Innovative forest monitoring in support of climate change mitigation

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Climate change mitigation and sustainable development in the land use sector

- **REDD+**: *Reducing emissions from deforestation and forest degradation, and conservation, sustainable management of forests, and enhancement of forest carbon stocks*
- **Paris agreement**: *Forest and land-use mitigation targets in nationally determined contributions (NDC)*
- **Sustainable development goals** *(SDG): improve food security*

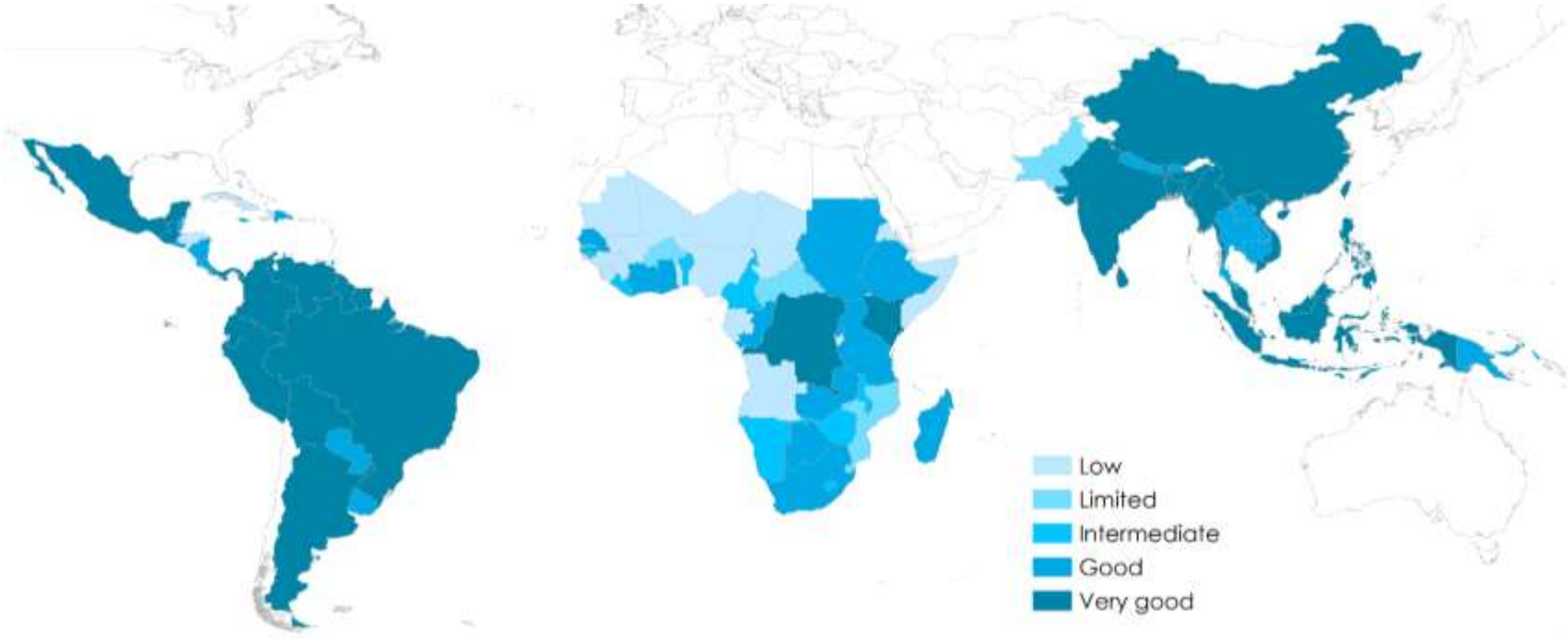
- *Publicly available, comprehensive, spatial information on land use (change) and associated carbon stocks and flows*

REDD+

- *Forest important role as sinks and storage of carbon*
- *Tropical deforestation and degradation source of GHG emissions (15-25%)*
- *Monitoring, Reporting and Verification (MRV) system crucial component REDD+*
- *Remote sensing combined with ground measurements plays key role: objective, practical and cost-effective tool*

Forest monitoring capacities – REDD+

Area change and remote sensing capacities (Romijn et al., 2015)



