International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

science for global insight

# IIASA Ecosystem Services and Management Program experience in the field of LCLUC

Dmitry Schepaschenko,

on behalf of IIASA ESM team

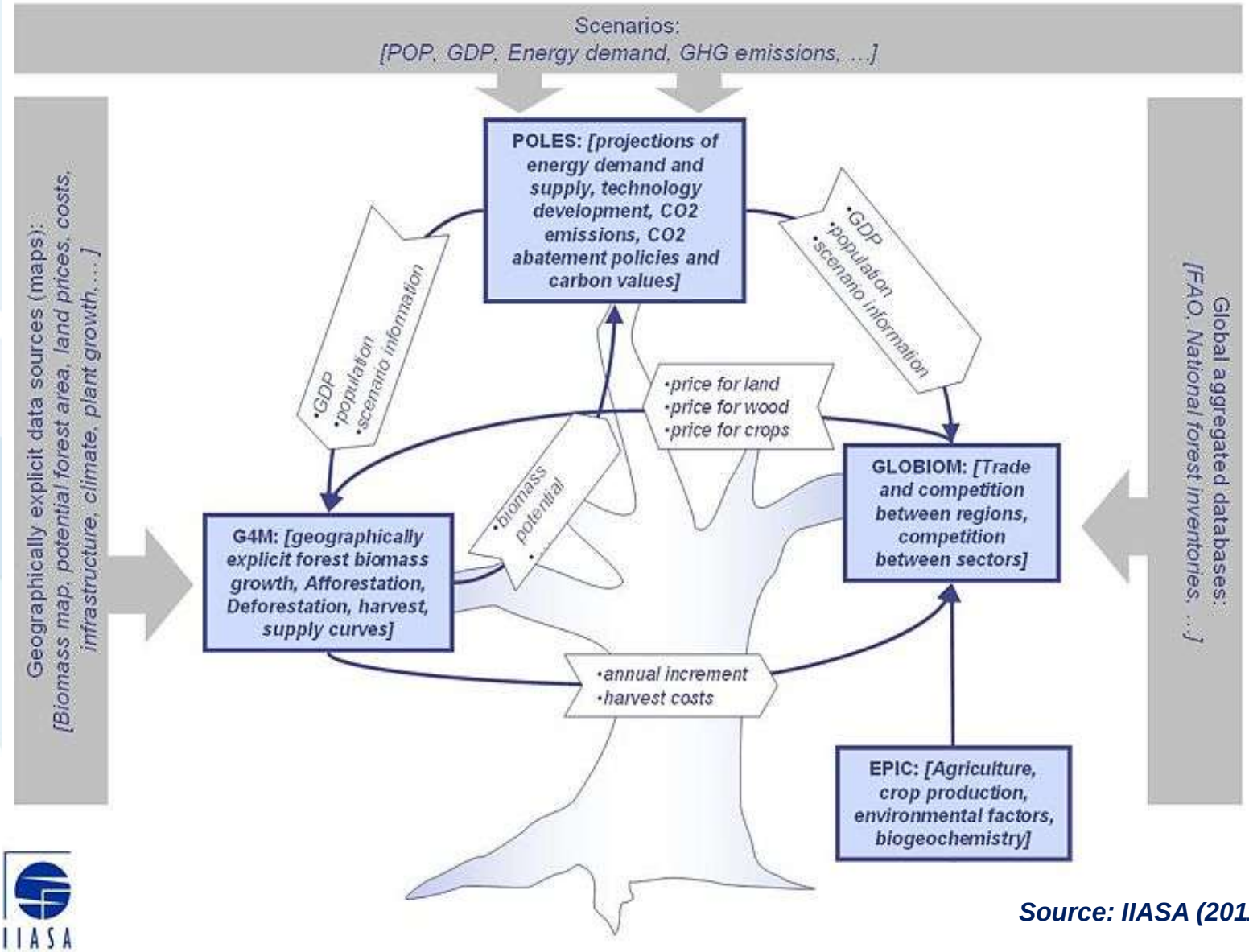


# IIASA - a Global Research Institute

- Est. in 1972 as a scientific bridge between East and West, later extended to North-South collaboration
- 24 member countries from all the continents
- Ecosystems Services and Management program

# Modeling Biomass Supply at Global Scale

## An Integrated Modeling Approach




***Source: IIASA (2011)***

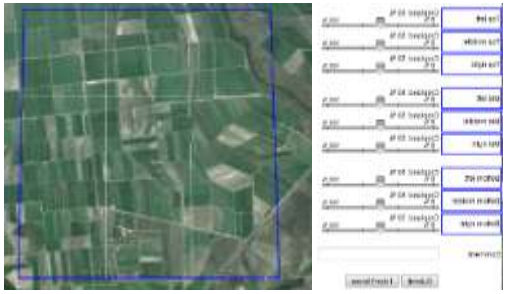
Visualization of Global Land Cover, Biomass, Photos, etc.

Crowdsourcing of Land Cover (Google Earth, Bing Maps)

