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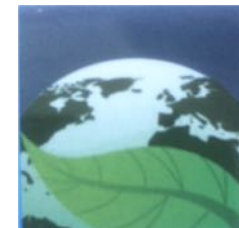
 **GAMMA REMOTE SENSING**

 **esa**

Experiences and requirements for biomass mapping

Martin Herold

Wageningen University



Biomass CCI 1. User Meeting
25/26. Sept. 2018 in Paris



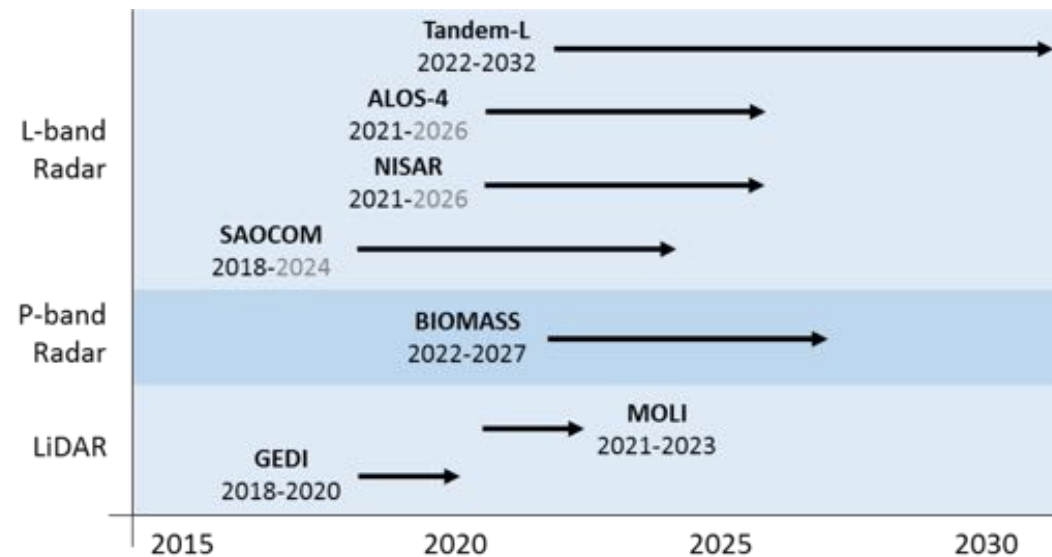
Need for biomass information is growing and diversifying

- **Climate and carbon cycle science**
- **UNFCCC and Paris Climate Agreement:**
 - GCOS and Essential Climate Variables (ECVs)
 - National GHG estimation and reporting
 - Performance-based mitigation activities (i.e. REDD+)
 - Transparency and global stocktake
- **Sustainable Development Goals (i.e. 15.3.1)**
- **Zero deforestation pledges / sustainable supply chains**
- **Forest and land management (i.e. certifications)**



Biomass observations from space vs. user needs

1. Many needs vs. many sensors in space
2. Biomass mapping should develop as a co-creation of producers & users



Synthesis of user needs and gaps: key issues

- **Insufficient level of detail (resolution, coverage, definitions)**
- **Biomass maps versus change**
- **Conflicting information (diversification vs. specific needs)**
- **Uncertainty characterization is missing or not suited**
- **Limitations in the complementary use of field and space data**
- **Lack of capacity of key stakeholders**
- **Gaps between theoretical opportunities and policy and management praxis**



2018 GCOS ECV biomass requirements (updated draft)

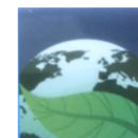
- DEFINITION: Aboveground biomass is defined as the mass of live and/or dead organic matter in terrestrial vegetation
- MEASUREMENT UNIT: Mass of dry weight in metric tons. Density of biomass, i.e. amount of biomass per unit area, is measured in g m^{-2} (dry matter) or multipliers (e.g. Mg ha^{-1}).
- UNCERTAINTY METRIC: relative and absolute bias and confidence interval or RMSE, overall and by biomass class/range derived from using reference data of higher quality
- UNIT OF UNCERTAINTY METRIC: % (for relative) and tons (for absolute), for different biomass classes/ranges
- STABILITY METRIC: relative and absolute bias and confidence interval or RMSE, overall and by biomass class/range derived from using multi-date reference data of higher quality
- UNIT OF STABILITY METRIC: % (for relative) and tons (for absolute), for different biomass classes/ranges
- UNCERTAINTY requirements (optimal/target/threshold): 10/20/30 % (relative RMSE) for different biomass classes/ranges
- STABILITY requirements (optimal/target/threshold) : 5/10/20 % (relative RMSE) for different biomass class/ranges
- HORIZONTAL RESOLUTION requirements (optimal/target/threshold): 50-100/100-300/500-1000 m (suitable resolution varies by ecozone)
- VERTICAL RESOLUTION: NA
- TEMPORAL SAMPLING requirements (optimal/target/threshold): annual/5-yearly/one time
- TIMELINESS requirements (optimal/target/threshold): annual/5-yearly/one time

