11th INTERNATIONAL SYMPOSIUM ON DIGITAL EARTH

Florence (Italy), September 24 – 27, 2019

Digital Earth in a transformed Society

20th Anniversary ISDE symposium series

11TH INTERNATIONAL SYMPOSIUM ON DIGITAL EARTH

BOOK OF SHORT ABSTRACTS

http://www.digitalearth2019.eu/

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MESSAGE FROM THE CHAIR

Thank you all for joining us at ISDE11!

About 400 delegates from 37 different Countries attended the 11th International Symposium on Digital Earth, which took place from 24 to 27 September 2019 in Florence, Italy.

260 short abstracts were reviewed by the Scientific Program Committee and 74 extended abstracts were submitted for publication in the IOP Conference Proceedings Series.

A couple of special Issues on two International Journals (IJDE and DATA) are planned.

28 scientific sessions have been organized with a total of 151 talks (including 10 Plenary Speakers and 4 Keynote Speakers at the Grand Debates) and 78 poster presentations.

The Opening Ceremony, held in Palazzo Vecchio, the Florence City Hall, included the celebration of the 20th Anniversary of the ISDE Symposia and the two award ceremonies for the ISDE “Lifetime Honorary President” and “Fellow” title.

Dr. Alessandro Annoni was appointed as the new President of ISDE. Prof. Huadong Guo was awarded the ISDE “Lifetime Honorary President” and the“Fellow” title.

The Manual of Digital Earth, with contributions of more than 100 scholars from 18 countries over three years, was announced.

Three focused Plenary Session and three Grand Debates provided a platform for inspiring presentations and fruitful discussions.

The 2019 Florence Declaration on Digital Earth was adopted as a milestone document after the 1999 and 2009 Beijing Declaration on Digital Earth.

Finally, the 8th Digital Earth Summit was officially announced to be held in Russia in 2020, while the next International Symposium on Digital Earth will take place in Salzburg, Austria in 2021.

Thank you so much to all those who helped in bringing the event together and see you all next year!

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SESSION:
Big SAR and InSAR data for sustainable urbanization and management of urban environments

A NEW THREE-COMPONENT DECOMPOSITION FOR URBAN AREAS

Han Wentao [1], Zhu Jianjun [2], Fu Haiqiang [3], Xie Qinghua [4]

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Abstract

Model-based decomposition is a powerful tool for the interpretation of polarimetric synthetic aperture radar (PolSAR) images, which facilitates us to analyze the scattering process of land covers [1]. One of the most popular model-based decomposition methods is Freeman-Durden decomposition, which has been successfully applied to tropical rain forests [2]. The volume scattering in Freeman-Durden decomposition has two important assumptions. The first assumes that it consists of completely random dipoles and the second is reflection symmetry assumption. However, these assumptions are not hold in urban areas [3] [4] [5]. Therefore, the performance of Freeman-Durden decomposition will be limited in urban areas. To improve the accuracy of the scattering mechanisms interpretation, in this paper, a volume scattering model suitable for urban areas is proposed, which does not satisfy the reflection symmetry assumption. In addition, we don't assume volume scattering consist of dipole. Combining with surface scattering and double-bounce scattering model, a three-component decomposition model is proposed. Most of the existing decomposition models have the problem of over-estimation of volume scattering in urban areas. The proposed method avoids the occurrence of such phenomenon. This decomposition scheme can further analyze the arrangement of urban buildings. The performance and advantages of the proposed decomposition is demonstrated by ALOS-2/PALSAR-2 data set.

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AN INNOVATIVE PLATFORM FOR THE MONITORING AND THE FORECAST IN REAL-TIME OF WATER RESOURCES: THE HYDROCONTROLLER PROJECT

Paloscia Simonetta [1], Santi Emanuele [2], Pettinato Simone [3], Fontanelli Giacomo [4], Lanzetta Ciro [5]

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Abstract

The hydrological monitoring of a basin is important for the management of water resources and the forecast of risk events (floods, avalanches and landslides, droughts). Systems that allow the visualization and interpretation in real-time of the hydrogeological conditions are therefore an essential tool for the players involved.