# Geo-Wiki

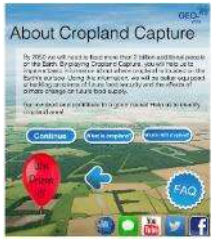

Creation of Hybrid Land Cover Maps

Validation of Land Cover Maps

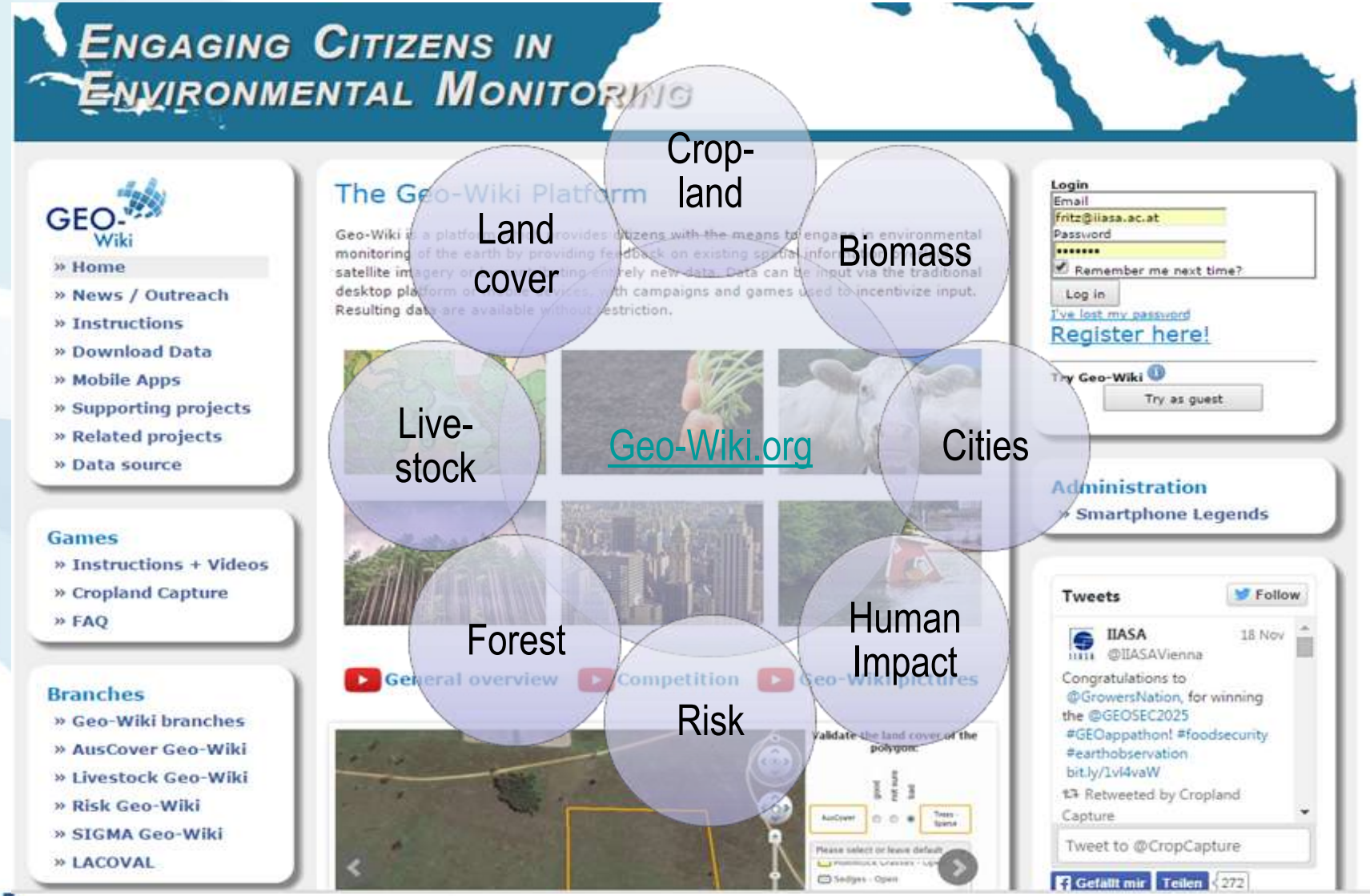


In-situ Data via Geo-Wiki Pictures, FotoQuest Go app

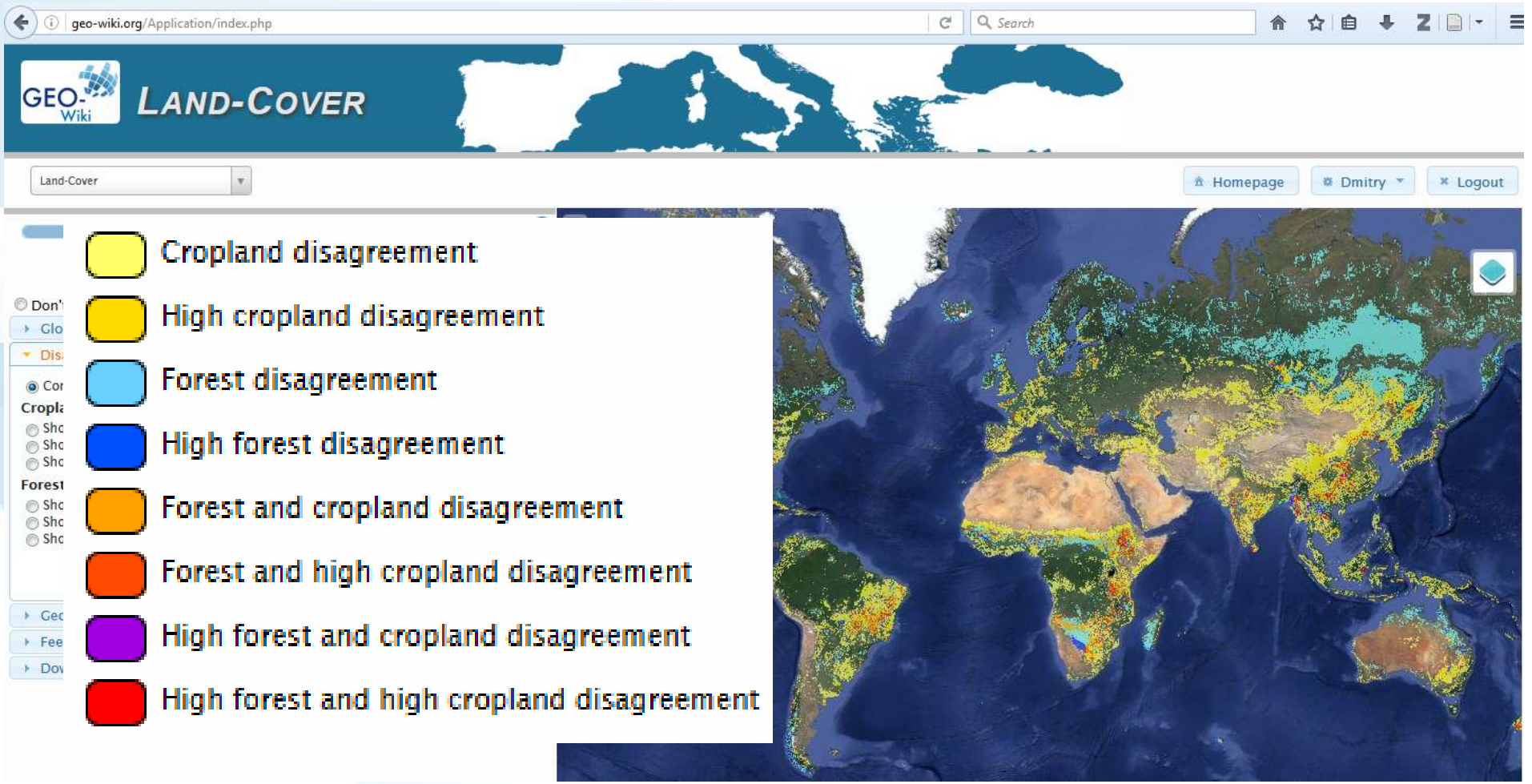
Serious Games (Cropland Capture, Picture Pile)



