10TH ADVANCED TRAINING COURSE ON LAND REMOTE SENSING

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Forest inventories and remote sensing

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Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object, in contrast to in situ or on-site observation.





FOREST INVENTORIES -> provide detail information about the current state and changes (growth) of forests END USER -> forest policy and management (sustainable, multifunctional)



Information for forest parcel / stand / ... (area based)

Information on plot level (point sampling)



FOREST INVENTORIES – AREA INFORMATION (STAND MAPS)

Use of RS information (aerial images, lidar data) and field survey.

- Manual delineation of stands -> visual photointerpretation -> photo interpretation key
- Variables: development phase, canopy closure, species mixture
- Field survey (map checking) and collecting additional forest attributes (basal area)
- Slovenian Forest Service: <u>https://prostor.zgs.gov.si/pregledovalnik/</u>



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R = 3.09

S = 30 m²

R = 7.98

 $S = 200 m^2$



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→ THE EUROPEAN SPACE AGENCY

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USE OF REMOTE SENSING DATA (aerial images, lidar data) Land-use classification

- Which plots are within forest (forest / non forest)?





USE OF REMOTE SENSING DATA (aerial images, lidar data) Land-use classification

- Which plots are within forest (forest / non forest)?
- National vs international definition on forest

Definition	Min area	Min tree height	Min canopy closure	Min distance	
National	≥ 0,25 ha	≥ 5 m	/	1 tree height	
FAO	> 0,50 ha	> 5 m	> 10 %	> 20 m	
UNFCCC	≥ 0,25 ha	≥ 5 m	/	1 tree height	
KP / EU	≥ 0,25 ha	≥ 2 m	≥ 30 %	/	
COST E43	> 0,50 ha	> 5 m	> 10 %	> 20 m	

RS NEEDS -> detailed land use map

- 1. High resolution images
- 2. Tree hight information (lidar, stereo image)





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When different definitions of forest are used, satellite forest cover measurements can vary widely. Here global forest cover as measured by Landsat is shown using two different UN Framework Convention of Climate Change (UNFCCC) forest definitions: 10 percent tree cover (left) and 30 percent tree cover (right). Data are publicly available at www.landcover.org. Credits: Sexton, et al.

NASA/USGS Mission Helps Answer: What Is a Forest?

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STATISTICAL FOREST INVENTORIES – POINT SAMPLING -> volume estimation (biomass)

- One, two or three parametric functions $(d_{1,3}, d_7, h)$ -
- Harmonisation of volume estimates on European level



NFI—country	Growing stock (million m ³)		Difference (%)	
	Country-level definition	Reference definition 2 Cost Action E43		the s
Austria	1106.5	1112.9	-0.6	5
Belgium	118.6	126.8	-6.5	
Czech Republic	942.2	1028.0	- 8.3	
Denmark	133.1	110.7	+ 20.2	
Estonia	476.0	462.4	+ 3.0	
Finland	2343.4	2343.4	0.0	
France	2566.5	2757.0	- 6.9	
Germany	3367.5	3185.8	+ 5.7	
Hungary	390.4	352.7	+ 10.7	
Ireland	97.5	99.4	-2.0	
Latvia	660.3	660.9	-0.1	
Lithuania	542.7	535.0	+ 1.4	age
Norway	1094.4	1126.3	-2.8	all branch
Portugal	158.1	179.4	- 11.9	ge branci
Romania	2156.5	1961.1	+ 10.0	
Serbia	375.1	284.5	+ 31.9	
Slovakia	569.5	608.8	-6.4	
Slovenia	416.8	403.9	+ 3.2	
Spain	1001.2	1088.5	-8.0	
Sweden	3493.5	3493.5	0.0	
Switzerland	409.7	408.2	+ 0.4	

Gschwantner T. et al. 2019. Harmonisation of stem volume estimates in European National Forest Inventories. Annals of forest science 76:24

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INACCESSIBLE NFI PLOTS

Use of aerial images and lidar data

Individual tree volume calculation

- height-diameter relationships (5908 trees)
- Mod DBH -> volume functions -> tree volume estimate § 30,0













USE OF REMOTE SENSING DATA for FOREST INVENTORIES **Detailed automatic / semi-automatic forest characteristics maps** (tree species mapping, tree species mixture, NDVI, canopy cover, etc.) -> objective additional information for forest management

Small area estimation (SAE) -> plot data + RS data (maps) as auxiliary information (canopy height, tree species, canopy cover)

- 1. To increase the estimation precision from NFI plots (forest statistics) on national and regional level
- 2. Estimation for area when the sample size (density of field plots) does not provide direct estimates



Hill A., Massey A. 2017. The R Package forestinventory: Design-Based Global and Small Area Estimations for Multi-Phase Forest Inventories.



USE OF REMOTE SENSING DATA for FOREST INVENTORIES

Use of RS data (satellite (active + passive), lidar ...) and plot data (ground truth) to develop prediction models through machine learning algorithms -> wall to wall maps

Ground truth data -> important for the validation of the RS maps and results







THANK YOU!

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