

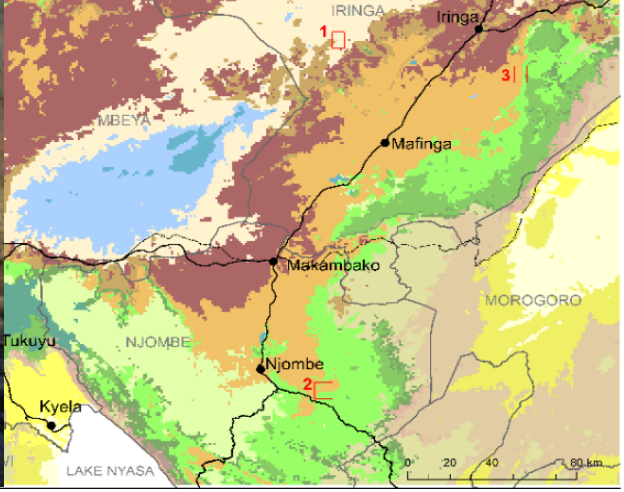

Remote Sensing and EO activities at the University of Turku

Niina Käyhkö
Associate Professor
Department of Geography and Geology

GEO meeting/SYKE
May 23rd, 2018

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University of Turku

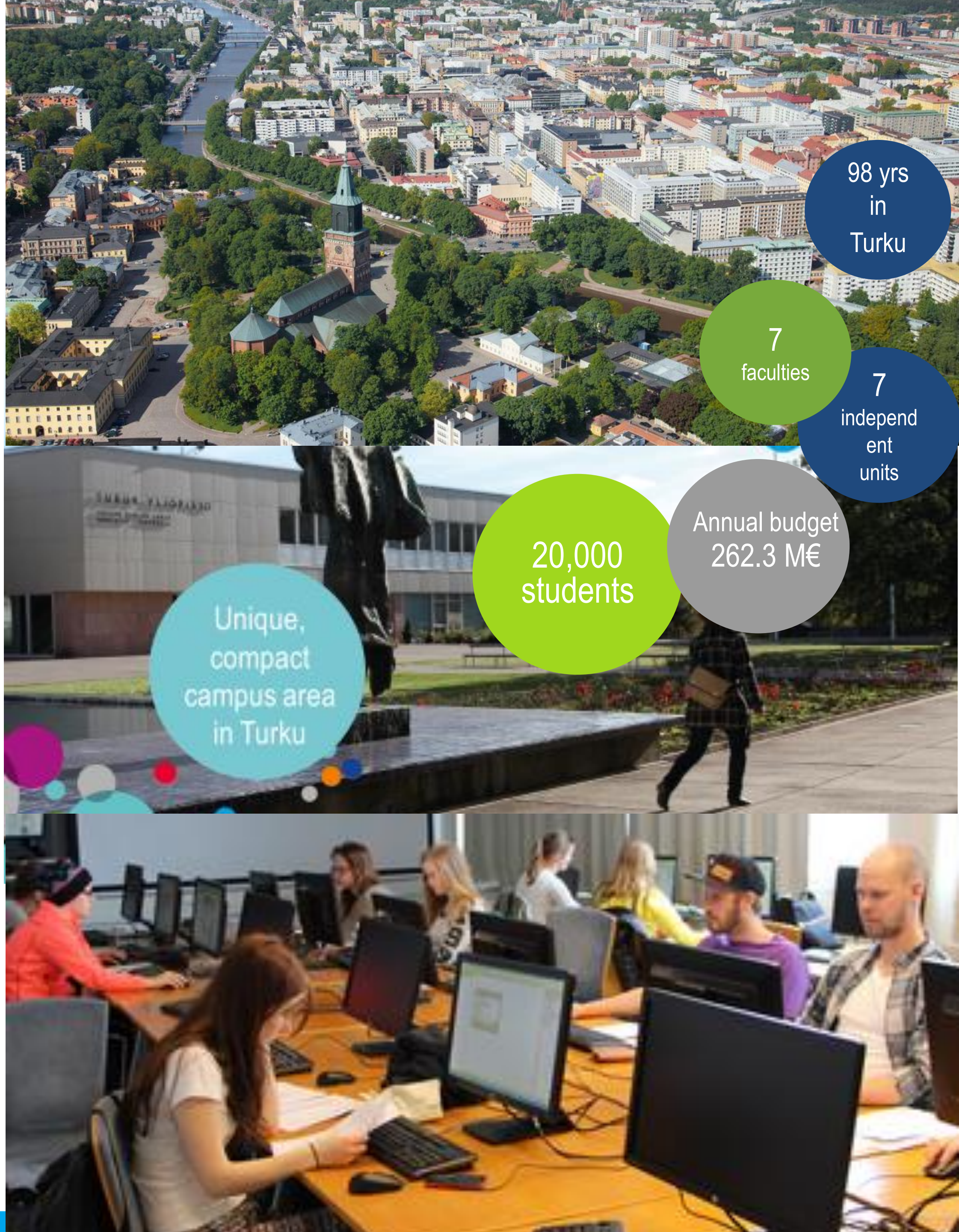
Geospatial competence at the University of Turku (UTU)

remote sensing, image processing, Earth Observation, LBS, geostatistical analysis and geovisualization play a **cross-cutting role at UTU's educational, research and networking activities**

The leading research and education role of geospatial applications is at the **Department of Geography and Geology**

EO skills are increasingly used and applied in ***biology*** *(landscape ecology, environmental modelling),* ***information technologies*** *(software engineering, business innovations),* ***economics*** *(economic geography, business),* ***medical sciences*** *(health geography),* ***social sciences*** *(urban studies),* ***humanities*** *(archaeology, landscape studies) and* ***education*** *(geospatial/geomedia).*

www.utu.fi/utu-gis



Earth Observation focus at the Faculty of Science and Engineering

EO is linked with research objectives and scientific challenges of the **multidisciplinary research teams** from Geography, Biology, Geology and Future Technologies

Key application fields are:

- ***Fluvial processes and flood modelling***
- ***Land cover and land use mapping and land change analysis***
- ***Biodiversity and mapping of forest dynamics***
- ***Coastal and marine environments***
- ***Urban climate***
- ***Participatory planning and citizen-science approaches***
- ***EO innovations and business development***

We use multiple data sources of remote sensing, from field measurements (LiDAR, UAV, aerial images) to satellite imagery, both optical and radar (Modis, Meris, Landsat, Spot, Sentinel…)

Few application examples….

