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Remote Sensing provides a forum for publishing regular research papers, reviews, technical notes and communications covering all aspects of remote sensing science, from sensor design, validation / calibration, to its application in geosciences, environmental sciences, ecology and civil engineering. Our aim is to publish novel / improved methods / approaches and / or algorithms of remote sensing to benefit the community, open to everyone in need of them.

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Welcome from Chair

Dear Colleagues,

The 4th International Electronic Conference on Remote Sensing with a focus on "Advances in Remote Sensing for the 17 Sustainable Development Goals" will be held from 25-27 Jan 2022. The main purpose of the conference is to promote the use of remote sensing and geospatial information technology, to address challenging problems, to share the latest scientific progress, to minimize limitations and issues, to exchange innovative approaches, to demonstrate evidence-decision making processes, to enhance forward thinking for remote sensing, to formulate better management plans using geospatial data, to promote the value of remote sensing, and to draw a better plan for the future of geospatial information technology.

This is an excellent opportunity for remote sensing researchers and scientists to interact with each other, communicate with their colleagues, learn from each other, share ideas and results, help solve problems, and suggest alternative options for better future. The best part of this energetic and dynamic nature of the virtual international conference is that you do not need to travel anywhere to attend the conference. You can simply achieve the above opportunities from wherever you live.

Specifically, you do not need to seek financial support for travel, purchase air tickets, leave your house, office, and family, make hotel room reservation, take a trip, or adjust to the time zone where the conference takes place during the entire conference period.

Under the virtual conference settings, there are additional advantages: (1) engagement tools that keep energy levels high, (2) participants are given a voice, (3) far stronger attention is received while one is talking, (4) Q&A through "Chat" is also possible if you do not wish to raise your question verbally, (5) polls, (6) feedback through Chat, (7) use of symbols under "Reactions" function to show your voice, appreciation, or request, (8) greater reach with remote audience, and (9) the ability to deliver live and pre-recorded presentations simultaneously.

The main topics and sessions of the conference cover:

1. Data Acquisitions from Ground, Airborne to Satellite Borne Sensors
2. High Resolution Image Analysis
3. Hyperspectral Image Data
4. SAR Data Processing
5. Terrestrial Data Use
6. Ocean and other Water Issues
7. Cryosphere Applications
8. Using satellite platforms for monitoring agriculture in the framework of EU policies
9. Disaster Management

All accepted abstracts will be published on the website of the conference. You are required to submit an abstract (minimum 250—maximum 500 word limit). Please see the abstract guidelines at "Instructions for Authors").

After the conference, there will be a possibility to submit selected papers to the e-conference related journal *Remote Sensing* (Impact Factor (2020), 4.848, 5-Year Impact Factor (2020): 5.353; Top Open Access Journal in Remote Sensing) with a 20% discount on the APCs.

On behalf of the Organizing Committee, we cordially invite you to join us at the 4th International Electronic Conference on Remote Sensing on "Advances in Remote Sensing for the 17 Sustainable Development Goals."

Prof. Dr. Soe Myint

School of Geographical Sciences and Urban Planning, Arizona State University, Tempe, AZ 85287, USA

Conference Program

CET: Central European Time
CST Asia: China Standard Time

Program Structure

	25 January 2022 Tuesday	26 January 2022 Wednesday	27 January 2022 Thursday
Morning	Welcome from the Chairs Keynote Speaker Session 1: Data Acquisitions from Ground, Airborne to Satellite borne sensors **Session chair: Dr. Riccardo Buccolieri**	Session 3: SAR data processing Session chair: Dr. Antonio Pepe Session 4: Urban Application Part 1 **Session chair: Dr. Zina Mitraka**	Session 6: Remote Sensing Application in Agriculture **Session chair: Dr. Flavio Lupia** The End
Break	13:30-14:00 CET 20:00-21:21:00 CST Asia	11:45-12:30 CET 18:45-19:30 CST Asia	
Afternoon	Poster Session I Session 2 : Disaster Management **Session chair: Prof. Dr. Magaly Koch**	Session 4: Urban Application Part 2 **Session chair: Dr. Zina Mitraka** Session 5: Hyperspectral Image Data and Terrestrial Data Use Session chair: Dr. Jose Moreno Poster Session II	

Tuesday 25 January 2022

CET	CST Asia	Speaker	Title
9:00-9:15	**16:00-16:15**	Welcome from the Conference Chair	
Session 1: Data Acquisitions from Ground, Airborne to Satellite borne sensors			
9:15-9:30	**16:15-16:30**	Dr. Riccardo Buccoloeri (Chair)	*Session Introduction*
9:30-9:45	**16:30-16:45**	Ana Novo (Selected)	*Mobile Laser Scanning data acquisition and pre-processing in Galicia Forests*
9:45-10:00	**16:45-17:00**	Nisrine Chekroun (Selected)	*NOAA series quadratic SW-LST algorithms analysis and evaluation: JPSS-1/NOAA-20 Algorithm proposal*
10:00-10:15	**17:00-17:15**	Mehmet Çağrı Aksoy (Selected)	*Object Recognition in Satellite Images using Wide and Deep Learning Models*
10:15-10:30	**17:15-17:30**	Break	
10:30-10:45	**17:30-17:45**	Caner Sahin (Selected)	*Category-level 3D Object Registration for Remote Sensing Image Data*
10:45-11:00	**17:45-18:00**	Munazza Usmani (Selected)	*Remote sensing and deep learning approach to understand noisy OSM*
11:00-11:15	**18:00-18:15**	Elaf AlMahmoud (Selected)	*SolarFarmNetwork - A Deep Learning Framework to Detect and Evaluate the Capacity of Solar Farms Using Satellite Imagery*
11:15-11:30	**18:15-18:30**	Q&A	
11:30-12:30	**18:30-19:30**	Break	
11:30-12:30	**19:30-20:10**	Poster Session I (Please find details on the page 10)	
Session 2 : Disaster Management			
14:10-14:20	**21:10-21:20**	Prof. Dr. Magaly Koch (Chair)	*Session Introduction*
14:20-14:35	**21:20-21:35**	Fernando Garcia (Selected)	*Learning from previous flood events to identify floodwaters in urban areas*
14:35-15:00	**21:35-22:00**	Yuta Izumi (Invited)	*Tropical Peatland Subsidence Monitoring by Time-Series InSAR for Evaluation of Peat Degradation in Indonesia*
15:00-15:20	**22:00-22:20**	Bruno Adriano (Invited)	*Earth Observation and Machine Learning for Disaster Management*
15:20-15:35	**22:20-22:35**	Break	
15:35-15:50	**22:35-22:50**	Amandangi Wahyuning Hastuti (Selected)	*Coastal Flooding and Risk Assessment under Climate Change in Bali Island*
15:50-16:10	**22:50-23:10**	Yusupujiang Aimaiti (Invited)	*Landslide identification and mapping using SAR data*
16:10-16:20	**23:10-23:20**	Q&A	
End of day one!			

Wednesday 26 January 2022

CET	CST Asia	Speaker	Title
Session 3: SAR data processing			
8:00-8:05	**15:00-15:05**	Dr. Antonio Pepe (Chair)	*Session Introduction*
8:05-8:20	**15:05-15:20**	Luigi Selmi (Selected)	*Flood mapping using Sentinel-1 SAR imagery and the ESA SNAP S1 Toolbox*
8:20-8:35	**15:20-15:35**	Shashi Kumar (Selected)	*Polarimetric distortion analysis of L- and S-band airborne SAR (LS-ASAR): A precursor study of the spaceborne dual-frequency L- and S-band NASA ISRO Synthetic Aperture Radar (NISAR)*
8:35-9:05	**15:35-16:05**	Antonio Pepe (Invited)	*Interferometric Synthetic Aperture Radar Interferometry: New Developments and Challenges*
9:05-9:35	**16:05-16:35**	Pietro Mastro (Invited)	*Effective InSAR algorithms for the study of large Earth's surface deformations*
9:35-9:45	**16:35-16:45**	Q&A	
9:45-9:55	**16:45-16:55**	Break	
Session 4: Urban Application (Part 1)			
9:55-10:00	**16:55-17:00**	Dr. Zina Mitraka (Chair)	*Session Introduction*
10:00-10:30	**17:00-17:30**	Felix Bachofer (Invited)	*UrbanTEP - EO tools, data and products in a cloud-based research and working environment for urban applications*
10:30-11:00	**17:30-18:00**	Beril Sirmacek (Invited)	*Climate adaptation observation of urban cities using remote sensing and AI methods*
11:00-11:30	**18:00-18:30**	Panagiotis Sismanidis (Invited)	*Towards a Consistent Global Surface Urban Heat Island Dataset*
11:30-11:50	**18:30-18:50**	Carlos Bartesaghi Koc (Invited)	*Decoding the spatio-temporal effects of urban greenery using remote sensing and numerical modelling methods*
11:50-12:30	**18:50-19:30**	Break	
Session 4: Urban Application (Part 2)			
12:30-12:45	**19:30-19:45**	Safae Ahsissene (Selected)	*Assessment and Synergy Analysis of Outdoor Thermal Comfort and Thermal Infrared Remote Sensing for Urban Heat Island Studies*
12:45-13:00	**19:45-20:00**	Miguel Estrada (Selected)	*Analysis of Multispectral Information from Satellite Images for Preliminary Inspection of Flexible Pvement*
13:00-13:15	**20:00-20:15**	Abdulwaheed Adebola Yusuf (Selected)	*Big Transfer Application on Eurosat for Deep Models' Class-based Performance Evaluation*
13:15-13:25	**20:15-20:25**	Q&A	
13:25-13:35	**20:25-20:35**	Break	

Session 5: Hyperspectral Image Data and Terrestrial Data Use			
13:35-13:40	**20:35-20:40**	Dr. Jose Moreno (Chair)	*Session Introduction*
13:40-14:10	**20:40-21:10**	Jochem Verrelst (Invited)	*Quantifying canopy nitrogen content and non-photosynthetic vegetation using hyperspectral PRISMA data in preparation for the upcoming Copernicus Hyperspectral Imaging Mission for the Environment (CHIME)*
14:10-14:25	**21:10-21:25**	Surya Pratap Chandra Kishore Bodi (Selected)	*Estimating the Seasonal Dynamics of Gross Primary Productivity in Tropical Deciduous Forests of Mudumalai Tiger Reserve, India using Sentinel 2A Satellite Observations*
14:25-14:40	**21:25-21:40**	Ashwini Mudaliar (Selected)	*Exploitation of multi-temporal PROBA V satellite data to establish the influence of Soil water on vitality of Tectona grandis L.: A case study of deciduous forest of Western, India*
14:40-15:00	**21:40-22:00**	Q&A	
15:00-15:30	**22:00-21:30**	Break	
15:30-16:15	**21:30-22:15**	Poster Session II (Please find details on the page 11)	
End of day two!			

Thursday 27 January 2022

CET	CST Asia	Speaker	Title
Session 6: Remote Sensing Application in Agriculture			
9:10-9:20	**16:10-16:20**	Dr. Flavio Lupia (Chair)	*Session Introduction*
9:20-9:45	**16:20-16:45**	Moritz Merker (Invited)	*EU-Wide Spatial Estimation of Temporary Grassland Using a Model-Based Approach*
9:45-10:05	**16:45-17:05**	Jesus Estrada (Invited)	*CAP Monitoring and Control Using SENTINEL Products And Services*
10:05-10:35	**17:05-17:35**	Break	
10:35-10:50	**17:35-17:50**	Sergio Morell-Monzó (Selected)	*Monitoring the Status of Citrus Smallholders through an Object-Based Analysis and Sub-Meter Resolution Imagery*
10:50-11:10	**17:50-18:10**	Livio Rossi (Invited)	*"Checks by Monitoring" through Copernicus Satellite Data: the new European Common Agricultural Policy Approach*
11:10-11:30	**18:10-18:30**	Yorgos Efstathiou (Invited)	*Quantifying crop damage due to extreme weather events for CAP monitoring*
11:30-11:45	**18:30-18:45**	Carlos I Arbizu (Selected)	*Vegetation indices with RGB and multispectral images using UAV to evaluate the ripening phase of bean crop (Phaseolus vulgaris L.) under the Peruvian coastal conditions*
11:45-12:00	**18:45-19:00**	Q&A	
Closing of the Conference			
End of Conference!			