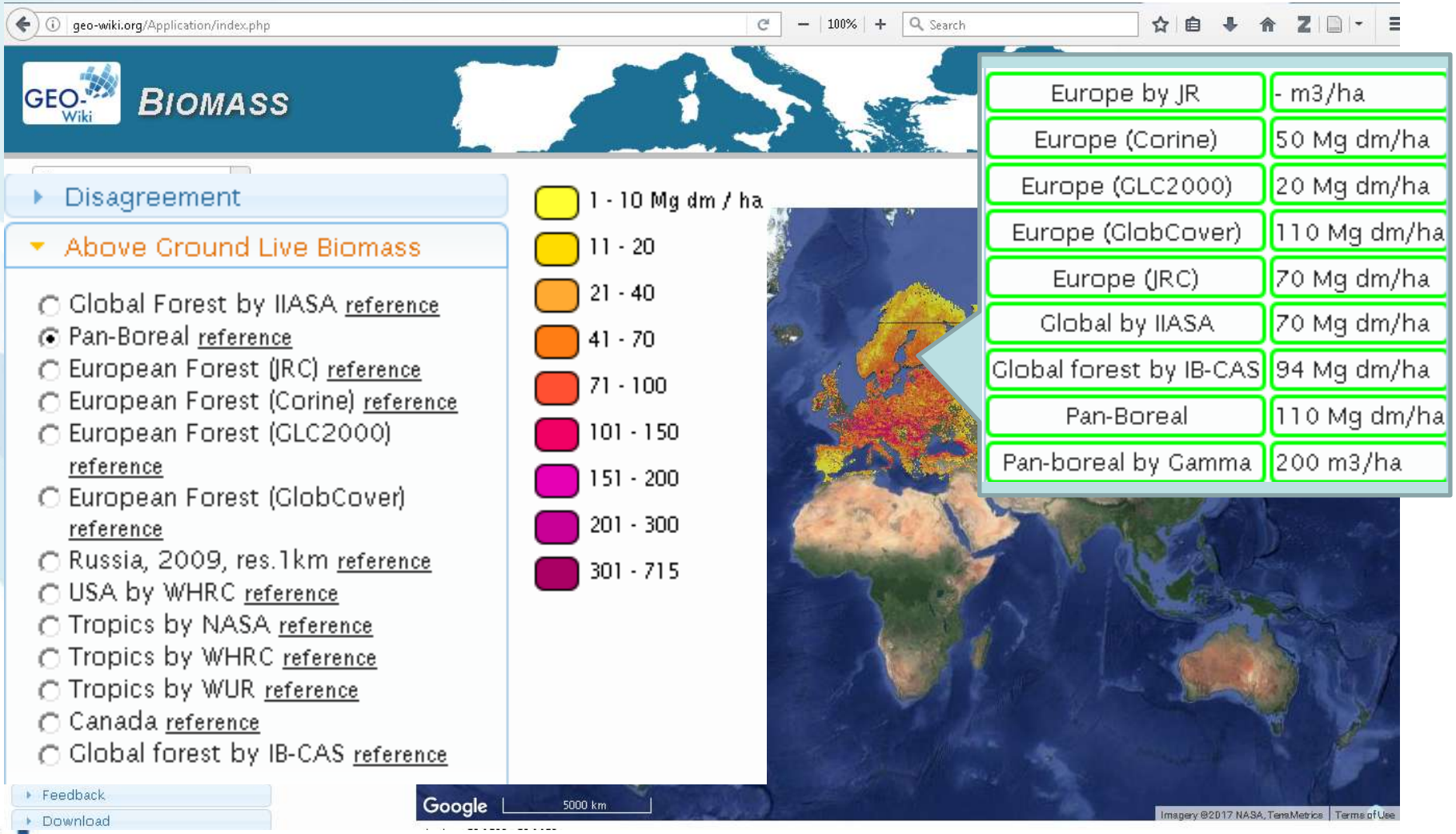

# http://Geo-Wiki.org: Visualization, Crowdsourcing and Validation



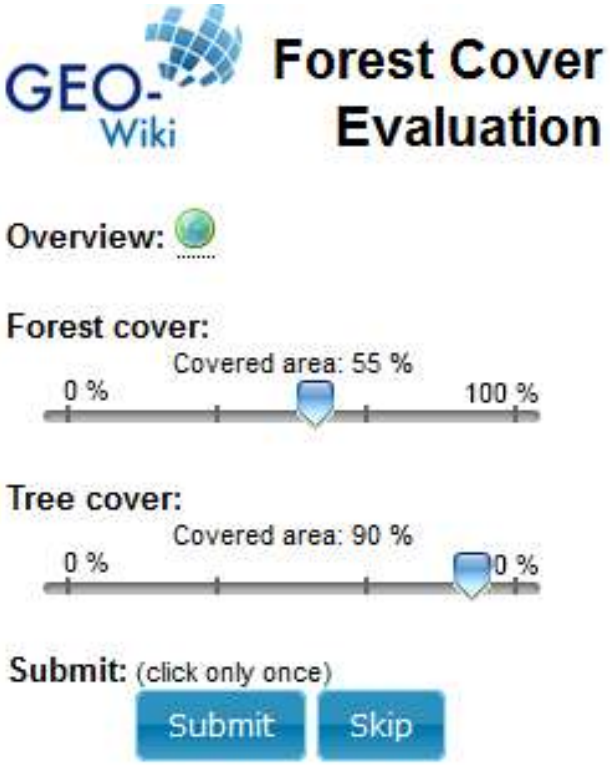
# Land cover disagreement



# Biomass.Geo-Wiki.org

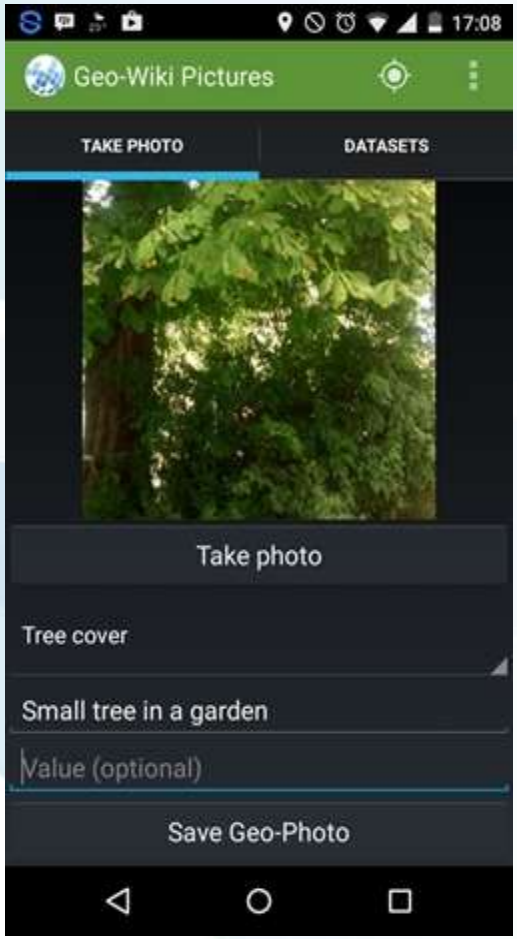


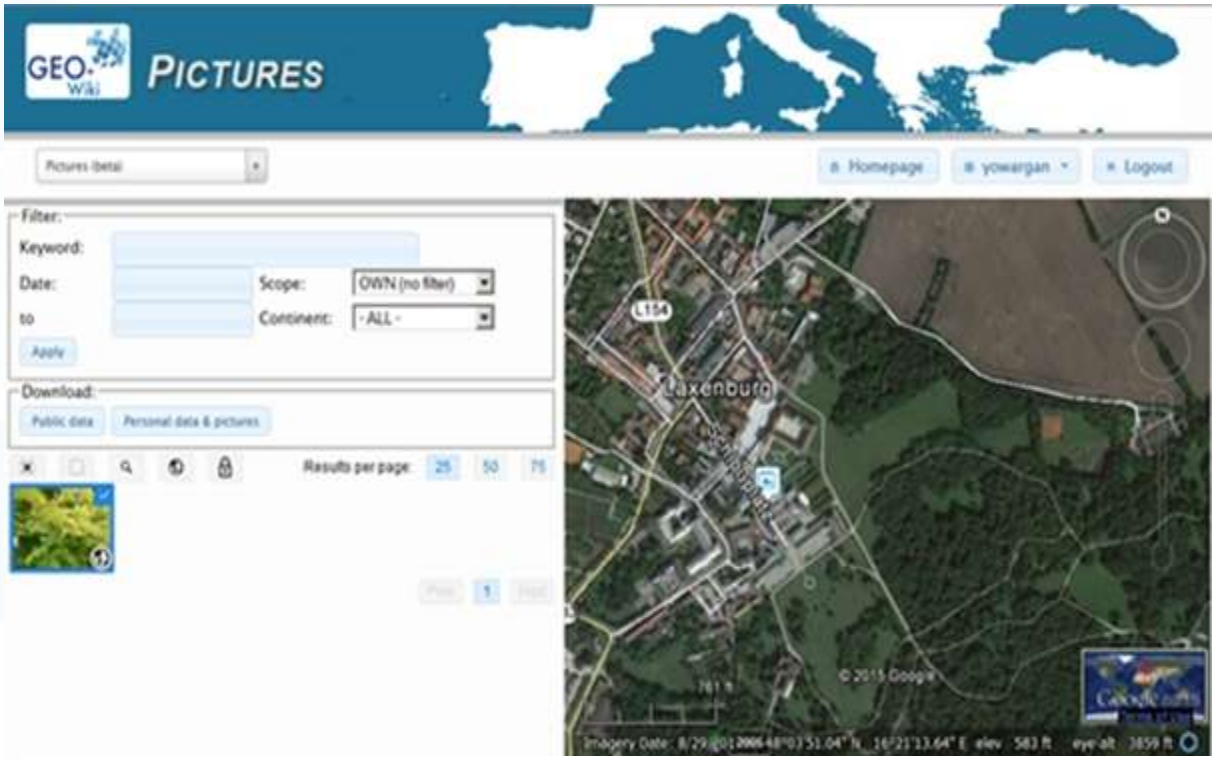
# Estimation of forest cover using Geo-Wiki and high resolution Google Earth imagery


where 55% of 1km pixel area is estimated to be forest cover with tree cover of 90% stocking in this example.

# Mobile App: Geo-Wiki Pictures




Automatically geo-referenced and tagged with information such as compass direction and the angle of tilt

# Serious Game: Picture Pile



914
Players

2,560,565+
Classifications

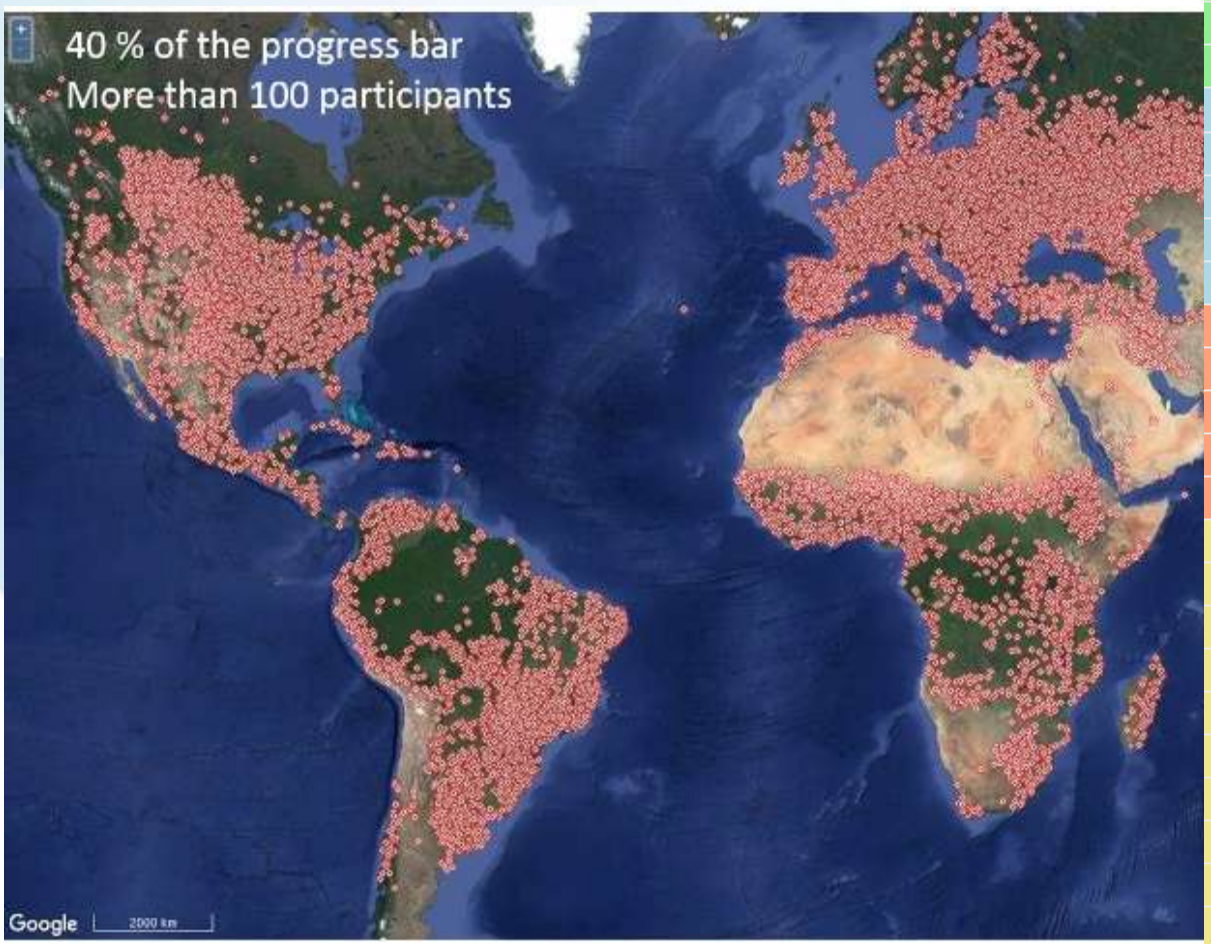
217,331
Unique images

90%
< 5 seconds

Available on the App Store

Get it on Google play

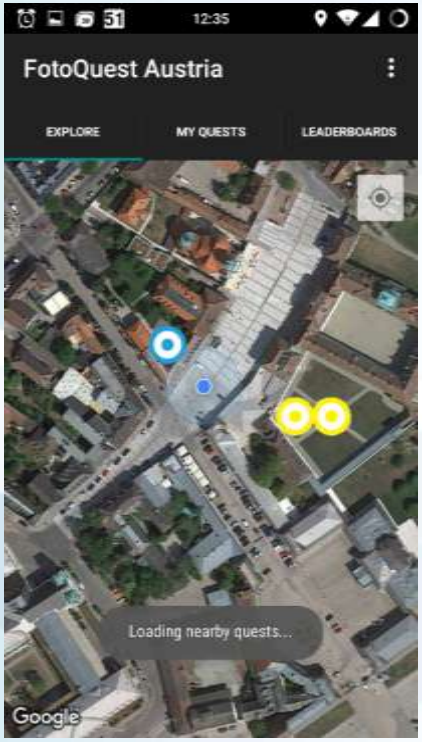
# fieldsize.geo-wiki.org ongoing campaign

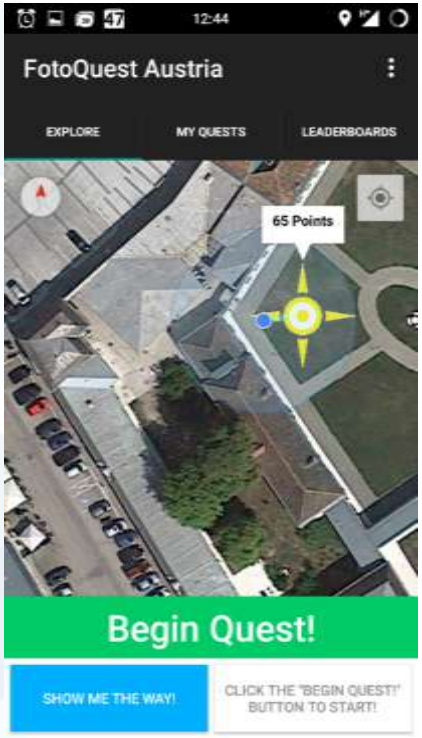



Individual overview 116 | Prizes

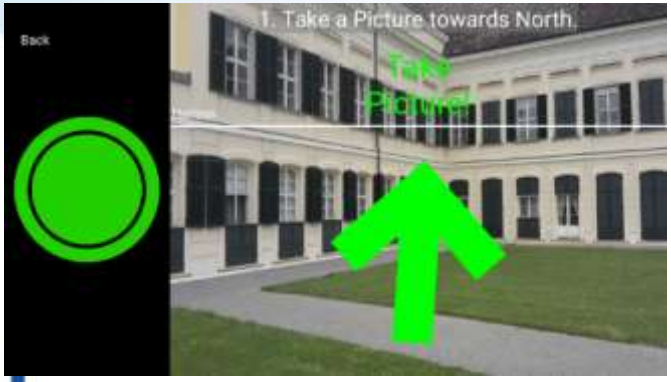
| User | Nr of Validations | Quality Score |
|---|---|---|
| juncopartner | 32,366 | 48,075 |
| 5Mari5M5 | 22,278 | 34,090 |
| rubulhazarika | 18,755 | 24,605 |
| paragksaharia | 23,295 | 24,045 |
| dellxrr | 15,681 | 23,365 |
| maryanaviktorivna | 7,325 | 12,675 |
| brigitte.magori | 5,582 | 8,685 |
| ana.perez-hoyos | 4,816 | 8,545 |
| bilous | 4,771 | 8,355 |
| diego.guizzardi | 5,871 | 7,775 |
| sarahgengler | 3,818 | 6,335 |
| GeoCBG | 3,327 | 5,400 |
| narzary.william11 | 3,632 | 5,395 |
| chetri.tilok | 3,526 | 5,315 |
| ziga.malek | 3,284 | 5,270 |
| reinhard.prestele | 2,742 | 4,910 |
| pschles | 3,172 | 4,165 |
| sachyn_boro | 2,913 | 4,140 |
| kuleswar08 | 2,452 | 3,570 |
| ksmbmei | 2,095 | 3,235 |
| ibrar.space | 1,954 | 3,135 |
| ckpawe | 1,905 | 3,125 |
| saktola | 1,891 | 3,000 |
| kemenen | 1,783 | 2,975 |
| julien.minet | 1,782 | 2,910 |
| moni.molinari | 1,638 | 2,495 |
| forest_biotech | 1,450 | 2,330 |

