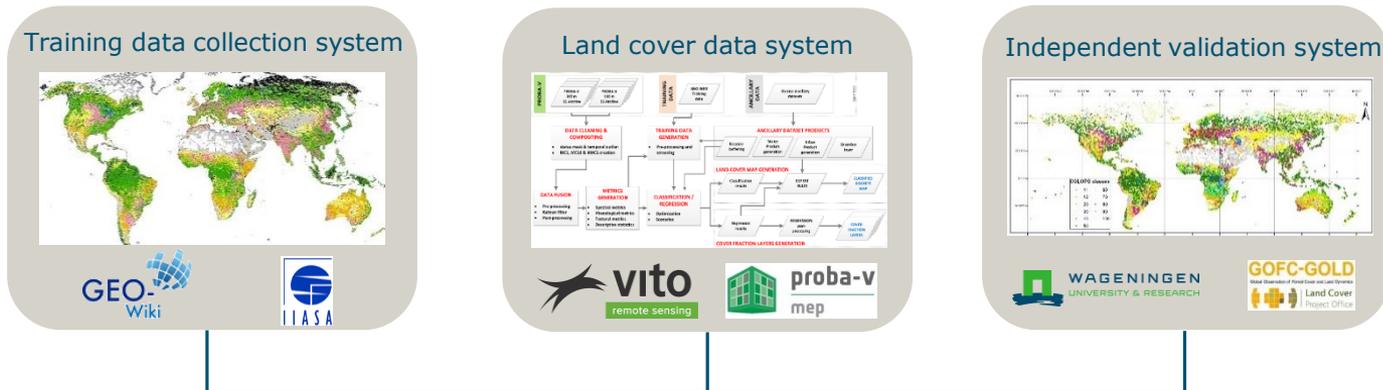


Global land cover monitoring, validation and participation: experiences from several case studies

Martin Herold – with contributions by many

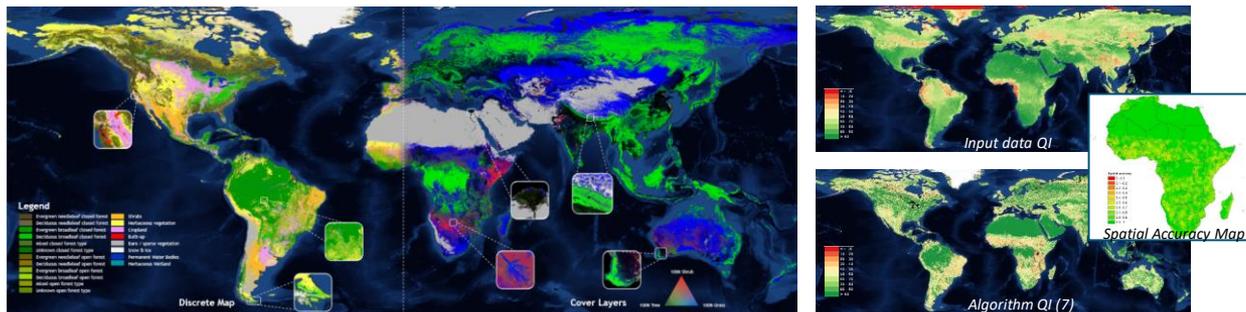
Copernicus Global Land Cover Monitoring Service



- Annual (2015-2019)
- Global
- 100m
- Land cover classes and fractions

<https://land.copernicus.eu/global/products/lc>

A systematic **service** providing dynamic, **yearly**, **user-oriented** global land cover maps from 2015



Buchhorn et al., 2020, Rem.Sens.
Szantoi et al., 2020, ESP, 112

Discrete Map (21 classes)