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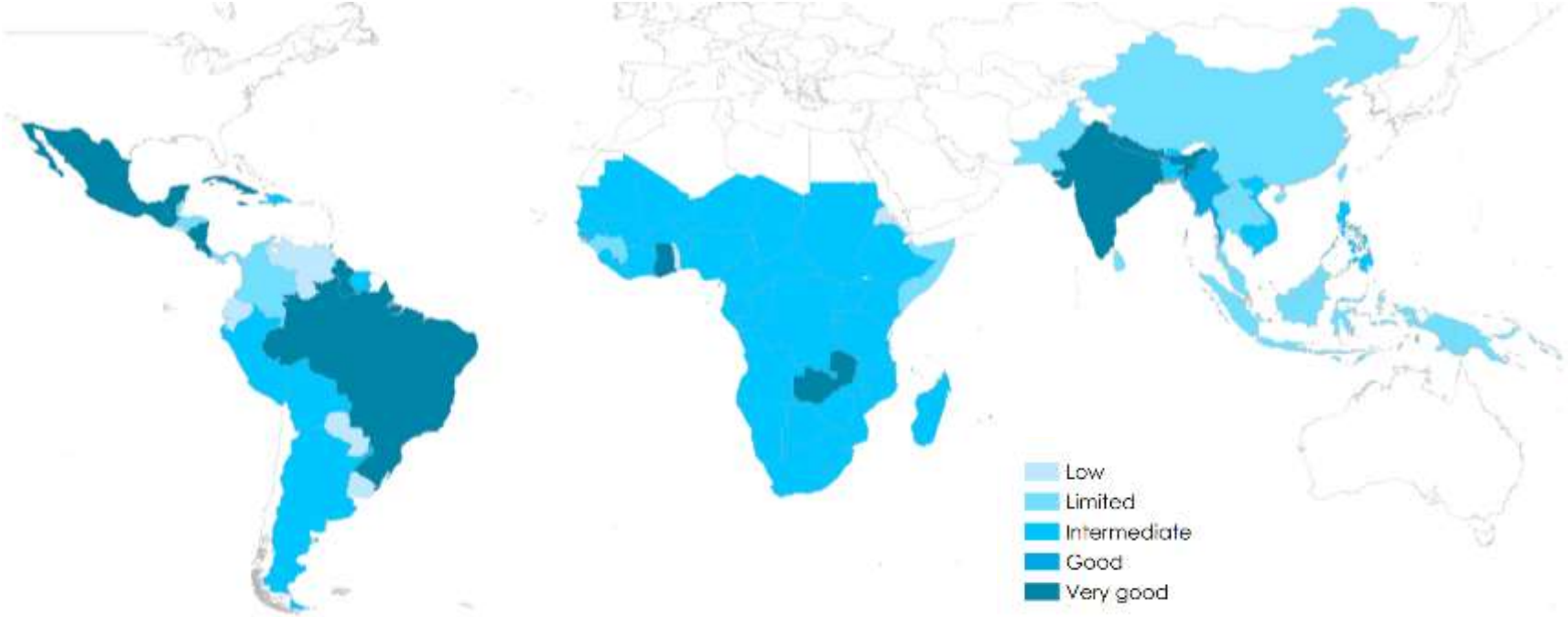
Forest monitoring capacities – REDD+

Carbon reporting capacities (Romijn et al., 2015)



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Forest monitoring needs along the policy cycle

- *Awareness/problem definitions*
  - *Land change trends/GHGs*
  - *IPCC AR6+*
- *Policy options/activities:*
  - *Drivers and hotspots of emissions/mitigation*
  - *Trade-offs other land use goals*
  - *Nat. determined contributions (NDCs)*
- *Implementation:*
  - *Local data supporting land management*
  - *Regular progress tracking, transparency*
  - *Near-real time alerting / interactive systems*
- *Evaluation/performance:*
  - *Impact assessments (REDD+)*
  - *National: GHG inventories, biannual update reports*
  - *Global: UNFCCC stocktake (2023+)*

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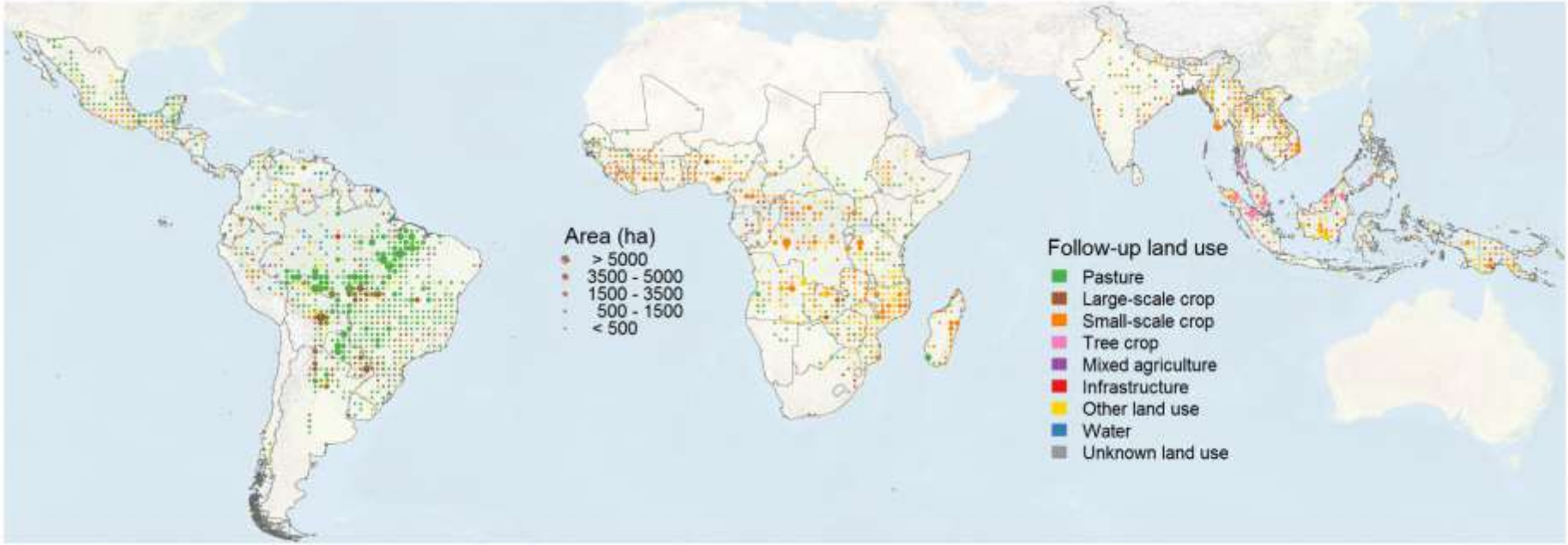
Agriculture as direct driver of deforestation



