FORECOMON 2021 – The 9th Forest Ecosystem Monitoring Conference
7-9 June 2021, Zurich/Birmensdorf, Switzerland

Forest monitoring from the cloud - Soil water content case study

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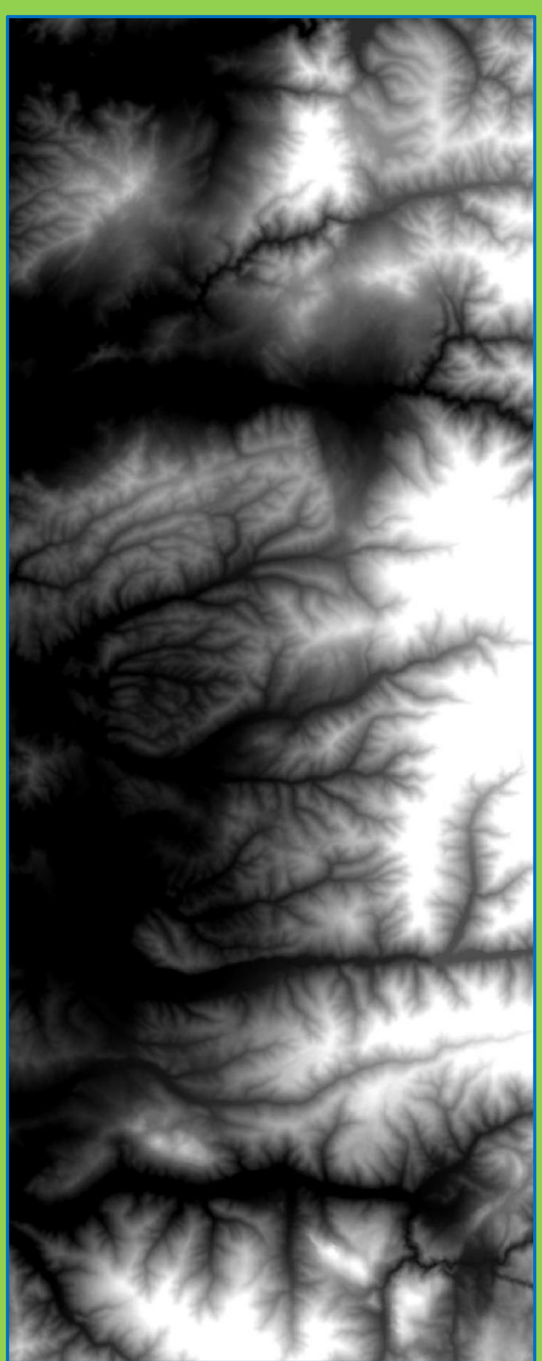
Abstract

While growing efforts have been invested in monitoring environmental changes impact on the forest ecosystems, anomalies increased in intensity and frequency. We are at the point of seeing them as one of the highest risks facing forests. ICP initiative stands proof that intensive monitoring is key in providing insight into the state of the forest ecosystems. Covering all major forest types in Europe in support of a centralized analysis, we still ask: is it enough? We tried answering this question with a case study focusing on Soil Water Content (SWC) in Romanian Level II plots. As main drought indicator, remote sensing (RS) has previously facilitated the evaluation of SWC on large scale. Resulting products are often low resolution inapplicable in detailed studies.

Using Spectral Mixing Analysis by means of the data collections and processing tools implemented in EarthEngine (GEE),we reached sub-pixel values best fitting pure spectra. Definition of accurate classes led to the extraction of percentages in which water, vegetation and bare land combine to make each Digital Number (pixel value). RS values were matched to the in-situ measurements for all analyzed sample areas. Converting percentages to concentrations, allowed us to take advantage of the high accuracy of field values as well as the high coverage of satellite imagery. The resulting SWC map is a product unattainable through field measurements alone, and can support the monitoring efforts in an unpredictable environmental context. Extending the study to Level I plots where we lack SWC measurements, can be a useful tool, especially in the light of the high automation capabilities that come with GEE.