10 Continuous Cover Fractions (0-100%)

Quality Indicators

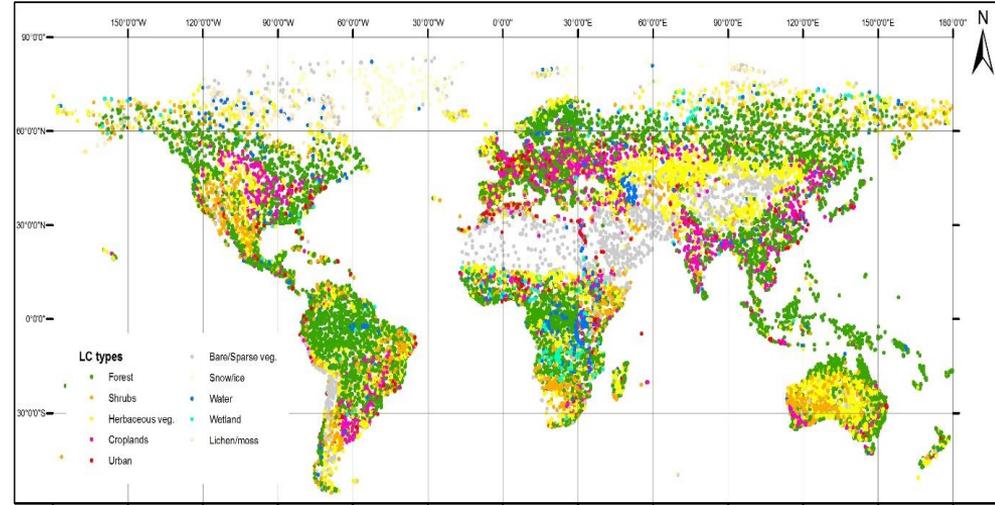
(*) demonstration over Africa, global maps under release test

Permanent water is derived from GSW (Pekel et al.)
 Built-up is derived from WSF (Marconcini et al.)

<https://blog.vito.be/remotesensing/annual-global-land-cover-maps>

Multi-purpose global land cover validation database

1. A global stratification that is **independent** of any land cover maps
2. More than **21 700** primary sampling units (PSUs) globally and minimum of 2700 PSUs per continent.
3. **Stage 4 validation dataset**: the PSUs are updated every year by focusing on areas that went under change since 2015 (until 2019).
4. **A multi-purpose** validation data suitable for validating and comparing 10m to 100m resolution maps.
5. Uses the Sentinel 2 UTM grid as geographic base