# FotoQuest Europe / FotoQuest Go

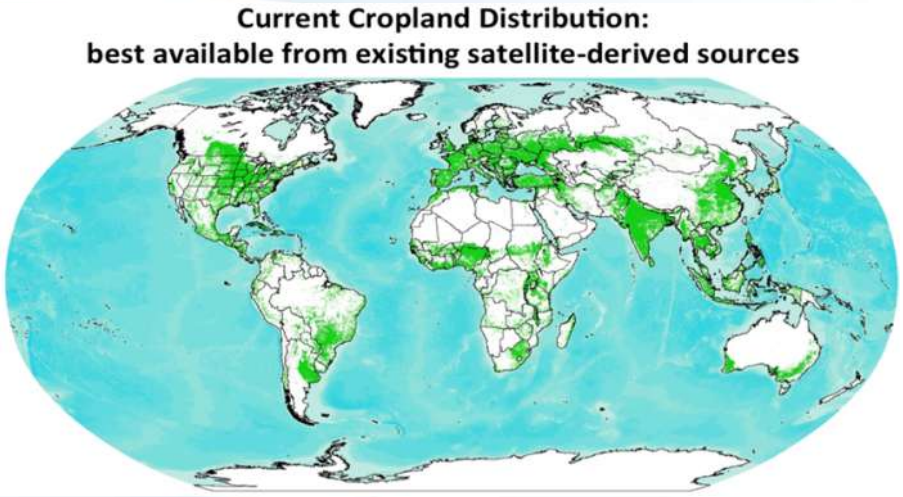




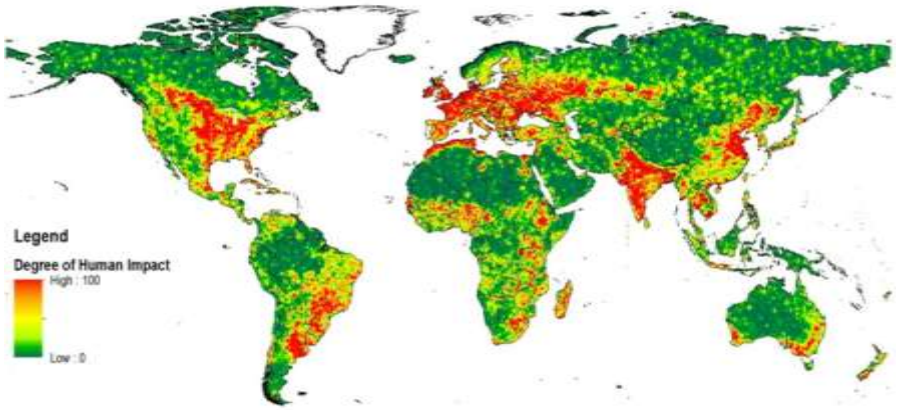



# Geo-Wiki Outputs



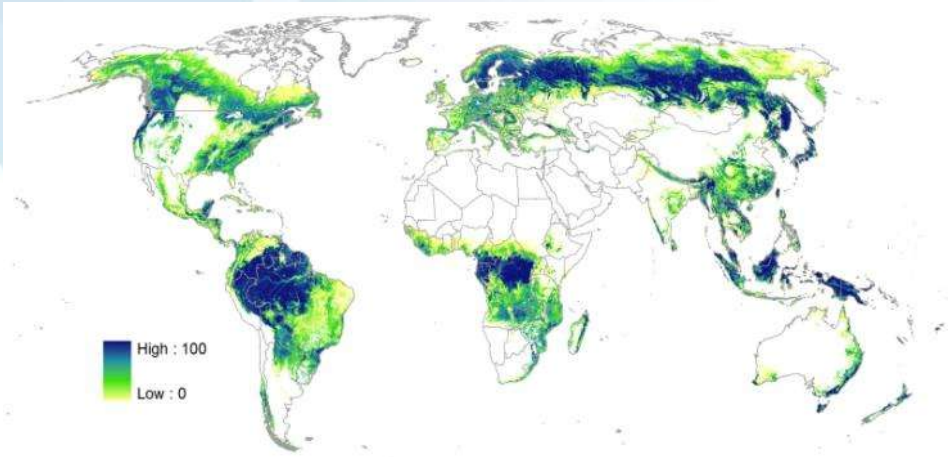

Fritz et al. (2015) in Global Change Biology

## Wilderness



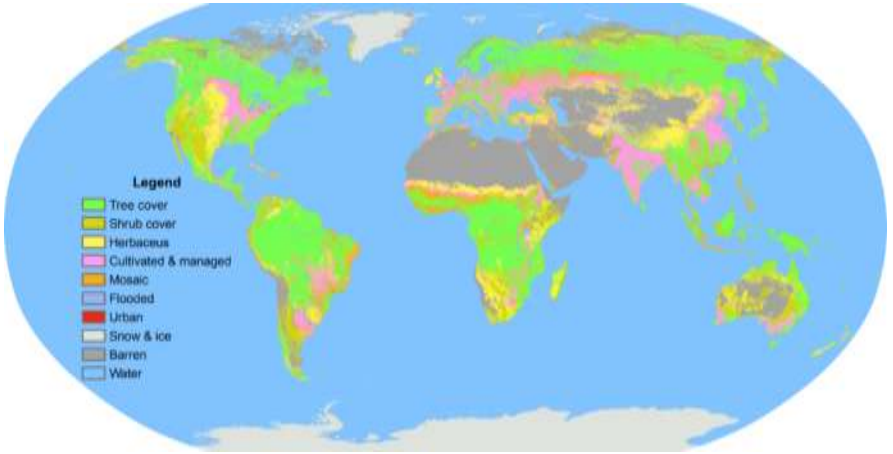

See et al. (2015) in Technological Forecasting and Social Change

## Forest Cover



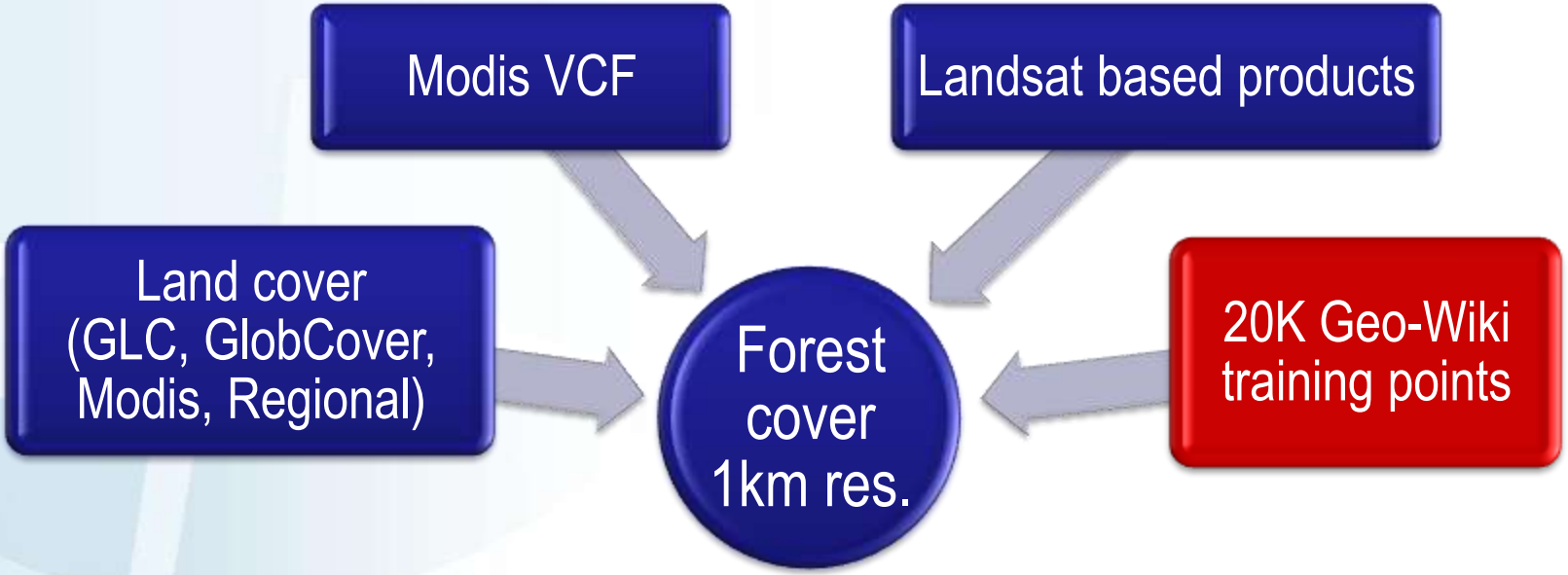

Schepaschenko et al. (2015) in Remote Sensing of Environment

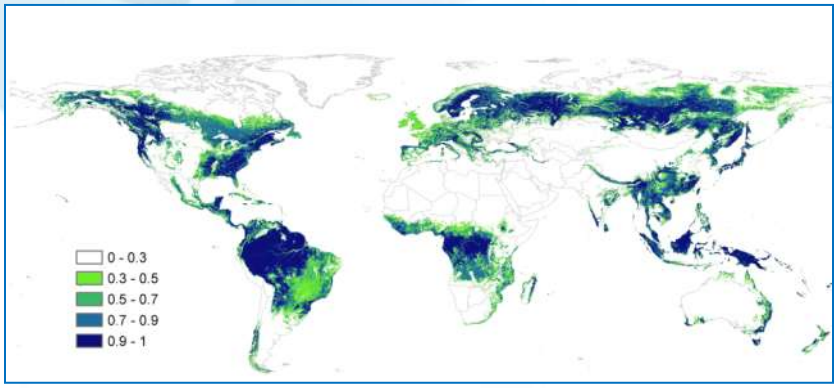
## Hybrid Land Cover



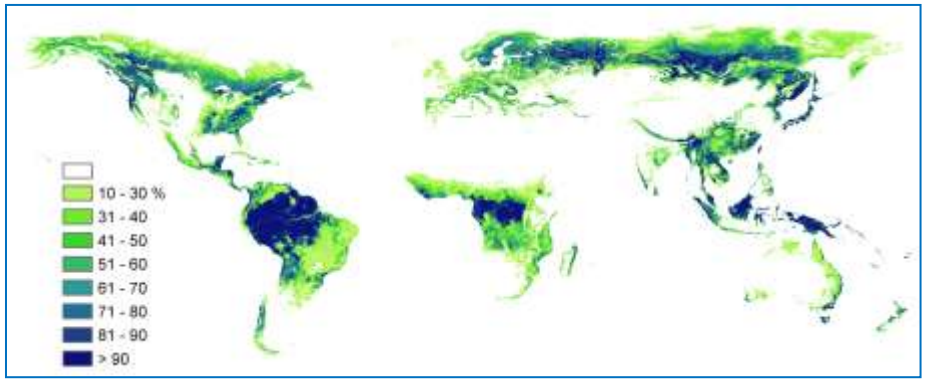

See et al. (2014) in ISPRS Photogrammetry and Remote Sensing

# Global Forest Mask: synergy of remote sensing and crowd-sourcing



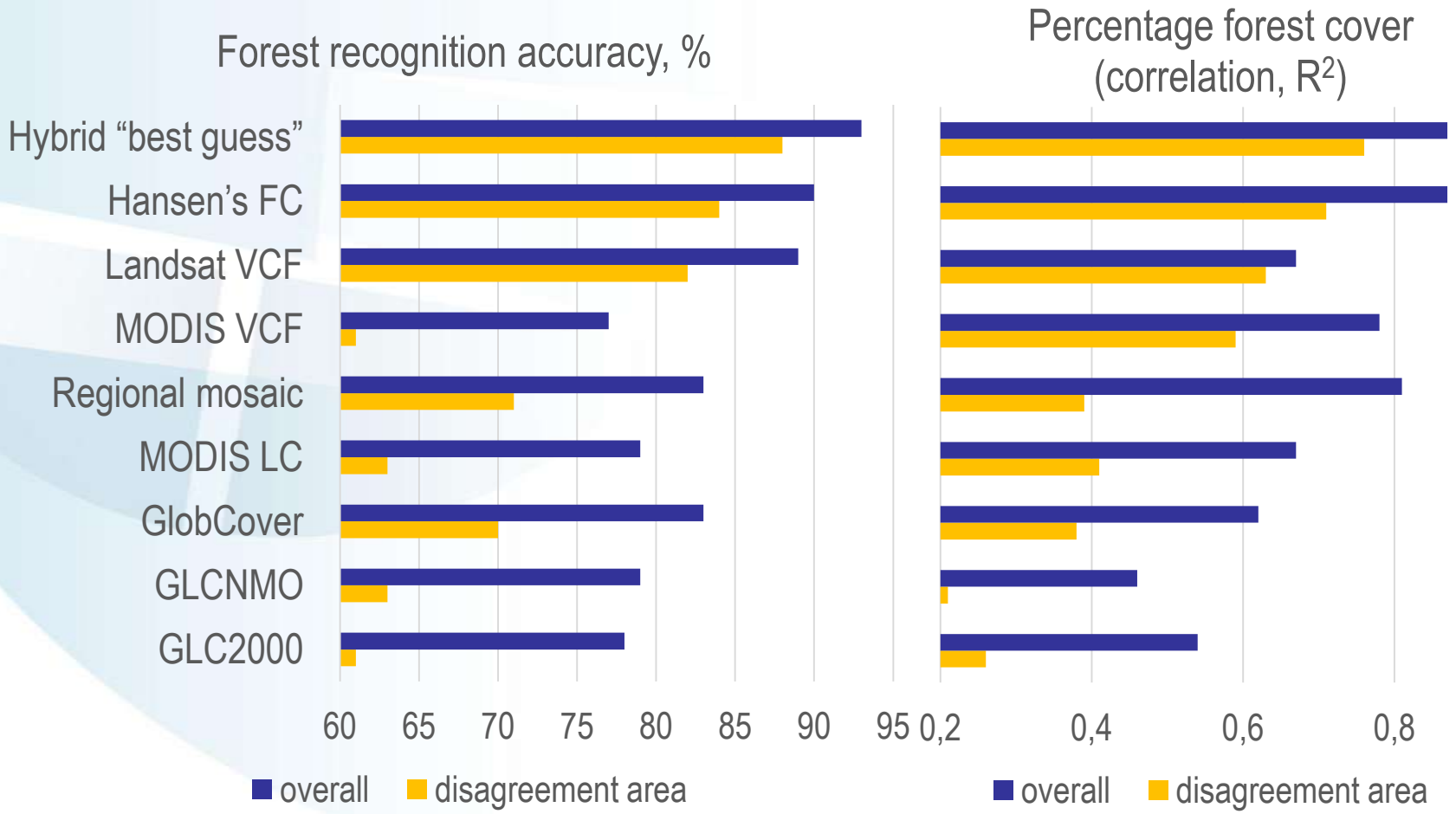




Forest probability



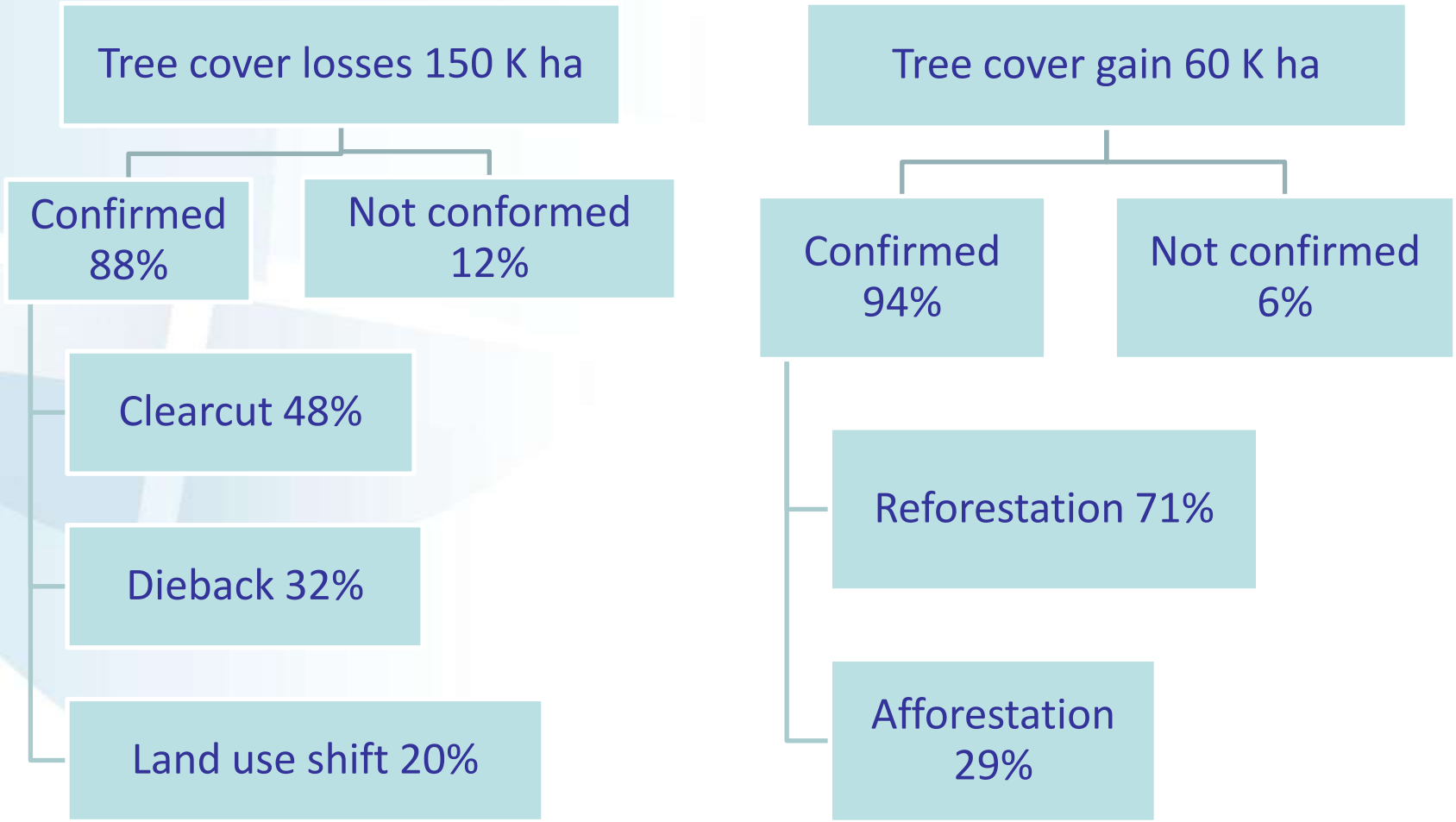

Forest cover, %

# Validation of input datasets and final hybrid product



# Tree cover change in Moscow region 2000-2013

## Validation of tree cover change dataset by Hansen et al., 2014



# http://Laco-Wiki.net

# Laco-Wiki
## The Land Cover Validation Platform

DRAFT

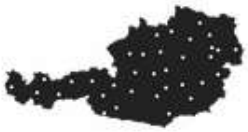
## Welcome to Laco-Wiki

LACO-Wiki is a new web-based solution for validating land cover and land use maps. Using a variety of reference layers including satellite and aerial imagery from Google and Bing as well as OpenStreetMap, validation is a simple four-step process. After uploading your dataset, generate and validate the samples and create a report with the accuracy assessment.

Share your validated samples with us and you will help to build an open database that can be used to improve future land cover and land use maps.

### Upload a dataset

You can upload your own maps for validation in either vector or raster format. Currently accepted formats are shape files and geoTIFFs in a WGS84 projection. Once uploaded you can design a customized legend for display. Additional datasets can also be uploaded to help you in the validation process.



### Generate a validation sample

Once you have uploaded your map, you can create sets of validation samples using random, stratified or systematic sampling. You can specify the size of each sample or be guided by calculations of the minimum sample size needed based on the required confidence levels for your project.