Poster Session I
Tuesday 25 January 2022

CET 12:30-13:10	CST Asia 19:30-20:10	Speaker	Title
(a)		Yahjeb Bouha Khatraty	*Prediction of satellite data using ARIMA and SARIMAX: the case of NDVI of Rosso Mauritania rice fields*
(b)		Vatosoa Andrianina	*Powerful of Random Forest classification for land cover dynamic monitoring : case of the new protected area Complex Mahavavy-Kinkony, Madagascar*
(c)		Usha M. Pandya	*Effect of Temperature Extremes on Growth Pattern of Banana: Application of SPOT-Vegetation, PROBA-V and MODIS Satellite NDVI Data with LST*
(d)		Naga Madhavi Lavanya gandi	*Synergistic Use of Airborne Hyperspectral And LiDAR Data for Enhanced Classification*
(e)		Avinash Kumar Ranjan	*Evaluating Impacts of Opencast Mining Activity on Vegetation Dynamics and Mining Heat Island Using Time-Series (2000–2020) Satellite Data*
(f)		Tony Arison Ramihangihajason	*Ecosystem Natural Capital Accounting, A Tool for The Management of A Protected Area: Antrema, Madagascar*
(g)		Lei Song	*A Super-Ensemble Approach to Map Land Cover Types with High Resolution over Data-Sparse African Savanna Landscapes*
(h)		Youssef M. Youssef	*An Integrated Remote Sensing and Geophysical-based Approach to Extract Dry and Wet Bare Soils in Urban Coastal Environment*

Poster Session II
Wednesday 26 January 2022

CET 15:30-16:15	CST Asia 21:30-22:15	Speaker	Title
(a)		Kateřina Fárová	*Response of the SAR intensity to above-average air temperature recorded in the northern part of the Antarctic Peninsula in February and November 2020*
(b)		Pratibha Prakash	*Monitoring surface water area dynamics using Sentinel 2 MSI in Google Earth Engine for semi-arid region*
(c)		Kamal Srogy Darwish	*GIS-based analysis and prediction of shoreline change using multi-temporal Landsat imagery: A case study of Al Arish coast, Egypt*
(d)		Andreea Florina Stoleriu	*Chlorophyll-a concentrations in the northern part of Moldavian Plateau reservoirs using remote sensing techniques*
(e)		Hao Zhang	*Research on the sea surface roughness and tilt changes caused by internal waves based on ALOS PALSAR images*
(f)		Sukanya Ghosh	*Spatiotemporal Mapping of Urban Heat Island (UHI) Footprint of Delhi-NCR in cloud-based Google Earth Engine platform*
(g)		Hongye Cao	*Two-decade Record (2000-2019) of Spatio-temporal Dynamics and Drivers of Cyanobacterial Harmful Algae Blooms (CyanoHABs) at Sub-pixel Level in Taihu Lake Observed by MODIS*
(h)		Ehsan Rostami	*Monitoring of Shoreline Changes Using Sentinel-2 Satellite Imagery in the Google Earth Engine Platform: A Case Study the Broome, Australia*
(i)		Iuliana Gabriela Breaban	*Assessment of soil organic carbon based on remote sensing and machine learning algorithms*
(j)		Rebeca Pérez González	**Recorded:** *The use of Sentinel 2 for the analysis of the ecological status of inland water bodies. A case study in the Ebro Delta (Spain)*

Abstract Book

Object Recognition in Satellite Images using Wide and Deep Learning Models

Mehmet Çağrı Aksoy [1], Beril Sirmacek [2], Cem Ünsalan [1]

[1] Marmara University, Faculty of Engineering, Department of Electrical and Electronics Eng., Istanbul, Turkey
[2] Smart Cities, The School of Creative Technologies, Saxion University of Applied Sciences, Enschede, The Netherlands

Deep learning methods have been used in remote sensing for more than a decade due their high capability to optimize and generalize image processing and object/pattern recognition solutions. There are many deep learning architectures which have been already well developed and used to solve various remote sensing problems such as image classification, region segmentation, object recognition, and change detection. A relatively new model, known as wide and deep learning, has also been successfully applied to several areas such as recommendation systems and search engines (specifically in e-commerce websites). In a wide and deep learning model, the representation of the wide structure brings a memorization factor to the system. The deep learning structure provides the ability to generalize data. Thus, such a model, that includes generalization and memorization factors, works more effectively, and increases accuracy. To the best of our knowledge, wide and deep learning methods have not been applied to remote sensing object recognition problems thus far. Therefore, we propose such an approach in this study by feeding external wide inputs as well as extra features to the deep learning system. Hence, the proposed system brings novelty and benefits to the existing literature in terms of offering better memorization and generalization capabilities in the remote sensing area. This opens up a new stage to develop robust object recognition algorithms in remote sensing data where the objects might show a high variety of appearances.
We tested the proposed algorithms on Planet satellite image data sets* of ships and airplanes. The data sets consist of 3.7 meter resolution RGB images and they are provided with groundtruth data which hold labels for ships and airplanes. We compared the ship and airplane detection results of the proposed system with a CNN-based benchmark method. Extensive tests indicate that the proposed wide and deep learning method has a performance increase on the Planet satellite image data sets compared to the chosen CNN-based method. We observed that performance of the object detection system is increased by providing wide input features, such as mean value, gray level co-occurrence matrix (GLCM), hu moments, local binary patterns, histogram oriented gradients and color invariants. We believe that the proposed wide and deep learning based object recognition method might provide opportunities to solve complex object recognition tasks on remote sensing images with higher accuracy.

Radar Interferometry in Assessing Structured-Light 3D Scanner's Gantry Stability: Performing DAVID's (Michelangelo) High-Accuracy 3D Survey

Francesco Mugnai

Civil and Environmental Engineering Department, University of Florence, Italy

"Digital twin" is one of the most used catchwords of the last years, especially in the contest of digital representation of the real. Building a 3D digital model as a perfect copy of the real object could be complicated; using the most advanced surveying techniques is a common approach. However, guarantying a micrometric accuracy for the whole surface of a statue, as Michelangelo's David, could be a very sophisticated task. The paper presents results from applying RADAR Interferometry to determine deformations and verify stability on a gantry during surveying operations on the Michelangelo's David at the *Galleria dell'Accademia di Firenze* museum in Florence. An advanced hi-resolution Structured-light 3D scanner has been used to create a hi-detailed digital twin of the masterpiece. Considering the high scanner sensitivity, a contactless, remote and passive monitoring system of the gantry stability has been chosen to guarantee maximum freedom of movement around the David and avoid interference during scanning operations. Due to the remarkable elevation of the statue, which reaches almost 7 meters on his pedestal, and considering the cramped operating area around the statue, an ad-hoc gantry has been designed and deployed. The sophisticated scanner's technique and the extreme hi-resolution required for the survey needed firm gantry stability during scanning operations from one side. The complex geometries and the considerable extension of the statue surface impose extended flexibility and an agile elevation platform from the other side. Thanks to RADAR interferometry, the gantry stability has been constantly monitored, optimising scanning scheduling and, consequently, operations efficiency. At the same time, the Digital Image Correlation technique has been applied to the pictures acquired using a commercial camera. Comparing results from the two monitoring systems, perfect correspondence between RADAR and Digital Image Correlation analysis resulted.

Assessing Use of Ground---Based Interferometric Radar Systems with Fast Acquisition Capabilities for Monitoring Land Deformation Processes

Francesco Mugnai [1], Dario Tarchi [2], Grazia Tucci [1]

[1] Civil and Environmental Engineering Department, University of Florence, Italy
[2] Joint Research Centre, European Commission, Belgium

A new class of Radar interferometer, based on an electronically scanned array in MIMO configuration (MIMO--SAR) has been assessed for the operational use in the monitoring of phenomena of geological interest, such as landslides and unstable slopes. The new system is able to apply the very well---known and proven Ground Based Interferometric technique and may guarantee and unprecedented short refreshing time in comparison with traditional systems based on the mechanical movement of the radar transceiver on a rail or on the mechanical steering of a real antenna. This new feature can allow monitoring a number of phenomena having deformation rates too high to be correctly retrieved by traditional systems currently in use. The implementation of a prototype, termed MELISSA, has been finalised and a full validation of the system in a controlled environment has been completed. A framework to assess in general terms all the different measurement parameters of a radar interferometer and how they relate and influence each other has been defined. This allowed identifying the advantages but also the expected limitations of the new system in comparison to existing instruments. Real cases where GB---InSAR is currently being applied have been first analysed to evaluate the possible advantages of using a similar system and then real experiments have been conducted on different sites including, the operational monitoring of the stability of the Costa Concordia wreck, the Vetto landslide and the Stromboli Volcano. The experimental results have been combined with the theoretical framework to provide the final assessment of the system and identify possible scenarios for its operational use. A reference design for the MIMO--SAR able to ensure about 125 images per second in a maximum range of about 500 m turns out to be fully validated. In this scenario the MIMO--SAR may acquire images with an unprecedented high rate while it is equivalent to existing system concerning other relevant measurement parameters. Over larger distances the MIMO---SAR system cannot actually maintain similar performances and the second recommended scenario is in support and combination with a traditional system to provide temporary close---in view over portions that exhibits an acceleration of the deformation rates. A third scenario concerning the provision of early warning is also defined. This is particularly tailored for situations where a fast evolving phenomenon may suddenly develop whit out clear precursors. Finally possible options to enhance the system are presented.

Category-level 3D Object Registration for Remote Sensing Image Data

Caner Sahin

Istanbul Medeniyet University, Turkey

Category-level 3D object registration is an intriguing problem that involves intra-class shape variation as an inherent challenge due to the existence of different and unseen instances. Existing methods for the problem represent a variety of shape instances in a given category in a shared pose-normalized canonical space. These methods, on one hand, work in a supervised fashion, requiring huge number of annotated images for either mapping observations to this space or for estimating unseen objects' 3D pose and size. On the other hand, generating annotated data for such mapping and estimation is a laborious and difficult-to-generalize task at the level of categories. This paper presents an unsupervised approach for the category-level registration problem, explicitly addressing intra-class shape variation. Semantic consistency among the shape structures is leveraged by co-analyzing the variety of shape instances in the shared canonical space. To this end, the problem is formulated as a 3D semantic shape correspondence task, in which semantically consistent and ordered 3D intrinsic structure points are explored. The presented method contains two separate encoder-decoder based networks taking the same candidate segmented point cloud of an observation as input. As a shape embedding net, the first network factors out the unknown rotation parameters of the input, of which the 3D structure points are estimated in the pose-normalized canonical space. Unlike the shape embedding net, the second network predicts 3D structure points of the input directly in the 3D space, and thus it is rotation-invariant. The embedding is ensured using the combination of several Chamfer Distance losses, which are designed for projecting the point cloud onto the canonical space while estimating structure points. Rotation augmented training data are utilized for providing invariance across rotation. 3D poses and sizes of unseen objects are recovered aligning ordered sets of 3D structure points in the pose-normalized canonical space and in the 3D space using the TEASER registration algorithm. The performance of the method is initially evaluated on NOCS, the category-level 6D object pose estimation dataset, which contains images of table-top scenarios in indoor scenes. Then, a series of experiments are conducted on the public Urban Semantic 3D dataset (US3D) which is developed for the 2019 IEEE GRSS Data Fusion Contest (DFC19). US3D includes satellite images and lidar-derived reference labels covering Jacksonville, Florida, Omaha, Nebraska, and Atlanta, Georgia. The analysis on the experiments validate the promising performance of the presented method.

Recognition in Satellite Images Using Wide and Deep Learning Models Comparing Unmanned Aircraft Systems in Low Altitude Surveys for Photogrammetric Mapping

Francesco Mugnai, Grazia Tucci

Civil and Environmental Engineering Department, University of Florence, Italy

This paper shows results of comparing performances of four Unmanned Aircraft Systems (UAS) in terms of photogrammetric survey's quality. The aim of this study is to investigate what is the more suitable UAS for specific applications considering the required scale factor, such as for architectural, environmental and restoration purposes.
A series of photogrammetric surveys were conducted in a hilly area of about 5 ha using Phantom 4 Adv, Mavic 2 Pro, Mavic Air 2 and Mavic Mini 2. These Unmanned Aircrafts are commercial user grade systems, mostly used by private professionals. From one hand, thanks to their off-the-shelf configurations, they can help in rapidly planning and performing low altitude surveys. From the other hand, due to their extraordinary easy-to-use vocation, are often deployed paying little attention to photogrammetric best practices. Following these considerations, the tests have been designed reproducing in field common critical issues such as poor planning of camera network geometry, camera autocalibration with predominant nadir direction of view, different flighting altitudes.
By varying essential parameters, such as flight altitude and cameras (UAV models), several photogrammetric reconstructions were performed applying Structure-from-Motion (SfM) algorithms to the pictures taken from the UAS. The surveys' quality was analysed by comparing the ground targets' coordinates extrapolated from the point clouds to those measured on the field with indirect georeferencing through GNSS technology. Fifty targets were installed and arranged following a reasonably regular mesh. The boundary conditions were maintained the same for each flight mission, as well as the flight trajectories, and the Ground control point distribution on the ground. For each survey made by each of the four UAS, altimetric and planimetric residuals were reported and compared. The results from Phantom 4 Adv, in terms of average residuals' value, about $15*10^{-3}$ meters, almost disappear compared to the other SAPRs' results; the discrepancy between best and worst results, obtained with Phantom 4 Adv and Mavic Air 2 respectively, is one order of magnitude.

Mobile Laser Scanning Data Acquisition and Pre-Processing in Galicia Forests

Ana Novo [1], Harri Kaartinen [2], Antero Kukko [2], Fernando Rodriguez [1]

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The conventional methods which are currently operationally applied in forest in-situ measurement are laborious and time-consuming. Therefore, new advances in forest field data collection through remote sensing technologies are in full swing. The development of devices capable of generating 3D point clouds of the forest is flourishing in recent years. It is possible to generate relatively dense and accurate 3D data not only by terrestrial laser scanning but also by mobile laser scanning and personal laser scanning (hand-held or in a backpack). In this work, we compared two different mobile laser scanning (MLS) technologies operated at the ground level under the forest canopy: backpack MLS and handheld laser scanning for field data collection in a dense forest in the Galicia region (northwest of Spain). The systems under study were an in-house developed AKHKA-R4DW backpack laser scanner and a handheld Zeb-Horizon laser scanner. The backpack laser scanner (BP-MLS) is equipped with a Riegl VUX-1HA and miniVUX-1UAV 2D laser scanners, a LITEF UIMU-LCI inertial measurement unit, and a positioning system consisting of a NovAtel PwrPak 7 GNSS receiver and GNSS-850 antenna. The other laser scanning system used is a GeoSLAM Zeb-Horizon scanner (HH-MLS) that is a handheld laser scanning system. For both systems the data collection followed approximately the same procedure: covering the research area by free walking method, forming a closed loop by starting and ending the survey at the same point. For these measurements, the settings for data collection and SLAM processing were set according to the manufacture's recommendations for a forest environment. In the data post-processing, simultaneous location and mapping technology were used to solve and improve the quality of the point clouds collected. For the backpack laser scanning data, in-house developed graph-SLAM method was used and for the Zeb-Horizon scanner, we used the integrated SLAM system that was in-built in these commercial laser scanning units. The raw data collected with the ZEB-Horizon scanner was processed using GeoSLAM Hub (version 6.0) software and the default processing parameters (Convergence threshold: 0, Window size: 0, Voxel density: 1, Rigidity:0, Maximum range: 100 m, Closed Loop) and exported into Las format. For Zeb-Horizon, the positioning of the scanner was fully based on the SLAM system, whereas the backpack laser scanner also utilized GNSS positioning together with an inertial measurement unit. The point clouds acquired by both systems were compared in study plots of 1 Ha of area. Both systems provide high precision data for the study of forest structure, where the main challenges are the high density of scrub and no differentiation between vegetation strata in the study area, which is the typical composition of Galicia Forest.

