

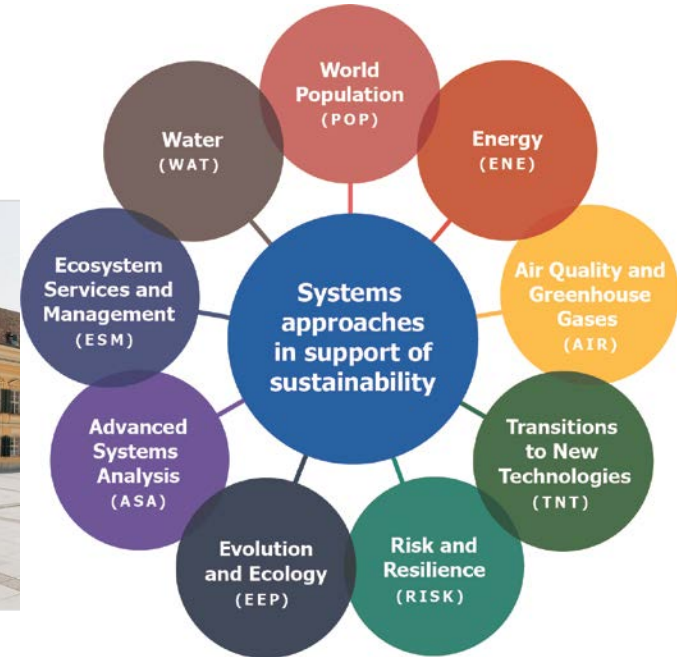
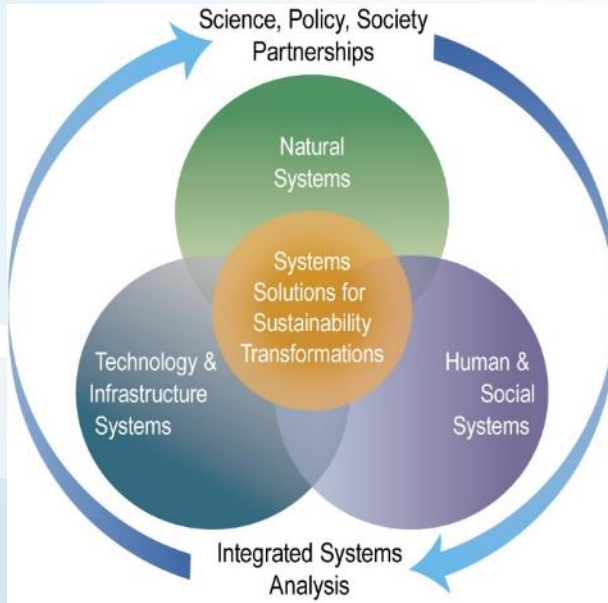
# Recent IIASA advances in global and regional forest assessment using remote sensing

Dmitry Schepaschenko <sup>1,2</sup>

<sup>1</sup> *International Institute for Applied Systems Analysis, Austria*

<sup>2</sup> *Center for Forest Ecology and Productivity of the Russian Academy  
of Sciences, Russia*

# International Institute for Applied Systems Analysis

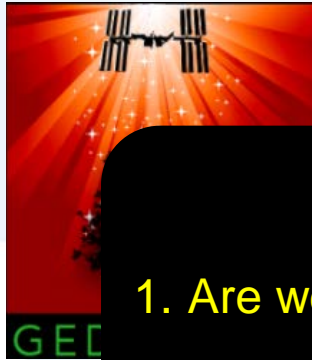


- Est. in 1972 as a scientific bridge between East and West, later extended to North-South collaboration
- 22 member countries
- Ecosystem Services and Management Program
  - Center for Earth Observation & Citizen Science (EOCS)
- Young Scientists Summer Program

# Current and expected forest & biomass-relevant missions

Mission	Funding Agency	Launch Date	Data Type	Measurement resolution	Geographic Domain	Accuracy Requirement
ICESat-2	NASA	09/2018	532 nm photon counting lidar	13m footprint aggregated to 100-m transect	Global	NA
SAOCOM 1A	CONAE	10/2018	L band SAR	10-100m	Global	NA
GEDI	NASA	12/2018	1064 nm waveform lidar	25m circular footprint	ISS (+/- ~51.6°)	<20% RMSE
SAOCOM 1B	CONAE	08/2020	L band SAR	10-100m	Global	NA
ALOS-4	JAXA	(2022)	L-band SAR	1-25 m	Global	NA
NISAR	NASA/ ISRO	(2023)	L-band SAR	3-10 m	Global	<20% RMSE for <100 Mg/ha
BIOMASS	ESA	(2022)	P-band SAR	60 x 8 m	Global except Europe and North America	<20% RMSE for AGB >50 Mg/ha
MOLI	JAXA	(2023)	1064 nm waveform lidar	25 m circular footprint	ISS (+/- ~51.6°)	25% RMSE for AGB >100 Mg/ha
TanDEM-L	DLR	(2023)	L-band SAR	TBD	Global	20% RMSE or 20 Mg/ha
Copernicus HPCM ROSE-L	ESA/EC	(2027)	L-band SAR	TBD	Global	TBD

# Spaceborne Missions to measure forest structure



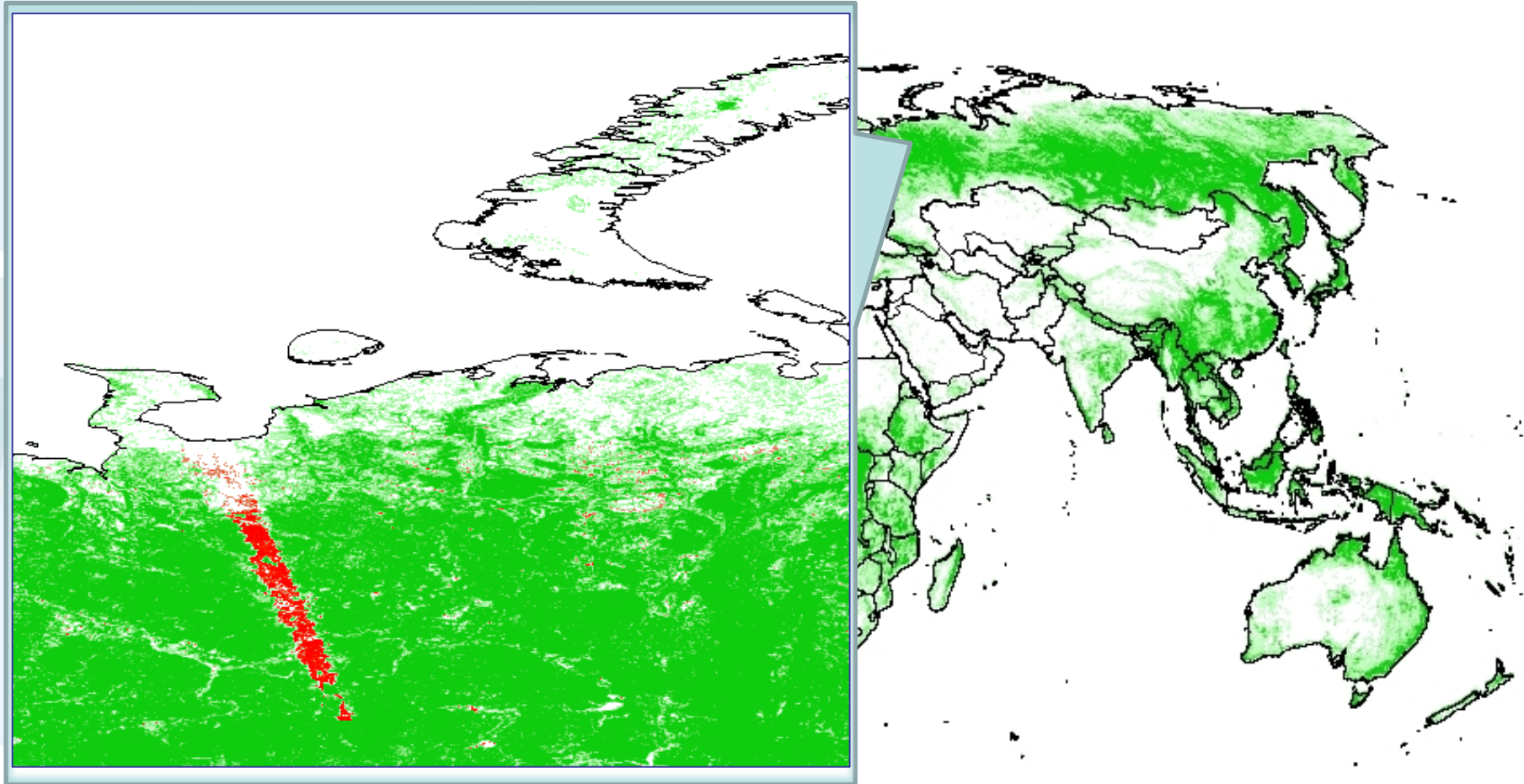
## Question:

1. Are we able to make best use of these missions?
2. Will users trust remote sensing products?

These missions will deliver measurements of

- forest height
- forest biomass
- biomass change

# Forest mask JAXA PALSAR (25m resolution)



[http://www.eorc.jaxa.jp/ALOS/en/palsar\\_fnf/fnf\\_index.htm](http://www.eorc.jaxa.jp/ALOS/en/palsar_fnf/fnf_index.htm)

# Source of validation/calibration data



- In situ measurements



- Visual interpretation of very high resolution imagery



# Forest-Observation-System.net

FOREST OBSERVATION SYSTEM

[MAP](#)
[NEWS](#)
[ABOUT](#)
[RESOURCES](#)
[CONTACTS](#)

### PLOT INFORMATION

**RK-10 (1)**  
 Russia  
 Network: IIASA  
 Institutions: IF.SB.RAS  
 Link: <http://forest.lakadem.ru/PerSyst/>  
 Pls: E. F. Vedrova, L. V. Mukhortova, V.V. Ivanov  
 Established: 2007  
 Plot area: 0.25 ha  
 Census: 2007  
 Measurements:  
 AGB Local HD : 73.9 t/ha  
 H Lorey Local: 10.3 m  
 Min DBH: 5 cm  
 Wood Density: 0.495 t/m<sup>3</sup>  
 Taxonomic Identifications:  
 Pinus sylvestris: 96 % (2736)  
 Pinus sibirica: 2 % (85)  
 Larix gmelinii: 2 % (86)

