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SDG 15.4.2 Mountain Green Cover-indicator for Finland

The aim of Sustainable Development Goal 15.4.2 Mountain Green Cover Index is to ensure the conservation of mountain ecosystems, including their biodiversity by measuring the changes of the green vegetation. SDG 15.4.2 consists of two sub-indicators; Sub-indicator 15.4.2a, Mountain Green Cover Index (MGCI) and Sub-indicator 15.4.2b, Proportion of Degraded Mountain Land (PDML). Finland has not reported the indicator before.

SDG 15.4.2 indicators

Mountain area is classified to 10 land cover classes (fig. 1) and these are divided to green (2, 3, 4, 5, 6) and non-green areas (classes 1, 7, 8, 9, 10).

- 15.4.2a MGCI: The proportion of green areas to whole mountain area

Types of land cover changes and their areas using change matrix (fig. 5)

- 15.4.2b PDML: The proportion of degraded mountain area to whole area

Previous studies

FAO has provided estimates based on global data:

- Global Multi-Resolution Terrain Elevation Data (GMTED2010)
- Mountain bioclimatic belt map by Global Mountain Biodiversity Assessment
- ESA-CCI Land Cover (Fig. 2d)

Results (fig. 4a & b):

- Total mountain area: 2858 km^2
- 15.4.2a: year 2000 70.3%, 2021 73.9%, increasing trend
- 15.4.2b: years 2000-2015 7.3%, 2015-2018 7.5%

Mountain area

Kapos mountain classes were determined using elevation model

Kapos Mountain Class	Description
Class 1	Elevation >= 4500 meters
Class 2	Elevation >= 3500 & < 4500 meters
Class 3	Elevation >= 2500 & < 3500 meters
Class 4	Elevation >= 1500 & < 2500 meters & slope >= 2 degrees
Class 5	Elevation>= 1000 & < 1500 meters & slope >= 5 degrees OR local (7 km radius) elevation range > 300 meters
Class 6	Elevation >= 300 & < 1000 meters & local (7 km radius) elevation range > 300 meters
Class 7	Inner isolated areas (<=25 Km^2 in size) that do not meet criteria but surrounded by mountains

- Postprocessing: Buffering 2 km out, then 2 km in, isolated areas classified manually

Mountain area divided to Bioclimatic belts

Bioclimatic belts	Growing season mean temperature	Growing season length	Bioclimatic belts adopted for SDG Indicator 15.4.2
Nival	< 3.5 °C	< 10 days	Nival
Upper alpine	< 3.5 °C	> 10 days & < 54 days	Alpine
Lower alpine	< 6.4°C	< 54 days	
THE TREELINE			
Upper montane	> 6.4°C & ≤ 10 °C	---	Montane
Lower montane	> 10°C & ≤ 15 °C	---	
Remaining mountain area with frost	> 15 °C	---	Remaining mountain areas
Remaining mountain area without frost	> 15 °C		

Input data

- EU-DEM: Elevation model of CLMS
- Temperature: FMI 1 km grid of daily mean temperatures 2004-2023

Result

- Total mountain area: 9510 km^2
- Bioclimate zone: Montane

Land cover

Three different datasets were tested to produce land cover information for SDG 15.4.2

- CLC: Harmonized Corine Land Cover time series for change detection 2000 – 2018 (fig. 2a): 20 m pixel, 46 LC/LU classes, MMU of change 0.5 ha
- CLMS: CLC+ 2018, 2021 & 2023 (10 m pixel, 11 thematic classes), HRL Water and Wetness 2018 and SYKE's yearly NDVI-maximum (fig. 2b)
- EDC: EcoDataCube annual land cover 2000, 2006, 2012, 2018 (fig. 2c): CLC-classes, Landsat-classification, 30 m pixel

Land cover data needs to be converted to SDG 15.4.2 classes

- CLC & EDC easy due to large number of classes
- CLC+ is more difficult due to small number of classes, so additional data like CLMS HRL Water and Wetness and SYKE's yearly NDVI-maximum is needed

Fig. 3 present the examples of changes detected using CLC- and EDC-data.