NOAA Series Quadratic SW-LST Algorithms Analysis and Evaluation: JPSS-1/NOAA-20 Algorithm Proposal

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As the direct source of information about temporal and spatial variations of the surface equilibrium state, Land Surface Temperature (LST) is considered as one of the key parameters in the bio-geo-physical processes of surface energy and water balance at local through global scales.
Making an allowance for Split-Window Land Surface Temperature (SW-LST) algorithms, special attention must be on linear and quadratic structures. Moreover, taking into consideration their operative applications, local and global aspects are differentiating because of the dependency on emissivity and atmospheric water vapor input parameters. In this way, in addition to the advantage of the split-window characteristic face to atmospheric corrections, the quadratic structure has been found to be effective compared to the linear one. Thus, in case applying linear structure, different cases depending on the corresponding amount of atmospheric water vapor impose.
In this research, the split-window Channels 4 and 5 of the AVHRR/NOAA satellites (7, 9, 11, 12, 14, 15, 16, 17, 18 and 19) and the split-window Channels M15 and M16 of the JPSS –VIIRS/NOAA20 satellite are used. The quadratic SW-LST algorithms coefficients were obtained from the minimization of 135000 simulation data. The results show margins of variations of 0.4 K and 0.2 K corresponding to split-window channels emissivity errors of 1% and 0.5% respectively. Further, the inter-assessment analysis presents differences values with a minimum of 0 K, maximum of 0.33 K (0.13 K), mean of 0.14 K (0.05 K) and standard deviation of 0.09 K (0.03).
Preliminary validation results using in-situ observations from Hay and Walpeup sites indicate maximum values of bias of about 0.2 K and RMSE of about 2.02 K. Further in-situ measurements archives are in filtering and adapting phases.

Remote Sensing and Deep Learning Approach to Understand Noisy OSM

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Abstract: Buildings are OSM's most popular annotated items. Although geometrical features and tags of buildings in OSM are usually precise (particularly in metropolitan areas), there are instances where volunteer mapping of building footprints is inaccurate. Despite the appeal of using OSM semantic information with remote sensing image, to train deep learning models, the crowd-source data quality is inconsistent. Typically, convolutional neural networks (CNNs) trained with this type of reference data may learn to anticipate the object location but not its actual size. In this article, we combine very high resolution (VHR) remote sensing data with famous computer vision technologies to deal with noisy OSM. This paper details our efforts in misalignment ambiguity (positional inaccuracy) with satellite imagery and using (CNNs) to detect changes in OSM data. The main contributions are: 1) resolve the mis-alignment issue and prepare the quality improved dataset for CNNs training 2) instance-semantic segmentation of buildings and 3) highlight missing buildings in OSM (never labeled or constructed in between image acquisitions). We purpose a translating method to align the OSM vector data with the satellite data. This strategy maximizes the correlation between the imagery and buildings vector data and further the quality improved OSM data well incorporate with high-resolution imagery to train CNNs model (Mask R-CNN) for buildings instance-semantic segmentation. The trained CNNs model has potential to highlight non-annotated buildings in OSM using VHR satellite/airborne imagery to update the map. The good results as precision (0.96) and recall (0.96) from this approach demonstrate the viability of high-resolution satellite imagery and OSM for buildings detection/change detection using deep learning approach.

Analysis of Multispectral Information from Satellite Images for Preliminary Inspection of Flexible Pavement

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This research work presents an integration between spectrometry of flexible pavement reflection and spectrometry obtained from satellite imagery in order to develop a tool for remote and automated evaluation of surface deterioration in flexible pavements. Satellite imagery are acquired from the WorldView-3 sensor and cover the area that comprises the northern of Ancon district in Lima city, Peru. The spectral signatures of the different type and severity of superficial damage on the asphalt layer are obtained based on the failure catalog of the Pavement Condition Index (PCI) through the use of a spectroradiometer with a filtering and statistical validation of the spectral signature's library of the flexible pavement condition. Once the spectral signature's library is obtained, the signatures show significant differences in their spectral response, which allow joining them in groups according to the loss of binder in the asphalt. It is important to mention that the library of spectral signatures will also serve as a training database that can be used in future researches based on machine learning. For the classification of satellite images, the pixel-oriented spectral classification algorithm, Spectral Angle Mapper (SAM) and autonomous learning algorithms are used. It was obtained different classes accordingly to the asphalt loss level. By using this training data, the supervised algorithms are calibrated and then evaluated. Finally, the experimental results of the methodology show good agreement with the field survey over the study area. Thus, it can be a low-cost alternative in comparison to traditional methods of pavement surface monitoring like PCI and an effective tool in the control and monitoring of the main asphalt roads condition.

Assessment and Synergy Analysis of Outdoor Thermal Comfort and Thermal Infrared Remote Sensing for Urban Heat Island Studies

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Urban Heat Island (UHI) is the explicit/implicit result of the industrial and urbanization condensational habits by more than half the world's population living in cities. Related LCLU and atmospheric changes alter microclimate, whereby cities are warmer than the surrounding countryside. Remote sensing in environment and climate studies was initially focused on UHI detection, but over the years, it has started being included in thermal comfort studies. Thermal comfort is an essential factor that affects the habitability of outdoor and indoor spaces. Its fluctuations can seriously affect the productivity and the health of the individual and diminish tolerance to other environmental hazards. Understanding the variables causing thermal discomfort and UHI might help urban areas adjust to the growing climate change and improve the living conditions of occupants.

More than 165 indices have been developed over the last century, and attempts have been made to bring forth a universal index that enables humans to summarize all the thermal comfort characteristics in one parameter. The complexity of the elements of the environment in our day-to-day life, in both indoor and outdoor situations, alongside the differences in climate between different zones of the world, made researchers sometimes develop indices that are only suitable for specific climate zones. Most indices used for outdoor thermal comfort evaluation were originally developed for indoor environments, and need to - for the most part - be adapted for use in outdoor spaces. Air temperature (Ta), radiant temperature, relative humidity, and air movement are the four basic environmental variables affecting human response to thermal environments. They are included – alongside the metabolic rate and the clothing insulation – in most thermal comfort indices.

The aim of this research is to explore the potentialities and limits of the integration of remote sensing biophysical data (e.g., Land Surface Temperature, LST, and Atmospheric Water Vapor, W) in the outdoor thermal comfort studies. Accordingly, by examining correlations between (LST and Ta) and (W and relative humidity), using respectively remote sensing satellite data (e.g., LANDSAT, MODIS and NOAA) and different weather stations archives. Currently, the parameters of thermal comfort indices are usually calculated using the data from one, or few permanent or portable ground-based weather stations. Due to the lack of adequate distribution of weather stations, those calculations generally do not accurately represent the alteration of thermal comfort, through time and space. Nevertheless, it has been essentially proved that despite strong tendencies between in-situ measured parameters and remotely sensed ones, various elements need to be studied (e.g., location, land surface type, vegetation, and elevation). Finally, preliminary results confirm that the proposed linear approaches are providing considerable and promising performance suitable for future specific situations and studies purposes.

Big Transfer Application on Eurosat for Deep Models' Class-Based Performance Evaluation

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Satellite Imagery classification is an aspect of remote sensing that is essential for the automation of Land Use and Land Cover (LULC) map production, an indispensable tool for geoscience applications. Owing to advancement in computing resources that ushered in the adoption of deep learning for satellite imagery classification, remarkable successes have been witnessed in reduction of human errors for the production of LULC maps. However, the data hungry nature of deep learning militates against full exploitation of this trend. This challenge has led to the development of transfer learning which aims at transferring knowledge acquired from a task to a similar but different task. In this manner, the dependence of deep learning systems on large amount of data can be reduced for a specific problem domain. Besides, most deep learning implementations employed accuracy metric for classification model evaluation due to its ease of calculation and comprehension. But unlike class-based evaluation metrics (such as user accuracy, producer accuracy and F1-score), accuracy is not suitable for situations of class imbalance as it only reflects model performance on dominating classes contained in a given dataset. Accordingly, this study presents a discussion on merits of class-based evaluation metrics. Further, we employed Big Transfer (BiT), a state-of-the-art transfer learning method, on Eurosat Land Use and Land Cover dataset using RESNET architectures to investigate class-based performances of resulting deep learning models. Our result reveals that depth of model architecture and abundance of image samples from which pretrained weights are loaded improves class-based performances of deep learning models.

Spatiotemporal Mapping of Urban Heat Island (UHI) Footprint of Delhi-NCR in cloud-based Google Earth Engine platform

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In the era of development, the urban planners majorly focused on economic growth with fewer concerns on ecological and environmental fronts. The abrupt change in the land use/land cover (LULC) with increased pollution levels further leads to climate change with the rise in land surface temperature (LST). It alters the thermal properties of the urban stretch and affects the existence of green cover. In this situation, satellite-based observations play a pivotal role in monitoring LULC change patterns and analyzing the impacts of extreme heat conditions. The remotely sensed data is applied to generate the near-real-time results with the help of cloud-based computational approaches and machine learning algorithms. Numerous studies have proposed assessment of LST using remote sensing datasets for Delhi but limited studies found on the suburbs of Delhi known as the National Capital Region (NCR) encompassing a total of 55,000 km2 of area.

This paper considered the case of Delhi-NCR, aimed at capturing the spatiotemporal variations of LULC patterns, LST, and the normalized difference vegetation index (NDVI) over 10-years (2008-2018). Moreover, the effect on urban heat island (UHI) footprint is analyzed using MODIS-derived datasets in Google Earth Engine (GEE). GEE is a cloud-based platform capable of managing large volumes of satellite data and allowing users to perform big-data analyses for real-time applications. In this study, the variations in UHI are examined and quantified with the intensity of LST and NDVI.

The revealed that the expansion of urban areas caused a rise in the mean LST from 28°C (2008) to 31°C (2018). The LST is high for the areas occupied by built-up and barren land, whereas water bodies and vegetated areas exhibit low LST. The districts such as Bhiwani, Mahendragarh, Rewari, Alwar, and Bharatpur present in West NCR witnessed the maximum change, comparably Muzaffarnagar, Shamli, Baghpat, and Karnal districts in the north and east NCR observed minimum change. Furthermore, the statistical analysis signified that the LST and UHI intensity of the overall NCR area showed an increasing trend with a negative correlation with NDVI, so the contributing factor for such results is the change in LULC patterns caused by the growth of the population density. The insights of this study can assist the urban planners in evaluating the environmental consequences to improve the base of sustainable urban planning.

An Integrated Remote Sensing and Geophysical-Based Approach to Extract Dry and Wet Bare Soils in Urban Coastal Environment

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Extraction of bare soils with high spatial precision is imperative for sustainable urban and agriculture development, especially in developing countries such as Egypt. Wet bare soil is more susceptible to urban salinity and waterlogging problems compared to dry bare soil in coastal cities, due to climate change and rising groundwater levels. However, there is still a lack of knowledge about which remote sensing methods are best to simply discriminate these soils from other land cover types in coastal environments. In the present work, an innovative approach of remote sensing and topsoil datasets into a geographic information system (GIS) is proposed to generate a composite overlay index (COI) verified by electrical resistivity tomography (ERT) survey for identifying wet and dry bare soils and their factors influencing in Suez city (Egypt). One Landsat8 OLI image was used along with a total of 130 reference points from field observations and shallow boreholes (describing grain size contents, soil type, and soil water levels). In the proposed approach, the COI index was constructed using an analytical procedure of four spectral indices (topsoil grain size index (GSI), dry bare soil index (DBSI), modified normalized difference water index (MNDWI), and normalized difference vegetation index (NDVI)) and their synergies vs original bands and the principal component analysis (PCA). A correlation matrix was created to figure out the significance and responses of indices and original bands with the environmental factors to understand the wet and dry soil distributions. Coarse sandy soils have displayed a high reflectivity, indicating the high influencing degree of the gravel content on the spectral bands compared to the clay effect. All original bands clarified moderate correlation (av. r = 0.45) with coarse sandy soils, depth to water, depth to clay below ground level, and strongly with brightness (DBSI and GSI) indices (av. r = 0.7). While moderate negative relationships were observed between bands and clay content (av. r = - 0.42) but strong with wetness (MNDWI and NDVI) indices (av. r = - 0.66). Consequently, the brightness and wetness indices were integrated to produce the COI image. The COI image shows a good agreement with the PCA image regarding wet and dry soils locations based on field observations and the spectral response patterns. The PC1, PC2, and PC3 bands yielded the highest positive association with the locations of waterlogging/wet soil, vegetation, and dry bare soil, respectively. The highest COI values were congruent with the PC3 band that dominates in the western parts with the deep soil water levels and coarse soil contents. Increasing clay contents with shallow depth raised the wet soil in the middle, southwestern, and northern parts of the study area. The ERT profiles, gathered in the middle and south-western parts, showed a very low resistivity (4 Ω.m) corresponding to clay and sandy clay soil, which is compatible with the obtained borehole data. The insights of this study can guide the decision-makers towards sustainable urban solutions by improving the monitoring of wet and dry bare soil in the coastal environment.

