from 20.4 to 21.4 tC ha−1.
- Brazil, Indonesia, China and India had largest increases in biomass C stored on agricultural land, while Argentina, Myanmar and Sierra Leone had largest decreases.
- Above-ground losses due to tropical deforestation estimated at 0.6–1.2 GtC yr−1



Key messages - 2016

- Approximately 43% of agricultural land in 2010 had >10% tree cover
  - Over one-billion hectares supporting more than 900 million persons
- IPCC default value of 5t C/ha of biomass for agric land is a gross under-estimate
  - Off by a factor of 4 - 75% of biomass on agricultural land is tree-based
- Agroforestry provides both adaptation and mitigation benefits
- Amount of carbon is significant, .. enough that it should be accounted for !!!
- Understanding environmental and national policy context is important
- IPCC mechanisms : REDD & REALU
- There is a rich set of spatial data available for understanding broad geographic patterns of agroforestry and the implications of national policy environments.

Thanks