Results

Fig 4.: The values of indicators of different input data

Finnish Harmonized CLC 2000 - 2018

+ Good thematic accuracy, plenty of classes
- No continuation after 2024, underestimates changes due to MMU

CLMS: CLC+ & HRL WaW

+ Update every 2-3 years
- Underestimates wetlands, maybe overestimating changes, no history

EDC annual land cover 2000 - 2020

+ Plenty of classes, yearly
- Project-based, continuation?, overestimates changes

Future reporting: use CLMS-products

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SDG 15.4.2 Metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-15-04-02.pdf
EU-DEM: https://ec.europa.eu/eurostat/web/gisco/geodata/digital-elevation-model/eu-dem
FMI grid: https://en.ilmatieteenlaitos.fi/gridded-observations-on-aws-s3
FI CLC: https://ckan.ymparisto.fi/dataset/harmonisoitu-corine-maanpeiteaikasarja-muutostulkintaan-20m
CLC+: https://land.copernicus.eu/en/products/clc-backbone
HRL Water & Wetness: https://land.copernicus.eu/en/products/high-resolution-layer-water-and-wetness
Yearly NDVI max: https://ckan.ymparisto.fi/dataset/sentinel-2-image-index-mosaics-s2ind-sentinel-2-kuvamosaiikit-s2ind
EDC: https://stac.ecodatacube.eu/lcv_landcover.hcl_lucas.corine.eml/collection.json
United Nations Global SDG Database: https://unstats.un.org/sdgs/dataportal

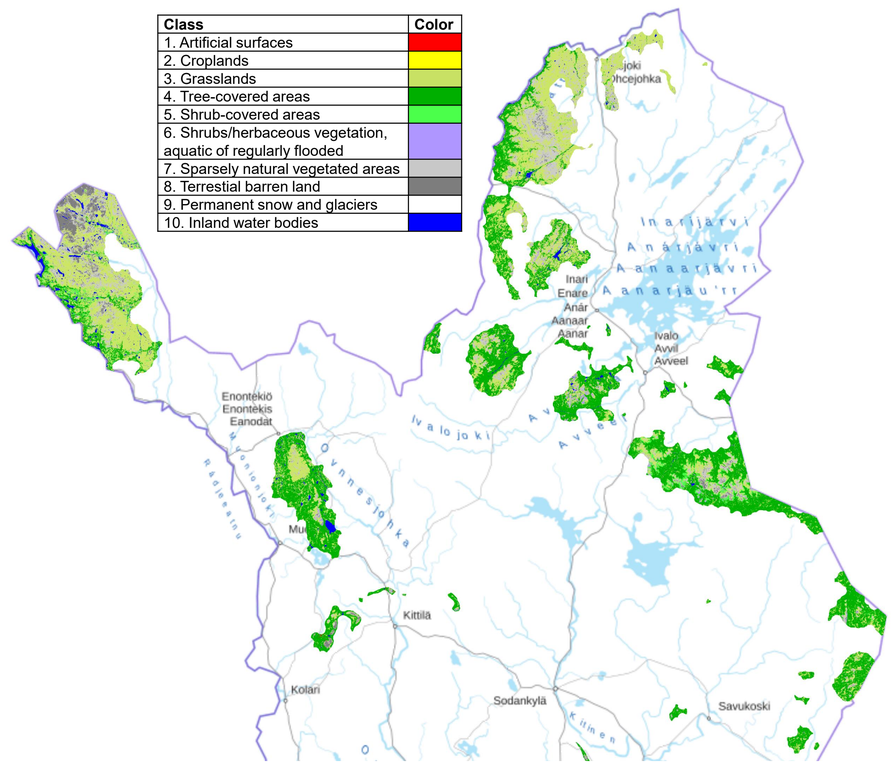

Figure 1. The mountain areas of Finland and their land cover based on CLMS-data. © Modified CLMS-data, background map MML, Esri Finland

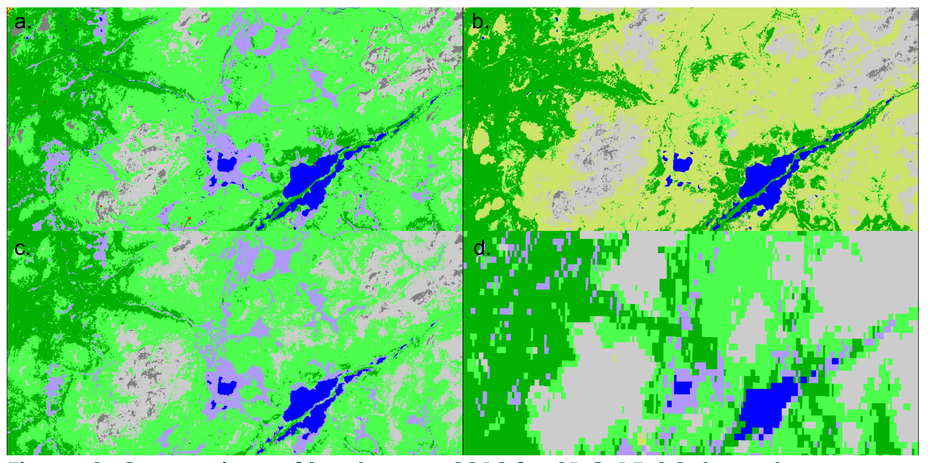

Figure 2. Comparison of land cover 2018 for SDG 15.4.2, based on different input data: a. Finnish CLC, b. CLMS-products, c. EDC-classification, d. ESA CCI classification. Area: Ailigas fell - Luomusjärvet lakes.