LiDAR applications in fluvial research

Laser scanning has enabled highly accurate data gathering with increased horizontal and vertical precision and better availability of detailed spatial data. For example, **airborne laser scanning** (ALS), ALS systems for bathymetric measurements, **fixed-position terrestrial laser scanning** (TLS) and **mobile laser scanning** (MLS), such as boat- and cart-based mapping systems (BoMMS/CartMMS), have revealed new potential in fluvial research.

Photogrammetry and UAV applications in fluvial studies

Aerial photography based bathymetry modelling allows us to create depth models at high spatial resolution, based on the connection between water depth and measured reflectance. Several models have been tested and developed on the Tana river in Lapland.

http://www.utu.fi/en/sites/fluvial/Pages/home.aspx

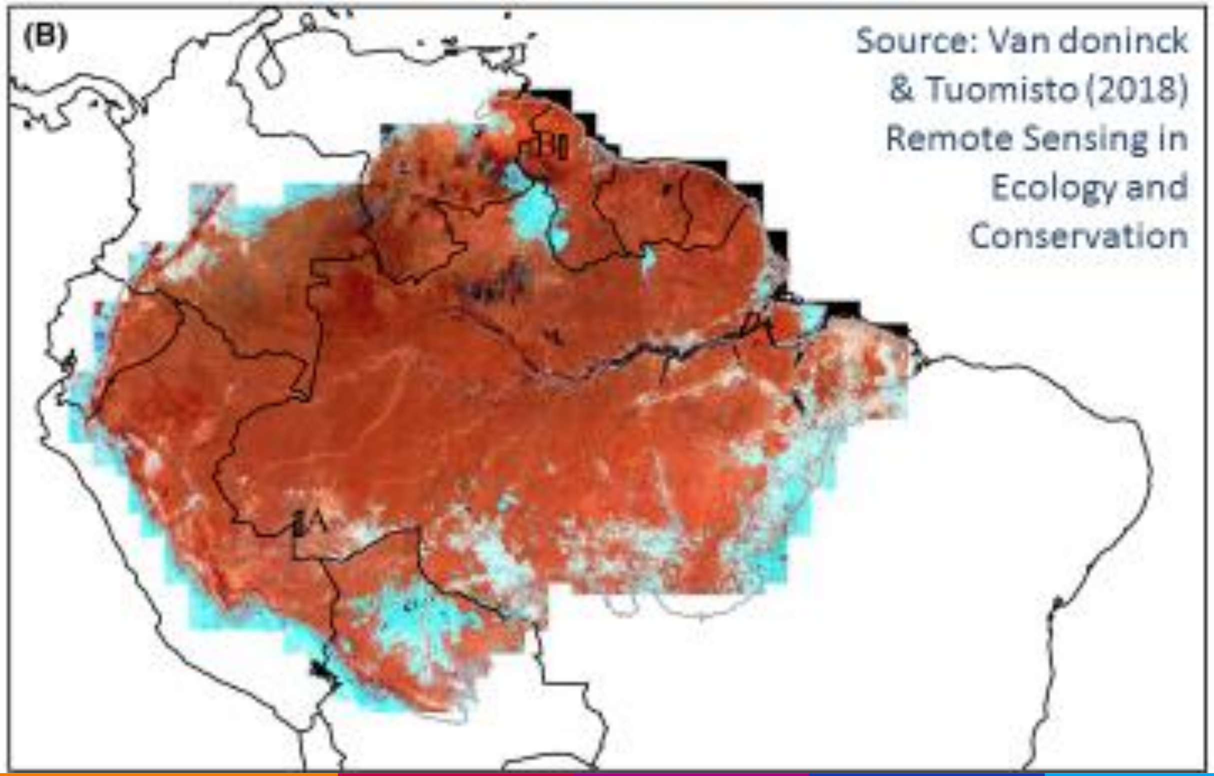
Mapping extensive and inaccessible forest areas: case Amazon

Remote Sensing in Ecology and Conservation
Open Access
ZSL LET'S WORK FOR WILDLIFE

ORIGINAL RESEARCH

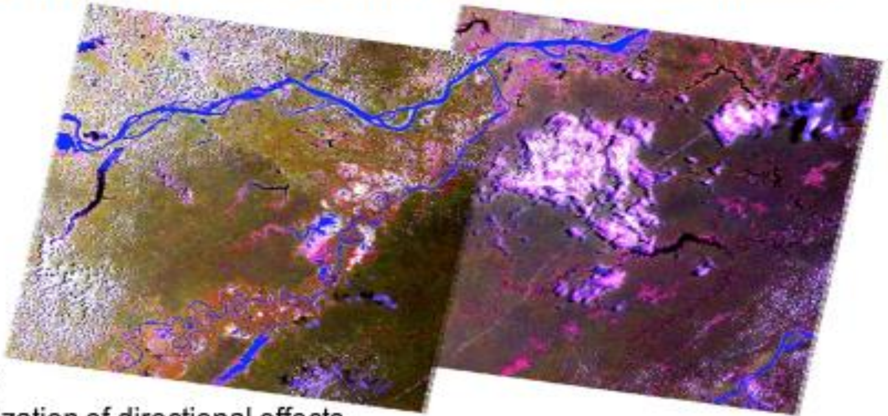
A Landsat composite covering all Amazonia for applications in ecology and conservation

Jasper Van doninck & Hanna Tuomisto
Amazon Research Team, Department of Biology, University of Turku, FI-20014 Turku Finland



Source: Van doninck & Tuomisto (2018) Remote Sensing in Ecology and Conservation

Landsat TM/ETM+ image compositing over Amazonia



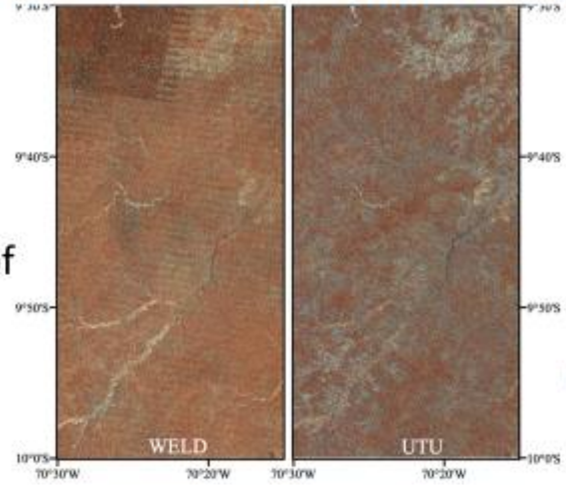
Challenges:

1. Normalization of directional effects
2. Pixel-based image compositing

Slide credit: Jasper Van doninck

Two views of an example area (infrared bands 4,5,7)

Web-enabled Landsat data (WELD) of USGS/NASA



Landsat TM/ETM+ mosaic of Univ. Turku

Source: Van Doninck & Tuomisto (2018) Remote Sensing in Ecology and Conservation

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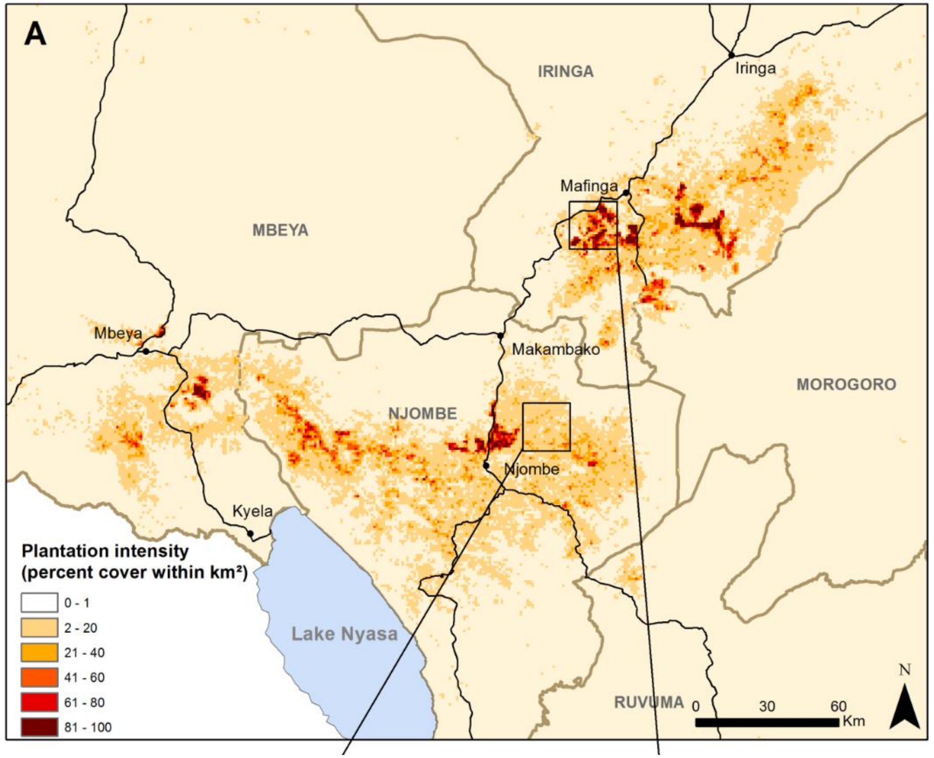
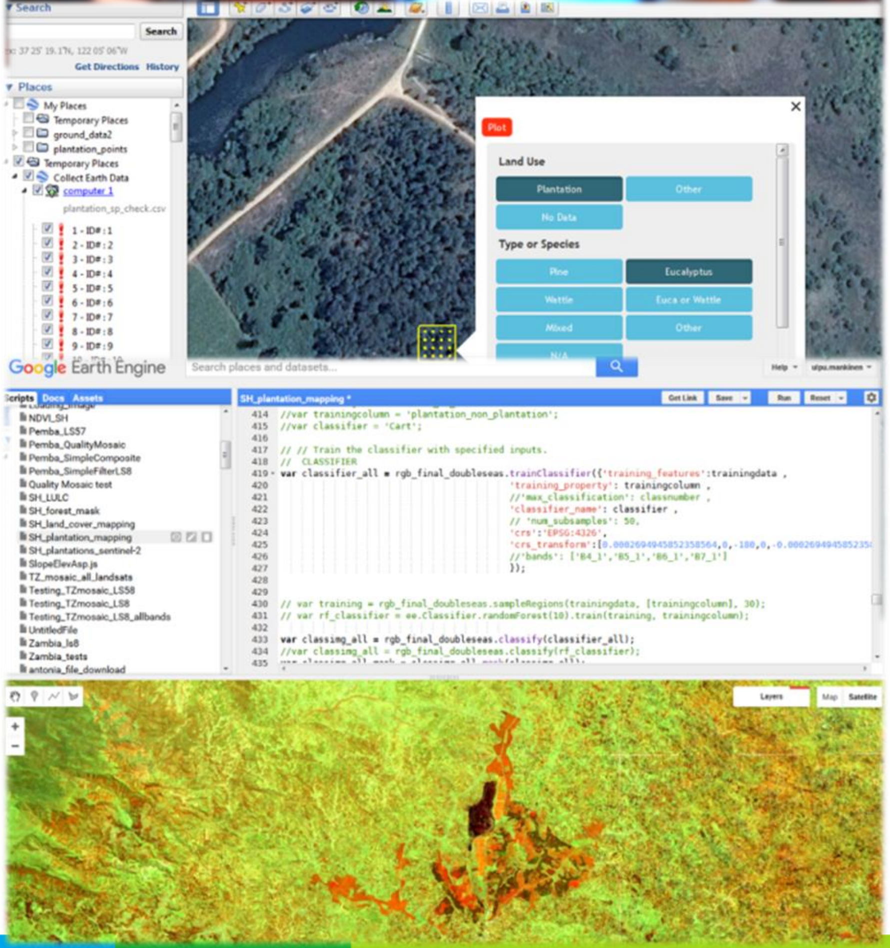
Mapping plantation forests in Tanzania with **OS and cloud solutions**

developing participatory mapping methodology, which utilizes open data catalogues and cloud computing capacity (**Open Foris tools, Google Earth Engine**) combined with **participation of local experts**

- Data collection event in Dar es Salaam
- 22 Tanzanian students and forestry experts
- 4 days Collect Earth training, 4 days data collection
- Target: 7000 plots
    - Total 5940 after data cleaning
  - Follow-up event in November 2016
    - Collect training and results dissemination