Methods and materials

```
ee.Image("USGS/SRTM")

ee.Image.constant(ee.Number(image.get('SOLAR_ZENITH_ANGLE'))).multiply(3.14159265359).divide(180).clip(image.geometry().buffer(10000))
ee.Image.constant(ee.Number(image.get('SOLAR_AZIMUTH_ANGLE')).multiply(3.14159265359).divide(180)).clip(image.geometry().buffer(10000))

cosZ >> Solar Zenith_rad.cos()
cosS >> Slope_rad.cos()
sinZ >> Solar Zenith_rad.sin()
sinS >> Slope_rad.sin()
cosS.expression("cosZ * cosS", {'cosZ': cosZ, 'cosS': cosS.select('slope')})
sinZ.expression("sinZ * sinS * (Solar Azimuth_rad.subtract(asp_rad)).cos()", {'sinZ': sinZ, 'sinS': sinS,
    '(Solar Azimuth_rad.subtract(asp_rad)).cos()': (Solar Azimuth_rad.subtract(asp_rad)).cos()})

image.addBands(.rename('Illumination Condition')).addBands(cosZ.rename('cosZ')).addBands(cosS.rename('cosS')).addBands(slp.rename('slope'))

.and(img_plus_ic.select('Illumination Condition').gte(0))

image.select(image.bandNames.removeAll(Interest Bands))

ee.Reducer.linearFit()

ee.Geometry(image.geometry().buffer(-5000))

ee.ImageCollection("COPERNICUS/S2")

newimg.reduceRegion(Bare Ground / Vegetation / Water)

ee.Array.cat([Bare Ground / Vegetation / Water], 1)

ee.Image(Bare Ground / Vegetation / Water).matrixSolve(arrayImage)
unmixed.arrayProject([0])

.unmix([Bare Ground / Vegetation / Water], true, true)
```

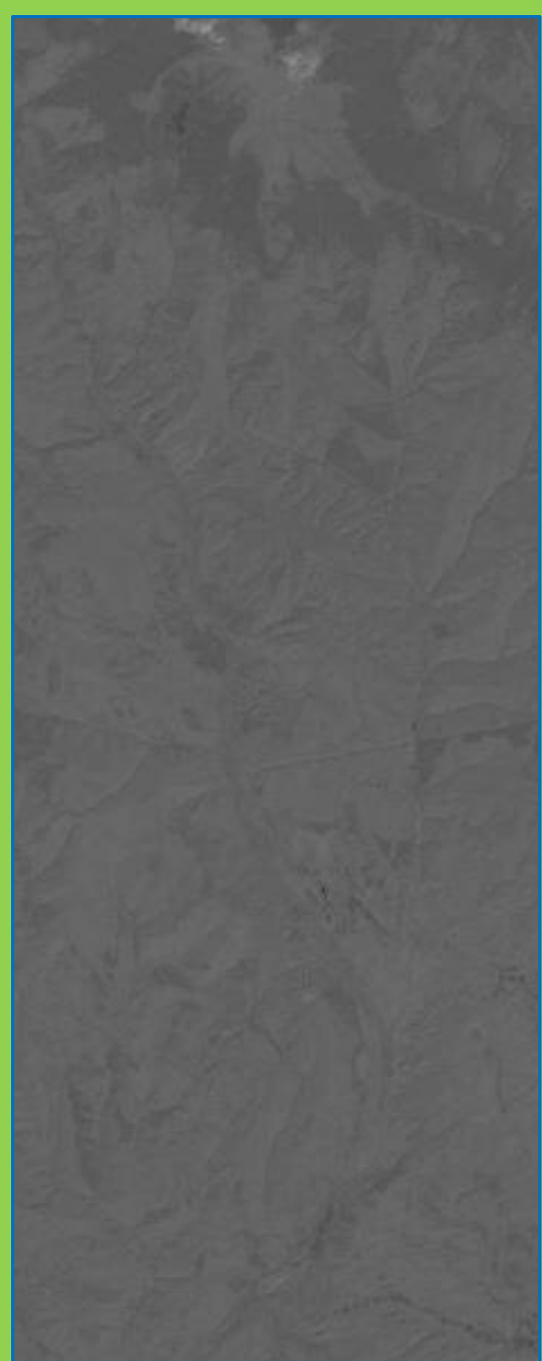


Terrain data

- *Import*
- *SRTM USGS*

Illumination conditions

- *Calculate*
- *Solar position image metadata*
- *Slope influence*
- *Aspect influence*
- *Integration into original data*