(Herold, Quegan, Saatchi, Avitabile)

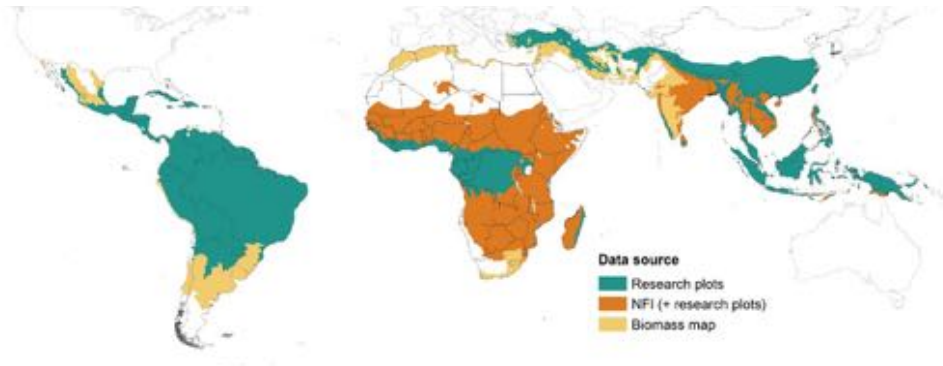


Requirements for different REDD+ performance-based mechanisms

Context	Purpose	Requirements/consideration of uncertainties
REDD+ related submissions and National GHG inventories to UNFCCC	Regular reporting required at the national level, REDD+ reports, in developing countries in the context of result-based finance, and biennial update reports (BURs) for all countries.	Key GHG source categories should be reported on Tier 2 level (using national emissions factors) in the national GHG Inventory. REDD+ FREL/FRLs and REDD+ Annexes to the BURs are assessed through specific technical assessments and reviews by UNFCCC roster of experts. The stepwise approach allows continuous improvements including uncertainty.
Green Climate Fund (GCF)	Finance for forest transformation for climate change mitigation and adaptation. Result-based payments for REDD+.	In the case of result-based payments for REDD+, these are based on the UNFCCC Technical Assessment and Technical Reviews and a further assessments through a score card where uncertainty is part of the scoring system to allocate payments.
Forest Carbon Partnership Facility's Carbon Fund (FCPF CF)	Pilot market transactions for REDD+.	An IPCC Tier 2 is required to estimate emissions and removals. Uncertainty needs to be assessed and reported. Verification of Emission Reductions by an independent third party. Potential discount based on overall uncertainty of reported and verified Emission Reductions.
Other standards (e.g. Verified Carbon Standard)	Issuance of emission reduction units for the voluntary carbon market.	Varies by standard but uncertainties should be assessed and considered. Independent verification is often part of the process. Often a preference for conservative approaches.




2019 Refinement of the IPCC GPG: updating biomass defaults



- Reduce the large AGB ranges: substrata and mean/SD
- Traceable estimates to allow for efficient updating
- Research network plots in humid tropics (incl. split in young/old secondary forests)
- Using NFI's make a big difference for Africa, still main gap for dry forests
- Biomass map (Globbiomass) for lower biomass area with missing data
- Current RS data sources too inconsistent (i.e. forest change vs. biomass)