The HYDROCONTROLLER regional project deals with the water resource monitoring and forecasting platform based on Big Data Analitycs approaches and aims to create an IT platform for real-time monitoring and forecasting of the hydro-meteorological conditions of a basin. This is achieved thanks to the combined use of satellite observation data (SAR, optical), meteorological forecast data and advanced sensor network, some of which are designed and developed ad hoc in the project, which allows rapid reconfiguration and flexibility to operate in a potentially critical environment. In particular, the project activities are focusing on a hydroelectric basin located in Tuscany (Pontecosi) and managed by an energy power supply firm (Enel Green Power, EGP). The monitoring of the basin in terms of water surface seasonal variations and of the hydrological cycle components affecting the power production and the water supply to the urban environment close by are the main objective of the project.

The project also includes automatic systems for the intelligent management of water resources in accordance with the objectives of "Industry 4.0". The platform will be able to display data either through an open layer (freely accessible according to the user license) or with a private layer (for specific customers). The main features of the planned platform are the acquisition and visualization in real-time of the hydro-meteorological information from the monitoring network; the generation of maps of the key-parameters of the hydrological cycle (soil moisture, biomass, and extension of the snowpack) from satellite images; the assimilation of data into forecasting models for the estimate of flows; the setup of a warning system for anomalous conditions of the basin, to support the intelligent management of water resources and of a semi-automatic system for managing hydroelectric plants in case of simple decisions. Moreover, a decision support system for the management of hydroelectric plants in case of complex situations in case the action of a human operator is necessary for matters of responsibility, will be implemented.

BUILDING MAPS DERIVED FROM SENTINEL-1 SAR DATA

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Abstract

The potential of using SAR data to map urban areas has been assessed in multiple studies. In this study, we present an automatic algorithm for mapping built-up areas using synthetic aperture radar (SAR) backscattering intensity and interferometric multi-temporal coherence generated from Sentinel-1 data in the framework of the Copernicus program [1]. The algorithm has been developed in the framework of the ESA CCI-LC initiative, which on 1 September 2015 has launched an Urban Round-Robin (RRob) exercise. The aim of the RRob activity was the selection and identification of the most efficient algorithm for improving/updating the existing global urban land cover products using S-1 data.

The underlying hypothesis of the algorithm is that, in SAR images, built-up areas exhibit very high backscattering values that are coherent in time. Based on the previous working hypothesis, several particular characteristics of the Sentinel-1 satellite mission are put to good use, such as its high revisit time, the availability of dual-polarized data, and its small orbital tube, to develop the proposed algorithm.

The algorithm is based on an adaptive parametric [2] thresholding that first identifies pixels with high backscattering values in both VV and VH polarimetric channels. The adaptive thresholding makes use of a hierarchical split-based approach (HSBA) method to parameterize the distribution functions of the classes of interest [2]. Subsequently, to map pixels with high backscattering values, based on the class distributions defined in the previous step, we employ an hybrid SAR-based methodology that consists of a sequence of region-growing and histogram thresholding [2].

First, the co-polarization channel is selected because urban areas are influenced by the double-bounce effect caused by the presence of buildings, making buildings distinguashable from other land cover classes. Considering the angle between the satellite flight direction and the buildings facade orientation, the backscattering is at its maximum when the line of sight is ortogonal to the building facade, and it declines gradually for higher angles. Secondly, in order to increase the chance of detecting buildings, the algorithm takes advantage of the cross-polarization backscattering, which usually increases due to multiple-bounce in the presence of more complex structures, such as buildings with façade not aligned with the satellite flight direction.

When handling SAR data, it is worth pointing out the importance of accounting for speckle noise, which generally hampers image classification using only backscattering values at the pixel level. A common and straightforward operation to reduce the speckle effect is the multi-looking operator, having as main drawback the decreasing the spatial resolution, thereby hampering the full exploitation of the high spatial resolution that SAR sensors offer. In this algorithm we propose the temporal averaging, which permits to reduces the speckle without decreasing the spatial resolution, making it well-suited for the classification of smaller objects with respect to the resolution of the sensor. The multitemporal averaging is possible thanks to the availability of Sentinel-1 series.

The interferometric SAR coherence is used to reduce false alarms caused by land cover classes that are characterized by high backscattering values but are not coherent in time (e.g., certain types of vegetated areas).

The algorithm was tested on Sentinel-1 Interferometric Wide Swath data from five different test sites located in semiarid and arid regions in the Mediterranean region and Northern Africa. The resulting building maps were compared with the Global Urban Footprint (GUF) derived from the TerraSAR-X mission data and, on average, a 92% agreement was obtained.