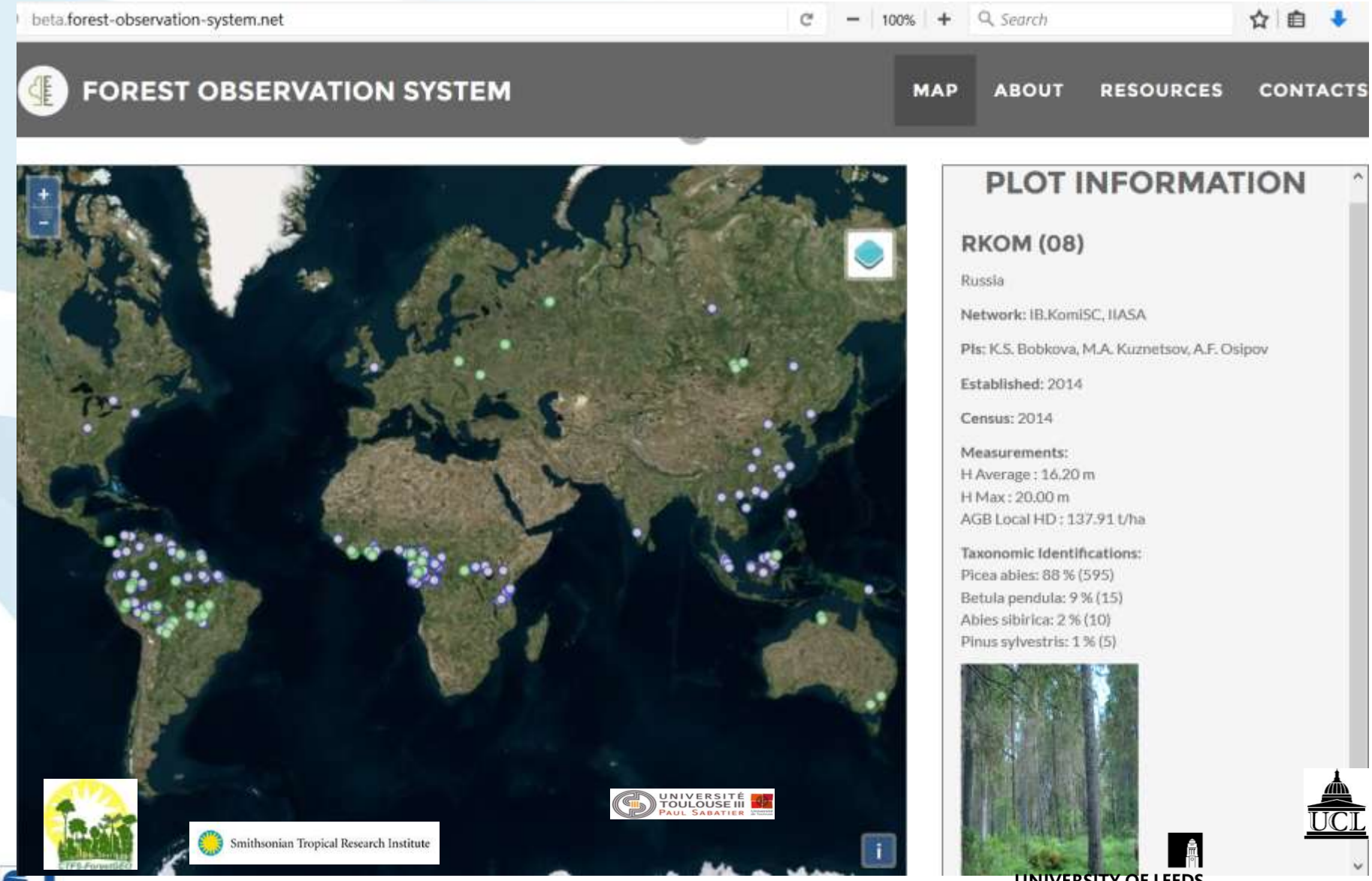
### Validate your map

Using reference information such as satellite imagery, you can validate your sample using your own legend, either by selecting the class, confirming the class or correcting incorrectly classified ones. You can validate the samples by yourself or you can share any validation session to distribute the work.

### Report on the accuracy

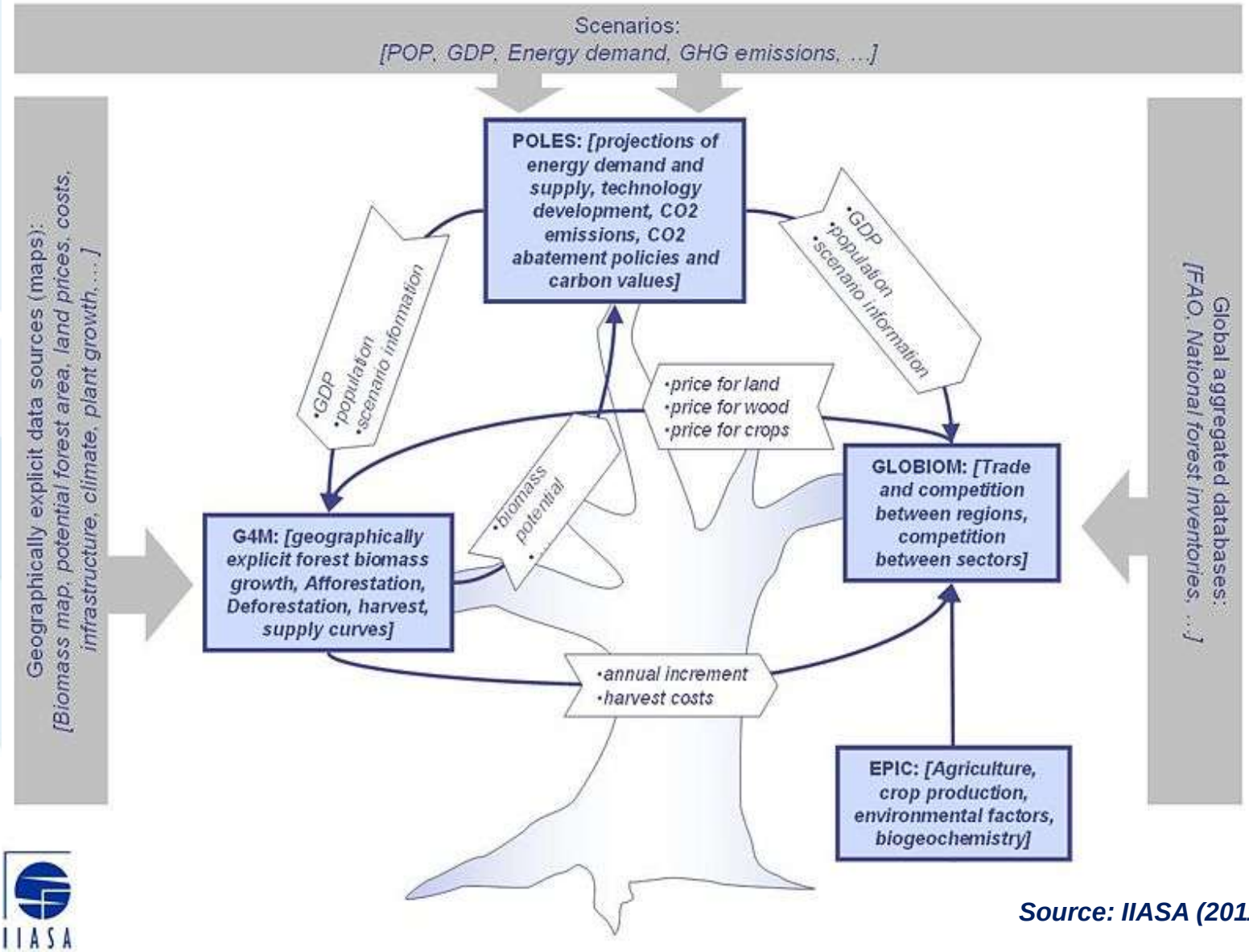
After validation you can download the raw data, the confusion matrix and generate a customized report on accuracy assessment, choosing from a set of different quality indicators including overall accuracy, omission and commission errors, kappa, average mutual information (AMI) and more.

# Forest-Observation-System.net

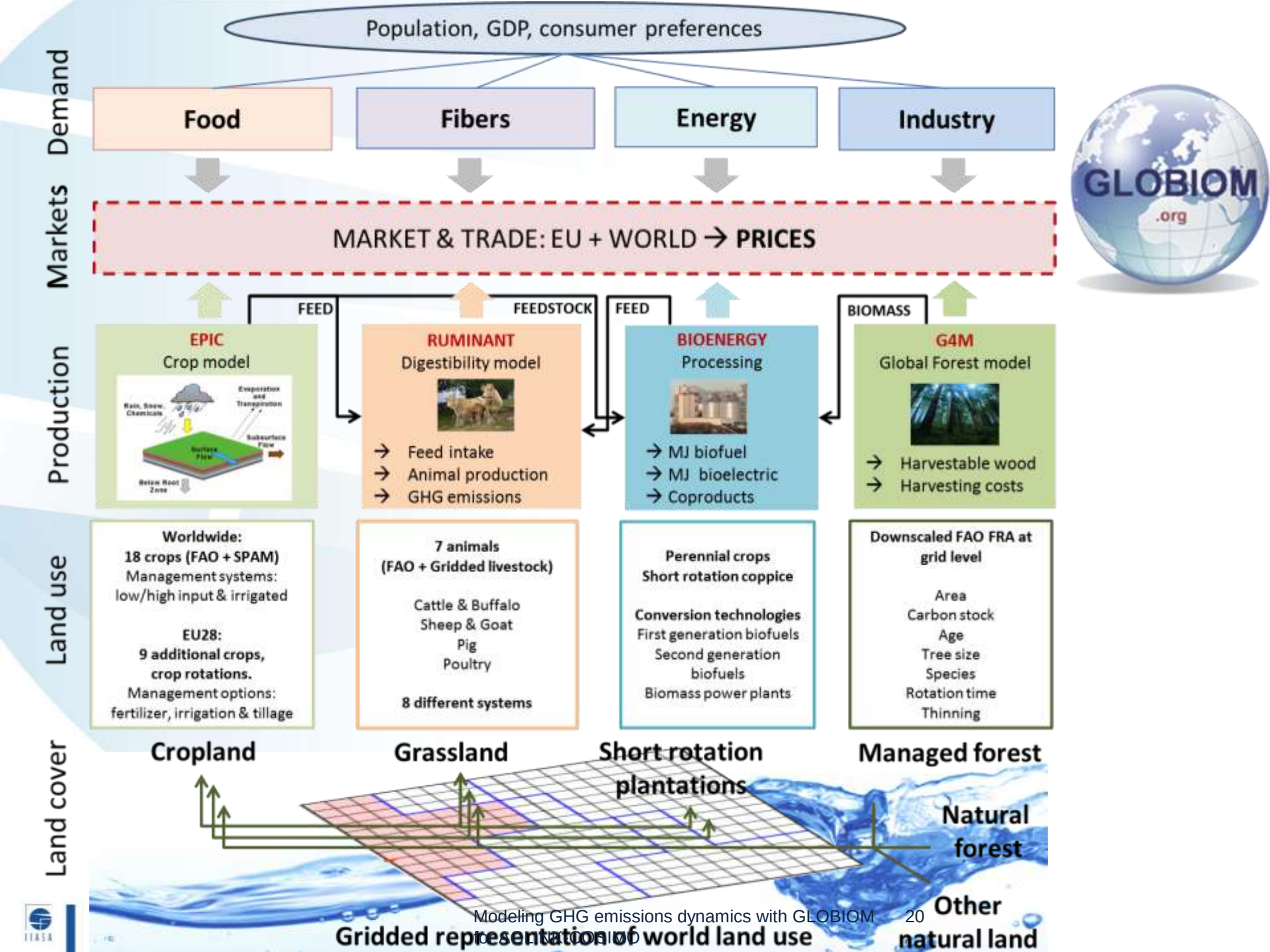


# Modeling Biomass Supply at Global Scale

## An Integrated Modeling Approach

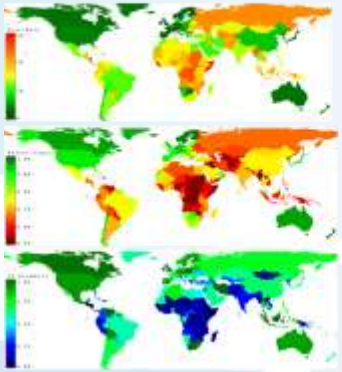



***Source: IIASA (2011)***


Population, GDP, consumer preferences
Demand
Food
Fibers
Energy
Industry
Markets
MARKET & TRADE: EU + WORLD → PRICES
GLOBIOM
.org
Production
FEED
FEEDSTOCK
FEED
BIOMASS
EPIC
Crop model
RUMINANT
Digestibility model
→ Feed intake
→ Animal production
→ GHG emissions
BIOENERGY
Processing
→ MJ biofuel
→ MJ bioelectric
→ Coproducts
G4M
Global Forest model
→ Harvestable wood
→ Harvesting costs
Land use
Worldwide:
18 crops (FAO + SPAM)
Management systems:
low/high input & irrigated
EU28:
9 additional crops,
crop rotations.
Management options:
fertilizer, irrigation & tillage
7 animals
(FAO + Gridded livestock)
Cattle & Buffalo
Sheep & Goat
Pig
Poultry
8 different systems
Perennial crops
Short rotation coppice
Conversion technologies
First generation biofuels
Second generation biofuels
Biomass power plants
Downscaled FAO FRA at grid level
Area
Carbon stock
Age
Tree size
Species
Rotation time
Thinning
Land cover
Cropland
Grassland
Short rotation plantations
Managed forest
Natural forest
Other natural land
Gridded representation of world land use