Powerful of Random Forest Classification for Land Cover Dynamic Monitoring : Case of The New Protected Area Complex Mahavavy-Kinkony, Madagascar

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The New Protected Area Complex Mahavavy-Kinkony located in northwestern of Madagascar is characterized by its richness in varied ecosystems. This biodiversity is highly threatened by anthropogenic deforestation and an important extension of agricultural land. The main objective of this study is to evaluated the dynamic of land use/cover and the development of agricultural area in order to analyze the variation in vegetation cover in this region. Landsat 8 satellite images were used, multi spectral and panchromatic were pan sharpened to produce high resolution image of 15 m. Machine learning Random Forest algorithm classifier were performed to quantify the land cover transition between 2013 and 2018. Accuracy assessment metrics using error-adjusted area estimator show that both approaches have similarly high classification performance (e.g., the overall accuracy of 2013 and 2018 image is 90.94% and 90.86%, respectively). Image analysis revealed the extension of urban area (119 ha), irrigated plantation (2,540 ha), non-irrigated plantation (8,472 ha) and Savannah (3,894 ha). In another hand, the vegetation cover (dry forest and mangrove) of the protected area decreases. Dry forest loss (14,884 ha) was largely from conversion to Savannah and tree shrub Savannah and plantations. Mangrove forest loss (2,714 ha) was converted to tan and bare sol. Gross gains irrigated agricultural (2,540 ha) and non-irrigated agricultural (8,472 ha) plantations by 2018 were mainly from conversion of dry forest and mangrove. The significant regression of vegetation is the result of demographic pressure and the agricultural extension. Therefore, the ecosystem of the protected area has gradually deteriorated in 5 years. These encouraging results demonstrate that freely-accessible multi-source remotely-sensed data have tremendous potential to improve understanding of the dynamic of land cover change, which can effectively support monitoring and management natural resources in a protected area.

SolarFarmNetwork - A Deep Learning Framework to Detect and Evaluate the Capacity of Solar Farms Using Satellite Imagery

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The global push for renewables coupled with the steadily decreasing cost of each unit of solar energy produced (decreasing cost of panel, increased efficiency) has resulted in a dramatic rise in photovoltaics deployment both at a residential and commercial level. Currently, the global solar energy capacity doubles every 18 months, of which expanding solar energy facilities are a major contributor.
In this paper, we propose, optimize, and validate a Deep Learning framework to detect and map solar farms across geographies using a state-of-the-art semantic segmentation convolutional neural network-based pipeline. Semantic segmentation enables the precise localization of solar panel areas from satellite imagery for a more accurate estimate of the deployment area. As a final step in the pipeline, we propose a multi-step capacity evaluation model to estimate the number of panels and energy generation capacity of the detected solar energy facilities. The capacity evaluation model is the first of its kind, while deep learning applied specifically for the detection and mapping of solar farms is the first of its kind for the United States.
We carried out this exercise and were able to validate/compare both detected areas and generation capacities against publicly available data including electricity generation data reported by solar farm management. Our model was trained on a dataset created by collecting satellite imagery of several major solar farms in the US (USDA NAIP dataset sourced via USGS) and tested on images of farms unseen by the model. Objectively, the model achieved highly competitive performance indicators including a mean accuracy of 96.87%, and a Jaccard Index (intersection over union of classified pixels) score of 95.5%. Subjectively, it was found to detect spaces between panels producing a segmentation output better than human labeling. Data augmentation and ablation studies were performed to check the model's robustness to complex backgrounds and edge cases.
The capacity evaluation model is a compound model of three independent parts - the accurate estimation of deployment area, the estimate of the number of panels, and finally the evaluation of the energy production capacity of the facility. The area estimate hinges on model accuracy and quality of imagery while the number of panels depends on panel dimensions, packing density, and axis system type. Finally, two approaches are explored to arrive at a capacity estimate. The first is a formula that uses a published Capacity Factor. The second, more complex but independent of assumptions, is based on NREL's PySAM model that uses actual hourly Meteorological data for the given location to arrive at the energy generated by a panel on a given day.
This work fits into a longer-term goal of creating a granular global database of solar energy capacity production which could serve as a single source of truth for industries and policymakers to inform decision-making. In the future, a highly refined version of this model could be used as a replacement for conventional sources of knowledge, or as a secondary source of intelligence for the cross-validation of reported figures.

Assessment of Soil Organic Carbon Based on Remote Sensing and Machine Learning Algorithms

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The synergistic use of topographic and remote sensing data in soil study has contributed to the development of competences in predicticting the spatial distribution of soils in the landscape. Recent research into digital soil mapping has shown that soil maps can be created based on quantitative predictive models with reasonable accuracy. The study's main aim is to estimate the SOC content applying machine learning algorithms by integrating terrain, classical and satellite datasets. Given the aim of this research and the background of previous studies, the main objectives were: (1) to assess Sentinel 2 bands and indices capabilities to be considered as environmental variables for SOC estimation; (2) to determine the importance of all variables categories: topographic, climatic, geographic context, S2 spectral bands and indices; (3) the comparison of the RF, GBM, CUB, SVM, LM, PLS models accuracy for SOC prediction; (4) the assessment of the objective accuracy by using internal and external validation of the models effectiveness and comparing different statistical parameters; (5) explain the relationships between variables and single predictions made by the model as well as the variables influence over the global model. The SOC content analysis, two variables sets derived from remote sensing data were used, including 10 Sentinel-2 bands often used to determine soil properties and 31 calculated spectral indices corresponding to humidity, texture, mineralogical composition and organic matter, including vegetation development stage and tillage. A total of six machine learning algorithms are tested: classification trees (RF, GBM, CUB), which are decision trees constructed by using thresholds for input characteristics at each division; SVM, which is a discriminator classifier formally defined by a separate hyperplane; linear regression (LM); dimensional reduction (PLS). To determine the performance of models, statistical tools such as MAE, RMSE, R^2 and sMAPE have been calculated. The main results can be summarized as follows: (1) RF regression algorithm was superior in predicting and mapping the soil organic carbon content compared with GBM, CUB, SVM, LM, PLS models in terms of explanatory value and error. Moreover, sMAPE shows an accuracy of 58% for RF while GBM reaches 49.7% and SVM achieves only 19.5%. The models performance results decreases in the following order: RFCUBPLSGBMSVMLM; (2) Among all variables, remote sensing variables are the most important, explaining from 25% to 89% of the SOC variability, spectral indices such as MSAVI2, WDVI, BI2, B2 and B3 bands providing the strongest correlation with SOC content; (3) Beside accuracy, due to the "black box" character of the models, the results interpretability implies also understandability and efficiency in order to identify the useful relationships between predictive results and predictor features. LIME and iml packages provide visualization techniques that explain the relationships between variables and single predictions made by the model as well as the variables influence over the global model. The findings highlight the potential of field and remote sensing data for quantifying the SOC at detailed scale. The advantage of satellite data usage can lead to optimized soil processing workflow, data fusion providing more accurate results than non-integrated approaches

Synergistic Use of Airborne Hyperspectral and Lidar Data for Enhanced Classification

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With the increasing demand for basic human needs, the information of land use and land cover is important. This information of land cover classification is used for effective selection, planning and implementation of land use schemes. Recent advancement in remote sensing technology used to collects both aerial and satellite data in repetitive basis and the remote sensing information together with GIS helps to generate various models of land cover classification. In this study we evaluate improvement in the classification by integrating airborne LiDAR point cloud and Hyperspectral data with the comparison of individual classification of Lidar point cloud data and Hyperspectral data . The goal is to derive efficient classification image for the integrated lidar point cloud and hyperspectral data. Land cover classification information plays a very important role in various applications. The present study presents an object-based classification method to classify the fusion data of LiDAR point cloud data and Hyperspectral data. The data used in this study are a LiDAR derived nDSM, intensity data, airborne point cloud data, and Hyperspectral image data. Three types of classifications were performed on three data types 1) LiDAR point cloud data alone (spatial classification using terrascan), 2) Hyperspectral data alone (supervised classification using support vector machine), 3) fusion data (object-based classification) with fourteen land cover classes. The classification accuracies were assessed using high resolution RGB data. From the results it is concluded that the fusion data classification results were by 12.6% and 28.9% than classified Hyperspectral and lidar images respectively. The overall accuracy and kappa coefficient of integrated Hyperspectral and LiDAR classified image was 93.27% and 0.96.

Flood Mapping Using Sentinel-1 SAR Imagery and The ESA Snap S1 Toolbox

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According to the World Health Organization, “between 1998-2017, floods affected more than 2 billion people worldwide”. Even if there has been a decline in the number of deaths due to natural hazards in the last decades, scientists do expect an increase in the number of such events in the future due to climate change. In addition to the death toll, floods cause heavy damage to buildings and infrastructures that amount to huge economic losses. The Copernicus Sentinel-1 mission is a constellation of two satellites that provides Earth observation data in the microwave region of the spectrum that is not affected by weather conditions, nor does it depend on sunlight. For these reasons it is used successfully to monitor flood events. In order to exploit such advantages, users of the Sentinel-1 data need to know the technical characteristics of the products delivered by the European Space Agency (ESA), the radar technology and how microwaves interact with different kinds of surfaces. All this information is rarely provided all together in a concise and actionable way. The purpose of this paper is to fill the gap between a bare list of instructions without explanations and a theoretical textbook. We are going to use the imagery from the Synthetic Aperture Radar (SAR) on board the Copernicus Sentinel-1A satellite and the SNAP S1 Toolbox software, developed by the ESA. Our goal is to map a flood event. We will focus on the flood that occurred in Western Germany in the middle of July 2021, and in particular on the Euskirchen district, in North Rhine-Westphalia, an area on the west side of the Rhine river which was hit hard by the flood. We will use two SAR images. One image was acquired on July 15th, during the flood, and another image was acquired on July 3rd, before the flood. We will refer to the 1st image as the crisis image and to the 2nd image as the archive image. The archive image is used to distinguish permanent water bodies, such as rivers or lakes, from flooded areas. The idea is quite simple: we will overlay the flooded areas of the crisis image over the archive image to distinguish the flooded areas from the permanent water bodies. We will create a binary image of the flooded areas to be exported in the Google KMZ format, and finally we will import it into Google Earth for 2D and 3D visualization. In order to achieve our goal, we will have to apply some transformations to the SAR data. We will start with a short introduction to the Sentinel-1 system, its data products, the SNAP software, and some information about the interaction between the radar pulses and the Earth surface. Next, we will define a workflow to get from the Sentinel-1 data products to a map of the flooding event, explaining the reasons that motivate the transformations that will be applied at each step of the workflow.

Polarimetric Distortion Analysis of L- and S-band Airborne SAR (LS-ASAR): A Precursor Study of The Spaceborne Dual-Frequency L- and S-band NASA ISRO Synthetic Aperture Radar (NISAR)

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Polarimetric Synthetic Aperture Radar (PolSAR) data has been extensively used in earth observation for scattering-based biophysical and geophysical parameters retrieval in different thematic applications. Several spaceborne SAR satellites have been launched, and many more sensors in different frequency ranges are scheduled and are yet to be launched into space by space agencies. The increased demand for the polarimetric SAR data and the state-of-the-art sensors that are planned in future missions require assurance about the distortion-free data for accurate backscatter information retrieval. Any error in PolSAR-based backscatter information retrieval for thematic applications will give inaccurate modelled output, so the distortion-free data is an essential requirement for accurate output. Polarimetric calibration (PolCal) is essential to minimize distortions from airborne and spaceborne SAR data for scattering-based characterization of the targeted objects. The present study investigates the polarimetric distortions in the L-and S-band airborne dual-frequency SAR data. The L- and S-band airborne SAR (LS-ASAR) is a precursor mission of the spaceborne dual-frequency L- and S-band NASA ISRO Synthetic Aperture Radar (NISAR). The present work utilizes the LS-ASAR data acquired over the Rosamond Corner Reflector Array (RCRA). Five corner reflectors (CRs) of 4.8-meter side-length were oriented to measure the backscatter responses from the CRs in L-and S-band SAR data. To analyze the polarimetric distortions in the SAR data, scatterplots were plotted for co-pol and cross-pol channels of the PolSAR scattering matrix. The correlation between cross-polarimetric combinations (HV and VH) should be very high for a perfectly calibrated monostatic SAR system. A linear trend will be obtained from the scatterplot for the backscatter values of HV and VH channels of polarimetrically calibrated SAR data. The scatterplot between HV and VH channels of LS-ASAR data shows that the backscatter values of HV and VH channels are equal. The scatterplot between the HV and VH channels of the LS-ASAR data shows that the backscatter values of the HV and VH channels are similar. The most efficient way to evaluate polarimetric distortions of SAR data is the analysis of polarimetric signatures of the backscatter responses for field-located corner reflectors that were mounted during SAR data acquisition. The polarimetric signature analysis of co-pol and cross-pol channels shows that the co-pol signature shows perfect behaviour. Still, the polarimetric distortions could be easily seen in the cross-pol signatures.

Interferometric Synthetic Aperture Radar Interferometry: New Developments and Challenges

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Earth Observation methods based on the use of regularly acquired synthetic aperture radar images has become nowadays a common practice for the study of Earth surface properties. Over almost the last thirty years, interferometric SAR techniques have been developed to map the height surface and its temporal changes, and several investigations have been proposed analysing and modelling the different sources of ground deformations. Earth constantly changes over a wide range of temporal and spatial scales due to natural processes and direct human activities, as volcanic eruptions, earthquakes, land subsidence, and buildings/public infrastructures settlement in urban areas. Therefore, InSAR techniques provide a unique way to resolve spatial and temporal characteristics of the Earth's surface deformation, with application to a plethora of natural and anthropogenic processes. In the recent years, refined interferometric SAR (InSAR) processing methodologies have been developed, thereby providing relevant information for a broader scientific community. For instance, large-scale SAR interferometric processing is recognized as being computationally intensive and data intensive. At the same time, Earth observation (EO) platforms with enhanced SAR sensors have rapidly evolved, thus acquiring information in different portions of the microwave spectrum, with enhanced resolution and improved spatial and temporal coverage.