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FLOODWATER DETECTION IN URBAN AREAS USING SENTINEL-1 INSAR COHERENCE

Chini Marco [1], Pelich Ramona [2], Pulvirenti Luca [3], Pierdicca Nazzareno [4], Hostache Renaud [5], Matgen Patrick [6]

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Abstract

We propose an algorithm that maps the presence of floodwater in urban areas making use of the Sentinel-1 Interferometric SAR coherence (InSAR) [1]. The algorithm is composed of two steps, it first uses the SAR data to classify buildings and then the InSAR coherence to detect the presence of floodwater in urbanized areas. The main hypothesis is that a building is a very steady target, even at large temporal baselines, i.e. high InSAR coherence. Previous studies used very high-resolution X-band SAR data from the COSMO-SkyMed mission to investigate the decrease of the InSAR coherence for double bounce features [2-3], assuming that the appearance of floodwater implies a significant decrease of the coherence between pairs of images.

In the presented approach, the preliminary detection of buildings it is a pre-requisite for focusing the analysis on double bounce features that also allow to detect the presence of water. To extract the double bounce objects, we use an approach developed for mapping buildings at global scale by means of Sentinel-1 data proposed by Chini et al. (2018) [4-5]. The method is based on the fact that in the co-polarization channel buildings are characterized by high backscattering values as well as by a high degree of temporal correlation between images. To increase the potential for detecting buildings when the line of sight is not orthogonal to the building facade, the cross-polarization backscattering is used as well, as it rises when rotated dihedrals are present. However, high backscattering values can also occur in the presence of vegetation. To cope with false alarms generated by vegetated areas, the algorithm exploits the InSAR coherence.

Once the double bounce feature is detected, the detection of the InSAR coherence drop-off on the previously detected double bounce map is used as an indicator of the presence of water. The method is based on a multi-pass approach exploiting a stack of three interferometric SAR acquisitions. The coherence map between each consecutive pair of images is extracted using a kernel sliding window. We calculate the pre-event coherence (cc-pre), using two images acquired before the event and the co-event one (cc-co), using one image acquired during the flood event and one before the event. Finally, we classify as inundated those buildings where the image difference between cc-pre – cc-co has pixels with positive values higher than a certain threshold.

For this study, data provided by the Sentinel-1 mission acquired in both Strip Map and Interferometric Wide Swath modes have been used, with a geometric resolution of 5m and 20m, respectively. The algorithm has been tested for two different test cases: the flood that affected the city of Houston (Texas) following the landfall of the Harvey hurricane in 2017 and the flood event that hit the Somalia in May 2018. The results have been evaluated through a comparison with very high-resolution optical images acquired almost simultaneously with the SAR images. The comparison with such independent datasets has shown that the proposed approach is able to detect flooded urban areas with high accuracy.

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FUSION OF SENTINEL-1 SAR AND SENTINEL-2 MSI DENSE TIME SERIES FOR URBAN EXTRACTION IN SUPPORT OF THE URBAN SUSTAINABLE DEVELOPMENT GOAL

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Abstract

The pace of urbanization has been unprecedented. Today, 55 per cent of the world's population live in cities and another 2.5 billion people is expected to move to urban areas by 2050 [1]. The UN 2030 Agenda for Sustainable Development gives a prominent role to monitoring the urbanization process. With its synoptic view and large area coverage at regular revisits, satellite remote sensing has been playing a crucial role in urbanization monitoring at regional and global scale. Several methodologies have been developed using Synthetic Aperture Radar (SAR) and/or multispectral imagery to map urban extent globally including the Global Urban Footprint (GUF) [2] and the Global Human Settlement Layer (GHSL) [3] . These datasets provide a reliable global map of the urban areas, but they are characterized by low temporal resolution (i.e. every five years) [4] which highlights the need of further research and methodology development