Land Use: ● Plantation ○ Other ○ No Data

Type or Species: ○ Pine ● Eucalyptus ○ Wattle ○ Euca or Wattle ○ Mixed ○ Other ○ N/A

```
//var trainingcolumn = 'plantation_non_plantation';
//var classifier = 'Cart';

// // Train the classifier with specified inputs.
//  CLASSIFIER
var classifier_all = rgb_final_doubleseas.trainClassifier({'training_features':trainingdata ,
                                                          'training_property': trainingcolumn ,
                                                          //'max_classification': classnumber ,
                                                          'classifier_name': classifier ,
                                                          // 'num_subsamples': 50,
                                                          'crs':'EPSG:4326',
                                                          'crs_transform':[0.0002694945852358564,0,-180,0,-0.00026949458523
                                                          //'bands': ['B4_1','B5_1','B6_1','B7_1']
                                                          });


// var training = rgb_final_doubleseas.sampleRegions(trainingdata, [trainingcolumn], 30);
// var rf_classifier = ee.Classifier.randomForest(10).train(training, trainingcolumn);

var classimg_all = rgb_final_doubleseas.classify(classifier_all);
//var classimg_all = rgb_final_doubleseas.classify(rf_classifier);
```

Food and Agriculture Organization of the United Nations

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Ministry for Foreign Affairs of Finland

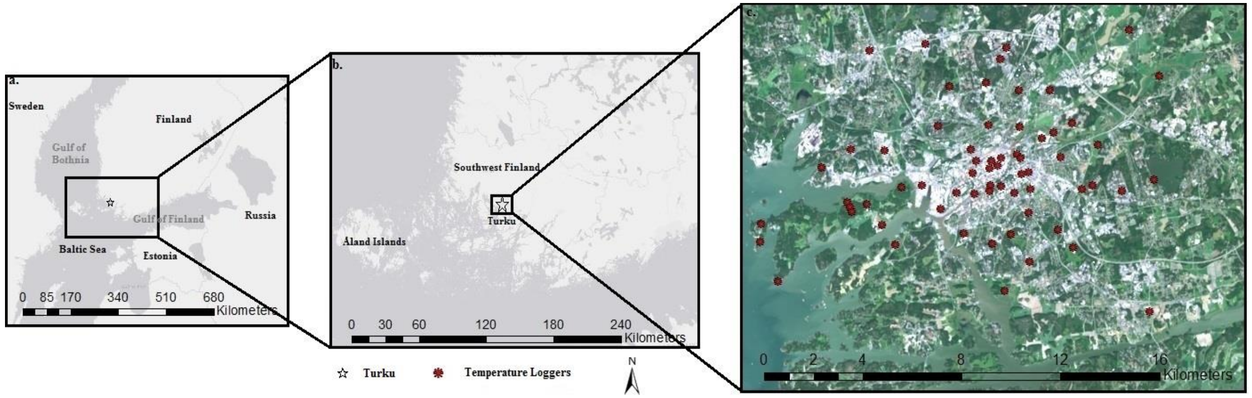
Academy of Finland

Tanzania Forest Services Agency
TFS
Forest is Wealth

Panda Miti Kibiashara
Private Forestry Programme

http://tanzania.utu.fi/

Turku Urban Climate Research Group (TURCLIM)



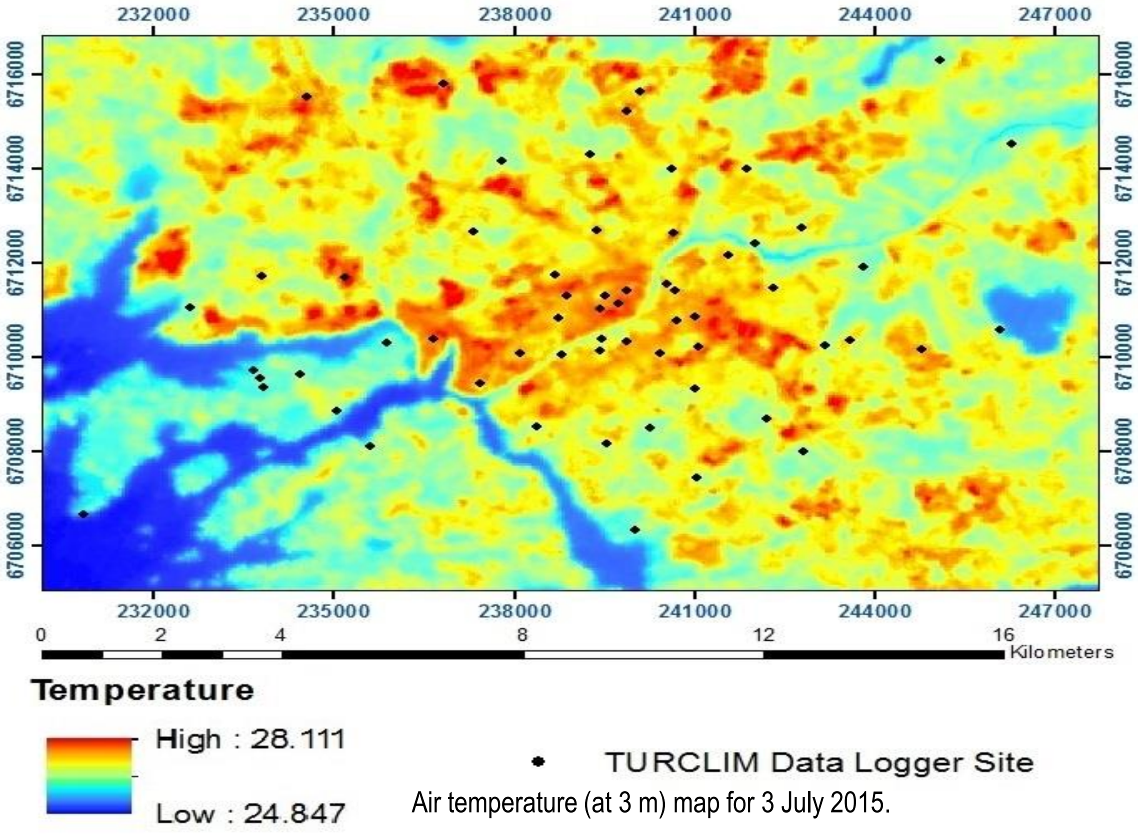
Air Temperature Modeling

Data

- Landsat 8 Thermal Infrared Band 10
- CORINE (20 m)
- TURCLIM Air Temperature

Air Temperature Prediction Accuracy (at 3 m height)

- March (93.7 %)
- July (98.3)
- August (97.7)
- October (92.8)
- December (92.1)