This works presents a short overview of conventional InSAR methods and their applications in different geophysical contexts, with a focus on the present-day new challenges concerning the effective exploitation of tons of data; the processing of large areas on the ground; the analysis of some specific processing stages related to new acquisition modes of the SAR images (e.g., the TOPSAR mode used by the interferometric wide mode SAR images acquired by the Sentinel-1/A-B sensors of the European Copernicus initiative) such as the focusing and the co-registration of new SAR data as well as the phase unwrapping of large-swath interferograms; the use of coherent SAR approaches for change detection applications; the characteristics of the forthcoming generations of SAR sensors and their practical exploitation for remote sensing analyses of the Earth's surface.

A Super-Ensemble Approach to Map Land Cover Types with High Resolution over Data-sparse African Savanna Landscapes

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Accurate and timely land cover products are critical inputs for landscape planning, and in turn provide key information for biodiversity conservation and food security. However, poor mapping quality and low resolution are considerable issues in existing land cover maps over the African savanna, where land use is complex and changing rapidly and necessary ground-truth data are sparse and hard to obtain.
To overcome this problem, to make optimal use of existing maps, and to avoid any human drawing, we proposed a three-stage ensemble method to get land cover maps over complex savanna landscapes. In the first stage, we extracted the consensus of multiple existing land cover products to generate fragmented pixel-wise training labels. In the second stage, we translated pixel-wise training labels to image-wise labels using the random forest as a guessing model and temporal features extracted from Sentinel-1 time series, raw bands, and vegetation indices derived from NICFI basemaps. These image-wise labels were scored and edited by humans and the quality information was used in the next stage. For stage 3, we fine-tuned a U-Net network based upon these image-wise labels using Sentinel-1 time series and raw bands of NICFI basemaps as image features. According to label information, a quality-weighted loss was used in the network to reduce the impacts of noises in the imperfect training labels. Taking Northern Tanzania as case study, the results demonstrate the usefulness of an approach to ensemble existing land cover maps and do land use classification over data sparse savanna landscape. The random forest guessing model gets overall accuracy 80.26% and kappa 0.73 on our independent test dataset with 7 classes. The final U-Net model gets overall accuracy 83.57% and kappa 0.78. Among all land cover types, water is the most confident type to be predicted and bareland is the hardest class. The proposed idea can fairly be applied to other scales (e.g., global) or other data sources (e.g., Sentinel-2).

Modified Linear Spectral Unmixing Method for Remote-Sensing Exploration of The Badlands and Sparrow-Vegetated Area on The Dried Bottom of The Aral Sea

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The desiccation of the Aral Sea resulted in a vast, highly saline plain with weak vegetation cover. National and international agencies are making significant efforts to re-vegetate this area, particularly with saxaul and halophytic shrubs. To support this effort, a study of the present condition of the extensive saline plains and their dynamics is necessary. The most effective approach to solve this problem is the use of remote sensing data. However, the application of traditional methods of supervised classification does not allow us to determine the extended local variations of mineral salts content appearing on a slightly sloping plain of the dried bed under the influence of wind transport, formation of micromorphological patterns and spills of collector-drainage discharge. We think that in this case, the return to the classical spectral unmixing methods with correction based on local geomorphological variables may be more effective than other classification methods adapted for contrasting geosystems, with well-defined landscape units. The linear spectral unmixing method involves decomposing the reflectance spectrum of each feature into a set of component spectra, or spectral signatures, and evaluating their comparative contribution to the endmember collection. We had used such methods as Pixel Purity Index and Iterative Error Analysis also. The exploration area doesn't demonstrate the occurrence of simultaneous scattering between the different surface components and every pixel belongs to a single land unity. Also, we can assume that surface components are known and spectral contrast allows component separation. An essential advantage of this approach is the possibility to use medium resolution images. For the initial calibration, we used soil salinity data for key points determined by laboratory methods with high accuracy. We used various spectral salinity indices, both brightness (SI_1=SQRT(G*R), SI_2=SQRT(G^2+R^2+NIR^2). SI_3=SQRT(G^2+R^2)) and composite ones, such as COSRI, as input data for linear spectral unmixing, given that such metrics produce a significant error for weakly saline areas. Our results show the satisfactory agreement of salt content variations with processing results of LANDSAT and SENTINEL satellite images in case of smooth slightly inclined areas outside bumps and slopes. At the same time, significant fluctuations of salt content and salt crusts formation limit the possibilities of the described approach and require its further improvement using optical-physical reflection models. The proposed method can be used for other highly saline wastelands with appearing micromorphology and local variations in salt content.

Ecosystem natural capital accounting, a tool for the management of a protected area: Antrema, Madagascar

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Maintaining critical natural capital is paramount. This implies a sustainable use of natural resources. Ecosystem accounts are able to show us how we are using natural resources. Ecosystem natural capital account (ENCA) allows the production of indicators of accessibility and sustainable use of natural resources. It also allows to assess evolvement of ecosystem services. ENCA approach is based on two land cover maps established at two different years. These years are considered as the opening date and closing date of ecosystem accounts. From this land cover account, associated with data from ecological and socio-economical surveys, one can derive the three biophysical accounts: the ecosystem carbon account, the ecosystem water account and the ecosystem functional service infrastructure (intangible services) account. These biophysical accounts are summarized in an account called ecosystem capability account. This last account gives the ecological capability unit value of the studied area. The Socio-Ecological Landscape Units (SELU) is defined as the analytical unit on which these three biophysical accounts are applied. Dominant land cover types and river subbasin boundaries are used to define SELU. In this paper, ENCA approach is applied at local scale, in the Protected Area of Antrema, north-western Madagascar. Our results show how ecosystem accounting could be applied at local scale and how it can be used by environment managers. For the case of Antrema, accounts show a decrease in resource stocks, but the use of ecosystem services remains sustainable except for carbon. The use of the biocarbon resources is mainly concentrated on the wooded cover comprising forest and mangroves.

Effect of Temperature Extremes on Growth Pattern of Banana: Application of SPOT-Vegetation, Proba-V and Modis Satellite NDVI Data with LST

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Banana (*Musa* sp.) is the second most important fruit crop in India next to mango. Its year-round availability, affordability, varietal range, taste, nutritive and medicinal value makes it the favorite fruit among all classes of people. It has also good export potential. Good yield quantity is very imperative for this plant which can be achieved by good plant growth. The dominant factor that affects the growth of bananas is temperature as it is a primary factor affecting the rate of plant development. Banana, basically a tropical crop, grows well in a temperature range of 15ºC – 35ºC with a relative humidity of 75-85%. This type of atmosphere prevails only in the summer months in the banana-growing districts. Yields are higher when temperatures are above 24 C for a considerable period. Leaf emergence stops when this range is compromised. High temperatures expected with the change in climate and the potential for more extreme temperature events will impact this plant productivity. The present study is undertaken in the Anand District of Gujarat India. SPOT-Vegetation and PROBA-V NDVI were used in combination with MODIS-LST Data from 2000-2017 to understand the growth of the Banana crops. A significant negative correlation between LST and NDVI was observed. This indicates that the variation in temperatures has a negative impact on the growth of a banana plant. It was also noted that the temperature also influenced the growing pattern of the Banana crop over a period of time. Thus, with the rise in temperature, there is a shift in growth patterns in the Banana crops.

Estimating the Seasonal Dynamics of Gross Primary Productivity in Tropical Deciduous Forests of Mudumalai Tiger Reserve, India using Sentinel 2A Satellite Observations

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Phenological variations in tropical deciduous forests (TDFs) have a significant influence on seasonal gross primary productivity (GPP) fluctuations. The present study focuses on the seasonal variations of phenology and GPP in the tropical deciduous vegetation ecosystems of Mudumalai Tiger Reserve (MTR), India using the vegetation photosynthesis model (VPM) based on various biophysical variables *viz.,* leaf area index (LAI), enhanced vegetation index (EVI), photosynthetically active radiation (PAR) and land surface water index (LSWI) and temporal Sentinel 2A satellite images (2017). The study exhibits that LSWI and EVI values were high (LSWI>0.4; EVI: >0.6) in the month of November exhibiting high moisture content and high vegetation cover in the region. The moderate LSWI and EVI in the month of May (LSWI 0.2-0.4; EVI 0.3-0.6), and low (LSWI0.2; EVI0.3) in the month of February exhibiting the implication of seasonality on the moisture content and the vegetation cover in the MTR. The eastern region (Southern Tropical Dry Thorn forests) of the MTR has very less LSWI and EVI values as compared to the central region (Southern Tropical Deciduous forests). In contrast, the western region, comprising Southern Tropical Semi-Evergreen forests, has high LSWI and EVI values. The satellite-based outputs related to phenological variations were reliably coinciding with the pattern of the previously reported literature. The GPP estimates were observed high (>10 $gCm^{-2}d^{-1}$) in November, moderate (5-10 $gCm^{-2}d^{-1}$) in May, and low (5 g $Cm^{-2}d^{-1}$) in February month. The GPP estimates were synchronous with ground phenological variations with high values in the wet season and low values in the dry season. The estimated GPP values agreed reasonably well with observed GPP of TDFs of Western Ghats, India. Despite high PAR values in May, GPP estimates were moderate, which suggests water availability rather than PAR is the most important driver in TDFs governing the GPP. The finer spatial and spectral properties of Sentinel 2A are necessary for monitoring spatiotemporal changes of TDFs, providing a basis for improving methodologies for the estimation of biophysical variables. The study aid in a better understanding of a variety of ecological patterns and processes at a particular site through accurate spatiotemporal estimation of productivity, the largest global carbon flux in forest ecosystems.

Evaluating Impacts of Opencast Mining Activity on Vegetation Dynamics and Mining Heat Island Using Time-Series (2000–2020) Satellite Data

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Vegetation is the vital component in the earth that incessantly regulates the gas and energy exchange between the biosphere and atmosphere and offers many more benefits. Timely and reliable information on the vegetation dynamics is vigorous for planning, policy-making, and implementing sustainable development programs. Opencast mining activities are one of the leading reasons for vegetation degradation among the various causes. The present study has employed the Mann–Kendall (MK) test (τ) on time-series Normalized Difference Vegetation Index (NDVI) dataset (derived from Landsat series satellite data) over the span 2000–2020 to estimate vegetation trends over the mining clusters across Jharkhand (JH) and Odisha (OD) states (India). Furthermore, the Theil–Sen slope estimator was used to analyse the land surface temperature (LST) (hereafter, mining heat island (MHI)) trends using Landsat dataset. The MK test and Sens Slope test were performed in R-CRAN software on time-series NDVI datasets and LST datasets, respectively. The results showed that the negative vegetation trends were predominantly associated with opencast mining, construction sites, roadways, deforestation, settlement, etc. Approximately 778 km^2 and 97291 km^2 areas were estimated under the negative and positive trends, respectively during 2000 – 2020 over the JH and OD states. Furthermore, the Sens slope test indicated that the MHI trends ranged between approx. – 0.39 °C/year to 0.56 °C/year. The mining patches over the JH and OD states have exhibited increasing temperature trends. The study's findings shall be valuable to the authorities and policymakers to frame and implement sustainable development programs over the mining regions to conserve vegetation.

Exploitation of Multi-Temporal PROBA V Satellite Data to Establish The Influence of Soil Water on Vitality of Tectona Grandis L.: A Case Study of Deciduous Forest of Western, India.

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The functional activity of a tree is affected by various biotic and abiotic factors. The vitality and health status of a tree also affects the growth. The hypothesis of this research is that available water, in terms of soil water status influence the vitality of the tree, and thus, affects the growth.The present study site was located in a Southern Tropical Dry Deciduous Forests, of Gujarat, western India. The deciduous forest was dominated by *Tectona grandis* L. Teak is considered a high valued timber crop of India. The healthy plots and the unhealthy plots of *T.grandis* were chosen for the present research.Vitality of *T. grandis* was understood after detailed study on damage assessment in 45 different plots distributed in the study area. Multi-temporal PROBA V Dry matter productivity (DMP) was taken, that represents the overall growth rate or dry biomass increase of the vegetation for homogenous plots of *T.grandis* and along with Soil water Index (SWI) of Proba V which represents the soil water status of the same plot. We found that SWI up to significantly influenced the tree health growth at the study site. A significant positive correlation between SWI and DMP was found. The unhealthy *T.grandis* plots, with lean stand, low biomass showed lesser SWI when it was compared with healthy *T.grandis* plots. The healthy tree plots showed significant growth (DMP) with high SWI. We conclude that decrease in SWI impeded the vitality (i.e. growth, DMP) of *T.grandis* in the present study area.