The objectives of this research are two folds, the first is to develop a globally applicable and entirely automatic method to monitor urban footprints using Sentinel-1 and Sentinel-2 dense time series exploiting the Google Earth Engine (GEE) cloud platform [4], and the second is to evaluation the urban footprints for monitoring UN 2030 urban SD indicator 11.3.1, Ratio of land consumption rate to population growth rate. The innovative aspect of the developed method is the fusion of Sentinel-1 SAR and Sentinel-2 MSI dense time series using a totally unsupervised approach. The estimation of the selected urban footprint is performed in several progressive steps. First, the area of interest is divided into mountainous and non-mountainous areas using an available DSM (i.e. SRTM or ALOS World 3D) to take into account the layover and foreshortening of SAR geometric distortions. Then, Sentinel-1 SAR ascending and descending time series are processed in order to enhance the backscatter of stable urban areas and to compute the Sentinel-1 Urban mask using an automatic thresholding procedure. The latest step is to compute a probability urban map combining the Sentinel-1 Urban mask with the Sentinel-2 multi-spectral time series. All available Sentinel-2 images, acquired during the selected sensing period, will be used to compute a cloud-free Sentinel-2 image composite, subsequently we applied a segmentation algorithm to the Sentinel-2 composite, and for each object, we compute several multitemporal spectral indexes statistics (i.e. Min/Max NDVI, Median NDBI, Mean NDWI). Finally, we use a ruleset to estimate the probability urban map combining the Sentinel-1 Urban mask with the computed Sentinel-2 indexes statistics.

To ensure its global applicability, we tested the developed approach in several cities worldwide (i.e. Beijing, Lagos, Milan, Mumbai, New York, Rio and Stockholm) characterized by different urban density and morphologies. We computed the urban footprint in different periods to evaluate the temporal stability of the method and to produce urban footprint time series. The results show that through this method it is possible to obtain high accuracy (kappa higher than 0.85) with respect to the reference data acquired within the EO4Urban project in all cities and in different periods [5]. The developed method obtains equal or higher accuracy than GUF and GHSL data in the same area, and a visual comparison shows that the integration of the Sentinel-1 SAR and Sentinel-2 MSI data leads to achieve highly detailed information.

Based on the methodology defined by the UN Habitat, the urban extraction results are being used in the monitoring of Urban SDG indicator 11.3.1 Ratio of land consumption rate to population growth rate in the selected cities. The preliminary results show that timely and reliable urban extraction is essential for the definition of cities and for monitoring the Urban SDG indicator 11.3.1.

IMPERVIOUS SURFACE MAPPING USING SENTINEL-1 CROSS-POL COHERENCE AND DECORRELATION TIME

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Abstract

Remote sensed imperviousness products share a large interest within the scientific community thanks to their importance in a high number of applications such as Urban Heat Island modelling, socioeconomic modelling (population, GDP, etc) and soil sealing monitoring [1].

Currently, Copernicus delivers a 20 x 20 m imperviousness density layer on a yearly basis, derived only from optical images (SPOT 5, Resourcesat-2, Landsat 8) using a regression model of calibrated Normalized Difference Vegetation Index (NDVI) values [2].

In this work, a very simple, innovative and quick methodology to derive such information, based only on the 20 x 5 m Sentinel-1 IW-TOPS SAR night and day, weather independent observations, is presented.

As in the first case, urban features classification depends on the assumption that NDVI value is very low, here we assume that urban features behave in the SAR scene as dihedral scatterers.

According to dihedral scattering theory, effective dihedrals can be only 0 or π valued in the cross-POL coherence, allowing to easily segment the scene in a binary map of urban features [3]. These two assumptions admit a similar degree of robustness with respect to the classification of impervious elements as defined in [2] and are here discussed. The classification is refined using targets amplitude and decorelation speed.

Thus, the 20 x 5m resolution binary map is converted in a 20 x 20 m density product downsampling the grid in the range direction from 5 to 20 m, achieving the capability of describing five degrees of imperviousness, from 0% to 100%.

Furthermore, the six days revisit time of Sentinel-1 constellation produces an abundance of observations, thus allowing a robust estimate of the cross-POL coherence, via multi-temporal averaging, as well as a very high temporal resolution.

The accuracy of the proposed methodology has been assessed over Milan, using as reference a raster derived from the municipality building footprint vector layer, released by Lombardy Region.

Results show a significant robustness of the product derived following the proposed methodology, thus pointing out that the optical and radar-derived products might be successfully integrated in order to obtain better results in overall accuracy.

