Novel methods for the accounting of forest ecosystems and circular materials

Discussion and conclusion

- Welcome and opening of the webinar (Pekka Hurskainen, SYKE)
- **A brief review on material flow and ecosystem accounting as part of environmental accounting (SEEA) (Jukka Muukkonen, Stats Fin)**
  - Becoming mandatory means increasing work load
  - Important that monetary ecosystem accounts are compatible to national accounts

- **Circular material accounting (Annika Johansson & Henri Virkkunen, SYKE) Commentary (Maija Holma, Suomen uusioraaka-aineliitto)**
  - Ongoing shift from linear economy to circular economy
  - Suggestions towards segregation of secondary material accounting from the primary material accounts
  - 14 waste material types were examinated, detailed analyses across the waste cycle
  - Amount of material going to energy was missing
  - E.g. plastic as 2nd largest fraction of houshold waste shows already change within a short time frame
  - Promissing approach and very much needed also by the companies, but clear instructions needed for reporting
  - Finally, it is important to harmonize the consistency of data in EU, amoung countries and the sectors

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- **Forest ecosystem accounting indicators (Annika Kangas, LUKE)**
- Conditions related to stock – ES related to the flows (harvest removal)
- Pollination and pest control as indicators for ES
- Age can serve as indicator for carbon sequestration, rereation and flood control
- Focus on remote sensing, e.g. landscape structure, NDVI; more challenging ones are tree species composition, deadwood, time from fire
- Literature review: most promising for RS were selected, then ML was applied -> enables modelling, e.g.:
  - Comparison & ranking of different areas;
  - Observing temporal trends within areas
- Comparability of indicators needs common scale (relative performance)

- **Indicators from existing spatial data - forest fragmentation (Pekka Hurskainen, SYKE)**
- SEEA-EA – potential indicators on ecosystem condition
- MS-NFI 16 m resolution was used, spruce, pine, deciduous, all, years 2009 / 2017
- Moving window analyis to calculate landscape mosaic model
- 6 indicators were calculated; edge width 48 m was the most appropiate for boundary analysis (interior/core, islet, linear connectors)

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- **(…continues…)**
- Forest fragementation pattern indicators needs to be interpretaed with care e.g. all/pine/spruce differ from deciduous forests that might be more fragmented in the study area
- Concluding: **robust and scalable method**, existing national spatial datasets available, applicable, free open-source
- Further work: definition of **reference level** values
- Discussion: relevance of different fragmentation metrix for biodiversity is challenging, the use of term ”natural state” –”less-fragmented” might be better term

- **Indicators from remote sensing data using machine learning (András Balázs, LUKE & Janne Mäyrä, SYKE)**
- Aerial false-color images with 30 cm resolution and ALS 1,66 pts/m2
- 1500 circular field plots with 9 m radius, over 5800 km2 area
- Aim to compare machine learning methods (RF, ANN) and modern deep-learning (CNN) to current benchmark method (k-nearest neigbors) of MS-NFI
- Traditional methods not able to process raw data – now ~100 optical features and 70 Lidar feartures were calculated

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- **(…continues…)**
- Data processing for deep learning methods: Voxels as 3D presentations of sample plots used by CNN
- Results: **CNN outperformed all other models even without aerial ground reference data!**
- All methods underestimated volume; DBH & average height – no big differences
- Tougher ones: Volume of pine – OK, spruce – not so OK, deciduous trees – CNN was worst-performing
- CNN was good for **non-species related**, but more ground/aerial/LiDAR data is needed for specie-dependent attributes
- Higher laser point density is expected to improve results of CNN
- Comparability
- Vertical & horizontal structure of forest canopy is one of the key ecosystem indicators

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