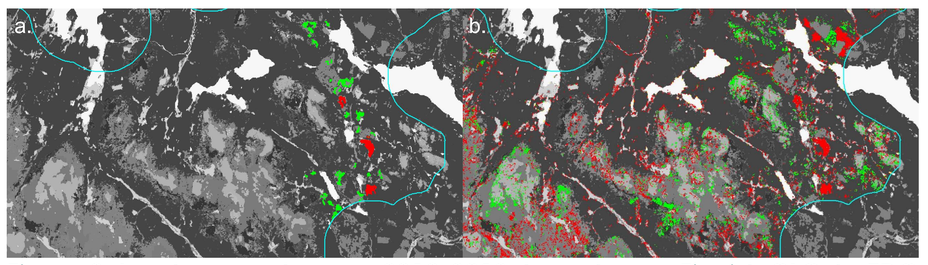

Figure 3. Land cover changes 2012-2018, based on a. Finnish CLC, b. EDC classification. Improved areas as green, degraded as red. Background map in grey: Finnish national CLC 2018. Mountain area border as cyan. Area: Hammastunturi fell - Pasasjärvi lake.

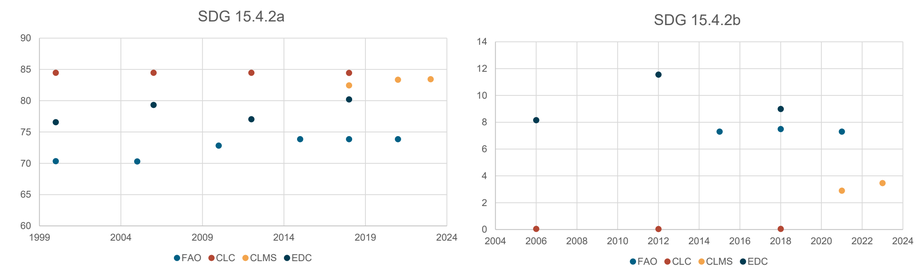

Figure 4. The values of SDG 15.4.2a and 2b indicators based on different input data.

ORIGINAL CLASS \ FINAL CLASS	Artificial surfaces	Cropland	Grassland	Tree-covered areas	Shrub-covered areas	Herbaceous or shrub vegetation, aquatic or regularly flooded	Sparsely natural vegetated areas	Barren land	Permanent snow & glaciers	Water bodies
Artificial Surfaces	Stable	Agricultural Expansion	Vegetation establishment	Forest expansion	Vegetation establishment	Wetland establishment	Withdrawal of settlements	Withdrawal of settlements	Withdrawal of settlements	Withdrawal of settlements
Cropland	Urban expansion	Stable	Withdrawal of agriculture	Forest expansion	Vegetation establishment	Wetland establishment	Vegetation loss	Vegetation loss	Glacier advance	Inundation
Grassland	Urban expansion	Agricultural Expansion	Stable	Forest expansion	Woody encroachment	Wetland establishment	Vegetation loss	Vegetation loss	Glacier advance	Inundation
Tree-covered areas	Deforestation	Deforestation	Deforestation	Stable	Vegetation loss	Inundation	Deforestation	Deforestation	Glacier advance	Inundation
Shrub-covered areas	Urban expansion	Agricultural expansion	Vegetation loss	Forest expansion	Stable	Inundation	Vegetation loss	Vegetation loss	Glacier advance	Inundation
Herbaceous or shrub vegetation, aquatic or regularly flooded	Wetland drainage	Wetland drainage	Wetland drainage	Wetland drainage	Woody encroachment	Stable	Wetland drainage	Wetland drainage	Glacier advance	Inundation
Sparsely natural vegetated areas	Urban expansion	Agricultural expansion	Vegetation establishment	Forest expansion	Vegetation establishment	Wetland establishment	Stable	Vegetation loss	Glacier advance	Inundation
Barren land	Urban expansion	Agricultural expansion	Vegetation establishment	Forest expansion	Vegetation establishment	Wetland establishment	Vegetation establishment	Stable	Glacier advance	Inundation
Permanent snow & glaciers	Urban expansion	Agricultural expansion	Glacier retreat	Glacier retreat	Glacier retreat	Glacier melting	Glacier retreat	Glacier retreat	Stable	Glacier melting
Water bodies	Urban expansion	Agricultural expansion	Lake dessication	Lake dessication	Lake dessication	Lake dessication	Lake dessication	Lake dessication	Glacier advance	Stable

Figure 5. The change matrix of land cover classes. Green: improvement, Orange: stable, Red: degradation