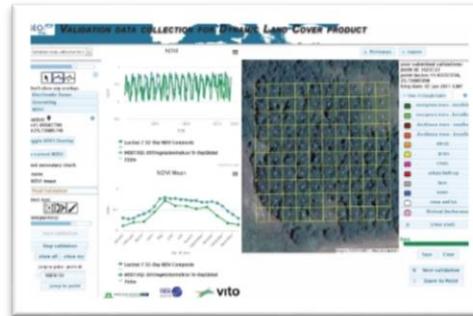


Remote Sensing of Environment
Volume 219, 15 December 2018, Pages 298-309

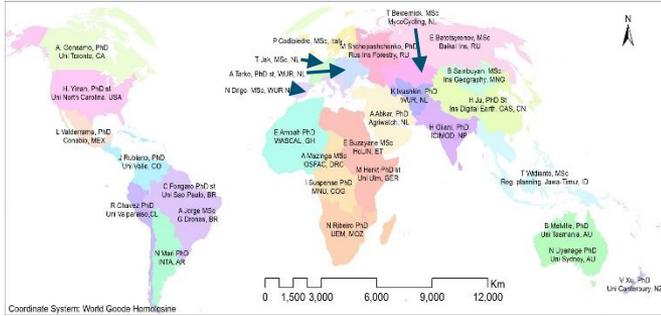


Developing and applying a multi-purpose land cover validation dataset for Africa

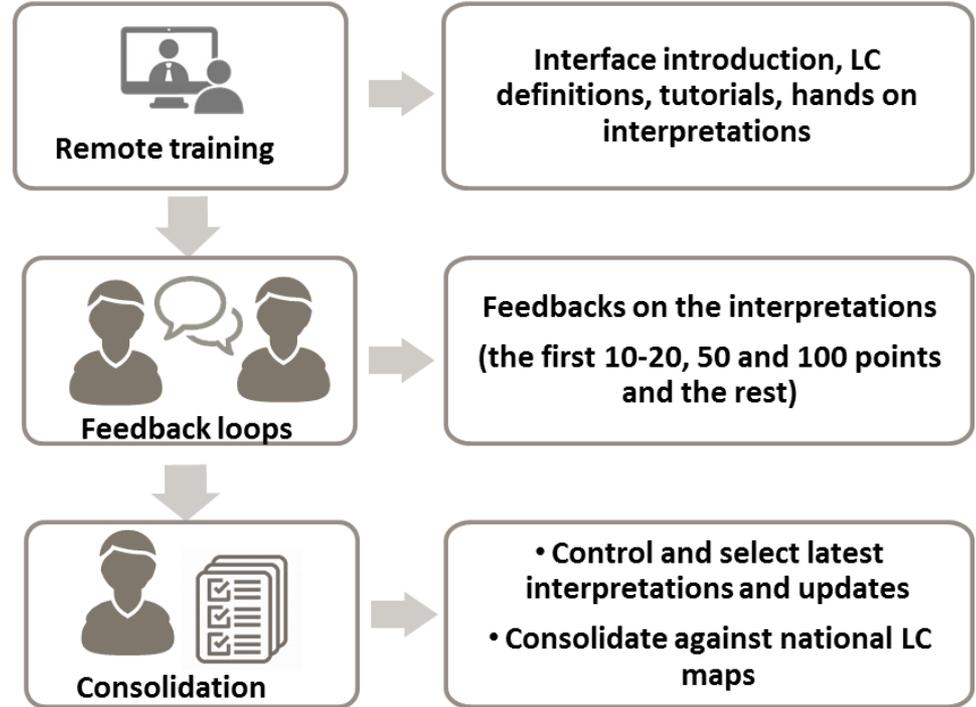
N.-E. Tsendbazar^a, M. Herold^a, S. de Bruin^a, M. Lesiv^b, S. Fritz^b, R. Van De Kerchove^c, M. Buchhorn^c, M. Duerauer^b, Z. Szantoi^{d,e}, J.-F. Pekel^d



Reference data collection process



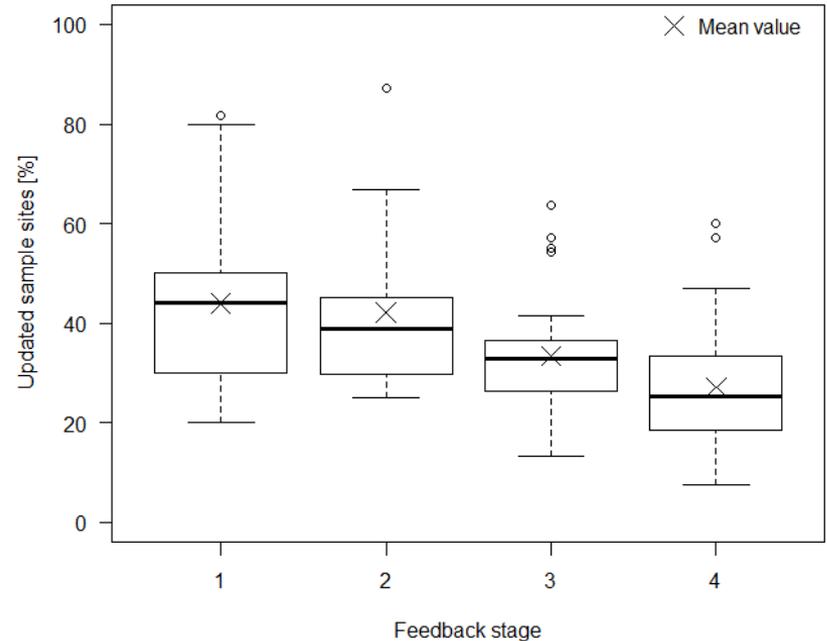
- 30 trained experts worldwide
- All have different experiences
- Their perception on land cover varies
- Training and review controls are necessary
- Continuous process of collaboration among global and regional experts