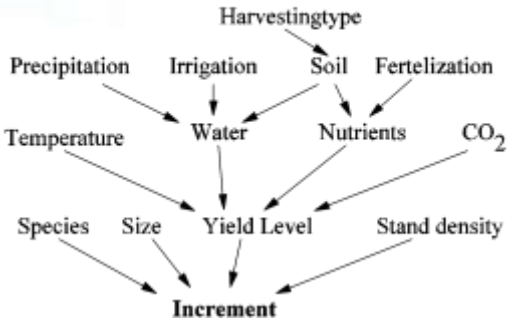
# The global forest model G4M

## Datasets



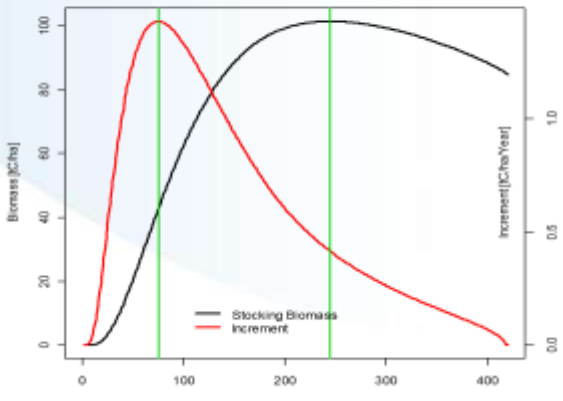
- NPP
- Population Density
- Land cover
- Agricultural suitability
- Forest Biomass
- Price level
- Discount rate
- Money efficiency
- Product use

## Forest increment

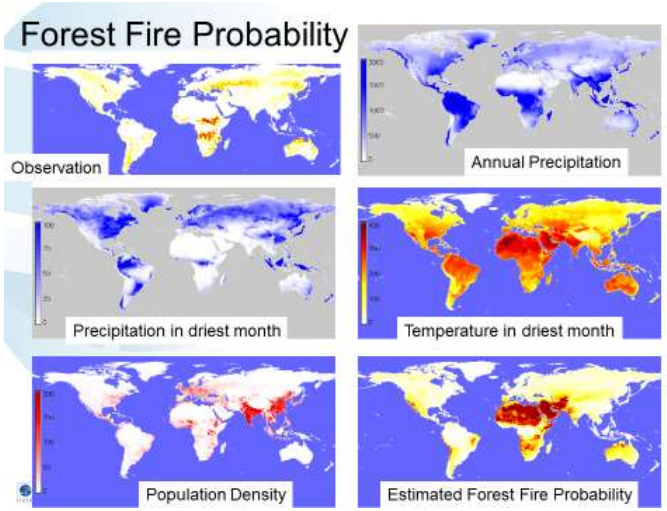



## Harvest


## Age dependent Increment and Biomass




## Forest Fire Probability



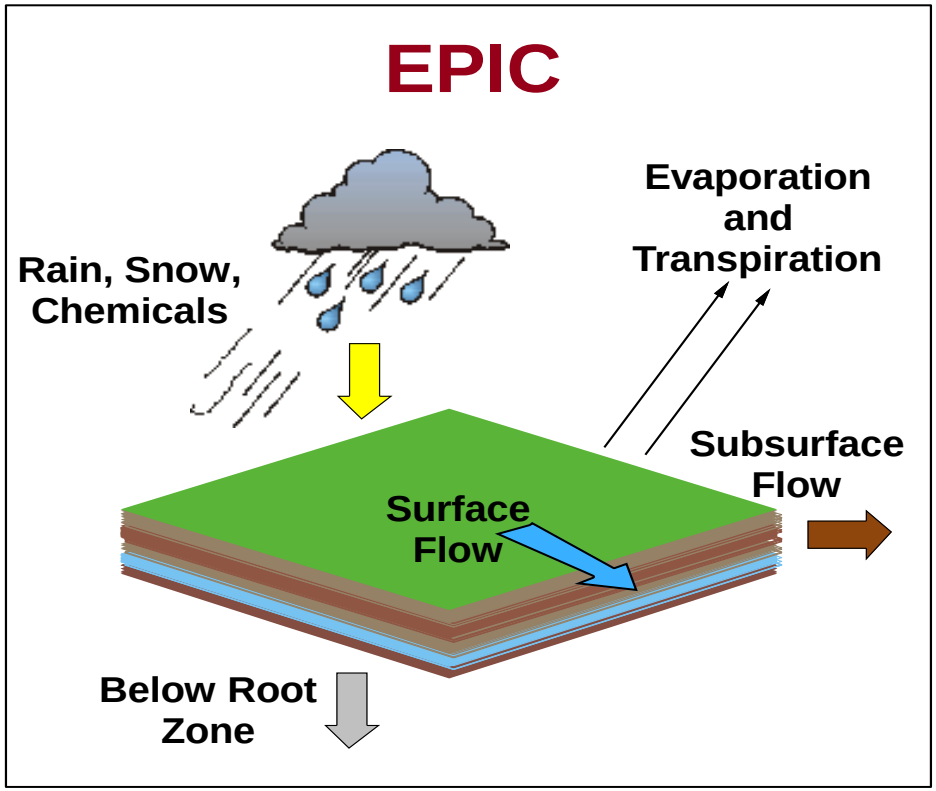
# G4M: what do we estimate

- Afforestation
- Deforestation
- Standing biomass
- Harvested Biomass

# Crops - EPIC

## Processes

- Weather
- Hydrology
- Erosion
- Carbon sequestration
- Crop growth
- Crop rotations
- Fertilization
- Tillage
- Irrigation
- Drainage
- Pesticide
- Grazing
- Manure




## Major outputs:

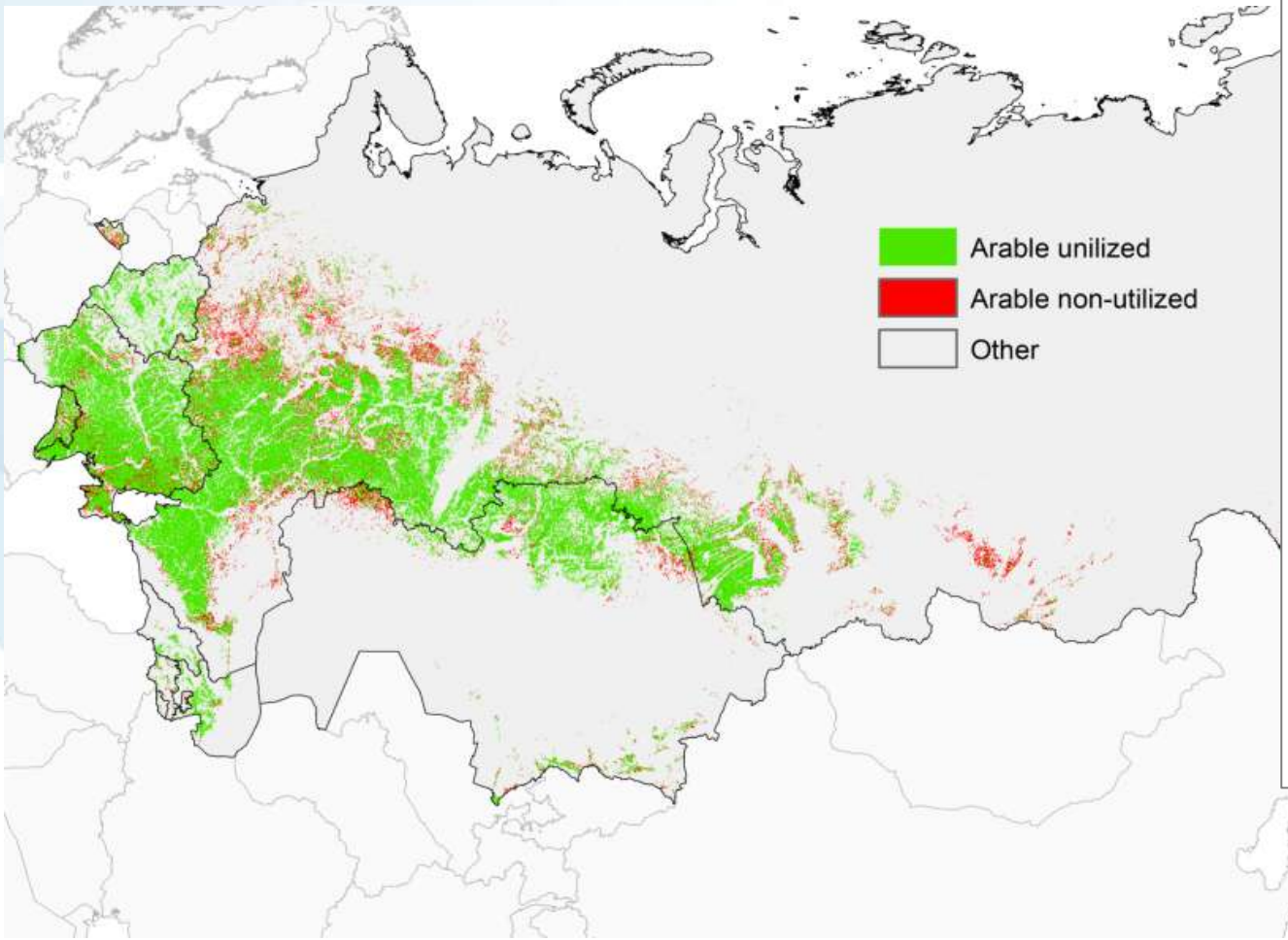
Crop yields, Environmental effects (e.g. soil carbon, nitrogen leaching)