Prediction of Satellite Data Using ARIMA and SARIMAX: The Case of NDVI of Rosso Mauritania Rice Fields

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The normalized difference vegetation index (NDVI) is a very important index for predicting crop yield in a region. Our main objective is to predict the NDVI of the Rosso Mauritania rice field using Arima-based models. First, after collecting our data from the sentinel_hub website, we did a statistical analysis of the data, we extracted the min, max, mean, variance and standard deviation. Thus, we extracted the repeated values and their dates. We found that the values are repeated in a periodic way. This is logical because there are two cultivation periods in ROSSO, each period is about 4 months. In addition, we performed an additive decomposition of our data into trend, seasonality and noise.Then, we checked the adaptation of our data with these models in terms of stationarity by comparing the statistical properties and calculating the ADF. Then, we applied ARIMA and SARIMAX on our dataset using three types of distributions: 100% training, 80% training and cross-validation by TimeSeriesSplit. The orders of the models were chosen by applying the Partial Auto-Correlation Function (PACF) and the Auto-Correlation Function (ACF). We measured the Akaike Information Criterion AIC, the Bayesian Information Criterion BIC, the Hannan-Quinn Information Criterion HQIC, and four prediction errors (Mean Prediction Error MFE, Mean Absolute Error MAE, Mean Square Error MSE, and Root Mean Square Error RMSE). The results revealed that the smallest MFE was accompanied with the use of ARIMA (1,0,1) (80% of the training data and 20% of the test data) and that even with a smaller AIC, the use of ARIMA and SARIMAX with 100% of the training data caused an overfitting.

Quantifying Canopy Nitrogen Content and Non-Photosynthetic Vegetation Using Hyperspectral PRISMA Data in Preparation for The Upcoming Copernicus Hyperspectral Imaging Mission for The Environment (CHIME)

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Satellite imaging spectroscopy for terrestrial applications is reaching maturity with recently launched and upcoming science-driven missions, e.g. PRecursore IperSpettrale della Missione Applicativa (PRISMA) and Environmental Mapping and Analysis Program (EnMAP), respectively. Moreover, the high-priority mission candidate Copernicus Hyperspectral Imaging Mission for the Environment (CHIME) is expected to globally provide routine hyperspectral observations to support new and enhanced services for, among others, sustainable agricultural and biodiversity management. Thanks to the provision of contiguous visible-to-shortwave infrared spectral data, hyperspectral missions open enhanced opportunities for the development of new-generation retrieval models of multiple vegetation traits. Among these, canopy nitrogen content (CNC) and non-photosynthetic vegetation (NPV) biomass (or lignocellulosic plant material), both in g/m^2 at the pixel scale, are the most promising variables given their importance for agricultural monitoring applications. These two variables have been also identified as priority variables for the upcoming CHIME mission.

This work presents the first hybrid CNC and NPV retrieval models for the operational delivery from spaceborne imaging spectroscopy data. To achieve this, physically-based models were combined with machine learning regression algorithms and active learning (AL). The key concepts involve: (1) coupling the radiative transfer models PROSPECT-PRO and 4SAIL for the generation of a wide range of vegetation states as training data, (2) using dimensionality reduction to deal with collinearity, (3) applying an AL technique in combination with Gaussian process regression (GPR) against a validation dataset for fine-tuning the training dataset, and (4) adding non-vegetated spectra to the model to deal with spectral heterogeneity in the image. The final CNC model was validated against field data of corn and winter wheat achieving a coefficient of determination (R^2) of 0.69, while the final NPV model was validated against soybean field data with R^2 of 0.85.

To demonstrate mapping capability, the models were applied on a PRISMA hyperspectral image acquired over agricultural areas in the North of Munich, Germany. Reliable estimates were mainly achieved over vegetated surfaces as suggested by associated model uncertainties. At the same time, the accompanying uncertainty layer can also be used to mask out uncertain areas. These promising results demonstrate the feasibility of routinely quantifying CNC and NPV from space, such as in an operational context as part of the future CHIME mission. Based on this PRISMA experience, this presentation will close with outlining the development of vegetation traits models in a simulated environment in preparation of CHIME.

Monitoring Surface Water Area Dynamics Using Sentinel 2 MSI in Google Earth Engine for Semi-Arid Region

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Surface water is the most readily accessible resource for the human population and is an essential natural resource that is required for a region's subsistence, livelihood, and growth. It is a vital resource, especially in the Bundelkhand region of India, which struggles from a scarcity of water and is vulnerable to drought. Monitoring of spatio-temporal variation in surface water has become popular in recent years and also supports the UN Substantiable Development Goals (SDG) 6.6.1 which measures the "Change in the extent of water-related ecosystems over time". Using remotely sensed datasets that are reliable, consistent, and benefit from repetitive mapping over the same region, one can efficiently map the surface water dynamics. Water indices, which are derived using two bands and differentiate water from non-water features, are a widespread and effective approach for surface water monitoring. Sentinel 2 MSI data, which was launched in June 2015 and is publicly available in the public domain, is used in this work.This dataset is ideal for water resource mapping and monitoring since it is available at a medium spatial resolution and at frequent intervals. For water resource mapping, the current study uses the modified Normalized Difference Water Index (mNDWI) established by (Xu, 2006a). The modified normalized difference water index is calculated using Green and Short Wavelength Infrared (SWIR) bands. Water has a higher absorbability in SWIR, allowing it to distinguish between water and non-water objects while also suppressing background noise from land cover and buildup features. The rainfall data used in this study is the India Meteorological Department gridded data, which has a spatial resolution of 0.25^0 x $0.\ 25^0$. The Google Earth Engine, an open-source cloud computing platform that gives access to time-series of global satellite images, was used to compute mNDWI. Inter-annual and intra-annual variations in surface water bodies were observed. The year was separated into four seasons to investigate intra-annual fluctuation in surface water bodies: pre-monsoon, monsoon, post-monsoon, and winter. The data for each season of the year were computed and compared both inter-annually and intra-annually. The results show that the region's annual rainfall and seasonal rainfall events are on the decline. It implies that the surface water is of the Bundelkhand region is gradually decreasing owing to a decrease in rainfall. The inter-annual and intra-annual fluctuations in surface water area have a positive correlation with rainfall events. The study concludes that mNDWI is a reliable approach for extracting surface water characteristics using Sentinel 2 MSI data. This method of surface water extraction is required because it can aid in the monitoring of surface water dynamics and the management of water resources during droughts.

Chlorophyll-a Concentrations in The Northern Part of Moldavian Plateau Reservoirs Using Remote Sensing Techniques

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Monitoring water quality and hydroclimatic events through remote sensing techniques has become an effective way to prevent major events, but also to preserve the quality of water resources. The purpose of the study is to evaluate the performance of several approaches based on multispectral data to estimate chlorophyll -a in reservoirs ecosystem situated in hilly area in order to monitoring the trophic states in summer seasons between 2017-2021. The spatial and temporal variability of the data allowed the comparison of MODIS and Sentinel 2 images for a large range of both chlorophyll -a and land surface temperature. The reflected and absorbed sunlight information enables the estimation of chlorophyll-a concentration using images from the Sentinel-2 satellite, equipped with a multispectral instrument, which makes it possible to study water bodies. Climate change can cause fluctuations in chlorophyll levels in reservoir water, therefore, by using land surface temperature (LST) data using infrared thermal bands (TIR) of MODIS (Moderate Resolution Imaging Spectroradiometer) optical sensors, the water surface temperature can be determined, which is one of the factors responsible for increasing the level of chlorophyll-a. To use the Sentinel-2 data for monitoring surface-water quality, the images must first be preprocessed, which involves geometric and atmospheric correction using C2RCC algorithm. Images corresponding to Level 1C - Top of Atmosphere products was subsequently processed using SNAP program with focus on reflectance bands B4, B5, B6, used for testing the empirical equations derived from the band ratios. The distribution of chlorophyll content was determined for three sections of the reservoirs: tail, middle and dam. The predominant state for the summer season indicates a hypertrophic ecosystem and secondarily oligotrophic, mesotrophic, and eutrophic state, with values exceeding the maximum allowed limit, in the following order from dam to middle and tail: 26.36 mg/m3; 28.18 mg/m3 ; 26.88 mg /m3 in 2017, and 25.21 mg/m3 ; 27.55 mg /m3; 26.55 mg /m3 in 2018. In general, the areas close to the dam are most affected by mechanical shock and hydraulic washing then the other parts located upstream. The results obtained indicate a promising application of these sensors to remotely estimate chlorophyll -a for coming decades in turbid inland waters.

Estimating The Water Carbon in The Negro River, Amazon Basin, with in Situ Remote Sensing Data

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Monitoring dissolved organic carbon (DOC) transported by large rivers is an important activity for understanding continental biogeochemical processes. The Negro River is the main tributary of dissolved organic matter to the Amazon River. The average concentration of DOC in this river is about 10 mg L^{-1}, which results in a low scattering coefficient and high absorption coefficient of colored dissolved organic matter (aCDOM at 440 nm >7 m^{-1}). As with large tropical rivers, there is a data gap in the Negro River to determine the flow of DOC and its spatial-temporal variation. This study aims to estimate the dissolved organic carbon in the Negro River surface using in situ measurements of remote sensing reflectance. Sentinel-2 MSI images were used to evaluate the empirical models developed and to mapping the DOC concentration over a multichannel reach in the lower course of the Negro River. The DOC data collected in 250 km of the lower course of the Negro River showed low spatio-temporal variation (mean 9.63 mg L^{-1}, minimum 7.03 mg L^{-1} and maximum 12.48 mg L^{-1}). The developed empirical models, based on regression analysis, presented better results with the use of the green band (simulated MSI Band 4 at 560 nm), with R^2 >0.60 and Mean Absolute Percentage Error of 10.40%. Complementary analyzes indicate that DOC in black-water rivers in the Amazon basin can be monitored using bio-optical models that relate the absorption coefficient of dissolved colored organic material and the remote sensing reflectance. The results indicated that in situ radiometric data are feasible to estimate the dissolved organic matter present in large tropical black-water rivers, and to monitoring the spatio-temporal dynamics of these large fluvial systems

GIS-Based Analysis and Prediction of Shoreline Change Using Multi-Temporal Landsat Imagery: A Case Study of Al Arish Coast, Egypt

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The Egyptian Mediterranean coastline is consider one of the most morphodynamic coasts in the world. In the last decades, a significant changes of coastline has been remarkably happened under the influence of natural and anthropogenic factors. Study area is located along the Egyptian Mediterranean coast of North Sinai Peninsula, it represents an alluvial fan (Delta) of Al Arish valley. In this study, analysis of historical changes of of Al Arish shoreline was detected and analyzed from 1990 to 2020 with 5-years interval to automatically extract the shoreline and change analysis in shoreline position due to accretion and erosion. The main aims of this study is evaluate of the coastal protection devices along Al Arish Port, as well as forecasting the shoreline change in the near future. Satellite Remote sensing imagery from different sensors were collected and analyzed using remote sensing softwares' ERDAS Imagine and ENVI ; a fourteen individual scenes of Landsat time-series images including Thematic Mapper (TM), Enhanced Thematic Mapper Plus (ETM+), and Operational Land Imager (OLI) within a tidal range of ±50 cm. The normalized difference water index (NDWI) and the modified normalized difference water index (MNDWI) as well as other water discriminate indices were applied to mapping water bodies, a thresholding method used to identify and shoreline extraction. The extracted coastline in 2020 were compared with a high resolution images from Google Earth to assess the accuracy and uncertainty error calculation of the extracted shorelines. Geographic Information System (GIS) software's ArcGIS 10.6 and Digital Shoreline Analysis System (DSAS) model were used to statistical geocomputation and analysis the extracted coastlines. The historical and future shoreline change rates in the form of erosion/accretion pattern are automatically quantified by four statistical parameters functioned in DSAS coding include End Point Rate (EPR), Net Shoreline Movement (NSM), and Linear Regression Rate (LRR). The results of this study produced a historical change mapping of coastal changes along Al Arish Port, and assessing the future of coastal erosion hazard along study area.

Monitoring of Shoreline Changes Using Sentinel-2 Satellite Imagery in the Google Earth Engine Platform: A Case Study the Broome, Australia

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Shoreline is defined as the line of contact between water and land. Shoreline shifting as one of the most critical environmental challenges directly influences on the inhabitant life in the costal cities. Due to global warming, the sea level has risen over the past centuries and threaten coastal infrastructures. Therefore, coastal management for economic, environmental, and recreational exploitation is an important issue for the coastal countries. In this study, potential of the Sentinel-2 imagery was investigated for monitoring shorelines in Australia. Therefore, we used the Sentinel-2 image time series from 2019 to 2021 on the Google Earth Engine (GEE) platform. First, we created cube data that includes the water body extraction indices like Modified Normalized Difference Water Index (MNDWI) and Normalized Difference Water Index (NDWI), etc. Then they divided the images into two classes of water and non-water area by supervised Random Forest (RF) classification. The overall accuracy (OA) and kappa coefficient (KC) of all maps were above 98%. Then we obtained the water class area for each map. We also calculated the correlation between the areas of the water class with tide gauge data from the Broome station with a correlation of 49%. Finally, we calculated the shoreline rate movement using the Digital Shoreline Analysis System (DSAS) software. Moreover, Net Shoreline Movement (NSM) and End Point Rate (EPR) was used for distance measurement and statistical analysis to measure the rate of change of shoreline between 2019 and 2021, 23% of total transects exceeded 10m of NSM. In consequence, shoreline length has also been changed between 2019 and 2021, from approximately 18295.1 m to 19352.6 m.

Research on The Sea Surface Roughness and Tilt Changes Caused by Internal Waves Based on ALOS PALSAR Images

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Internal wave is a kind of fluctuation phenomenon in the ocean, which has an important influence on ocean energy mixing, ocean engineering construction, military activities and so on. During the propagation process, it can not only cause convergence and divergence of the sea surface, but also cause the roughness of the sea surface to change and cause vertical fluctuations. In addition, the use of SAR images to study the characteristics of internal waves is relatively mature, and the SAR imaging mechanism of internal waves is based on the Bragg scattering model. However, the roughness of a random surface is a perturbation effect, and it is difficult to describe characteristics of sea surface changes caused by internal waves using conventional single-polarization images and Bragg scattering models. The fully polarized SAR can completely obtain the scattering characteristics of the detected object, which significantly improves the ability to observe the target, and the surface roughness and tilt changes can be manifested as depolarization and cross-polarization effects in the fully polarized SAR image. Hajnesk introduced the X-Bragg model in 2003, which overcomes the inability to describe the non-zero cross-polarization backscattering and depolarization effects in the Bragg model. Based on the X-Bragg model, this paper uses ALOS PALSAR fully polarized images to study the sea surface changes caused by internal waves. The introduction of the X-Bragg model realizes the description of the rough disturbance effect, and obtains the angle β that can characterize the change of sea surface tilt. In addition, there is a positive correlation between the sea surface roughness change caused by internal waves and its amplitude. The larger the amplitude of the internal wave, the greater the sea surface roughness change caused by it.