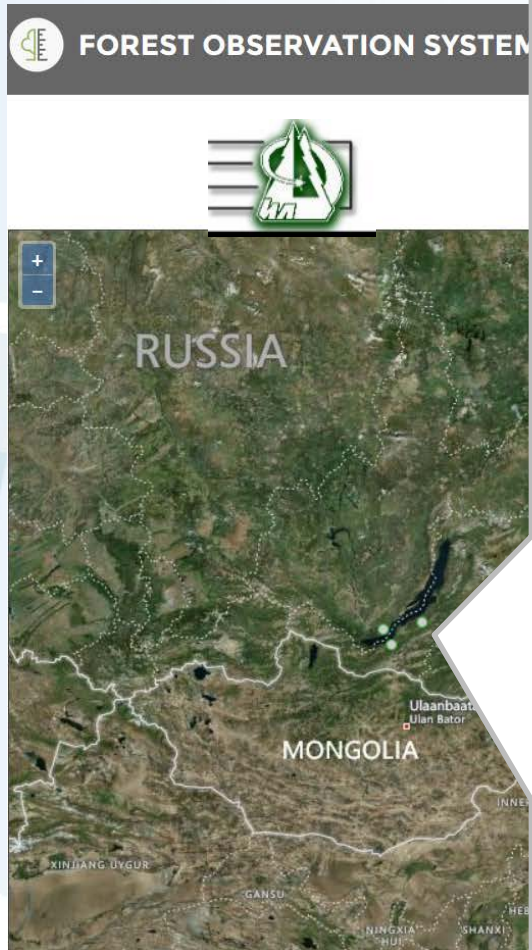
nature > scientific data



NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE



# An example of FOS permanent forest sample plot



PlotCode: RK-10 (1)

CountryName: Russia

PlotArea: 0.25 ha

Network: IIASA/IF

Link:

<http://forest.akadem.ru/PerSyst/>

PI: V.V. Ivanov, E. F. Vedrova, L. V. Mukhortova

Year: 2007

Image: [RK 10](#)

H Average: 10.3 m

AGB Local HD: 73.93 t/ha

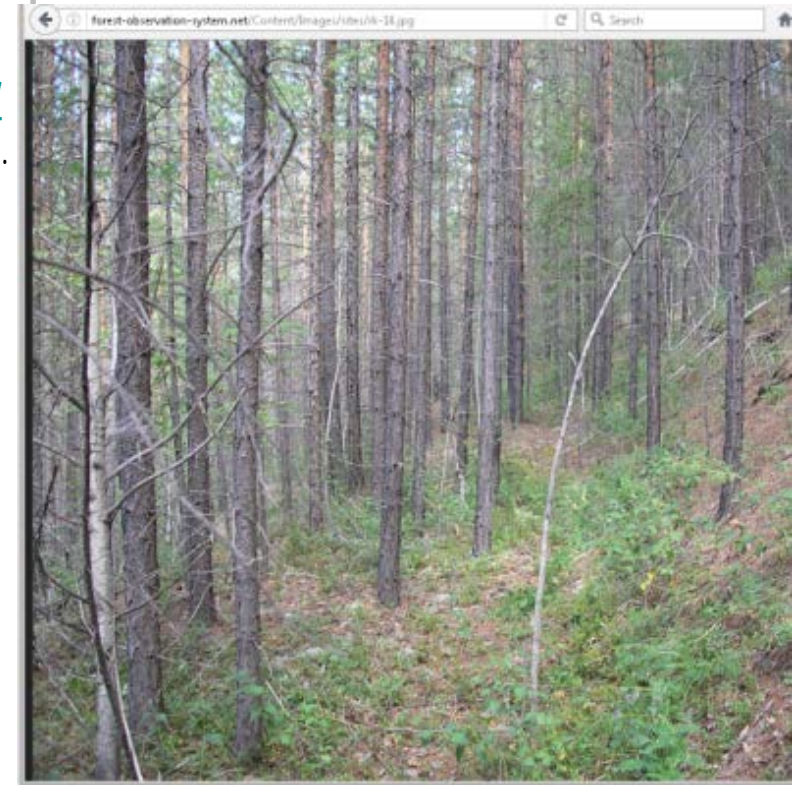
Wood Density: 0.495 t/m<sup>3</sup>

**Taxonomic Identification**

2736 (96 %) - *Pinus sylvestris*

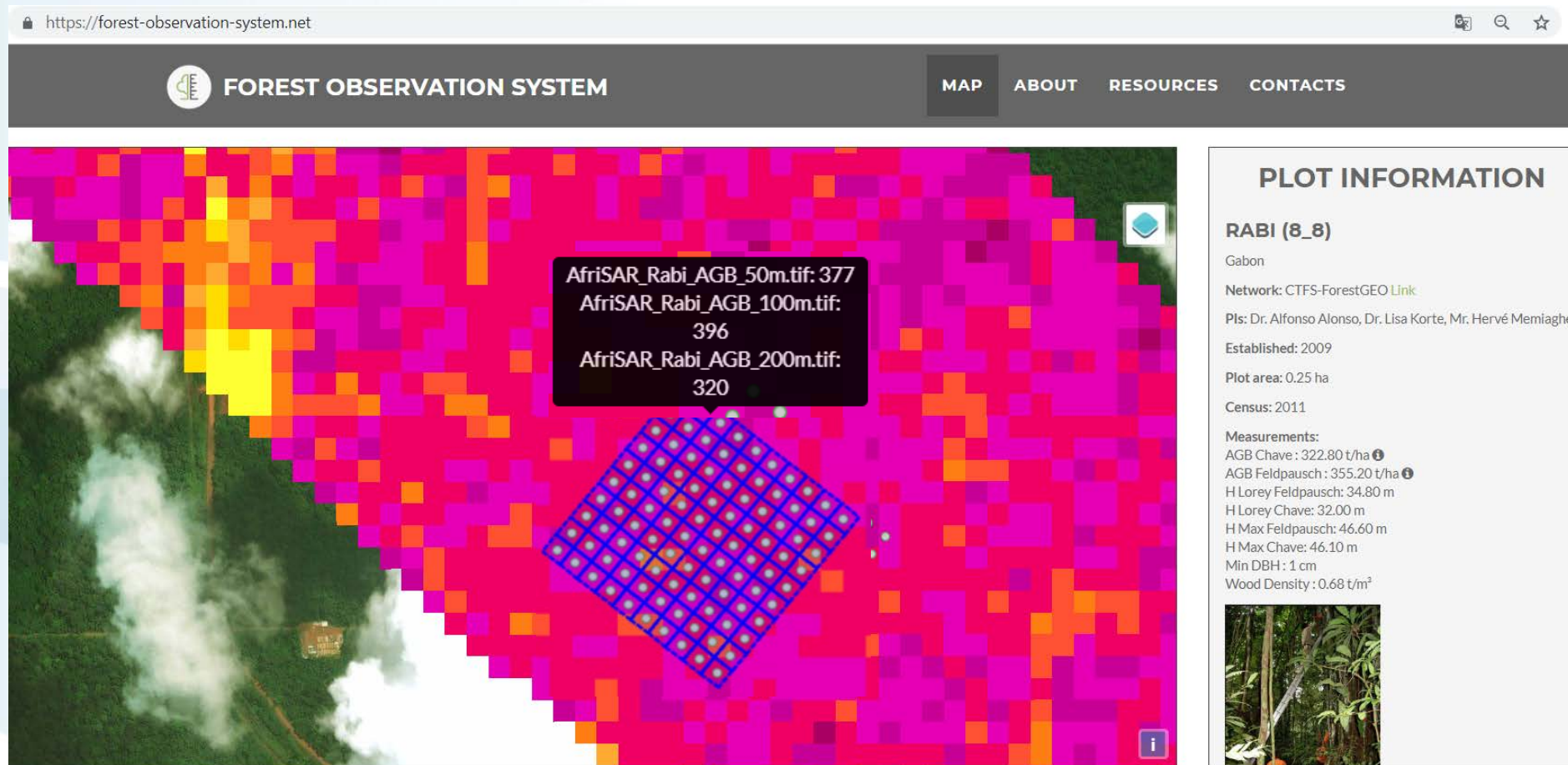
85 (2 %) - *Pinus sibirica*

86 (2 %) - *Larix gmelinii*

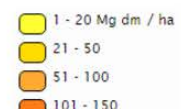




# Airborne Lidar-based biomass maps



Biomass maps legend:



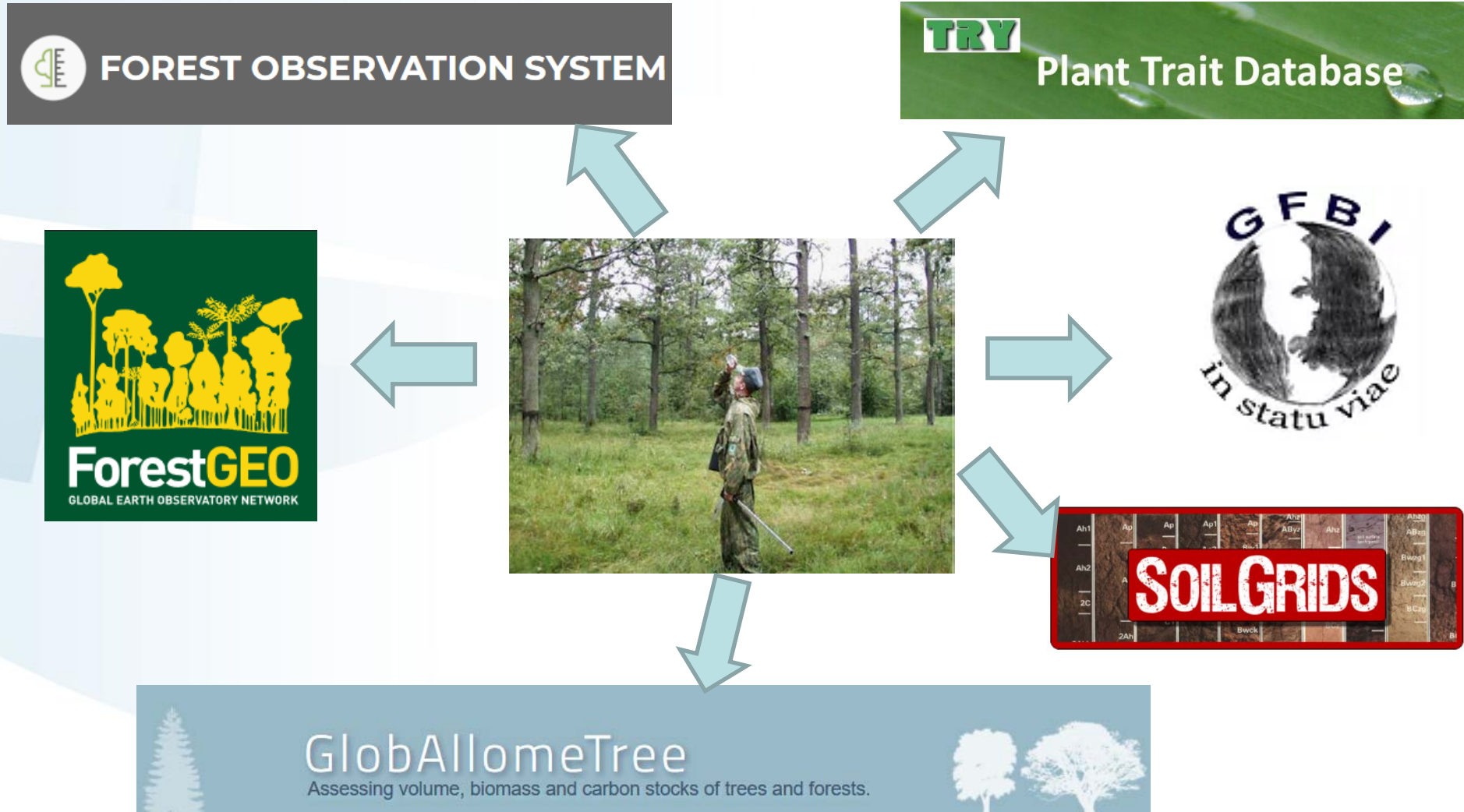
Resources:

- Tropics by WUR [reference](#)
- Pan Boreal [reference](#)
- IIASA hybrid biomass [reference](#)

## DOWNLOAD DATA

Only logged in users are allowed to download.

# Sharing data – win-win strategy



# Discrepancy in estimation of forest dynamics

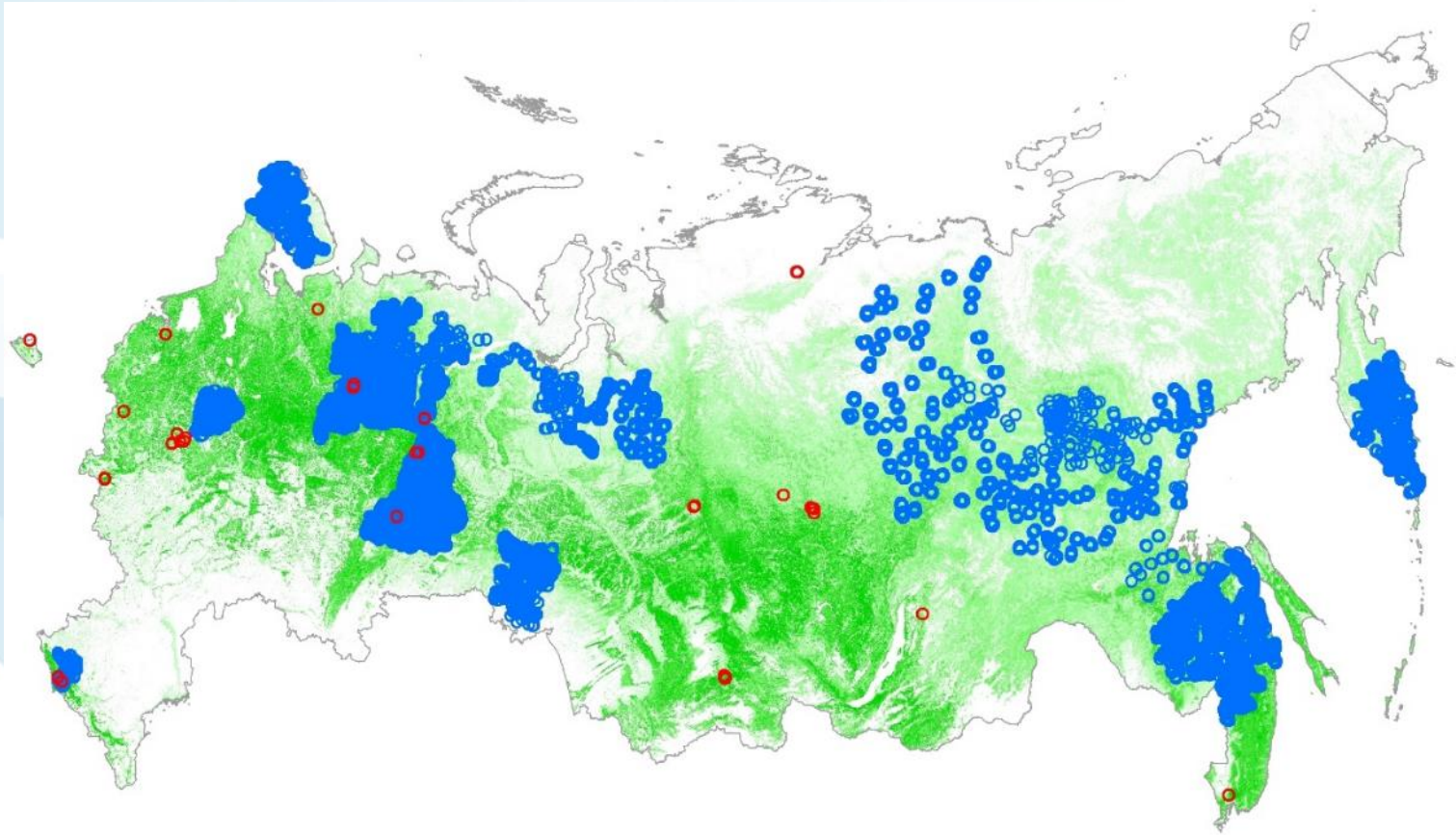
## Independent estimations

- Tree cover: +0.42% (1982–2016)  
Song X.-P. et al. *Nature*, 2018
- Above-ground biomass: **+0.99%**  
(2000–2007)  
(Liu Y.Y. et al. *Nature Climate Change*, 2015)
- Biomass: **+0.44%** (1990–2007)  
(Pan Y. et al. *Science*, 2011).
- Greening  
(Guay K.C. et al. *Global change biology*, 2014)

## National FAO FRA report (1990-2015)

- Forested area:  
+0.03% per year
- Growing stock volume:  
**+0.07%** per year
- Above-ground biomass:  
**+0.02%** per year

# Forest sample plots NFI and FOS



- 101 Forest Observation System research sample plots
- ~10'000 National Forest Inventory sample plots

# New estimation of Growing Stock Volume for 2014

CCI Biomass

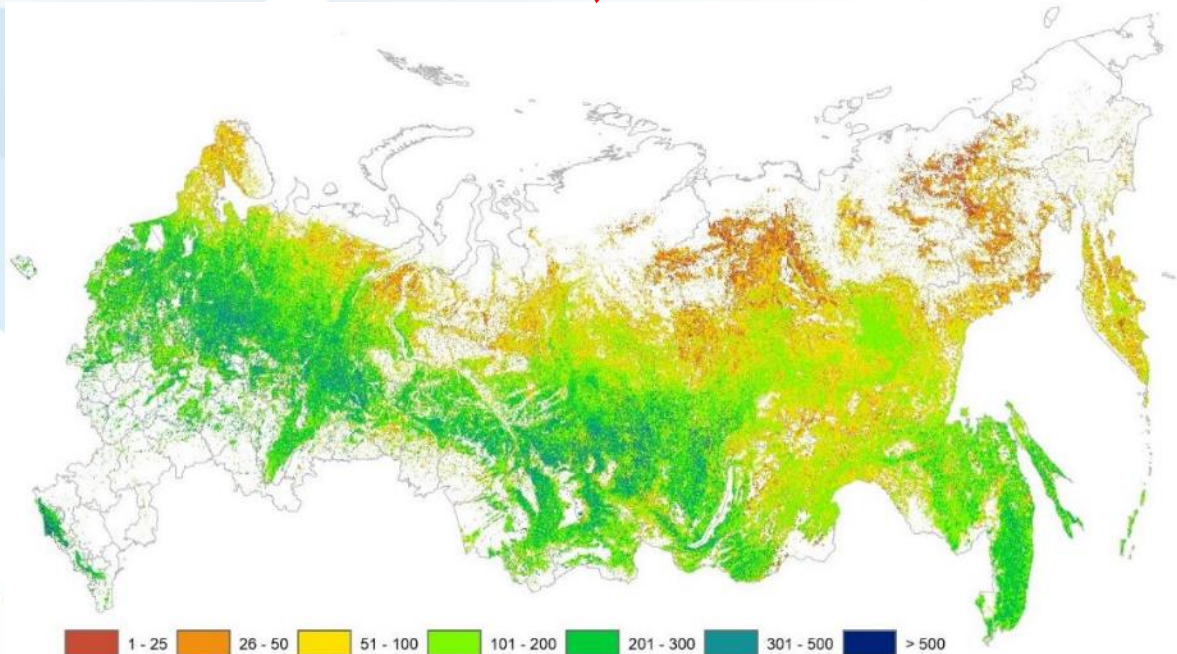
*in situ* data

GlobBiomass

Our GSV estimation:

**114.9**±1.3 10<sup>9</sup> m<sup>3</sup> or **44%**  
higher than Forest Register  
(79.9 10<sup>9</sup> m<sup>3</sup>), incl.