Lessons learnt on reference data collection and learning

- Influence of certain factors on interpretation agreement
- Feedback loops:
 - First 10-20 interpretations
 - First 50 interpretations
 - First 100 interpretations
 - The rest of the sample sites
- Feedback loops improved consistency of the interpretations
- Interpersonal differences and autonomous learning of interpreters have key effects and cannot be fully controlled, but made more consistent through collaborative feedback

Tarko et al., 2020. Producing consistent visually interpreted land cover reference data: learning from feedback, *IJDE*, DOI: [10.1080/17538947.2020.1729878](https://doi.org/10.1080/17538947.2020.1729878)



Operational global land cover validation

1. Statistical design and accuracy analysis with flexibility for different users and map characteristics (detail, resolution etc.)
2. Regional land cover interpreters/expertise essential, but account and control for interpersonal differences/learning
3. Continuous process of data collection (availability and efficiency)

What about the use of Volunteer-acquired data:

- Disadvantages: simple (thematic) and for a given scale, individual experiences/preferences affecting quality, issues for long-term sustainability of systematic global data collection
- Advantages: many data points, engagement/ownership, “own” quality control mechanisms, “different” perspective

Importance of “volunteer” data for spatial accuracy predictions

Table 6: List of datasets used for spatial accuracy assessment

Dataset name	Classes	Number of sample sites	Description	Reference
C-GLS LC100 validation dataset	forest, crop, and other natural vegetation	21700	The dataset is used for statistical accuracy assessment of the C-GLS-LC100 product and is independent of product generation.	CGLOPS1_VR_LC100m-V2.0
SIGMA cropland campaign	crop	30 000	This global reference data set on cropland was collected through a crowdsourcing campaign using the Geo-Wiki platform. The dataset was generated by over 80 participants from around the world focusing on cropland identification. The dataset contains the cropland area fraction in a 300 meter Proba-V pixel. The sampling stratification focused on areas with higher probability of misclassification based on a cropland probability map from IASA.	(Fritz et al. 2015)
NatureMap.org	forest	170 000	This dataset was produced as part of a forest management crowdsourcing campaign organized by the NatureMap project. The campaign collected for around 450 K locations information about the type of forest management (e.g., intact forest, forest with signs of management, planted forests, agroforestry). The data collected was based on the 100 meter Proba-V grid. Forest and non-forest sample locations were used.	https://naturemap.org/
Hybrid forest cover dataset	forest	16 800	This is a crowdsourcing data on forest cover which were collected through the Geo-Wiki platform. Over numerous campaigns, volunteers have been asked to visually estimate land cover visible in cells of a grid overlaid onto very high resolution Google Earth imagery. Based on the hybrid forest cover map, data points that were based on 1-km grid was used. The dataset contains presence/absence of forest information.	(Lesiv et al. 2016)

