Determining crop traits using multi-spectral data & radiative transfer models

BOKU – INSTITUTE FOR SURVEYING, REMOTE SENSING AND LAND INFORMATION

History: ... since 1875
Staffing: ... ca. 20
Teaching: ... several bachelor & master programs
Thematics: ... Remote sensing & photogrammetry
... GIS & land information
... Surveying & geodesy
CLASSICAL APPLICATIONS OF REMOTE SENSING

... CROP & TREE SPECIES IDENTIFICATION ...

High resolution land cover classification
High resolution tree species classification

- 12 tree species
  OAA: 89.9%

---

High resolution crop type classification

**TREE SPECIES IDENTIFICATION**

- Fagus silvatica
- Alnus sp.
- Carpinus betulus
- Picea sp.
- Quercus sp.
- Prunus sp.
- Picea abies
- Pseudotsuga menziesii

**CROP TYPE IDENTIFICATION**

- Maize
- Onion
- Soybean
- Other vegetable
- Sugar beet
- Potato
- Pumpkin
- Alfalfa
- Winter cereal
- Carrot
- Sunflower
- Asparagus
- Pea

https://ivfl.maps.arcgis.com/apps/webappviewer/index.html?id=589e41739e474c0f92ad8009b2c09fb5
Regional crop rotation

14% of total crop land was under a single crop production system (2016-2018)

Change detection

„Change detection“
OBSERVING CROPS USING EO DATA:

DROUGHT RESISTANCE
PHENOLOGICAL DEVELOPMENT
NITROGEN UPTAKE
WATER STRESS

https://ivfl-arc.boku.ac.at/kenya/map/
Coarse scale monitoring

... LAND SURFACE PHENOLOGY ...

End of season differences from 2010-2014 and 2015

PrecAg: Nitrogen management

... N-MANAGEMENT...
PrecAg: Nitrogen management

03.07.2019

... N-MANAGEMENT...

Sentinel-2

1st VRT N appl.
April 26th 2017

PrecAg: Irrigation management

... IRRIGATION MANAGEMENT ...

Beregnungsplan.at

13

14
... PHENOTYPING ...

Cooperation with:

Pablo Rischbeck - Division of Agricultural Engineering
Heinrich Grausgruber - Division of Plant Breeding
FERTILIZATION EXPERIMENTS

NEW SENSORS FOR LEAN PHENOTYPING
The Sentinel-2 mission is a land monitoring constellation of two identical satellites providing high resolution optical imagery and provide continuity for the current SPOT and Landsat missions for the next ~20 years.

The mission provides a global coverage of the Earth's land surface every 5 days, making the data of great use for agricultural applications.

The satellites are equipped with the state-of-the-art MSI (Multispectral Imager) instrument, that offers high-resolution optical imagery. All data are for free to everyone.
... THE ARRIVAL OF A GAME CHANGER ...

Rich and uncorrelated information

Single image

RADIATIVE TRANSFER MODELLING:

MAKING OPTIMUM USE OF FULL SPECTRAL INFORMATION
Whats wrong with (2-band) VIs?

...RADIATIVE TRANSFER MODELING...

NDVI isolines

Leaf area index (LAI)

Soil brightness

Leaf inclination

What's wrong with (2-band) VIs?

...RADIATIVE TRANSFER MODELING...


c(LAI)

nIR

red

1.300

50

50

LAI

SCALE

ALA

Leaf area index

Soil brightness

Leaf inclination
Radiative transfer modeling: “Use of physical laws”

- Field data only for validation needed
- More generic (time, landscape)
- Not sensor specific
- Data redundancy not a problem

Jones & Vaughan, 2010

RTM based on physical principles

... RADIATIVE TRANSFER MODELING...

LAI validation

... RADIATIVE TRANSFER MODELING...
Validation of PROSAIL-derived LAI

... RADIATIVE TRANSFER MODELING...

Total leaf chlorophyll concentration (Cab) at Eriskay study site

... RADIATIVE TRANSFER MODELING...
Solving the ill-posed inverse problem

... RADIATIVE TRANSFER MODELING...

The ill-posed inverse problem illustrated for a Landsat-TM sensor: (left): 15 different parameter combinations lead to a similar canopy reflectance spectra (SAILH+PROSPECT simulations); (right): counterbalancing effect between average leaf angle (ALA) and leaf area index (LAI).

Optimization of "soil-isolines" for pixels within 3 x 3 gliding windows, assuming that only LAI shows a remarkable variation within ± 1 pixel.
Vegetation indices (VI) only capture part of the available information! ... too much information is lost & no generalization

Radiative transfer models link crop types with spectral signatures! ... based on physical principles ... & using all bands

Method transfer from (classical) Earth Observation to phenotyping is warranted ... leveraging experience in EO

Thank you!

CONTACT

University of Natural Resources and Life Sciences, Vienna, Austria

Department of Landscape, Spatial and Infrastructure Sciences
Institute of Surveying, Remote Sensing and Land Information

Clement ATZBERGER, Univ.-Prof. Dr.
Peter Jordanstraße 82, A-1190 Vienna, Austria
Tel.: +43 1 47654-85701

clement.atzberger@boku.ac.at

http://ivfl-info.boku.ac.at/index.php/homepage
http://s2.boku.eodc.eu/