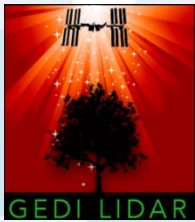
- +6.9 10<sup>9</sup> m<sup>3</sup> or +9% due to larger forested area
- +28.1 10<sup>9</sup> m<sup>3</sup> or +35% higher GSV density



# Source of validation/calibration data



- In situ measurements

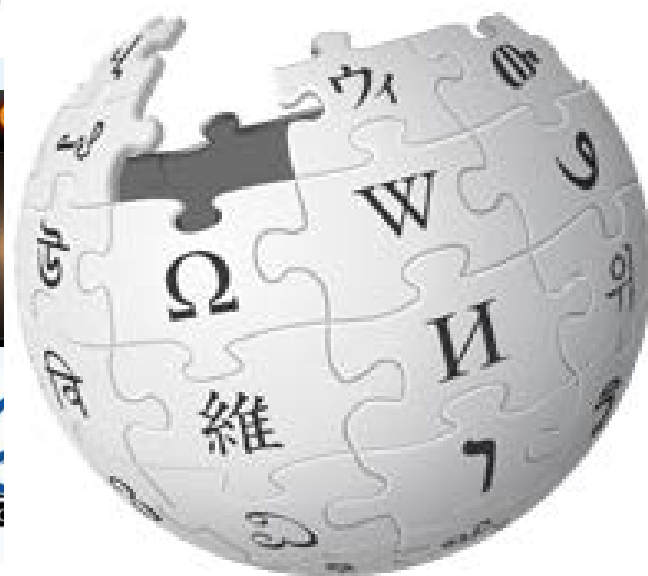


- Visual interpretation of very high resolution imagery





GALAXY Z



WIKIPEDIA

GEO-  
Wiki



iNaturalist



CITIZEN SCIENCE  
FOUNDATION



# Serious Game: Picture Pile



914  
Players



2,560,565+  
Classifications



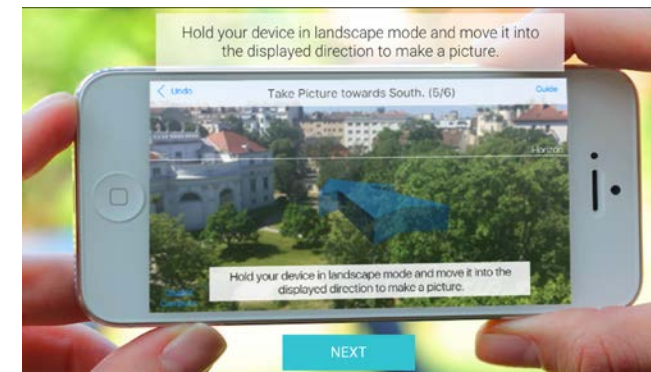
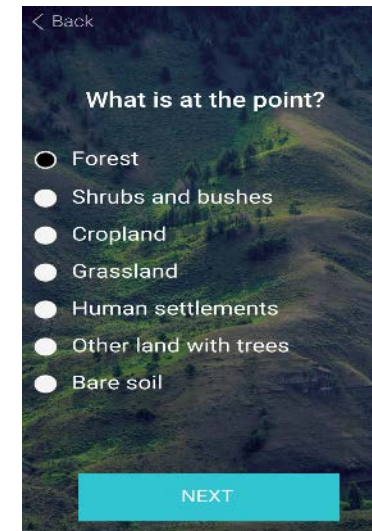
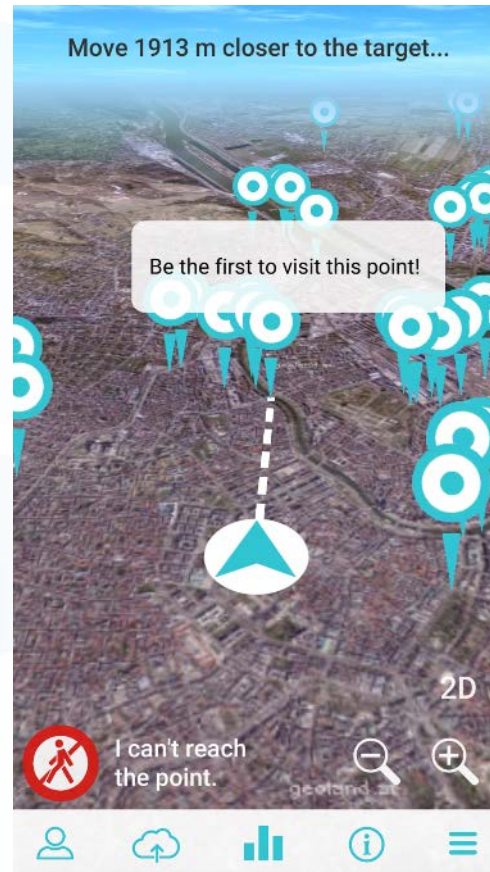
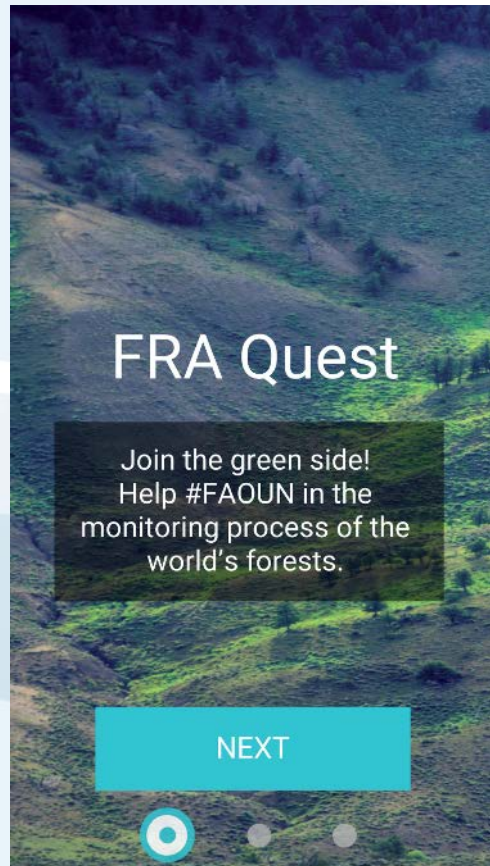
217,331  
Unique images



90%  
< 5 seconds



# FotoQuest Go / FRA Quest



<https://www.youtube.com/watch?v=DCTTKXK-YVQ>

# Visualization of Global Land Cover, Biomass, Photos, etc.



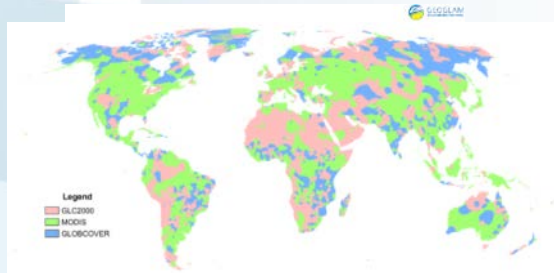
# Crowdsourcing of Land Cover (Google Earth, Bing Maps)