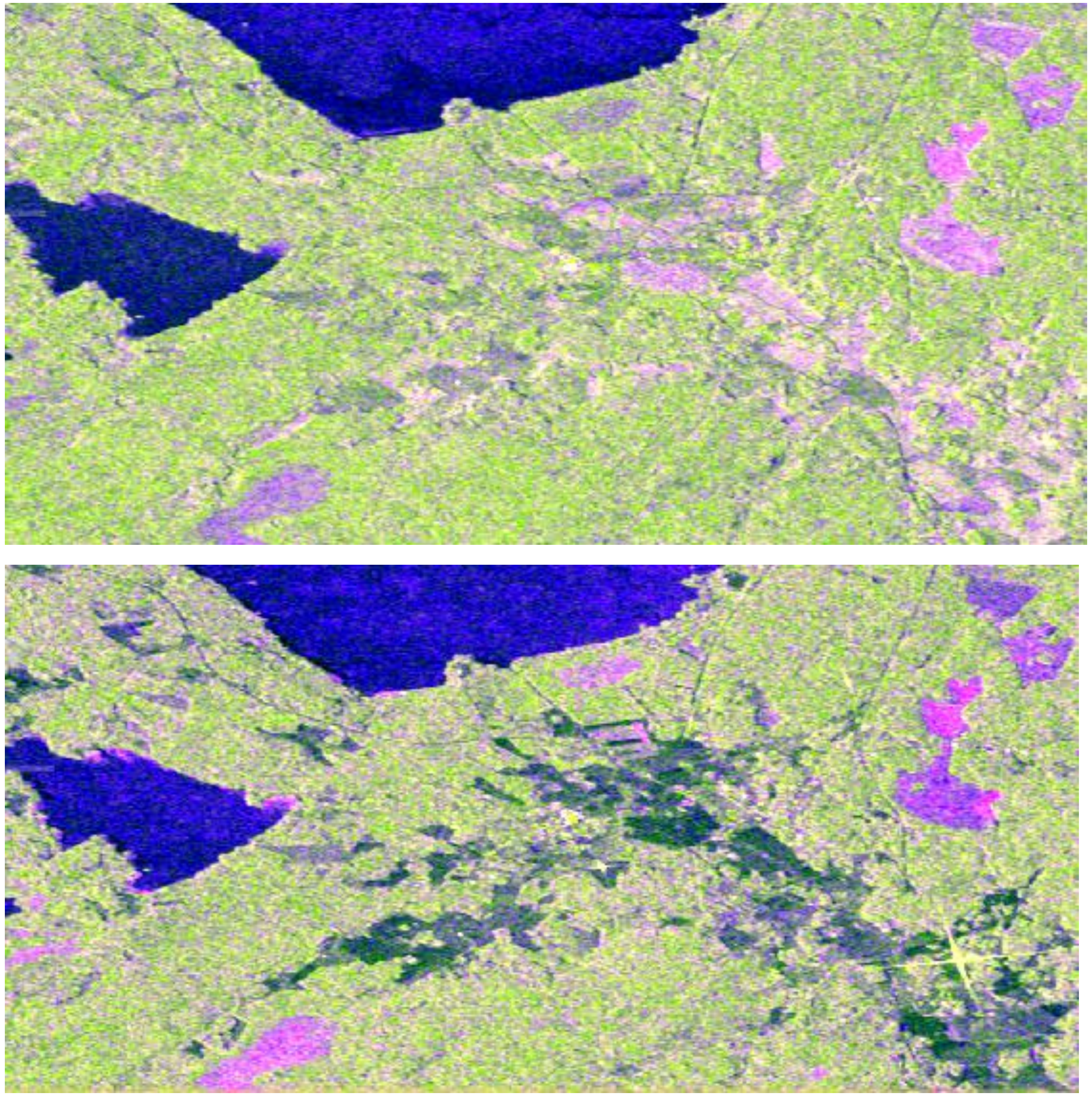
Air temperature (at 3 m) map for 3 July 2015.

Use of time-series of SAR satellite data (Sentinel 1) to detect crop types and crop rotation

Carlos Gonzales Inca, Department of Geography and Geology, University of Turku, Finland (cagoin@utu.fi)

Use of time-series of SAR satellite data (Sentinel1) to detect crop types and crop rotation in Yläneenjoki, SW Finland.

The information is used to compute nutrient loading from agricultural areas to rivers.

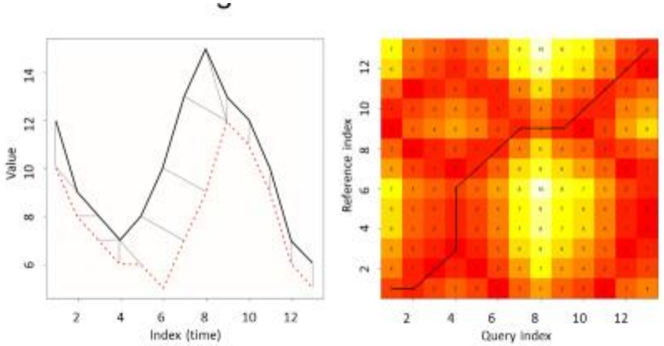


Identifying areas with similar temporal behaviour from MERIS reflectance time series

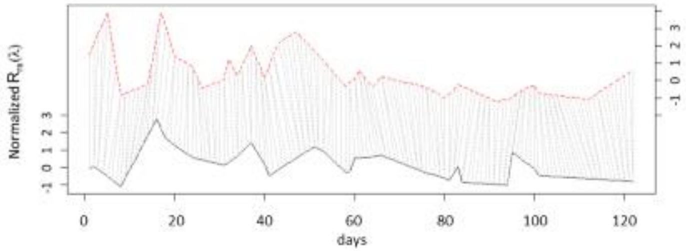
Tapio Suominen, Department of Geography and Geology, University of Turku, Finland (tapio.suominen@utu.fi)