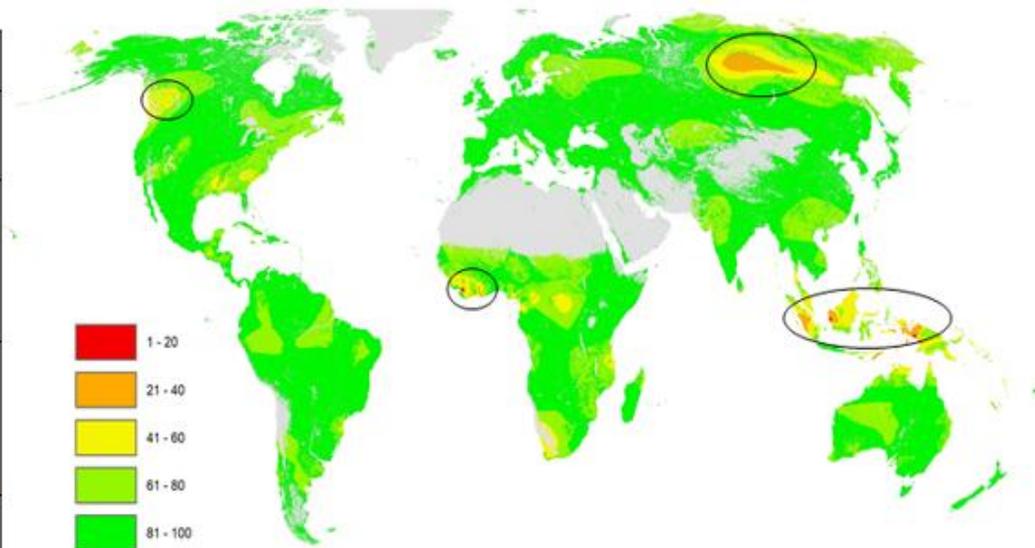


Figure 24. Composite map representing spatial accuracy outlining 4 hotspot areas of lower spatial accuracy

LandSense project focus on interactive land cover/use monitoring

1. LandSense Citizen Observatory trigger volunteer networks for in-situ data collection to help monitor areas important for biodiversity and conservation
2. “Triggering” by Copernicus Sentinel-1 based forest change alerts
3. Providing timely and relevant land change information that is “actionable”
4. Interactive system: complementary data streams

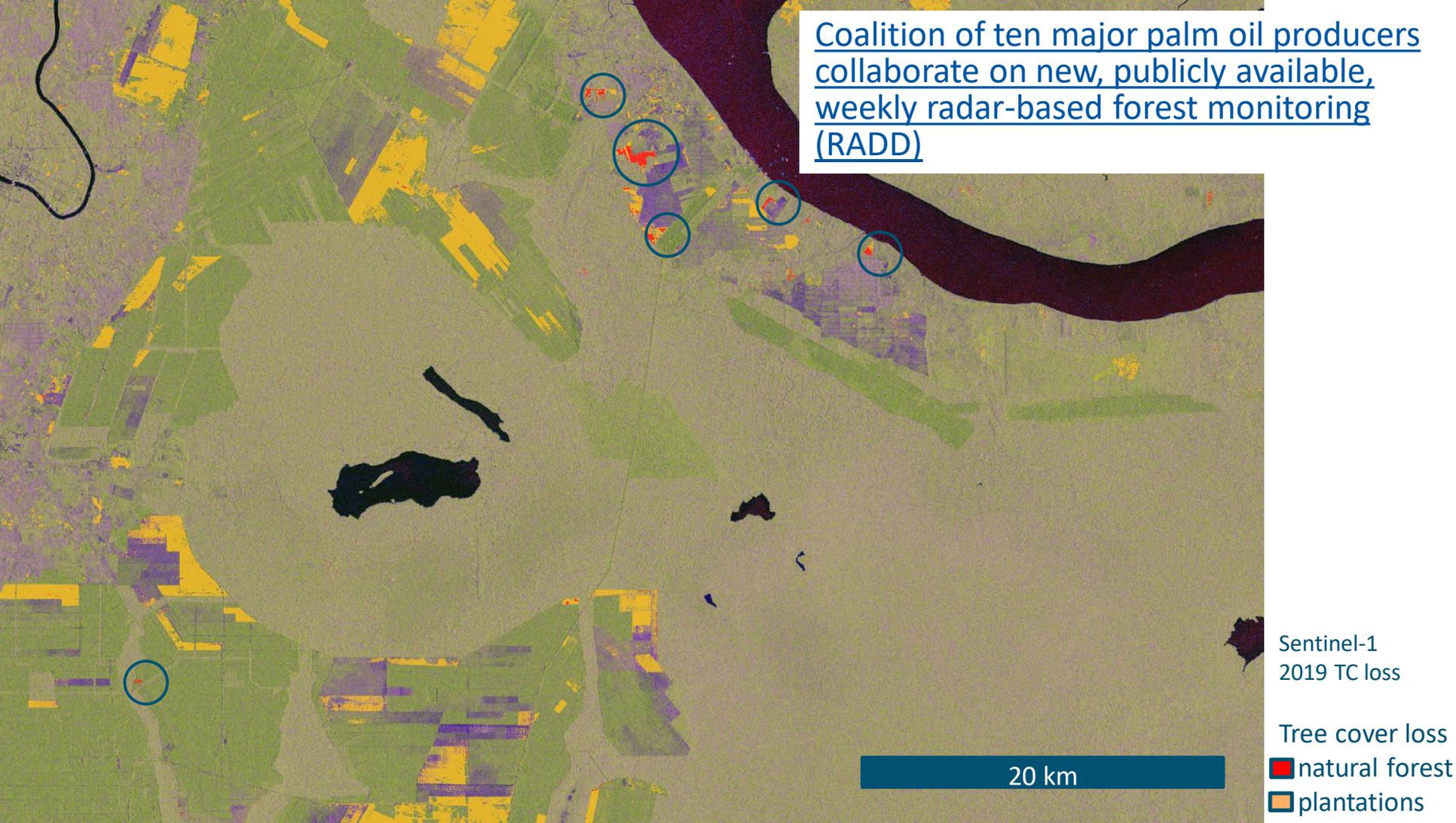
Radar-based weekly forest change alerts, Sumatra based on open-source data and methods