# Geo-Wiki



# Creation of Hybrid Land Cover Maps



# Validation of Land Cover Maps

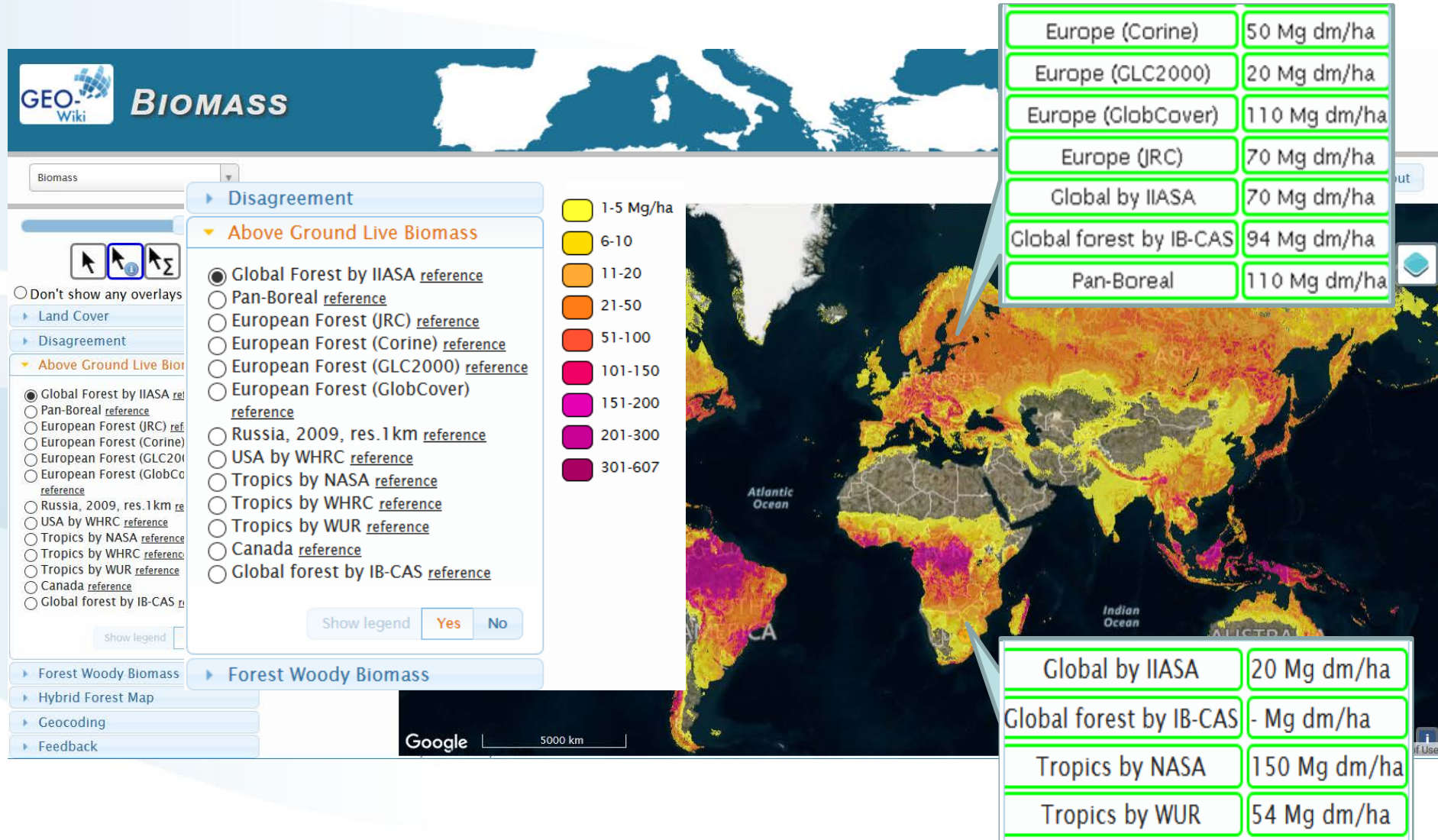


In-situ Data via Geo-Wiki Pictures, FotoQuest Go app

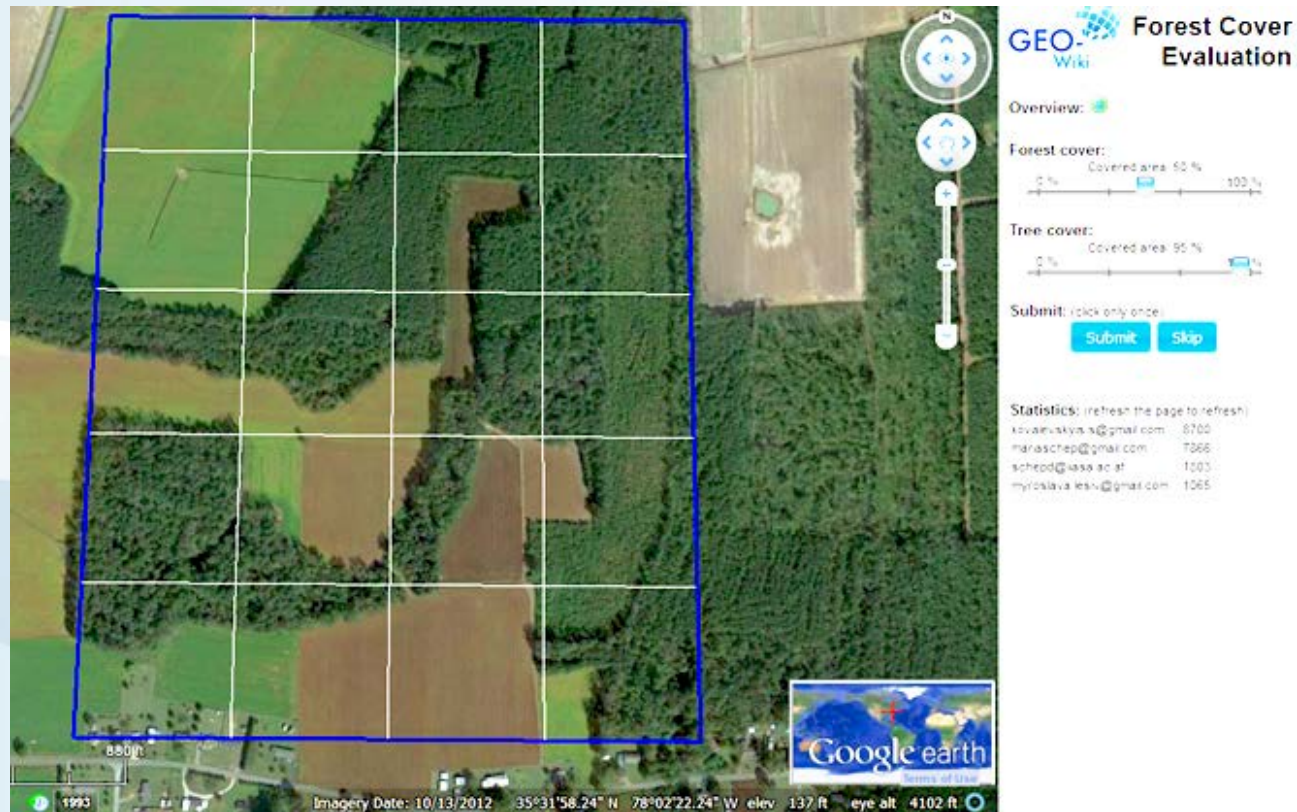
Serious Games (Cropland Capture, Picture Pile)



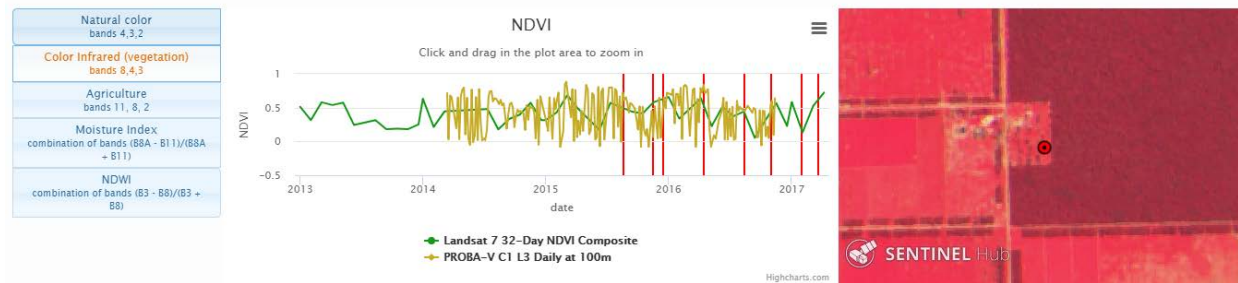
# Biomass.Geo-Wiki.org



# Estimation of forest cover using Geo-Wiki and VHR Google Earth imagery



- Land cover type, forest / non-forest
- Homogenous / heterogeneous pixel
- Disturbances / changes (time series of VHR images)
- Low / medium / high biomass
- Young / old forest
- Plantation / natural
- Evergreen / deciduous