METHODS

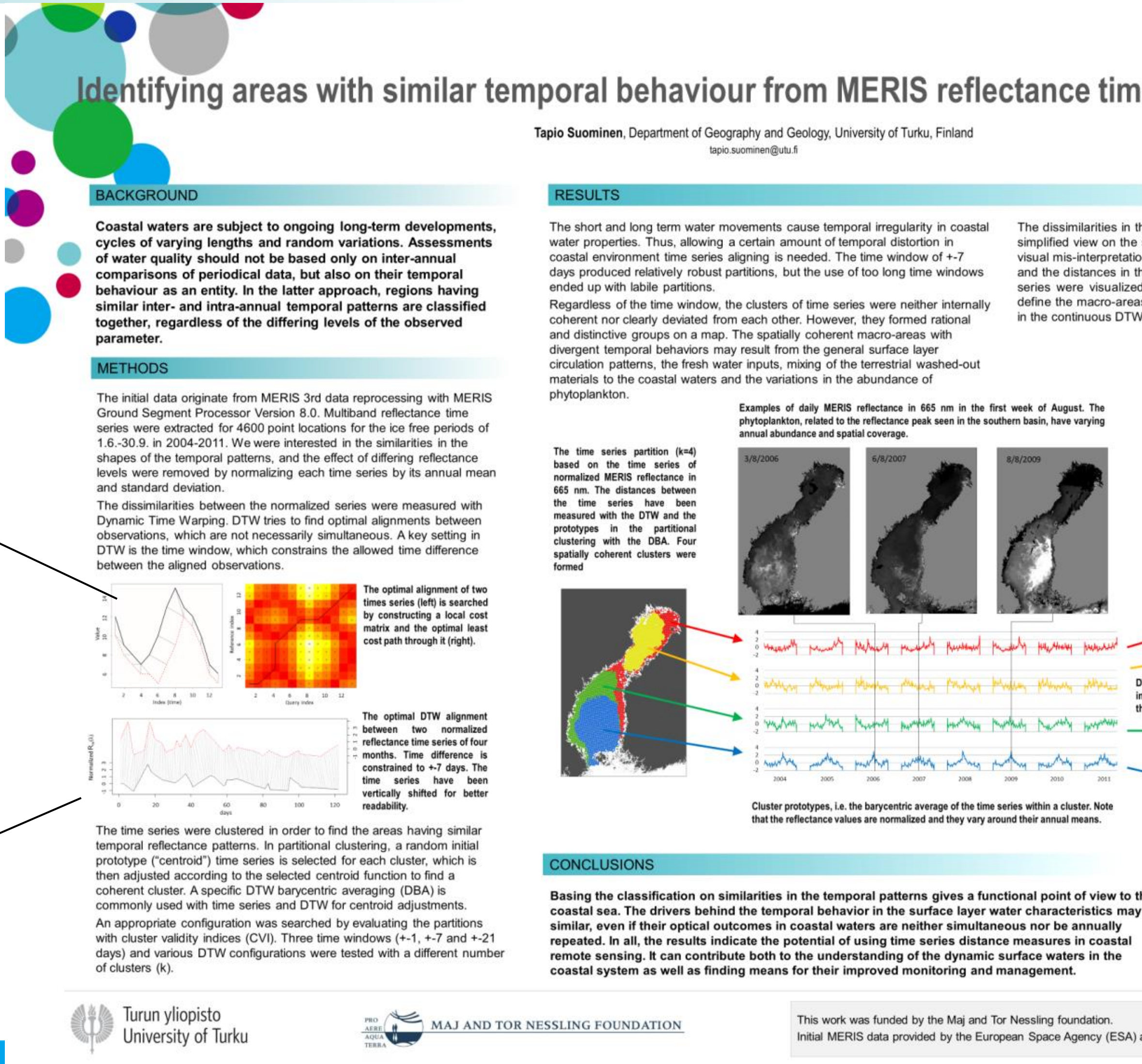
The initial data originate from MERIS 3rd data reprocessing with MERIS Ground Segment Processor Version 8.0. Multiband reflectance time series were extracted for 4600 point locations for the ice free periods of 1.6.-30.9. in 2004-2011. We were interested in the similarities in the shapes of the temporal patterns, and the effect of differing reflectance levels were removed by normalizing each time series by its annual mean and standard deviation.



The optimal alignment of two times series (left) is searched by constructing a local cost matrix and the optimal least cost path through it (right).



The optimal DTW alignment between two normalized reflectance time series of four months. Time difference is constrained to +-7 days. The time series have been vertically shifted for better readability.



Identifying areas with similar temporal behaviour from MERIS reflectance tim

Tapio Suominen, Department of Geography and Geology, University of Turku, Finland
tapio.suominen@utu.fi

BACKGROUND

Coastal waters are subject to ongoing long-term developments, cycles of varying lengths and random variations. Assessments of water quality should not be based only on inter-annual comparisons of periodical data, but also on their temporal behaviour as an entity. In the latter approach, regions having similar inter- and intra-annual temporal patterns are classified together, regardless of the differing levels of the observed parameter.

METHODS

The initial data originate from MERIS 3rd data reprocessing with MERIS Ground Segment Processor Version 8.0. Multiband reflectance time series were extracted for 4600 point locations for the ice free periods of 1.6.-30.9. in 2004-2011. We were interested in the similarities in the shapes of the temporal patterns, and the effect of differing reflectance levels were removed by normalizing each time series by its annual mean and standard deviation.

The dissimilarities between the normalized series were measured with Dynamic Time Warping. DTW tries to find optimal alignments between observations, which are not necessarily simultaneous. A key setting in DTW is the time window, which constrains the allowed time difference between the aligned observations.

The optimal alignment of two times series (left) is searched by constructing a local cost matrix and the optimal least cost path through it (right).

The optimal DTW alignment between two normalized reflectance time series of four months. Time difference is constrained to +-7 days. The time series have been vertically shifted for better readability.

The time series were clustered in order to find the areas having similar temporal reflectance patterns. In partitional clustering, a random initial prototype ("centroid") time series is selected for each cluster, which is then adjusted according to the selected centroid function to find a coherent cluster. A specific DTW barycentric averaging (DBA) is commonly used with time series and DTW for centroid adjustments.

An appropriate configuration was searched by evaluating the partitions with cluster validity indices (CVI). Three time windows (+-1, +-7 and +-21 days) and various DTW configurations were tested with a different number of clusters (k).

RESULTS

The short and long term water movements cause temporal irregularity in coastal water properties. Thus, allowing a certain amount of temporal distortion in coastal environment time series aligning is needed. The time window of +-7 days produced relatively robust partitions, but the use of too long time windows ended up with labile partitions.

Regardless of the time window, the clusters of time series were neither internally coherent nor clearly deviated from each other. However, they formed rational and distinctive groups on a map. The spatially coherent macro-areas with divergent temporal behaviors may result from the general surface layer circulation patterns, the fresh water inputs, mixing of the terrestrial washed-out materials to the coastal waters and the variations in the abundance of phytoplankton.