De Sy et al, 2005 – ERL
De Sy et al, in review

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Data available: http://lucid.wur.nl/

Table 1 Estimates of deforested area (10^3 ha (SE) and % of total) per follow-up land use (Table 1) from 1990 to 2000

Follow-up land use	Africa		Latin America		Asia	
	10^3 ha	**%**	**10^3 ha**	**%**	**10^3 ha**	**%**
Small-scale crop	12 028 (1 174)	61.1	1 419 (269)	3.5	5 813 (921)	35.0
Large-scale crop	812 (425)	4.1	4 429 (864)	10.9	89 (36)	0.5
Tree crop	476 (194)	2.4	253 (63)	0.6	4 630 (1 078)	27.9
Pasture	2 883 (811)	14.7	29 272 (2 259)	72.2	210 (66)	1.3
Mixed agriculture	35 (30)	0.2	372 (264)	0.9	91 (59)	0.5
Total agriculture	**16 234 (1 552)**	**82.5**	**35 745 (2 456)**	**88.2**	**10 832 (1 441)**	**65.2**
Infrastructure	255 (41)	1.3	735 (264)	1.8	554 (119)	3.3
Other land use	3 050 (419)	15.5	2 760 (363)	6.8	5 000 (1 076)	30.1
Water	72 (29)	0.4	1 220 (476)	3.0	206 (57)	1.2
Unknown	69 (51)	0.3	88 (77)	0.2	29 (28)	0.2
Total other	**3 446 (429)**	**17.5**	**4 803 (719)**	**11.8**	**5 789 (1 128)**	**34.8**
Total	19 679 (1 663)	100	40 548 (2 613)	100	16 621 (1 916)	100

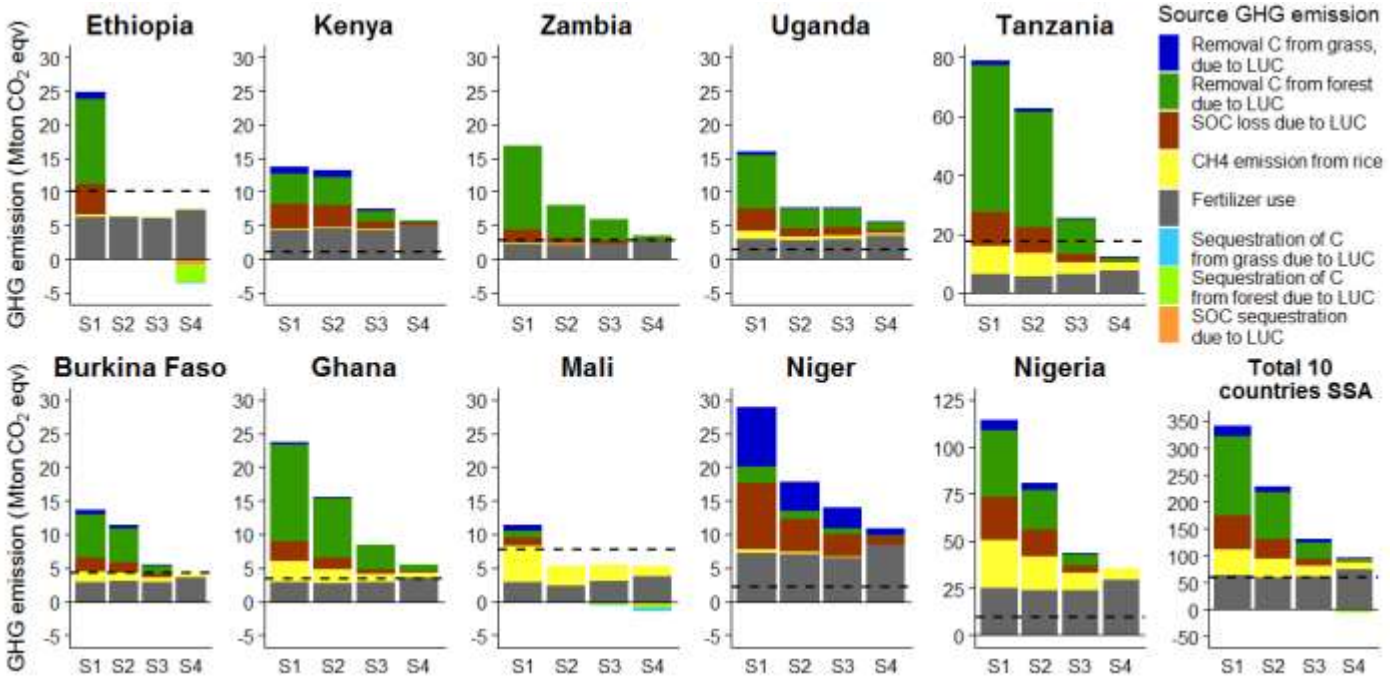
Mean carbon stock estimates (Mg C ha^{-1}) for all forests, for converted forests and for forests converted to a specific follow-up land use.