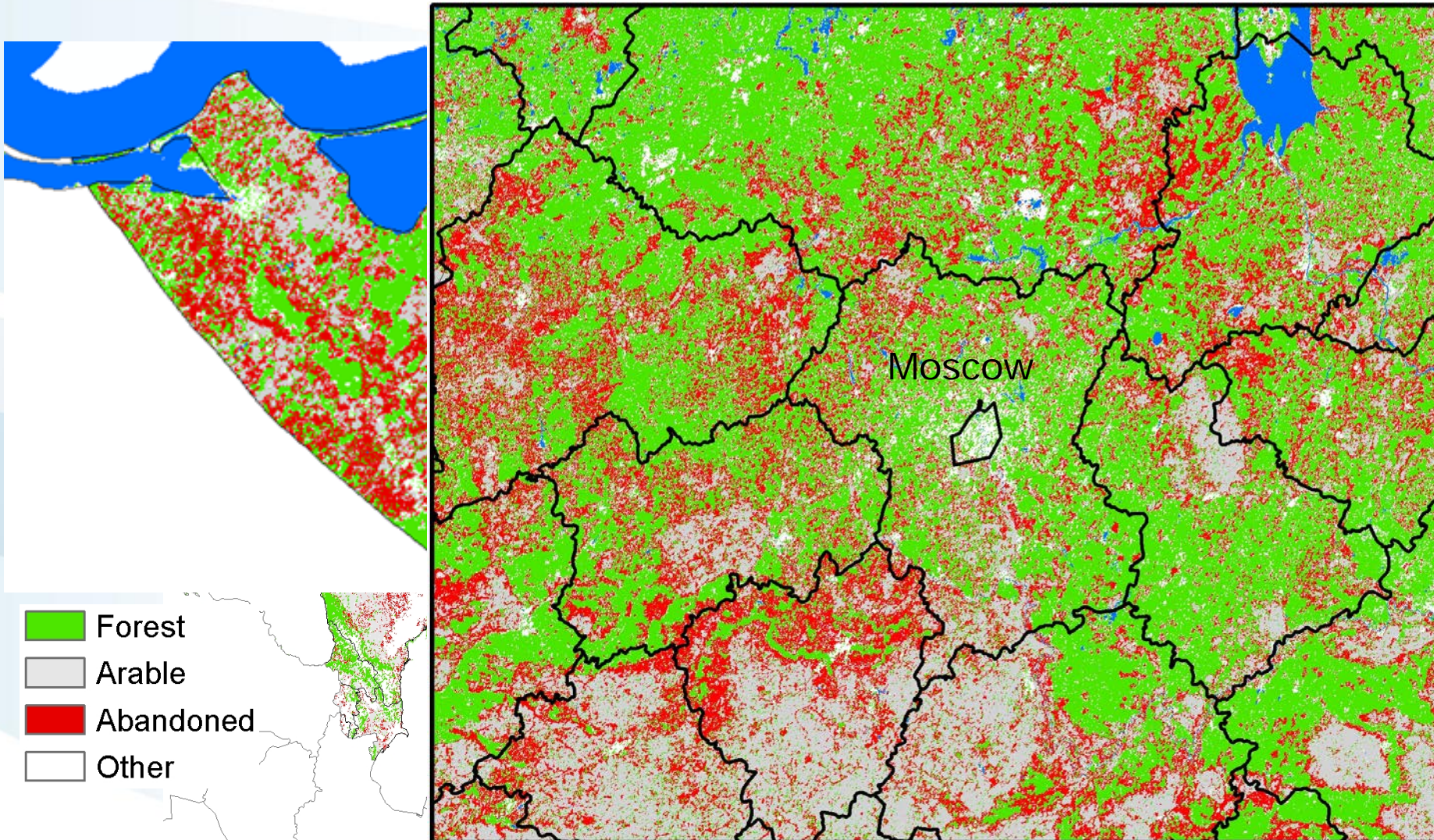


Statistically  
proved sample

# Abandoned arable field at very high resolution space images and ground photo

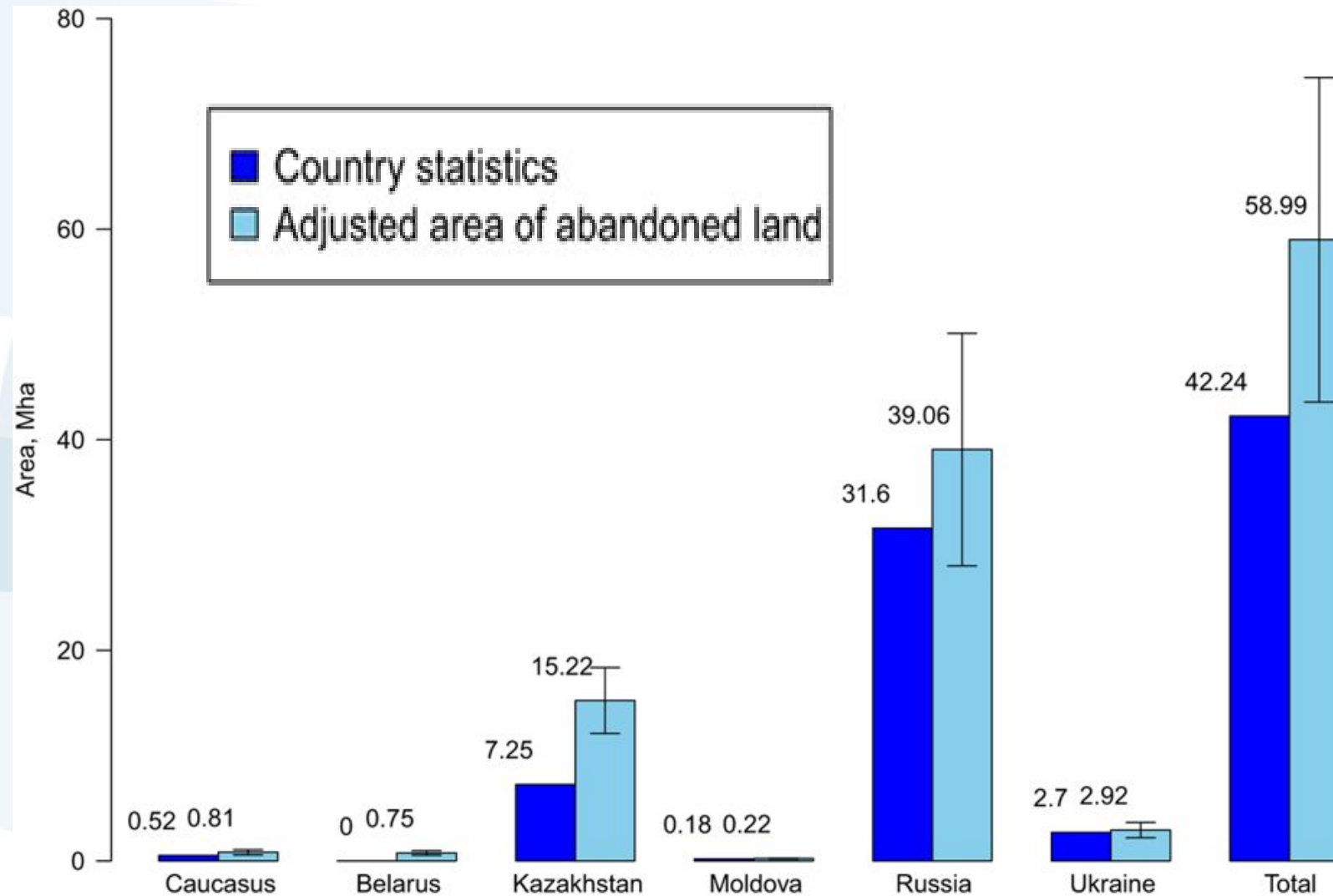


# Abandoned arable land in 8 FSU countries



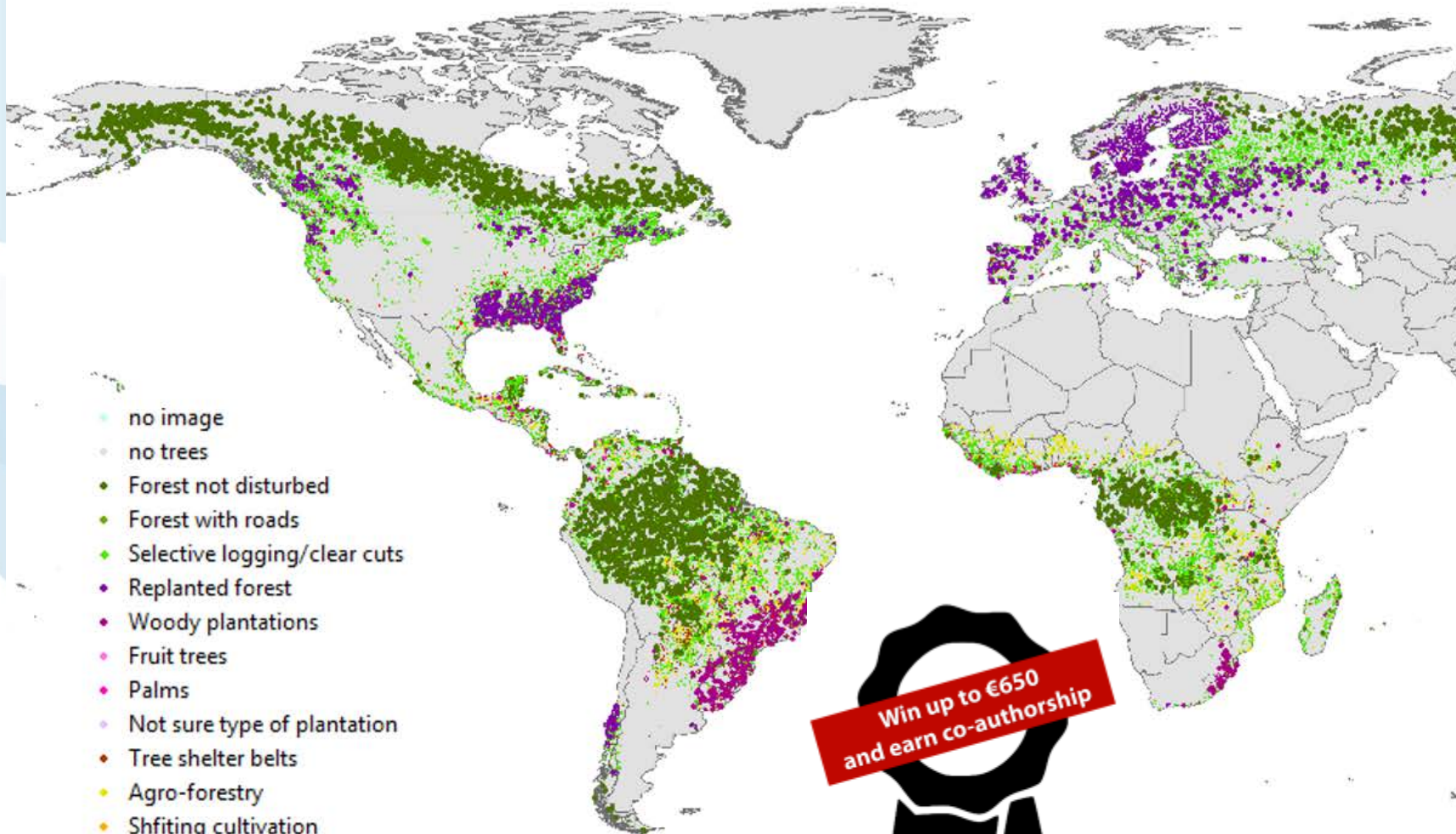
Source: Lesiv, Schepaschenko et al., 2018

# Area of abandoned arable land, 10<sup>6</sup> ha



Source: Lesiv, Schepaschenko et al., 2018

# Forest management (completed campaign)



- no image
- no trees
- Forest not disturbed
- Forest with roads
- Selective logging/clear cuts
- Replanted forest
- Woody plantations
- Fruit trees
- Palms
- Not sure type of plantation
- Tree shelter belts
- Agro-forestry
- Shifting cultivation
- Urban/built up



Individual overview <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">130</span>		Prizes	
User	Nr of Validations	Quality Score	
juncopartner	57,578	88,115	
5Mari5M5	48,943	74,025	
rubulhazarika	49,114	72,880	
delbxrr	32,986	48,540	
paragksaharia	39,995	43,830	
maryanaviktorivna	13,475	23,050	
munteanvictor7	13,959	20,775	
brigitte.magori	12,017	17,715	
predsed	10,415	17,500	
bilous	10,106	17,050	
GeoCBG	10,125	15,780	
ana.perez-hoyos	9,198	15,720	
sarahgengler	7,668	12,455	
diego.guizzardi	9,625	12,300	
reinhard.prestele	6,477	11,210	
forest_biotech	6,500	10,180	
ibrar.space	6,375	9,970	
kuleswar08	6,688	9,820	
sachyn_boro	6,824	9,530	
chetri.tilok	6,360	9,505	
ziga.malek	6,008	9,415	
ksmbmei	5,979	9,265	
andy9tht	6,529	9,015	
saktola	5,912	9,000	
narzary.william11	5,945	8,710	
kemenen	4,873	7,755	
moni.molinari	5,815	7,630	
marco.minghini86	5,087	6,815	