The Use of Sentinel 2 for The Analysis of The Ecological Status of Inland Water Bodies. A Case study in the Ebro Delta (Spain)

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The Ebro Delta is a convex geographical feature formed at the mouth of the Ebro River from sediments transported by the Ebro and its water. It is located in the NE of the Iberian Peninsula, being the mouth of the Ebro River. This deltaic formation has been greatly modified over the years due to the traditional cultivation of rice crops in the area. This anthropological practice has had a great impact on the lagoons that bring the delta into existence, resulting in many of them to be lost. These types of lagoons are very fluctuating ecosystems characterized mainly by the mixture of inland waters along with marine waters. This mixture determines an exchange between both systems, which is mainly determined by seasonal changes that cause very important geochemical and biological variations throughout the year leading to alterations and changes in their ecological status. This is a process that is more accentuated in summer when the temperatures increase significantly. Specifically, the Ebro Delta receives mostly freshwater through the channels that come from the river, that being water that is used for the rice fields in the area as well, which also alters the hydrological regime in the area. This is because the water inputs are more abundant from May to November and almost completely null the rest of the year. The Ebro Delta has an area of 350 km^2, being one of the largest wetland areas in the western Mediterranean. This work focuses on analyzing the ecological status of the lagoons that form the Ebro delta: El Clot, La Tancada, Buda, and the Canal Vell, over a period of 5 years (2017-2021) during the periods of water input and cessation by remote sensing. For this, Sentinel 2 satellite (ESA) has been used, applying the atmospheric correction C2RCC type and a series of equations that allow us to know the amount of chlorophyll a (chl a), the depth at which 90% of the radiation that reaches the water is absorbed (Kd_z90max), the suspended solids (tsm) and the phycocyanin (PC) of the lagoons in the area The results that have been obtained corresponding to the season of more water intake are Chl a=63.03mg/m^3, Kd_z90max=0.48m, tsm=32.50g/m^3 and PC=226.36µg/L. Additionally, when the supply of water ceases, and therefore there is more exchange with the sea the results are the following Chl a=15.85mg/m^3 Kd_z90max=0.73m, tsm=25.72g/m^3 and PC=34.29µg/L. Although the data shows that there is a slight improvement between both periods, the lagoons are in a hypertrophic state most of the year, which implies a great risk for the flora and fauna of the area. This phenomenon, added to the loss of sediments that are being seen in most deltas around the world, indicates that there is a great problem that needs to be addressed and proves how remote sensing allows us to monitor these aspects almost in real-time.

Two-Decade Record (2000-2019) of Spatio-Temporal Dynamics and Drivers of Cyanobacterial Harmful Algae Blooms (CyanoHABs) at Sub-pixel Level in Taihu Lake Observed by MODIS Images

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The increasing severity of CyanoHABs in Lake Taihu has caused great losses to economic construction and people's lives in the Taihu area. Moderate-resolution imaging spectrum-radiometer (MODIS) data are very suitable for the monitoring of CyanoHABs due to its high temporal resolution and high spectrum. However, conventional monitoring methods based on remote sensing require a lot of time to process data, which is inefficient. Compared with traditional image processing software such as ENVI, the Google Earth Engine (GEE) cloud platform can process massive images quickly and in batches. GEE provides a new idea for this article to obtain long-term CyanoHABs information in the study area. We embed the whole data processing work into the GEE cloud platform through API (Application Programming Interface) program. The extraction algorithm of CyanoHABs selects the floating algae index (FAI). In this paper, we extract the coverage area of Lake Taihu from 2000 to 2019 and discuss the main environmental drivers of CyanoHABs in Lake Taihu based on the analysis of the spatial and temporal distribution of CyanoHABs from 2000 to 2019 and the environmental data such as water quality and meteorological data in the past 20 years. The results show that the GEE-based platform can efficiently obtain long-term trends with higher accuracy in the study area; the CyanoHABs reached a peak around 2017 after the outbreak crisis event in 2007. The CyanoHABs in the Bay Area and Northwest Lake area were more severe than those in the open lake area; CyanoHABs in Lake Taihu mainly occurred between April and October, with the worst in July and August; environmental factors such as mean temperature, TP, and wind speed showed a significant positive correlation with the characteristics of CyanoHABs. The GEE platform provided an efficient method for long-term monitoring of CyanoHABs, which provided new ideas for the scientific and effective regulation of inland water safety.

Response of the SAR Intensity to above-average Air Temperature Recorded in The Northern Part of The Antarctic Peninsula in February and November 2020

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Two significant periods of above-average air temperature occurred during 2020 in the area of the northern part of the Antarctic Peninsula. The first one, on February 6, meant the hottest temperature (18.3°C) recorded at the Esperanza Base. Regarding the second case, at the beginning of November, it was warmer than average for this month.
Melting of the ice surface can be observed in optical satellite images, but continuous cloudfree time series are usually not available. Synthetic aperture radar (SAR) imagery, acquired independently of the weather conditions, can serve as a good source of information about the processes on glaciers. SAR intensity reflects the changes on the snow and ice cover dependent mainly on water content and grain size. The aim of this paper is to demonstrate the effect of short-term warming on the extent of melting areas utilizing SAR data. Sentinel-1 data seem to be the best choice for the input. Firstly, they are freely available under the ESA Copernicus Programme, secondly, they pride themselves on the very short temporal resolution in S1A and S1B constellation which is 6 days. Last but not least, the Sentinel-1 data can be processed in a tailor-made program made by ESA.
Time series analysis of SAR intensity during two consecutive austral summer seasons (from October to February 2019–2020 and 2020–2021 respectively) brings the comparison of usual seasonal variations with those that have occurred during extreme temperatures. The extent of defined glacier zones is calculated and summarized in tables, graphs and maps.
The study of glacier dynamics and changes helps us to understand current processes in polar areas. This post aims to be a contribution to the mosaic of the climate change issue.

"Checks by Monitoring" through Copernicus Satellite Data: the new European Common Agricultural Policy Approach

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With the Copernicus program, Europe obtained an open and frequent spatial observation and positioning system, together with several "downstream programs" for vertical interventions. Thanks to Copernicus, the agricultural sector is improving the use of spatial data and simplifying the several agronomic requirement solutions. This also due to the use of dedicated "application platforms" allowing to manage satellite and GNSS data in integrated way, with other available information, to achieve a closer dialogue between the agro-chain (administration, associations and farmers), which each year, require the CAP- Common Agricultural Policy subsidies for around 8 million of European farmers.
This model has undergone a significant acceleration, due to COVID emergency, fostering both for further increase of Copernicus Sentinel monitoring and the massive use of GNSS geo-referenced photos to minimize the usual human movements in field, in favor of a greater data exchange among the agricultural players, through dedicated digital platforms.
Italy, through AGEA agency (EU funding controls and distribution) , first in Europe, started the new Check by Monitoring program in 2018, moving from 5% sampling of the CAP aids to a total Sentinel-based territorial monitoring with 5 days frequency throughout the territory, avoiding to "forget" the other territorial 95% always excluded by the controls .
The continuous satellite monitoring offers several advantages: reducing costs and burden by automation, reducing field visits, increasing fairness between beneficiaries and improving EU citizens awareness and farmers' compliance, by prevention mechanisms.
The presentation will embrace the different remote sensing and integrated technologies used, including the current limitations, for automatically managing, in a short time windows, several million of CAP agronomic parcels declared by farmers.

CAP Monitoring and Control Using Sentinel Products and Services

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A comprehensive strategy combining remote sensing and field data can be helpful for more effective agriculture management. Satellite data are suitable for monitoring large areas over time, while other sources (as LiDAR) provide specific and accurate data on height and relief. Both types of data can be used for calibration and validation purposes, avoiding field visits and saving useful resources. In this presentation, we propose a process for objective and automated identification of agricultural parcel features based on processing and combining Sentinel2 data and other datasets (to detect landscape elements). An important application example of this process is the European Union (EU) Common Agriculture Policy (CAP) monitoring systems.

EU-wide Spatial Estimation of Temporary Grassland Using a Model-Based Approach

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Abstract: Monitoring of grassland (both permanent, i.e., more than five years and, temporary typologies) is relevant for the ecosystem perspective and for agricultural sustainability. Assessing the spatial and areal extent of grassland at country and sub-country level, is relevant for a number of ecosystem services, agri-environmental indicators and EU policies (e.g., Common Agricultural Policy, Nitrates Directive, Natura 2000 etc.). Here, we focus on temporary grassland (TG), defined as "agriculturally improved grassland and temporary pastures typically used for fodder or for grazing, included in the agricultural rotation". Usually, the available information on TG relies on crop production statistical data provided by EU countries, but detailed spatial data and extent at sub-country level are missing. In this work, we developed and applied a model-based approach to estimate spatial patterns of TG and areal extent. The model uses the in-situ collected data from the European Land Use/Cover Area frame Survey (LUCAS) as the dependent variable, and several covariates as predictors, including (among others) gridded remotely sensed derived products from Copernicus Programme (High Resolution Layers). In particular, a multinomial additive mixed model is applied, where nonlinear dependencies of grassland types on covariates (e.g., elevation, geographical coordinates) can be described. The presented approach leads to land cover area estimates very similar to those estimated by design-based (model-assisted) methods but has the additional advantages that (a) continuous probability maps can be generated, and (b) land cover area can be predicted for arbitrary small sub-regions.
We produced an EU-wide gridded map of TG probability (0-1) along with the estimation of the areal extent for the following administrative units: country, region, and province (NUTS levels). Plausibility of results was additionally assessed by computing the correlation of areal estimates with Eurostat statistics at country level, resulting in a strong correlation. The work will be extended to produce gridded maps and area estimation for the grassland system as whole by including permanent grassland and grassland in marginal areas in order to provide a detailed and thorough picture for the EU agricultural and environmental policies.

Monitoring the Status of Citrus Smallholders through an Object-Based Analysis and Sub-Meter Resolution Imagery

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Developing world urgently demands increased production and improvements in the governance of food production systems. These improvements are also a prerequisite for the achievement of the United Nations (UN) Sustainable Development Goals. Food production and local economies in developing world often depend on sub-hectare smallholder fields. Monitoring these crops is of key importance, however small fields are difficult to monitor using moderate resolution imagery. These fragmented areas require the use of Very High-Resolution (VHR) imagery. Spaceborne and airborne VHR imagery are increasingly available and allows to perform object-based image analysis (OBIA) to monitor parcel-level crops over large areas.

In this work, small citrus parcels (0.25-0.5 ha.) are monitored using VHR airborne imagery. 240 parcels were classified in a field campaign. In order to provide useful information for the monitoring of citrus groves, a classification based on three categories was defined: *non-productive*, *productive* and *abandoned*. Parcel monitoring was carried out using an OBIA approach and two machine learning algorithms commonly used in remote sensing (Support Vector Machine—SVM and Random Forests—RF) were evaluated through a 4-folds cross-validation.

Airborne data has a spatial resolution of 0.25 m, 4 spectral bands and 8-bit radiometric resolution. 36 features were extracted from each parcel following an OBIA approach. The extracted features were: *mean*, *standard deviation*, *minimum*, *maximum, range*, and *mode* of each spectral band; *mean*, *standard deviation*, *minimum*, *maximum* and *range* of the NDVI; *uniformity*, *entropy*, *contrast*, *inverse different moment*, *covariance*, *variance* and *correlation* from NDVI based on the Gray Level Co-Occurrence Matrix with 64 gray levels. RF model was trained using 100 decision trees and 6 features in each bagging. SVM model with radial basin function was trained with 93 support vectors.

The results obtained were similar for both classifiers. The OBIA approach used allowed to monitor small citrus parcels with an OA > 90%. The approach used was suitable to monitor citrus parcels from a single VHR image, but it should be tested in other types of permanent crops (evergreen).

Quantifying Crop Damage Due to Extreme Weather Events for CAP Monitoring

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The increased frequency of weather extremes can cause severe crop damages reducing yields and putting food supply at risk. At the same time, while yields declining, global food demand is rising leading to the intensification of agriculture. These issues considered instrumental by the EU for enhancing the environmental and climatic performance of the Common Agricultural Policy (CAP) under the greening schemes. The use of advanced technologies such as Earth Observation (EO) and Internet-of-Things (IoT) is highly suitable for crop monitoring and crop damage assessment assisting all farming entities to withstand the influence of climate change. The timely and accurate damage assessment of crops is of high importance. Until recently, crop damage assessment due to extreme events is implemented by agro-experts who carry out field visits to inspect and verify damage severity and crop loss after every reported disastrous weather event. This process is costly, time consuming, labor intensive but most importantly error prone. Our automated method focuses on estimating crop damage remotely, at parcel level and near-real time. By integrating satellite imagery and IoT-acquired field data we are able to (i) detect extreme events (frost, hail, flood, drought, windstorm etc.) at local scale, (ii) visualize the influenced areas by creating damage maps that indicate the area, severity and persistence of damaged crops. The results proved to be satisfying as they were additionally validated by agro-insurance appraisers. Hence, we aim to further develop this service by performing a correlation analysis between crop damage and yield loss and by generating time-series that could add valuable information regarding climate change impact on yield loss.