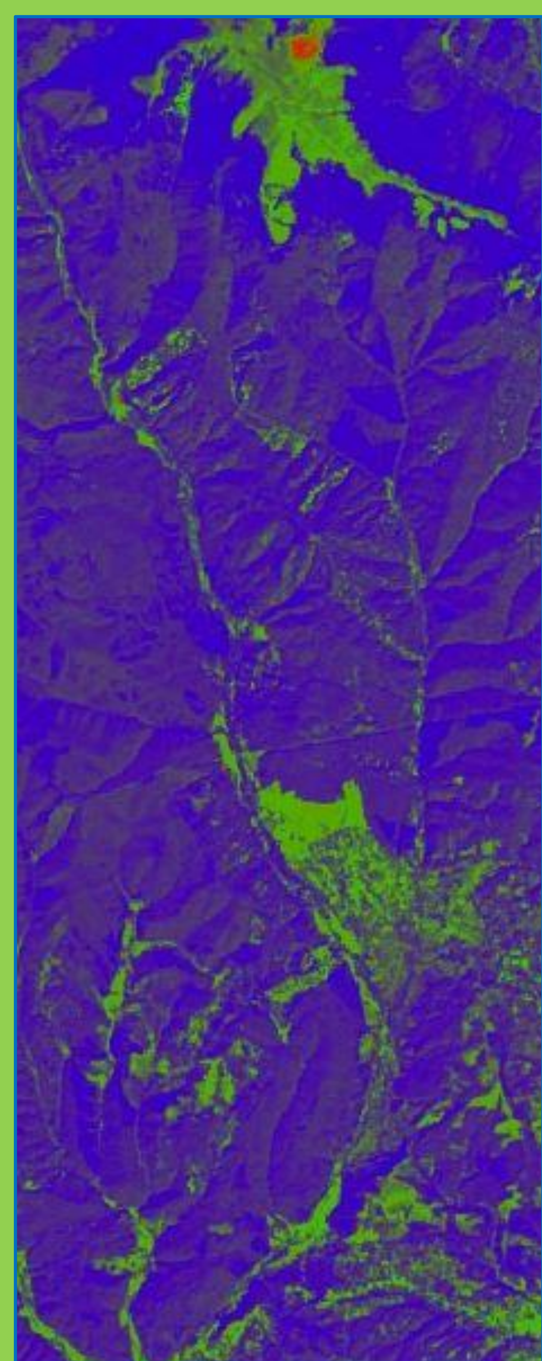


Sun-canopy sensors correction

- *Calculate*
- *Select bands*
- *Compute coefficients*
- *Trim outer edges*
- *Apply correction*

Satellite scene

- *Import*
- *SENTINEL 2/Landsat 8*



Soil water content

- *Extract training region*
- *Reduce region*
- *Compute endmembers*
- *Apply spectral unmixing*
- *Compute constrained fraction*

Discussion

The presented research is just a small part of an attempt to convert ICP field measurements towards remote sensing techniques in order to extend both temporal and spatial resolution of the specific reporting variables.

As a consequence, alongside the methodological character of the work involved, relevant results are yet to be obtained.

From the preliminary results correlation between remote sensing derived data and a small sample of Romanian ICP network, solely with regard to soil water content show a significant relationship between the two.

Acknowledgment & Contact

This work was developed under the auspices of Nucleu National Programme - Project PN19070102, funded by the Romanian Ministry of Research and Innovation.

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