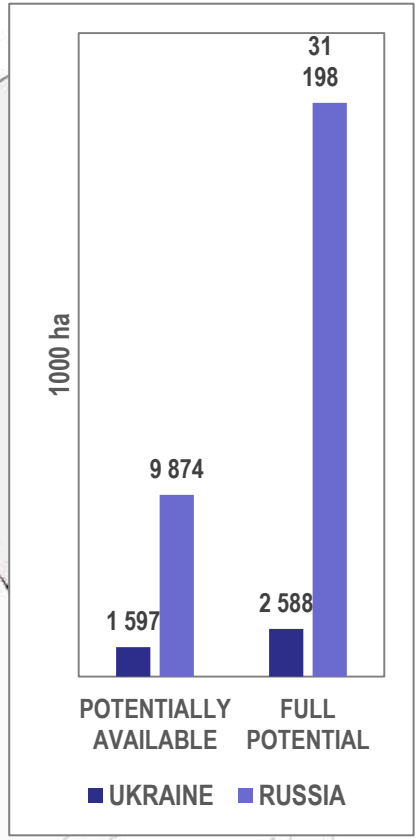
**20 crops** (>75% of harvested area)

**4 management systems:** High input, Low input, Irrigated, Subsistence

# Abandoned agricultural land

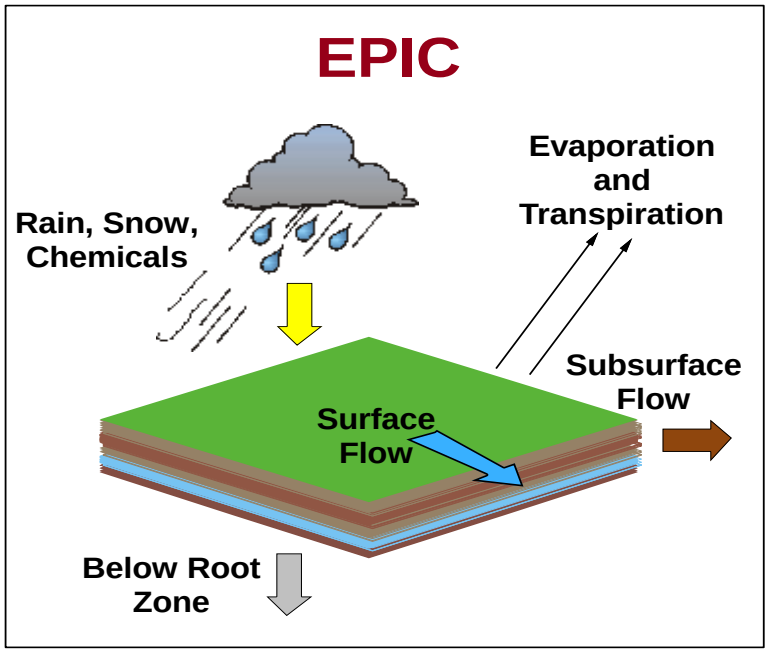
- Merging of existing land cover data with official statistics and “Ground truth” information (verified information) via a Bayesian network approach

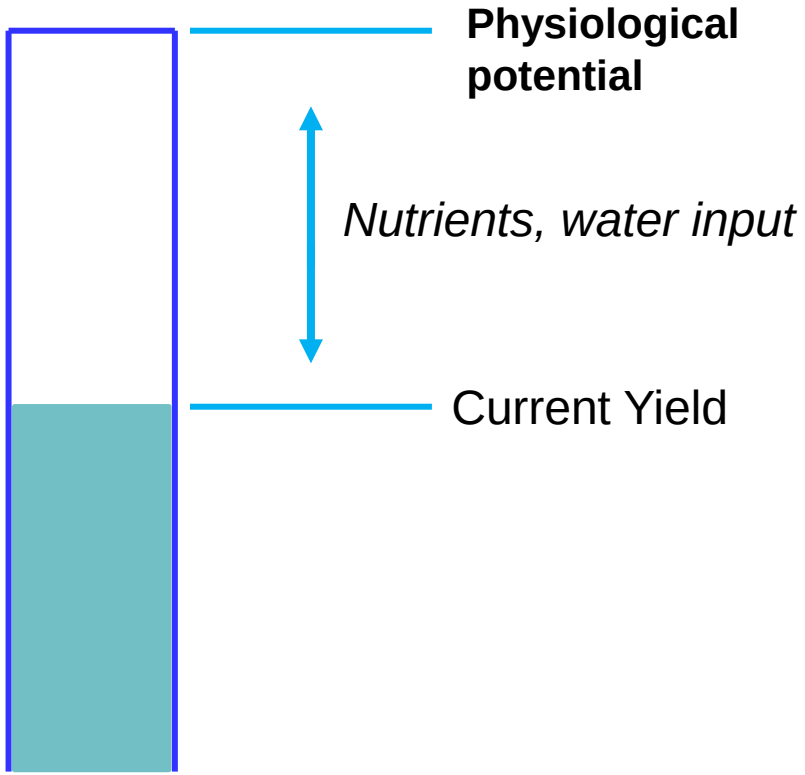


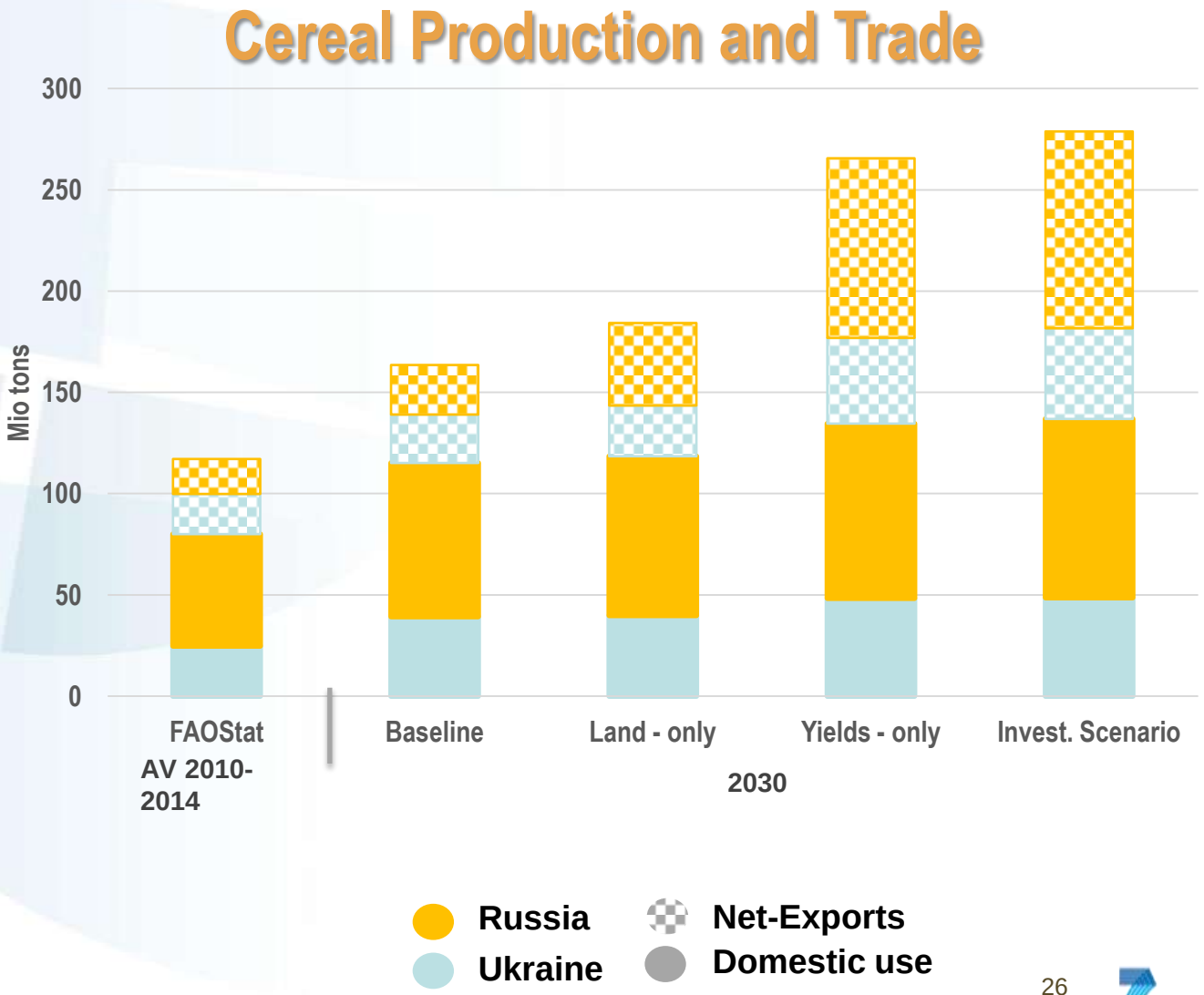
# Potential Yields

- EPIC: process-based model for crop yields (5 arc min, ca. 10 × 10 km)



# Economic Impacts Assessment



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science for global insight

# LandSense

## A Citizen Observatory and Innovation Marketplace for Land Use and Land Cover Monitoring


**Steffen Fritz**
fritz@iiasa.ac.at
IIASA, International Institute for Applied Systems Analysis

# LandSense Demonstration Cases

## LANDSENSE DEMONSTRATION CASES

MONITORING URBAN & RURAL LANDSCAPE CHANGES

**Complementing authoritative data sources**

- → Reducing costs in professional surveying
- → Optimizing workflows of mapping agencies
- → Opening up access to land take information

MONITORING AGRICULTURAL LAND USE

**EO-driven services for farm management**

- → Lowering barriers to technology for farmers
- → Creating an ecosystem of EO-based services
- → Improving agriculture policy compliance

HABITAT & FOREST MONITORING

**High-res EO data for biodiversity preservation**

- → Adding LULC data into biodiversity databases
- → Reducing habit degradation and deforestation
- → Opening up EO-data for forest monitoring

# Thank you for your attention

## Geo-Wiki.org
## Forest-Observation-System.net

rainfor

FORESTPLOTS.NET

AusCover
Remote Sensing
Data Facility

TFO

CTFS-ForestGEO

IBL

MEYA

UNIVERSITÉ TOULOUSE III PAUL SABATIER

Spatial Focus

UCL

International Institute for Applied Systems Analysis

IIASA

Smithsonian Tropical Research Institute

UNIVERSITY OF LEEDS

# GLOBIOM

- **Global scale model based detailed spatial resolution**
- **Partial equilibrium**
  - Agricultural, wood and bioenergy markets
  - 30 world regions
  - Bilateral trade flows based on spatial equilibrium approach
- **Bottom-up approach**
  - Explicit description of production technologies a la Leontief
  - Technologies specified by production system and grid cell
- **Linear programming approach**
  - Maximization of consumer + producer (incl. trade costs) surplus
  - Non linear expansion costs
  - Optimization constraints
- **Base year: 2000**
- **Time step**: 10 years, **time horizon**: 2030/2050 but also 2100