	All Forests	Converted Forests	Forests converted to				
			Pasture	Large-scale cropland	Small-scale cropland	Other land use	Tree crop
Africa	76 [a]	41 [a]	10	10 [a]	53 [a]	19 [a]	72 [a]
L. America	128	85 [ad]	86 [ab]	77 [c]	103 [d]	85 [ad]	54 [bc]
Asia	156 [a]	128 [ad]	89 [b]	100 [bcd]	122 [cd]	125 [a]	139 [c]

Food security vs climate change mitigation

- *Intensifying or expanding cereal cropping in Africa: impacts on GHG emissions (van Loon et al., in review)*
- *4 scenarios to reach full self-sufficiency in 2050:*
  - *S1: actual yields in 2015*
  - *S2: yield trends 1991-2014*
  - *S3: 50% of potential yields*
  - *S4: 80% of potential yields*

Total GHG emission from cereal production in 2050



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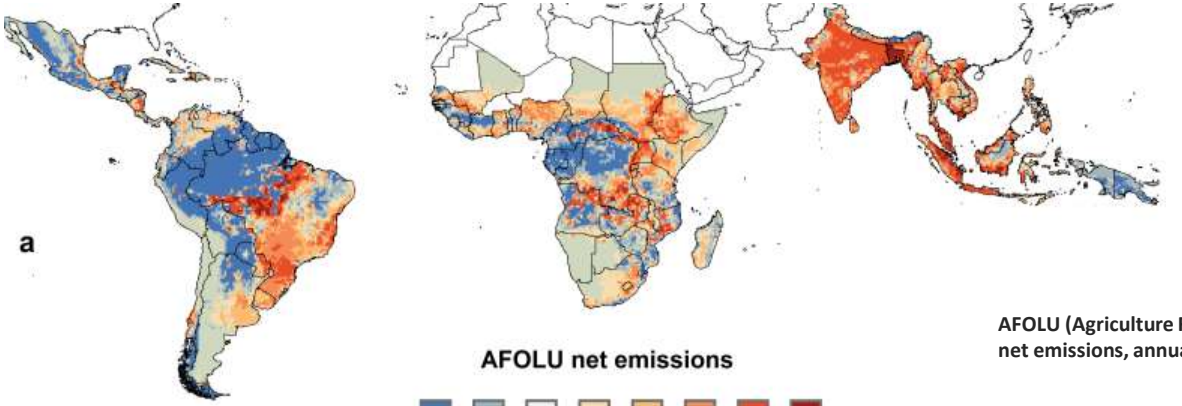
Data-driven spatially explicit approaches

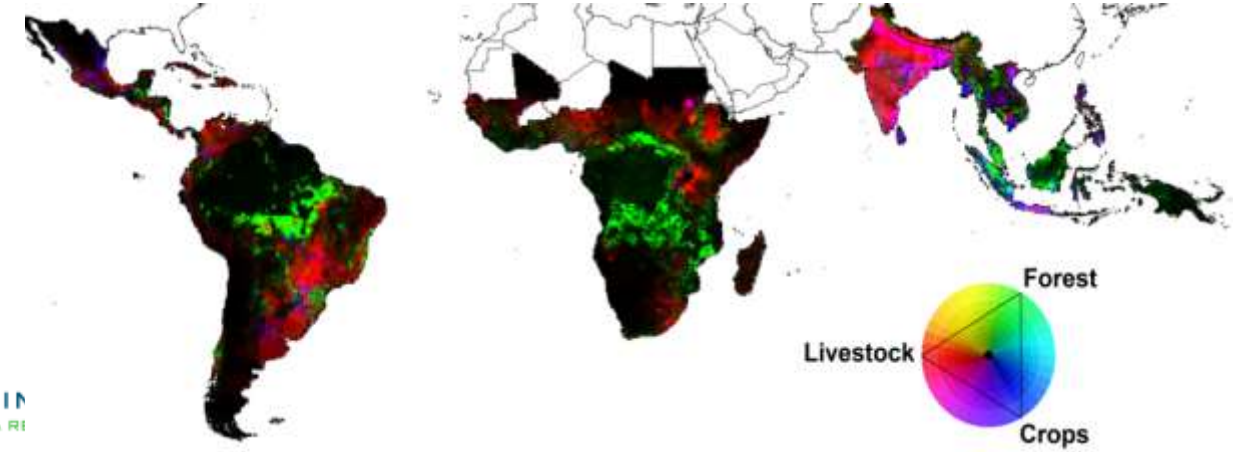
- *Integration of key spatial data sources:*
  - *Forest change*
  - *Drivers of deforestation*
  - *Forest plantations*
  - *Biomass stocks*
  - *Biomass burning/burnt area*
  - *Peatlands, Mangroves*
  - *Soil carbon*
  - *…*
- *Combine forest related data with those of direct agriculture emissions (livestock, rice, soils etc.)*