Go to: <https://www.geo-wiki.org/> and Launch Geo-Wiki

**Geo-Wiki: Earth Observation & Citizen Science**

**Launch Geo-Wiki**  
Register, login or enter Geo-Wiki as guest

**Get involved**  
Current and upcoming campaigns

**Our results**  
Recent scientific findings

News Team About Projects Tools Data Publications Contact

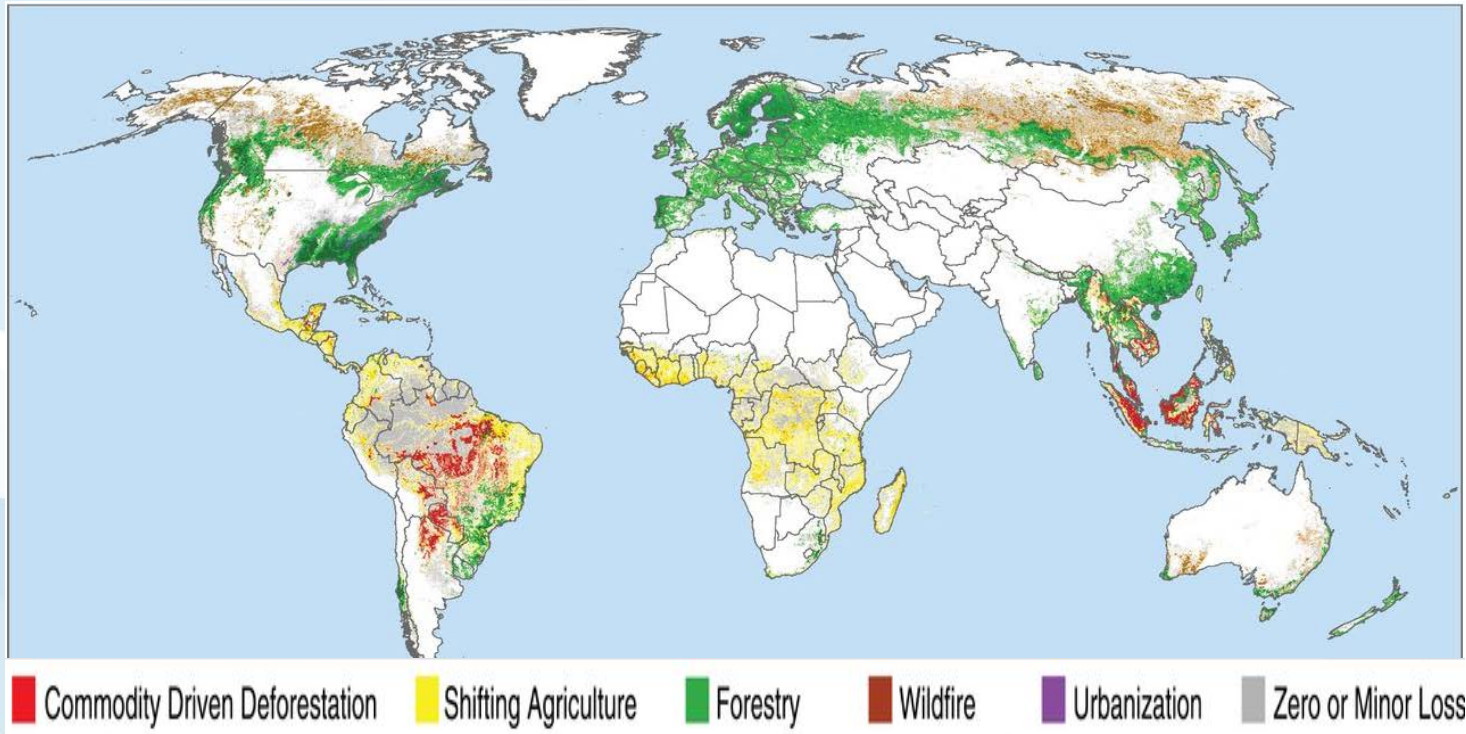
**New Campaign**  
Help understand how our forests are managed globally  
[More Info](#)

PREV NEXT

"We use earth observation and citizen science to conduct research and provide innovative, cost effective and high quality data, tools and services to help society achieve the sustainable development goals"

<https://fb.watch/1MMZNfgfGT/>

# Drivers of global forest loss



## Classifying drivers of global forest loss

Philip G. Curtis<sup>1,\*</sup>, Christy M. Slay<sup>1</sup>, Nancy L. Harris<sup>2</sup>, Alexandra Tyukavina<sup>3</sup>, Matthew C. Hansen<sup>3</sup>

<sup>1</sup>Sustainability Consortium, University of Arkansas, Fayetteville, AR 72701, USA.

<sup>2</sup>World Resources Institute, 10 G Street N.E., Washington, DC 20002, USA.

<sup>3</sup>Department of Geographical Sciences, University of Maryland, College Park, MD 20742, USA.

\*Corresponding author. Email: philip.curtis@sustainabilityconsortium.org

- Hide authors and affiliations

Science 14 Sep 2018:  
Vol. 361, Issue 6407, pp. 1108-1111  
DOI: 10.1126/science.aau3445

## Curtis et al., 2018:

- 5'000 training sample cells
- 10x10 km
- dominant disturbance type

## Next Geo-Wiki campaign:

- 100'000 training sample for the Tropics only
- 1x1 km
- Dominant + accompanying drivers



# DRIVERS OF FOREST LOSS (2008 TO 2019)

Drivers of forest loss (2008 to 2019)

Homepage

Dmitry

Logout

Don't show any overlays

Reported tree loss (2008-2019)

Drivers of forest loss

Start validation

Stop validation

Google image date: 2019-12-28  
Bing image date: 2006-12-10

View in Google Earth

Quick Start Guide

View Examples

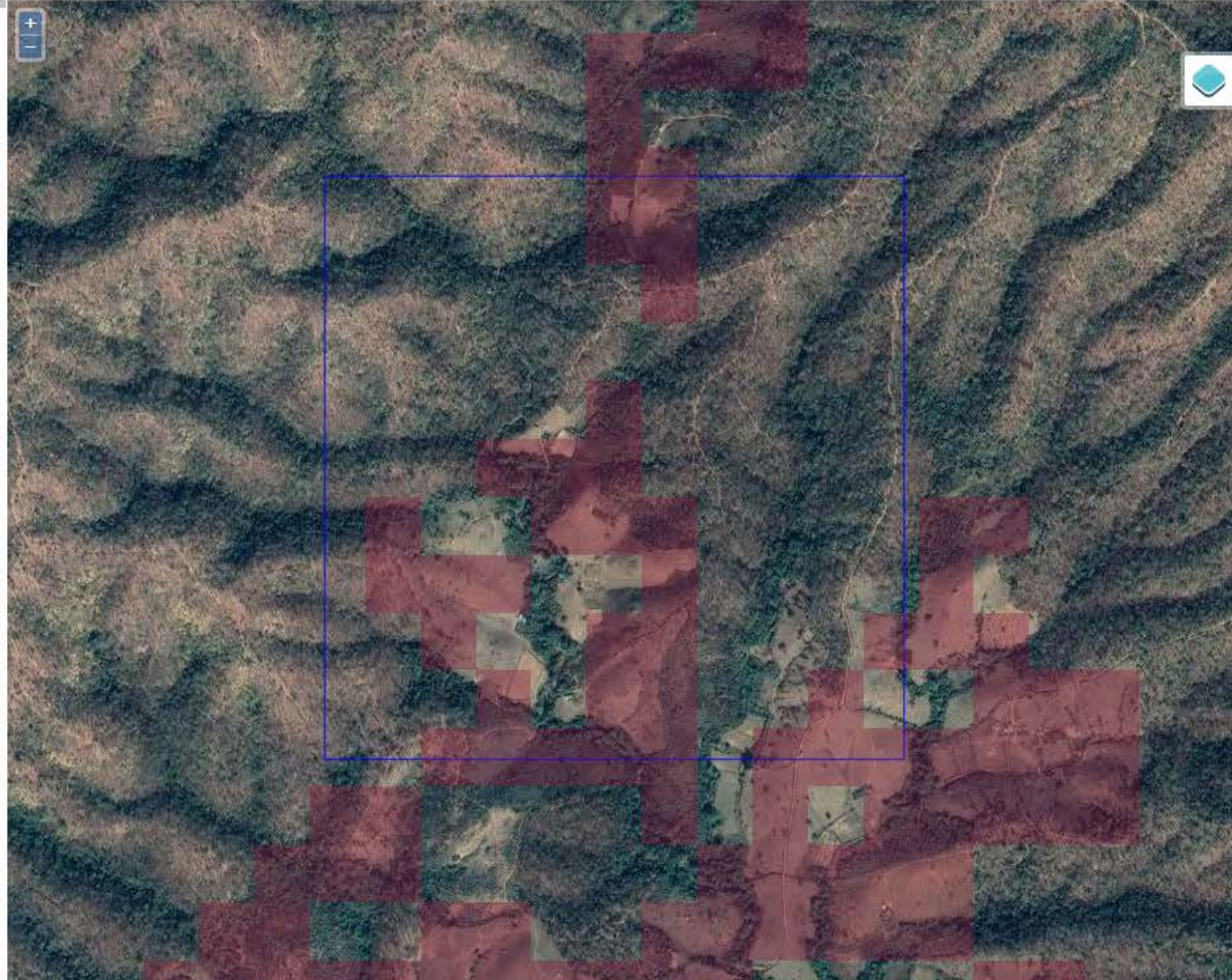
Ask experts for help

current sample point: 1738080  
Your validations: 38  
Your quality score: 0  
lat/lon:  
17.50285821/101.1363022  
classified points: 195/5000

Leaderboard

Jump to point - point id:

Jump to point



**STEP 1:**  
Please select the predominant tree loss driver visible inside the tree loss pixels in the blue box

- Subsistence agriculture
- Commercial agriculture
- Commercial oil palm or other palm plantations
- Pasture
- Managed forest/forestry
- Roads/trails/buildings
- Mining and crude oil extraction
- Wildfire (disturbance)
- Other natural disturbances/No tree-loss driver

**STEP 2:**  
Please select all other tree loss drivers visible inside the tree loss pixels in the blue box

- Agriculture/Pasture
- Managed forest/forestry
- Roads/trails/buildings
- Natural disturbances
- No other tree loss driver visible

**STEP 3:**  
Can you see roads, trails or buildings in the blue box

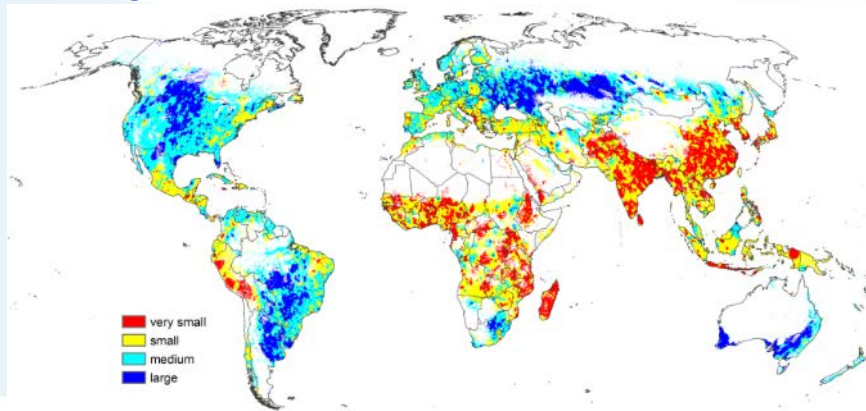
Yes No

Comment:

Submit Skip

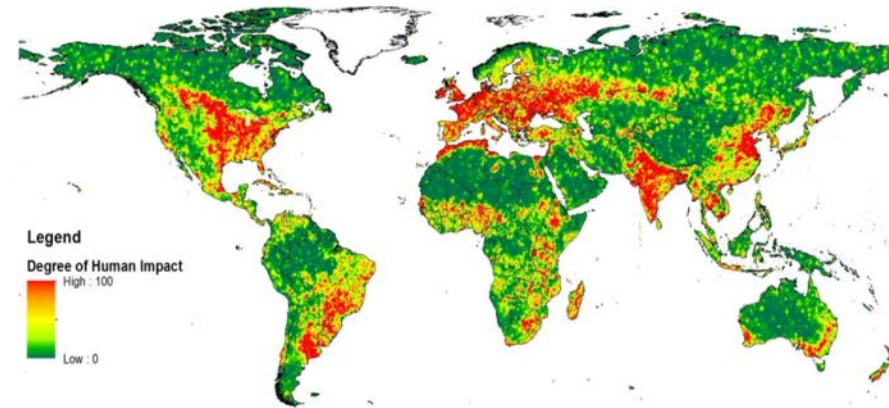
# Geo-Wiki output

## Agriculture field size



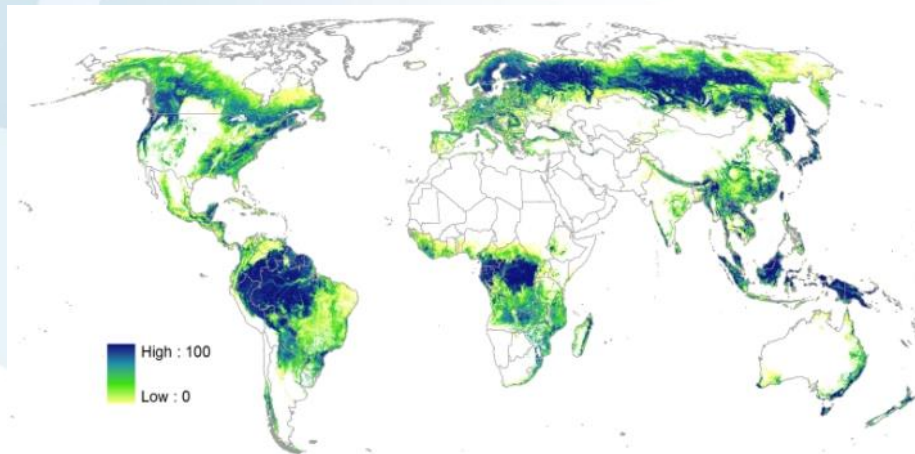
Lesiv et al. (2018) in *Global Change Biology*

## Human impact



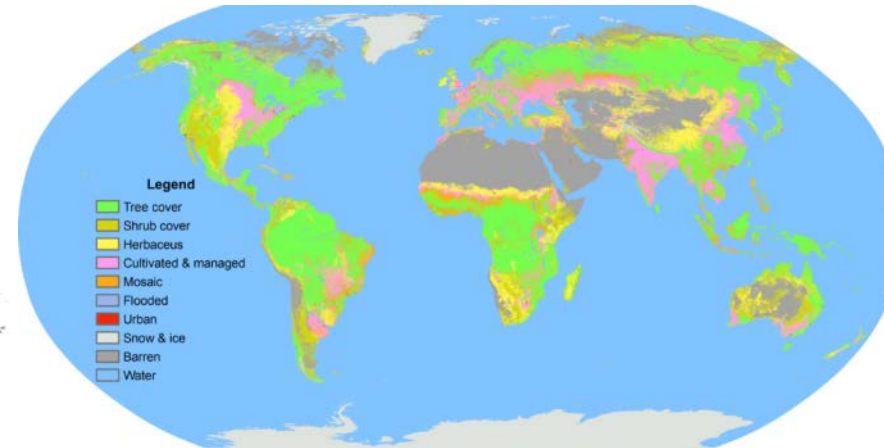
See et al. (2015) in *Technological Forecasting and Social Change*

## Forest mask



Schepaschenko et al. (2015) in *Remote Sensing of Environment*

## Land cover



See et al. (2014) in *ISPRS Photogrammetry and Remote Sensing*

# Other publications

**REVIEW** **Science**

## Boreal forest health and global change

S. Gauthier<sup>1,\*</sup>, P. Bernier<sup>1</sup>, T. Kuuluvainen<sup>2</sup>, A. Z. Shvidenko<sup>3</sup>, D. G. Schepaschenko<sup>3</sup>

+ Author Affiliations  
\*Corresponding author. E-mail: [sylvie.gauthier@mcan.gc.ca](mailto:sylvie.gauthier@mcan.gc.ca)

Science 21 Aug 2015;  
Vol. 349, Issue 6250, pp. 819-822  
DOI: 10.1126/science.aaa9092

**nature**

NATURE | CORRESPONDENCE

## Carbon tracking: Limit uncertainties in land emissions

Steffen Fritz, Dmitry Schepaschenko & Linda See


Affiliations | Corresponding author

Nature 534, 621 (30 June 2016) | doi:10.1038/534621e

**Springer Link**

Open Access | Published: 11 May 2019

## Recent Advances in Forest Observation with Visual Interpretation of Very High-Resolution Imagery

[Dmitry Schepaschenko](#) , [Linda See](#), [Myroslava Lesiv](#), [Jean-François Bastin](#), [Danilo Mollicone](#), [Nandin-Erdene Tsendbazar](#), [Lucy Bastin](#), [Ian McCallum](#), [Juan Carlos Laso Bayas](#), [Artem Baklanov](#), [Christoph Perger](#), [Martina Dürauer](#) & [Steffen Fritz](#)

[Surveys in Geophysics](#) **40**, 839–862(2019) | [Cite this article](#)

**2953** Accesses | **6** Citations | **5** Altmetric | [Metrics](#)

### Global Biomass Information: From Data Generation to Application

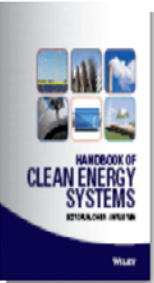
Renewable Energy

Biomass Resources and Biofuel Production

Dmitry Schepaschenko<sup>1</sup>, Florian Kraxner<sup>1</sup>, Linda See<sup>1</sup>, Sabine Fuss<sup>1,2</sup>, Ian McCallum<sup>1</sup>, Steffen Fritz<sup>1</sup>, Christoph Perger<sup>1</sup>, Anatoly Shvidenko<sup>1</sup>, Georg Kindermann<sup>1</sup>, Stefan Frank<sup>1</sup>, Markus Tum<sup>3</sup>, Erwin Schmid<sup>4</sup>, Juraj Balkovič<sup>1</sup>, Kurt Günther<sup>3</sup>

Published Online: 16 JUL 2015

Book Title



Handbook of Clean Energy Systems

Contents lists available at ScienceDirect

**Remote Sensing of Environment**

journal homepage: [www.elsevier.com/locate/rse](http://www.elsevier.com/locate/rse)

Development of a global hybrid forest mask through the synergy of remote sensing, crowdsourcing and FAO statistics

Dmitry Schepaschenko<sup>a,b,\*</sup>, Linda See<sup>a</sup>, Myroslava Lesiv<sup>a,c,d</sup>, Ian McCallum<sup>a</sup>, Steffen Fritz<sup>a</sup>, Carl Salk<sup>a,e</sup>, Elena Moltchanova<sup>f</sup>, Christoph Perger<sup>a</sup>, Maria Shchepashchenko<sup>g</sup>, Anatoly Shvidenko<sup>a</sup>, Sergii Kovalevskiy<sup>h</sup>, Dmytro Gilitukha<sup>h</sup>, Franziska Albrecht<sup>a</sup>, Florian Kraxner<sup>a</sup>, Andriy Bun<sup>i</sup>, Shamil Maksyutov<sup>j</sup>, Alexander Sokolov<sup>k</sup>, Martina Dürauer<sup>a</sup>, Michael Obersteiner<sup>a</sup>, Viktor Karminov<sup>b</sup>, Petr Ontikov<sup>b,k</sup>

Forest Policy and Economics 83 (2017) 10–18

Contents lists available at ScienceDirect

**Forest Policy and Economics**

journal homepage: [www.elsevier.com/locate/forpol](http://www.elsevier.com/locate/forpol)

Mapping certified forests for sustainable management - A global tool for information improvement through participatory and collaborative mapping

Florian Kraxner<sup>a,\*</sup>, Dmitry Schepaschenko<sup>a,g</sup>, Sabine Fuss<sup>b,a</sup>, Anders Lunnan<sup>c,a</sup>, Georg Kindermann<sup>a,d</sup>, Kentaro Aoki<sup>e,a</sup>, Martina Dürauer<sup>a</sup>, Anatoly Shvidenko<sup>a,f</sup>, Linda See<sup>a</sup>

# Opportunities for young scientists

- Apply for IIASA YSSP program
- Share your ground forest measurements with global networks
- Participate in Geo-Wiki campaigns

# Thank you for your attention!

## **Dr. Dmitry Schepaschenko**

*Senior Research Scholar*

International Institute for Applied Systems Analysis (IIASA) | Web:

<http://www.iiasa.ac.at/ESM>

Schlossplatz 1, A-2361 Laxenburg, Austria

E-Mail: [schepd@iiasa.ac.at](mailto:schepd@iiasa.ac.at) | Phone: [+43 2236 807-453](tel:+432236807453) | Skype: schepd | Google Scholar [publications](#)

## *Guest Leading Researcher*

Siberian Federal University, Russia | Web: <http://www.sfu-kras.ru/en/>

## *Guest Leading Researcher*

Center for Forest Ecology and Productivity of the Russian Academy of Sciences (CEPF RAS) |

Web: <http://cepl.rssi.ru/en/>

## *Guest Leading Researcher*

V.N. Sukachev Institute of Forest SB RAS | Web: <http://forest.akadem.ru/>

## *Coordinator*

IUFRO working group 8.01.06 – Boreal and Alpine Forest Ecosystems |

Web: <https://www.iufro.org/science/divisions/division-8/80000/80100/80106/>



## Additional info:

<https://www.geo-wiki.org/>

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<https://www.facebook.com/GeoWiki/>