	South America	Africa	Asia
Tropical wet			
Primary	604	349	214
Secondary >20 years	328	62	94
Secondary ≤20 years	513	29	88
Tropical moist			
Primary	147	25	11
Secondary >20 years	185	7052	60
Secondary ≤20 years	353		
Tropical dry			
Primary	33	9216	36
Secondary >20 years	72		
Secondary ≤20 years	44		
Tropical shrubland			
Primary		19	
Secondary >20 years		2607	
Secondary ≤20 years			
Tropical mountain system			
Primary	106	64	30
Secondary >20 years	21	1852	14
Secondary ≤20 years	114		36
Subtropical humid			
Primary			29
Secondary >20 years			26
Secondary ≤20 years			5
Subtropical dry			
Primary			
Secondary >20 years			
Secondary ≤20 years			
Subtropical steppe			
Primary			
Secondary >20 years			
Secondary ≤20 years			

Research plots
 NFI plots, or both
 No data
 Value = number of plots




2019 Refinement of the IPCC GPG – section on biomass maps

- What is the potential use of biomass density maps in frame of GHG inventories:
 - Assess C-stocks and EF to produce emissions estimates, incl. to increase data density in under-sampled or inaccessible areas
 - Integration with AD to produce wall-to-wall maps/estimations
 - Direct estimation of biomass change (i.e. for Tier 3)
 - Verification purposes
- National “calibration” required, link with NFI efforts
- Need to consider uncertainties and perhaps update in GPG uncertainty chapter (currently does not include such issues)
- Little practical experiences



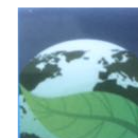
GFOI - R&D synthesis workshops

- MGD, REDD+ compass (www.gfoi.org)
- 8 R&D workshops in 2014-18 (www.gfoi.org/rd)
- Biomass/EF related expert meetings:
 - Emission factor (EF) uncertainty (relation to total C-emissions) and uncertainty of the trend in emissions (Febr. 2018, in Bilbao, more info [here](#)):
 - Framework for estimating of uncertainties of emissions factors
 - Use of biomass maps for national GHG reporting (linked to 2019 IPCC refinement)
 - Country examples on estimating EFs and uncertainties
 - **GFOI Biomass/EF** expert meeting this week September at Worldbank premises in Paris, info [here](#))



REDD+ and ESA Biomass-CCI project

- Lack of a proposed approach for the REDD+ user case as “secondary objective” in original proposal
- Reply to ESA and proposed approach
- (evolving) REDD+ need will be reflected in the user requirements
- Close ties to GFOI (R&D, partnership), IPCC refinement (role of biomass maps, UNFCCC processes, and evolving REDD+ implementation (Worldbank FCPF, Green Climate Fund etc.)
- Develop “Biomass-CCI for REDD+ Strategy” to be developed in the first year of the project (Wageningen lead)
- Scoping for specific case study on how to integrate Biomass-CCI products in national GHG inventories



A first draft of product specifications for REDD+

Global biomass mapping product specifications

	Threshold (minimum) Requirements	Target (desired) Requirements
Product	Map of aboveground biomass with associated uncertainty	<ul style="list-style-type: none"> • Map of aboveground biomass • Map of change in aboveground biomass • Map of belowground biomass all with uncertainty estimated, definition of biomass might vary for different countries circumstances
Spatial Coverage	Global	Global with targeted/calibrated products for specific countries or other areas of interest
Spatial Resolution	At least 100x100 m / 1 ha resolution	0,25-1 ha - resolution might vary depending on forest and ecosystem type, and country needs
Temporal Extent	One time coverage for most recent period	2000-now
Temporal Resolution	Every 5-10 years	1 year (annual maps)
Reference System	Lat-Long (WGS-84) and equi-area projections	Provided in country-specific reference grids
Accuracy	Accuracy should be higher than existing maps. Continental-scale uncertainty estimation.	Data should unbiased and with high precision ($\geq 90\%$ rel. RMSE) for target estimation regions (i.e. countries)
Delivery Mode	FTP or Web Service	FTP or Web Service and combined with training materials on how to use the data and within country capacity development
Data Format	GeoTIFF	GeoTIFF (or other country preferred formats)
Other Requirements	<ul style="list-style-type: none"> • Fully documented, transparent and standardized mapping methods • Robust and standardized global validation scheme with protocol • Metadata available • Free and open access 	<ul style="list-style-type: none"> • Fully documented, transparent and standardized mapping methods, • Metadata available, • Robust calibration and validation using available national data sources (i.e. NFI data) • Clear and transparent reporting of regional accuracy / uncertainty • Consistent spatial-temporal coverage • Consistency with forest area change data • Free and open access