AFOLU (Agriculture Forests and Other Land Uses) net emissions, annual, 2000-2005

Roman et al., 2016, Biogeosciences

Data available: http://lucid.wur.nl/



Contribution of emission sources per pixel

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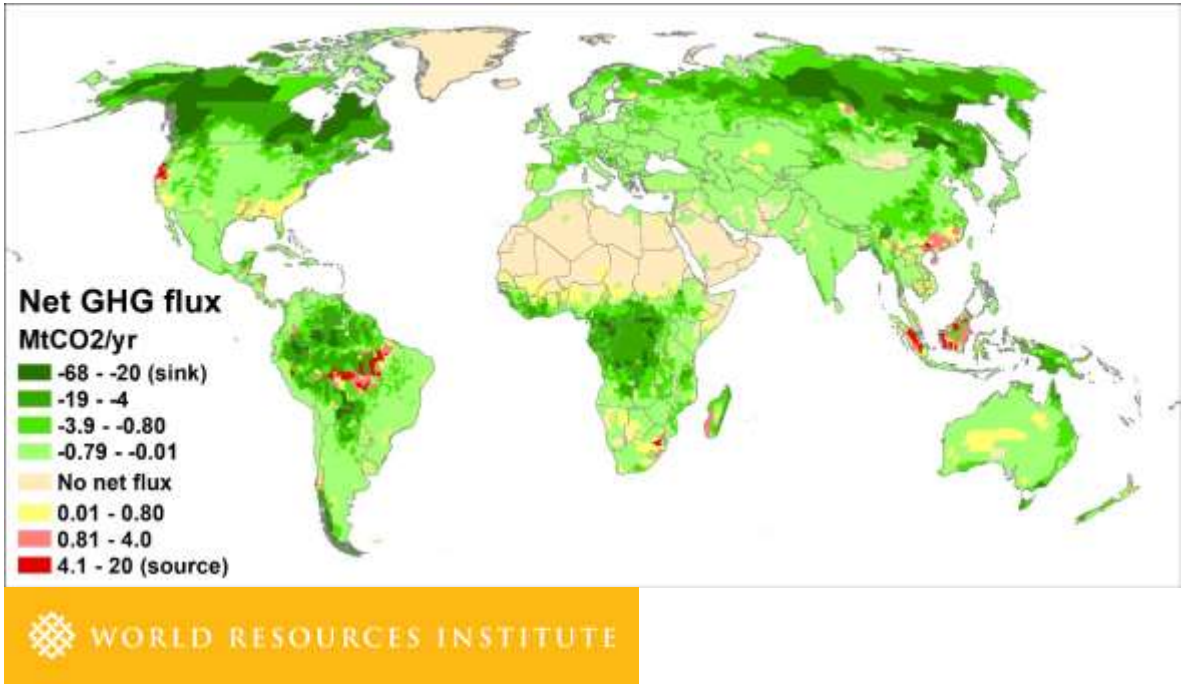
Data-driven spatially explicit approaches

Combine data to provide forest related gross emissions, removals, and net GHG from 2001 annually at high resolution, building upon IPCC GPG reporting framework



Forest-related net GHG (LULUCF) flux from 2001 to 2015 (draft)

(credit: N. Harris and D. Gibbs)

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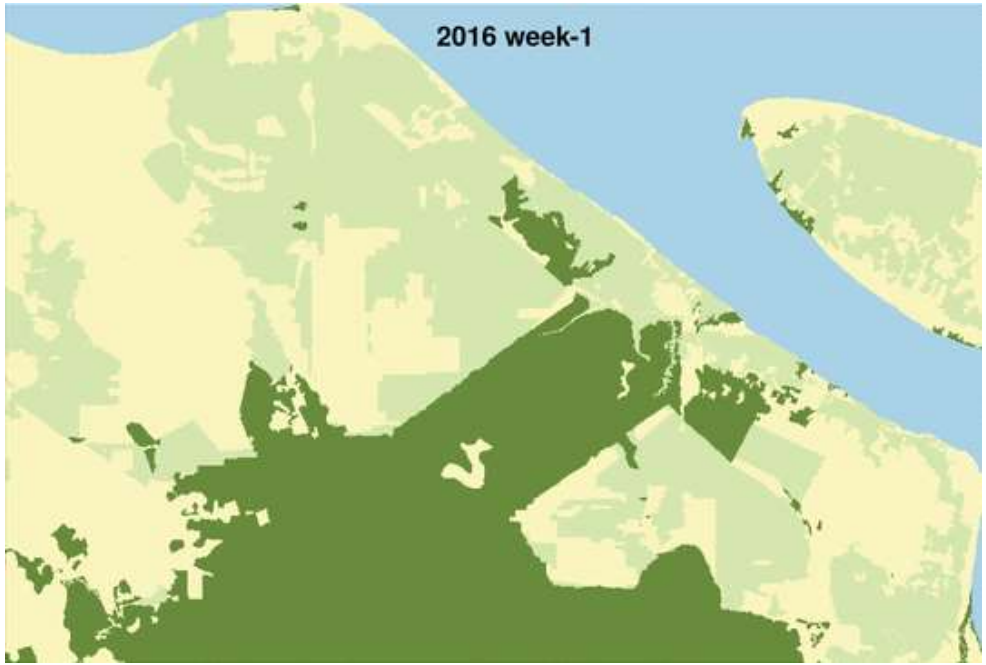
Weekly Sentinel 1 **Radar alerts** *2016-18, Riau, Indonesia*



Sentinel -1 Radar alerts

- *Open source tool (Reiche et al., 2018)*
- *Gap-free and consistent information in near real-time*
- *Combination with active fire alerts – more insight into deforestation/ fire dynamics*

- Natural forest
- Plantations
- Old clearing
- New clearing

Reiche et al. 2018. Improving near-real time deforestation monitoring in tropical dry forests by combining dense Sentinel-1 time series with Landsat and ALOS-2 PALSAR-2. RSE

Reiche et al 2018. Characterizing Tropical Forest Cover Loss Using Dense Sentinel-1 Data and Active Fire Alerts, Rem. Sens.