Sentinel 1
weekly forest
loss alerts

Reiche et al. 2018, RS

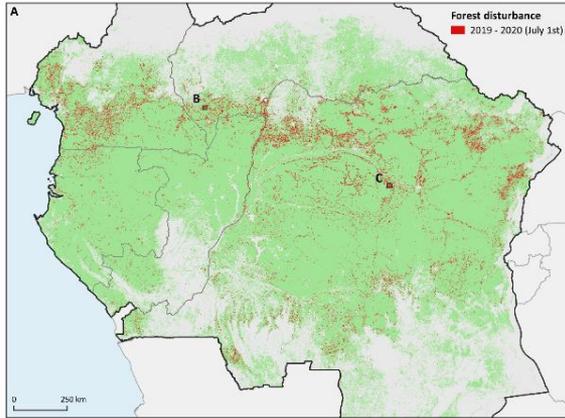
Coalition of ten major palm oil producers collaborate on new, publicly available, weekly radar-based forest monitoring (RADD)



Sentinel-1
2019 TC loss

Tree cover loss
■ natural forest
■ plantations

20 km



Selective logging pattern in DRC based on weekly forest disturbance alerts

Reiche et al. (accepted), ERL

Lessons learned from case studies (Peru, Ethiopia, Indonesia)

- Alert-driven, interactive and participatory forest change monitoring demonstrations:
 - Particularly useful on tracking (land use) activities
 - Synergistic use of top-down and bottom up data streams
 - Enhancing transparency and engagement
- Sustainability of such interactive monitoring systems:
 - Many examples operate for project duration (only)
 - Example with follow up if linked to incentive/governance structure:
 - Peru: TDC incentive system (payment for forest protection by local communities)
 - Birdlife (Landsense) with monitoring focus on Important Bird and Biodiversity Areas (IBAs) and Key Biodiversity Areas (KBA) networks
 - Indonesia: oil palm companies for transparency of sustainable supply chains
- “Data to action” scenarios to be developed

Global land cover monitoring, validation and participation

- Need of continuous and consistent land cover and change reference data collection as part of global operational monitoring systems
- For global monitoring: volunteer information most useful for providing training data, “land use” information, spatial accuracy predictions
- Engagement, participation and ownership (through volunteer information) most relevant when linking to regional and local uses/uptake (i.e. interactive systems)
- Interactive systems more successful when linked with incentive/governance system
- Enhancing transparency and “actionable” information as catalyst for local actions and underpinning transformational changes