The dissimilarities in th
simplified view on the
visual mis-interpretatio
and the distances in th
series were visualized
define the macro-area
in the continuous DTW

Examples of daily MERIS reflectance in 665 nm in the first week of August. The phytoplankton, related to the reflectance peak seen in the southern basin, have varying annual abundance and spatial coverage.

The time series partition (k=4) based on the time series of normalized MERIS reflectance in 665 nm. The distances between the time series have been measured with the DTW and the prototypes in the partitional clustering with the DBA. Four spatially coherent clusters were formed

3/8/2006
6/8/2007
8/8/2009

Cluster prototypes, i.e. the barycentric average of the time series within a cluster. Note that the reflectance values are normalized and they vary around their annual means.

CONCLUSIONS

Basing the classification on similarities in the temporal patterns gives a functional point of view to t coastal sea. The drivers behind the temporal behavior in the surface layer water characteristics may similar, even if their optical outcomes in coastal waters are neither simultaneous nor be annually repeated. In all, the results indicate the potential of using time series distance measures in coastal remote sensing. It can contribute both to the understanding of the dynamic surface waters in the coastal system as well as finding means for their improved monitoring and management.

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PRO AERE AQUA TERRA MAJ AND TOR NESSLING FOUNDATION

This work was funded by the Maj and Tor Nessling foundation.
Initial MERIS data provided by the European Space Agency (ESA)

Science-practice solutions from EO data:
case Village Land Use Planning in Tanzania

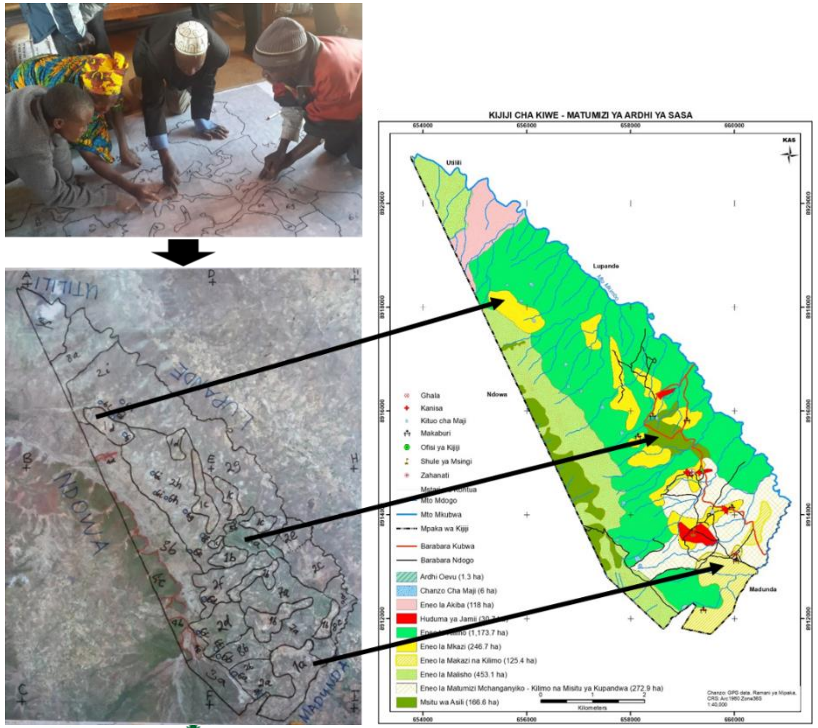
High-res satellite image as a base for community mapping

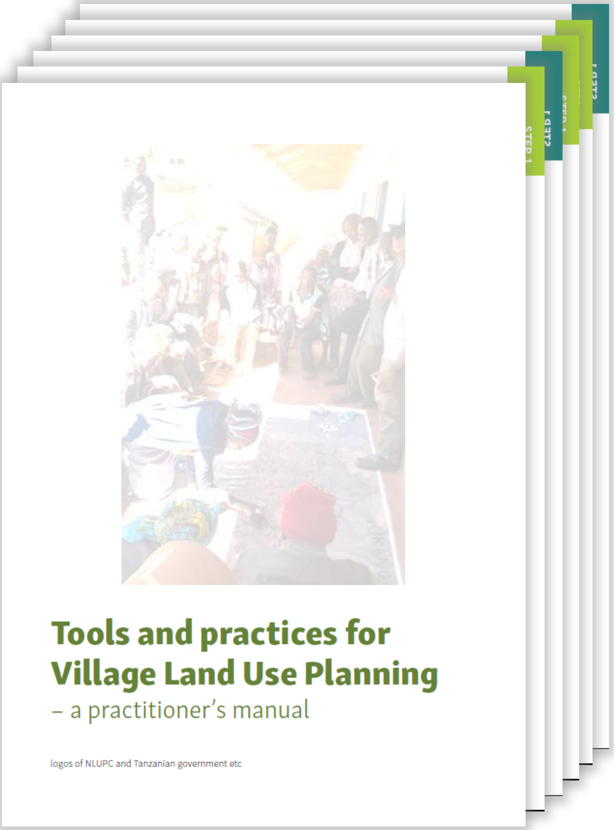
- is feasible for stakeholders to use
- enhances shared understanding of the location and nature of places, areas and boundaries under discussion
- increases spatial accuracy, precision and detail of the plan
- reduces field tracking time

Possibilities for using digital location-based solutions in local level planning processes

Salla Eilola, Andrew Ferdinands, Nora Fagerholm, Niina Käyhkö

RAMANI SHIRIKISHI –
Participatory geospatial solutions for Village Land Use Planning
7.6.2017