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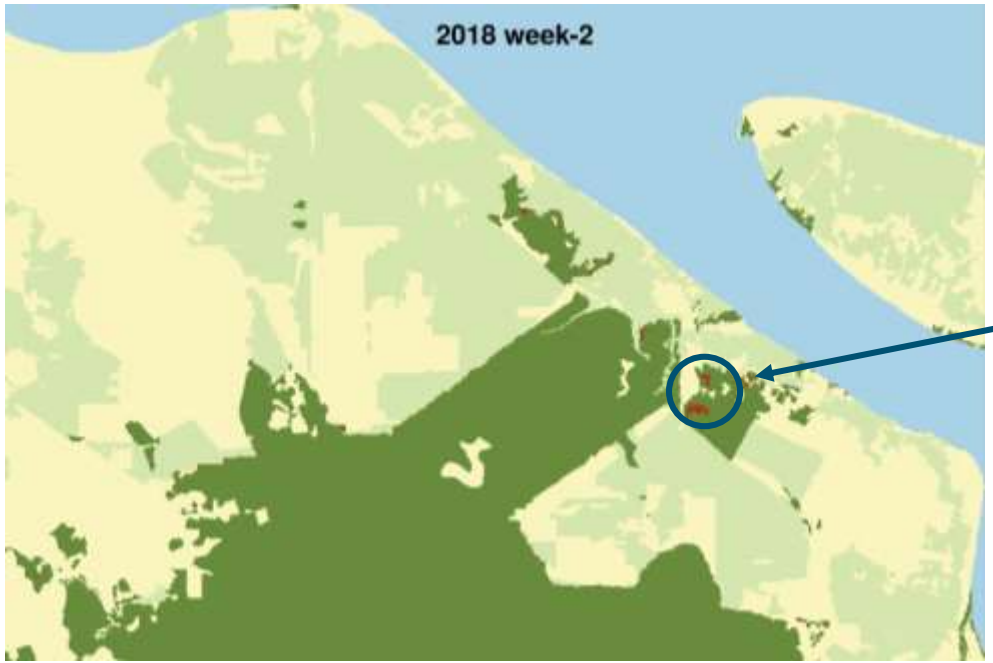

Encroachment

- Natural forest
- Plantations
- Old clearing
- New clearing

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Interactive/participatory monitoring

- *Create an environment of open exchange of information*
- *Operational monitoring in Kafa Biosphere Reserve, Ethiopia in near-real time mode since Oct. 2014*
- *System at national and local level in Peru incentivising indigenous communities to protect forests*
- *Alert-driven monitoring for sustainable oil palm sourcing in Indonesia and Malaysia (https://landsense.eu/)*

http://www.wageningenur.nl/cbm

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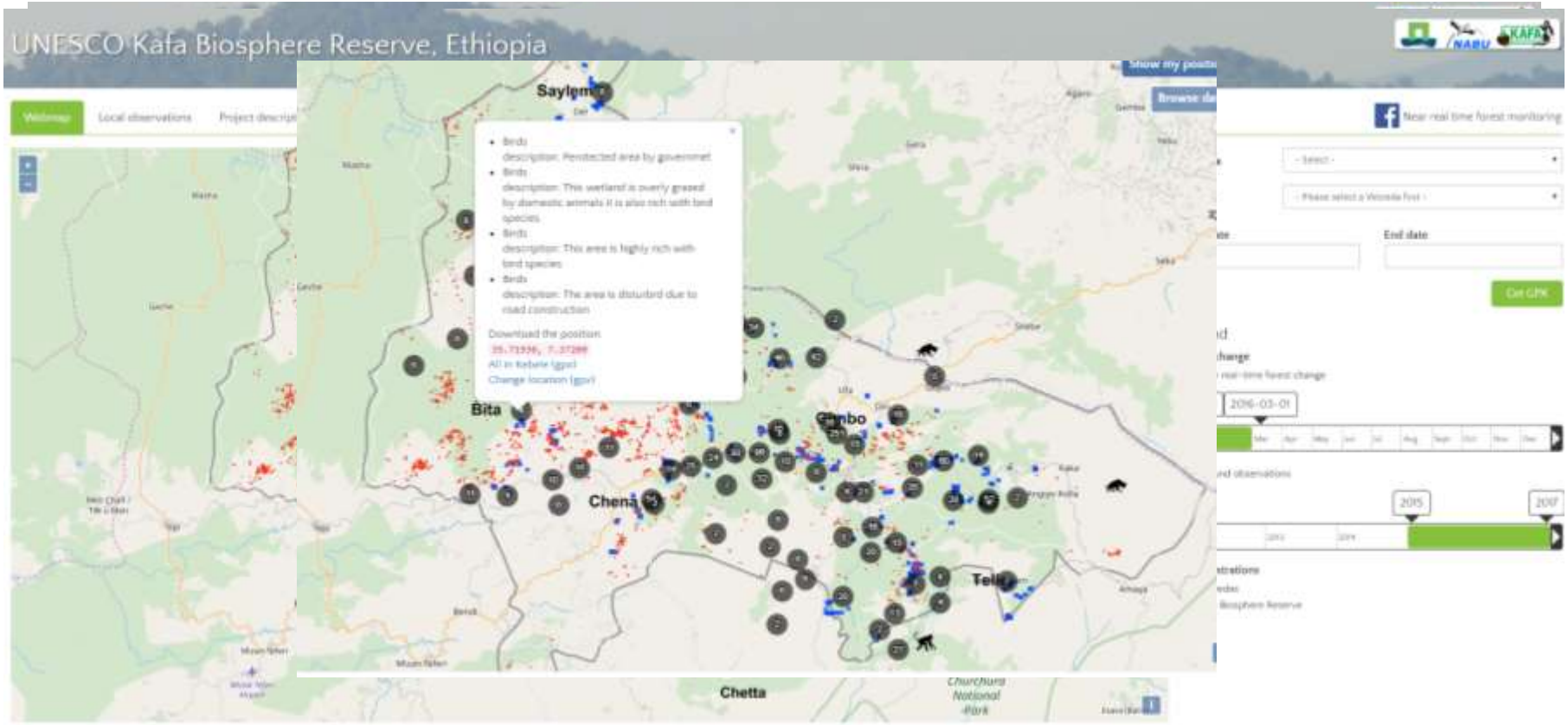