Tree Counting and Height Estimation by Drone Images Using YOLO Deep Learning

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An accurate tree counting approach from aerial imagery data provides a critical piece of information to inform management decision-making in various industries such as forestry, agriculture, and the honey production industry to name just a few. Counting trees is of considerable importance for two reasons. At first, it causes to supply an inventory of trees on the fields that may help the farmers better plan the irrigation or fertilization process. On the other hand, information about the number of trees on the farm is necessary to evaluate the production estimate as well as to calculate the value of the farm. Traditionally, tree counting data is created by human operators which is a laborious task and very time-consuming. There have been several approaches in the literature to solve this problem using and combination of computer vision techniques, but these haven't been able to produce accurate results and are limited to one or two datasets. Counting tree is a complex challenge in remote sensing topics because trees and weeds typically appear in rows with different sizes and shapes at the same time, which may largely vary from one image to another. This makes counting processes based on image analysis complex and dependent on several parameters for each image. To offer a solution to this problem, a deep learning framework to automatically count trees in drone images was developed. Recent advances in artificial intelligence have opened a new world of opportunities to solve this challenge. The deep learning framework is adopted to use since convolution neural networks (CNNs) have become the state-of-the-art method because they have good performance in different fields such as computer vision and classification tasks in recent years. This study was conducted in three areas, namely Epping, Kukerin, and Mooribin. Our solution comprises three steps. First, create an orthophoto from raw drone images at 1.8 cm resolution and next, trained a deep learning approach based on Yolo to detect tree crowns and identify treetops. We used 250 images of trees in a wide range of sizes and shapes to train Yolo and Random Forest. 9 and 580 trees are counted manually in two tested areas which are small and large. Treetop data was used to interpolate tree height from the canopy height model (CHM) for two tested areas. Four quality metrics, namely Precision, Recall, IoU, and mAP parameters were used to evaluate the quality of the method. Our trained YOLO model detected trees in rows of trees and weeds with accuracy near to 97%.

Using Advanced Sensor Technologies for The Selection of Durum Wheat Varieties Resistant to Fungal Attacks

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Food security represents a major problem for world population and this concern will rise even more in the coming future in line with climate change predictions. Ongoing climate change causing water scarcity or flooding not only affects crop productivity through abiotic stresses, but also by increasing the appearance and impacts of new diseases. Within this context, wheat phenotyping may provide one solution to ensure the selection of wheat varieties more tolerant to biotic stresses and consequently reducing the impacts to yield and seed quality. New precision phenotyping techniques need to ensure more effective monitoring of plant stress during different physiological stages and provide a detailed assessment of possible threats. Within this context it is necessary to develop new methodologies for plant phenotyping based on the use of different spectral sensors in order to study the impact and tolerance to new diseases on wheat. The analysis of aerial and ground RGB images may help to select those wheat genotypes better adapted to abiotic stress, which may help to better manage crop growth, increase plant health, and calculate plant necessity under abiotic stress such as fungal disease. It is within this context that our study is based, testing different advanced lines of Durum wheat (*Triticum turgidum L. var. durum*) at five different locations (Sos, Ejea, Tordomar, Briviesca and Elorz) across Northern Spain. We have monitored an F8 generation produced by a commercial breeding program composed by 40 lines, all growing under rainfed conditions. For each site and line, 4 replications, including one without fungicide treatments were evaluated. Different measurements at different scales were performed, at canopy level and at leaf level, from the beginning of stem elongation (March) to mid grain filling (June) of 2021. At leaf level, chlorophyll and other pigments were evaluated using leaf sensors. At plot level, canopy vigor and color were evaluated by measuring multispectral and RGB camera vegetation indices from the ground and mounted on an unmanned aerial vehicle (UAV) platform. According to the phenotyping field sensors, we found that the Normalized Difference Vegetation Index (NDVI) and Normalized Green-Red Difference Index (NGRDI) parameters measured in March recorded an important difference between the genotypes (p 0.001). Moreover, the site also influenced the crop performance (p 0.001). At canopy level, the sites that showed the highest early plant vigor, measured as NDVI, during stem elongation owing to the effect of the fungicide where Elorz (P 0.001) and Ejea (P 0.001). Regarding the RGB indexes measured at canopy level, the Greener Green Area (GGA) parameter measured during mid grain filling (June) was higher in treated plots (P 0.001) compared to untreated plots. These general results showed that treated plants were overall more vigorous than untreated ones. This finding highlights the effectiveness of indices as NDVI, NGRDI and GGA in the assessments of fungicide treatments on wheat varieties. Thereafter, the importance of these multispectral sensors as a non-destructive instrument could have a potential use for abiotic stress in wheat phenotyping.

Vegetation Indices with RGB and Multispectral Images Using UAV to Evaluate The Ripening Phase of Bean Crop (Phaseolus Vulgaris L.) under The Peruvian Coastal Conditions

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Bean (*Phaseolus vulgaris* L.) is an important legume as a source of protein and dietary fiber for millions of people. In Peru a total of 74,000 ha of beans are cultivated, representing 0.8% of the Gross Value of Agricultural Production (GVaP). To increase agricultural production with limited resources, important technological advances have been implemented such as the use of unmanned aerial vehicles (UAVs). However, this technology has not been exploited in Peru yet. We scored four biometric variables (plant height, leaf area index, chlorophyll content and biomass) on 16 plots at 90, 97 and 101 days after sowing (DAS) under the Peruvian coastal conditions. Moreover, we used a Quadcopter type UAV platform with an RGB camera. In addition, a multispectral sensor Parrot Sequoia which is a synchronized array of four single band multispectral camera was attached. All four biometric variables were correlated using Pearson's correlation coefficient and coefficient of determination. A highly significant correlation was obtained for plant height with 12 RGB image vegetation indices in a commercial bean crop, which were used to develop multiple linear regression models (four models in total), obtaining a maximum correlation of $R^2 = 0.79$ in model I. The indices obtained from multispectral images did not show significant correlations. The use of these tools is important due to the need to conduct more agronomic evaluations in a timely manner in crops and mainly in those that are cultivated in arid environments such as the Peruvian coast. To our best knowledge, this is the first research work in Peru using technology such as UAV for an agronomic monitoring of canary beans.

Assessment of Active Seismic Zones and Earthquake Vulnerability in The Himalaya by Machine Learning and Fuzzy AHP-TOPSIS

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Himalayan mountains are one of the most seismo-tectonically active zones on the surface of the earth. Continuous collision of the Indian and the Eurasian plates results in the accumulation of the strain energy, which is frequently released in the form of earthquakes. One of the most recent and devastating earthquakes, i.e., the Gorkha earthquake, occurred in the central Himalayas on 25th April 2015. In this paper, we use machine learning to identify spatial clusters of earthquakes, besides using multi-criteria decision-making (MCDM) models to estimate earthquake vulnerability in the Himalayan seismo-tectonic zone. Seismicity data available from the ISC-EHB catalogue having more than 1100 earthquakes indicate 12 active source zones of earthquakes in the study area. The source clusters located in the eastern Himalayas are larger in areal extent than those located in the western Himalayas, which are relatively smaller. The vulnerability assessment has been done by integrating two MCDM models, i.e. fuzzy analytical hierarchy process (AHP) and fuzzy technique for order preference by similarity to ideal solution (TOPSIS) through Geographical Information System (GIS). Twenty-six parameters that may influence vulnerability in a region were collected from different open sources, categorized in social, geotechnical, structural, and physical parameters, and utilized to estimate earthquake vulnerability. The results show that more than 50% of the population resides in the Himalayas are under very high to high threat due to earthquakes, 25.81% are moderately threatened, and 23.44% are under low to very low vulnerability. Identifying active source zones and vulnerabilities could be extremely useful for various hazard mitigation and infrastructure planning agencies working in the Himalayan region.

Coastal Flooding and Risk Assessment under Climate Change in Bali Island

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The most commonly recognized consequences of eustatic climate change are the continuous rise of sea levels as global warming leads to the melting of sea ice. Sea-level rise is accelerating at a dangerous pace and it will contribute to more frequent and severe coastal flooding and other destructive types of disaster in low-lying areas. This issue is starting to become a big concern because of the very detrimental impact on all economic activities in the coastal area. Coastal flooding usually occurs on Bali Island during seasonal high tides and inundates the mainland, causing significant damage and disrupting livelihoods. The study presents a methodology to develop a potential risk map for different scenarios of sea-level rise by using a combination of the Digital Elevation Model (DEM) and regional sea-level changes reconstructed by tide gauge and altimetry data. In addition, an extreme sea-level situation, which typically occurs as a result of high water on a spring tide, was also evaluated. Furthermore, the extent of losses was examined in this study. The methodology is applied to the areas identified as highly and extremely vulnerable based on the coastal vulnerability map of Bali Island. Those areas show very different sensitivities depending on the geomorphology, topography, land use, and human activities. In terms of potential impact, assessing the distribution of flood-prone areas is necessary. It can provide recommendations for mitigation measures to reduce the impact of flooding on the site and surrounding area, as well as develop appropriate adaptation policies to prevent disasters caused by global climate change.

Landslide identification and mapping using SAR data

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Abstract: Landslides are significant disasters that occur around the world, causing severe damage to infrastructures and widespread loss of human lives. Timely information about landslides during or immediately after an event is an invaluable source for emergency response and management. Remote sensing satellite observations are widely used in landslide mapping, owing to its capability for wide-area observations and relatively low cost. Synthetic aperture radar (SAR) satellite imagery, which uses active emission and sensing of electromagnetic radiation in the microwave can be an optimal solution owing to the capability of day-and-night and all-weather imaging. In this work, we employed the intensity, coherence information from pre- and post-event Advanced Land Observation Satellite 2 Phased Array L-band Synthetic Aperture Radar 2 (ALOS-2 PALSAR-2) images to identify and map the landslides triggered following the 2018 Hokkaido Eastern Iburi earthquake. Moreover, we also implemented the data fusion of pre-event optical image and post-event ALOS-2 PALSAR-2 full polarimetric data with the polarimetric decomposition for detecting the landslides. Additionally, the landslide mapping result is refined by slope information from a 10m digital elevation model (DEM). The accuracy of the classification results from the SAR intensity, coherence and the optical and SAR data fusion were compared with the available truth data. The advantages and cons of optical image, SAR coherence, intensity and polarimetry were discussed. The detected landslides show a good match with the reference high-resolution optical images. Quantitative comparison results showed that the intensity-based landslide classification has the best accuracy with an overall accuracy and kappa coefficient of 80% and 0.45, respectively.

Learning from Previous Flood Events to Identify Floodwaters in Urban Areas

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In recent years, flood monitoring with synthetic aperture radar (SAR) images has proven to be useful in the early identification of affected regions. In particular, the use of intensity thresholds has been very successful in mapping water bodies in open areas. However, identifying urban flooded areas is more complicated. This is because the intensities can show increases or decreases, depending on the spatial configuration of the buildings. This study analyzes a possible solution to the referred issue using the interferometric coherence parameter in an assembly of automatic learning algorithms. The training data was based on the data collected in the floods in the cities of Koriyama and Iwaki, Japan, due to typhoon Hagibis in October 2019 and the floods due to heavy rains in July 2018 in the city of Mabi, Japan. Sentinel-1 SAR images are used to compute interferometric coherence. Two images, recorded before and after the flood event, are used to compute a co-event coherence. In addition, a pre-event coherence is computed from two images recorded before to serve as a baseline reference. A combination of (i) supervised, based on the collected training data, (ii) semi-supervised, to consider the changes in samples distributions between flood events, and (iii) unsupervised, based on the expected behaviour of interferometric coherence, learning algorithms are adopted in this study to identify flooded urban areas. The experimental results of this approach show good agreement with the flood maps provided by governments and public institutions and support the assumption that the interferometric coherence parameter of previous floods can be used with relative success to identify urban areas flooded by new events.

Tropical Peatland Subsidence Monitoring by Time-Series InSAR for Evaluation of Peat Degradation in Indonesia

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Tropical peatland, recognized as an important terrestrial carbon pool, plays a critical role in carbon cycling, hydrology, and biodiversity, positively impacting the global environment. A tropical peatland is spread out mostly in Southeast Asia, particularly Indonesia and Malaysia. In Southeast Asia, a considerable amount of peat has been accumulated under lowland swamp forests. Once this carbon reservoir ecosystem is destroyed due to human activities such as deforestation, agricultural expansion, and resource exploitation, it causes a severe negative impact on the global environment. Tropical peatland in Indonesia had experienced many land-transformation programs for agricultural areas such as oil palms, rubber, pulp trees, and food production. Those had increased the number of drainage canals required for conveying logged timbers and land draining, resulting in a decrease in groundwater table level (GWL) and drying of the land surface. As a result of GWL decrease, peat/forest fire is more likely to occur, and peat microorganism oxidation is accelerated (peat microbial decomposition), especially during the El Nino. Both fire and decomposition emit massive CO2, leading to carbon loss in peat carbon reservoirs and peatland subsidence. This study attempts to monitor the tropical peatland subsidence by time-series interferometric synthetic aperture radar (TInSAR). Peat subsidence rate is crucial for estimating CO2 emission and GWL based on their strong mutual relationships. A 3-years TInSAR monitoring from Jan. 2018 to Dec. 2020 by Sentinel-1 has been conducted over tropical peatland in Indonesia. The data of GWL in-situ sensors distributed over Indonesia are employed for the analysis with Sentinel-1 TInSAR results, indicating a strong relationship between dry-season averaged GWL and TInSAR subsidence rate over peatland. We further discuss the pros and cons of using Sentinel-1 C-band SAR data for tropical peatland regions and future perspectives.