Tools and practices for Village Land Use Planning
– a practitioner's manual

logos of NLUPC and Tanzanian government etc

http://tanzania.utu.fi/

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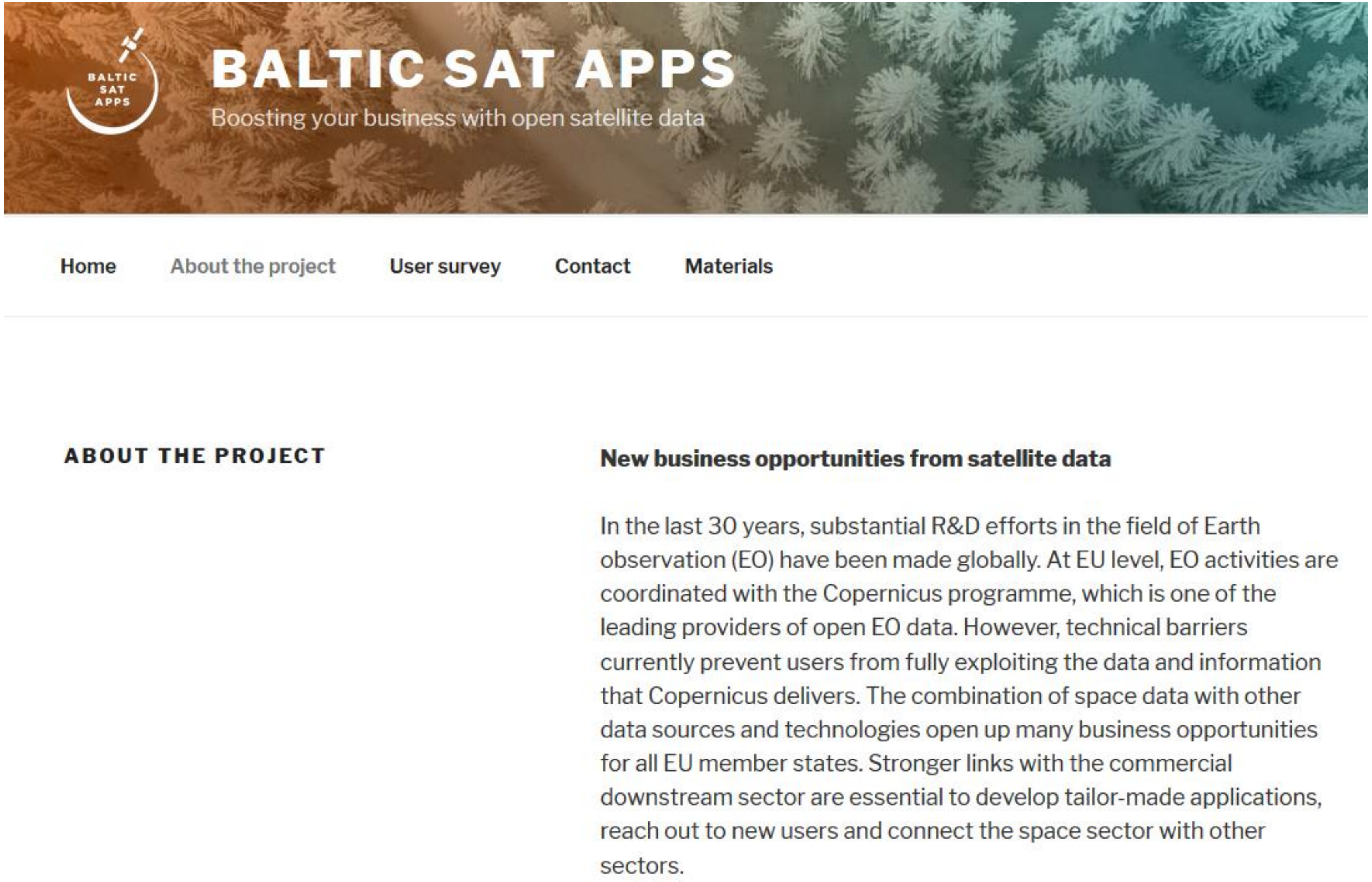
Remote sensing boosting new businesses?

Interreg
Baltic Sea Region

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

BALTIC SAT APPS



ABOUT THE PROJECT

New business opportunities from satellite data

In the last 30 years, substantial R&D efforts in the field of Earth observation (EO) have been made globally. At EU level, EO activities are coordinated with the Copernicus programme, which is one of the leading providers of open EO data. However, technical barriers currently prevent users from fully exploiting the data and information that Copernicus delivers. The combination of space data with other data sources and technologies open up many business opportunities for all EU member states. Stronger links with the commercial downstream sector are essential to develop tailor-made applications, reach out to new users and connect the space sector with other sectors.

"BalticSatApps strives to speed up the market uptake of EO satellite data in the Baltic Sea Region by utilising societal challenges and needs along with the developer community as innovation drivers"

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Copernicus Academy http://copernicus.eu/main/copernicus-academy

Since January 2018, UTU has been a Copernicus Academy member.

Our main focus as a member of the Copernicus Academy is:

- **Speeding innovations and business** from Copernicus data in the Baltic Sea Region (as part of the Baltic SatApps project)
- **Disseminating and promoting** the Sentinel data use possibilities in Finland (awareness, promoting data access, training experts etc.)
- Developing **open-access teaching and learning materials** based on Copernicus data
- Develop internship possibilities for students and graduates (in RS companies)
- **Linking North-South possibilities** into Sentinel user realm through our strong cooperation in East Africa (Tanzania living lab case)

Copernicus Academy

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Remote sensing education in Geography: BSc/MSc -curricula

BSc level/Geography

Introduction to Geoinformatics (5 ECTS)

Methods in Physical Geography (5 ECTS)

Methods in GIS (5 ECTS)

Methods in Remote Sensing (5 ECTS)

MSc level/examples

Specialization in Geospatial Research (5 ECTS)

Environmental Remote Sensing (5 ECTS)

Applied geospatial methods (5 ECTS)

Geospatial Data Management and visualization (5 ECTS)

Participation, spatial planning and GIS (5 ECTS)

Fluvial and Coastal Environments (5 ECTS)

Practicals in Fluvial and Coastal Environments (3 ECTS)

Spatial biodiversity informatics and landscape ecology (5 ECTS)

Marine and coastal spatial planning (5 ECTS)

Emerging development needs

- *Build national level open-access research Infrastructure (**OGIIR 2017-2019, Academy of Finland**)*
- *Integrating cloud environments to geospatial research and teaching*
- *Integrating Spatial R analytics to RS data processing, also machine learning*
- *Integrate RS data into hackathons, mapathons and data challenges*
- *Combined uses of optical and SAR data*

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- *Land change science, forests, landscape ecology, spatial planning*
- *competence development, OS solutions, EO innovations and business, Global South*

Petteri Alho (petteri.alho@utu.fi)

- *Remote sensing, hydrology, fluvial modelling*
- *field working instruments, UAV, LiDAR, Global North/Cold regions*

Risto Kalliola (risto.kalliola@utu.fi)

- *Coastal and marine applications, biodiversity, forests, spatial planning*
- *Geospatial infrastructures, SDIs, cooperation models, South-North*

Jukka Käyhkö (jukka.kayhko@utu.fi)

- *Remote sensing and urban climate, global change, physical geography*
- *Sustainable development, environmental sciences, Cold regions*

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