http://www.cbm.wur.nl/

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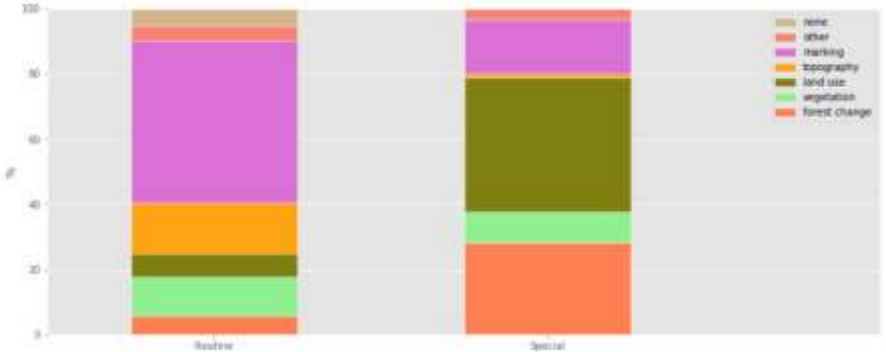
100years

Peru: Support for the improvement of the national forest monitoring system for local forest protection

- *Remote sensing-based forest change data*
- *Two types of ground-based monitoring 2015-18 (N~ 2500):*
  - *Routine monitoring (95%): periodic monitoring performed at least 4 times a year by trained "vigilance committees"*
  - *Special monitoring (5%): additional monitoring responding to early warnings from the Government or alerts from communities*



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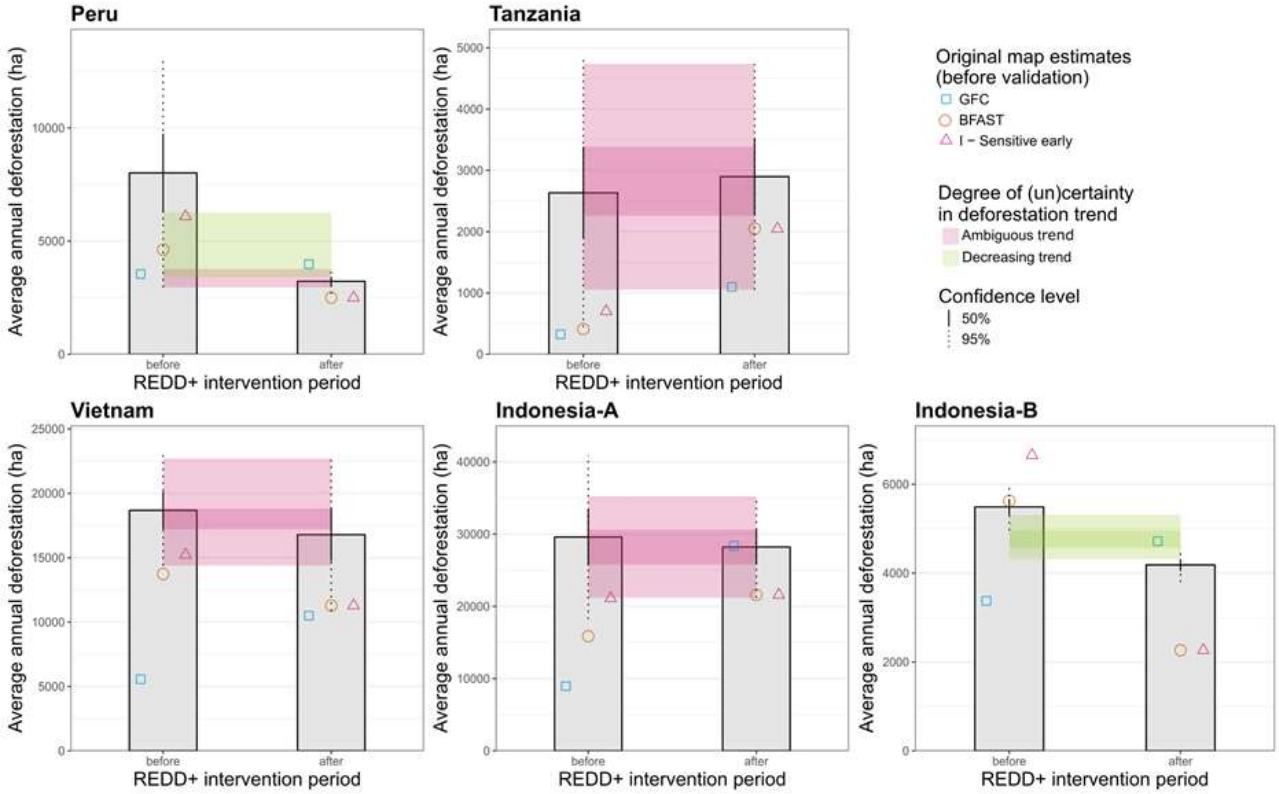
REDD+ performance

- *Global data and open-source tools for local forest cover loss and REDD+ performance assessment (Bos et al, 2019)*
- *Five local REDD+ initiatives in 4 countries*
- *Global forest cover product (Hansen - GFC) and open-source algorithm (BFAST) for forest change detection*
  - *Accuracy depends on site*
  - *Some complementary*
  - *Deforestation trends*



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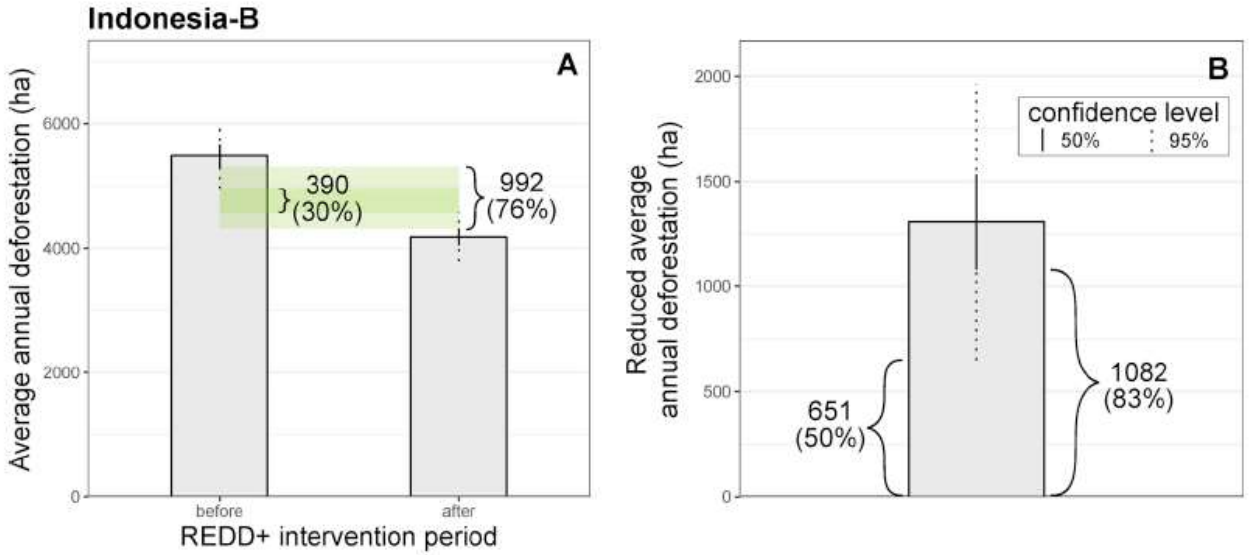
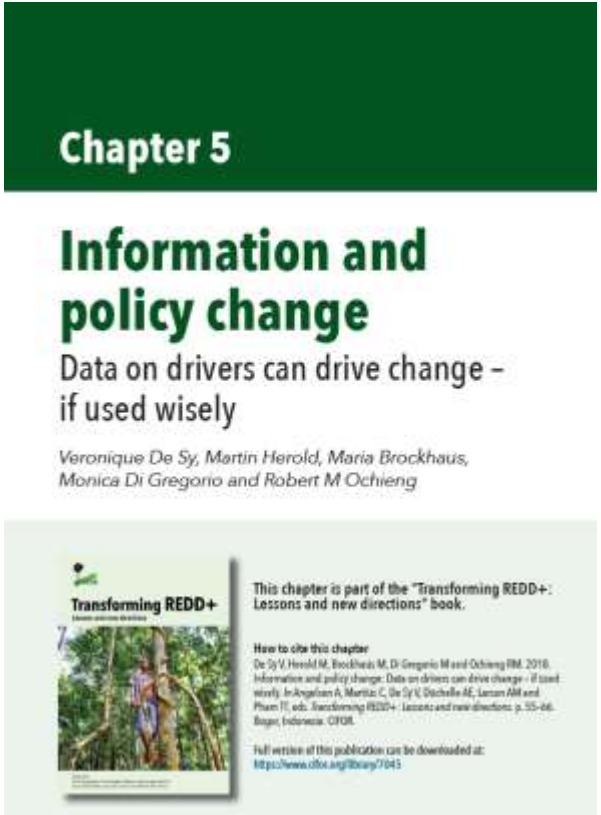


Fig. 8. Conservativeness principle applied to calculate the REDD + estimates for Indonesia-B. With approach A (left) one prevents overestimation of the reference estimates (before period) and underestimation of the assessment period (after period). Estimates in approach B (right) are derived from the uncertainty of the trend. Numbers next to curly brackets show the conservative REDD + estimate (activity data only) in ha assessed at the 95%CI and 50%CI, and as percentages of the trend from the reference-based area estimates (grey bar in B) (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

Information and policy change



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100years

Information and policy change

- *New information technologies offer new opportunities, but also come with diverse implications and new risks.*
- *Information use is influenced by* **interests** *of powerful agents of deforestation and forest degradation.*
- *Actors have* **different capacities and resources** *to access, process and provide information, as well as to contribute to policy decisions about REDD+.*
- *National forest monitoring systems will need to address* **participation, transparency, accountability and coordination** *to counteract the differences in the capacities, resources and powers (decision making or political) of various stakeholders.*

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Forest monitoring for climate change mitigation ACTION

- *New EO opportunities for supporting sustainable and climate-smart* **land use** *addressing the* **whole policy cycle**
  - *Monitoring progress towards NDC/REDD+ and SDGs and trade-offs among them*
  - *Use of data from EO and national GHG-I for assessing policy options and implementation (UNFCCC transparency framework)*
- *Open data and transparency as catalyst for action*
  - *data-driven analysis for developing solutions*
  - *stakeholder participation*
  - *accountability for sustainable and climate smart land use*
- *Requires interdisciplinary research & looking beyond technical challenges*

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Questions?

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