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MAPPING IMPACT OF URBANIZATION IN SHAHAT-CYRENE (LIBYA) USING A BIG SAR DATA APPROACH OF CHANGE DETECTION WITH COSMO-SKYMED TIME SERIES

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Abstract

COSMO-SkyMed, the Italian Space Agency (ASI)'s flagship Synthetic Aperture Radar (SAR) constellation, provides very short repeat cycles (up to 1 day) thanks to the deployment strategy and configuration of the four twin satellites. With a regular schedule, long time series of hundreds of images can be acquired over few years and used to track dynamic surface processes, such as spreading urbanization. This Earth Observation facility could be an asset for R&D activities aiming to support decision-makers in regions with limited resource for land management. In this paper, we present an experiment carried out on modern Shahat, Libya, where uncontrolled and unregulated urbanization south of Cyrene UNESCO World Heritage Site has been reported by recent studies as a pressing issue, and of which we have found clear evidence by analysing the full archive of cloud-free Sentinel-2 at 10-m resolution since mid-2015 [1]. In particular, we present the results obtained by implementing a big SAR data analysis approach on a selection of more than 180 StripMap images, that the COSMO-SkyMed background mission has consistently collected at 3-m resolution since 2011. We prove the accuracy of the method and highlight the mutual complementarity with coeval optical satellite images provided by Copernicus Sentinel-2 to improve the timeliness of new urban feature detection.

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MONITORING URBAN AREAS WITH MULTI-TEMPORAL SAR DATA: CURRENT AND FUTURE TRENDS

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Abstract

During the last two decades, results obtained by processing multi-temporal SAR data acquired by different satellite sensors have shown their potential for different applications. Radar interferometry (InSAR) has proven to be effective in measuring surface deformation phenomena, in particular over urban areas, with precision up to 1 mm, while change detection algorithms applied to multi-temporal SAR data have shown how simple and effective can be their use for flood mapping and for monitoring urban sprawl. Key points for an operational use of this space technology are: (1) regular acquisition of SAR data using the same acquisition geometry; (2) use of advanced processing algorithms; (3) access to significant processing power; (4) availability of fast and easy-to-use visualization tools. All these constraints have been overcome thanks to recent advances in SAR data processing, the advent of cloud computing, WebGIS solutions, and the launch of a growing number of satellite platforms. Indeed, since the launch of the ESA ERS-1 mission in 1991, the number of satellite SAR sensors has increased steadily, as well as the number of users of radar data, while the cost of both radar sensors and satellite imagery is getting lower. The technical features of satellite radar platforms are also improving and sub-meter resolution has become available for civilian applications too. Spatial resolution is particularly important when radar data have to be used for monitoring individual buildings and structures, as it is the case for projects related to urban areas. Based on the present scenario and the trends we see in the market, we expect radar data to complement more and more optical images in any monitoring solution based on satellite imagery, making it possible to generate huge databases of information, continuously updated. Hopefully, this information will be used by decision makers for improving safety and for a more effective management of the territory.

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MULTI-BASELINE SAR INTERFEROMETRY FOR SUBSIDENCE MONITORING IN WUHAN, CHINA

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Abstract

SAR interferometry is an immensely valuable tool for measuring small distance differences from space. The differences are measured as phase differences and are therefore a) measured in fractions of a system's wavelength and b) wrapped in the phase cycle between -pi to pi. Differential SAR interferometry therefore allows to measure precisely motions that do not exceed half of the wavelength, because larger motions lead to phase changes larger than 2pi, which leads to ambiguities. The much bigger problem of differential interferometry is the temporal decorellation. Interferometry requires coherent electromagnetic signals to generate a (meaningful) interferogram. Changes on the ground can lead to changes in distances that exceed the half wavelength limitation, which will lead to incoherent phases, not suitable for interferometry. This basically leads to differential interferometry with short wavelengths being unsuitable for vegetated areas. However, in urban areas, we can find a large amount of relatively stable backscattering objects that provide phase stability even over long time periods.

The remaining issue are the influences of the atmosphere. In a simplified approach, we assume the electromagnetic signal traveling with the speed of light. However, going through the atmosphere, the signal is slowing down. Unfortunately, this reduction in speed is not constant. The main influence is the water content of the atmosphere and the electron content of the ionosphere for longer wavelengths. These are highly variable and the difference in travel speed between images can easily accumulate to > 30 cm from the variabel wet atmosphere influence alone. It is therefore essential to eliminate influences from the atmosphere for long-term and wide area monitoring.

There are several approaches of reducing the atmospheric influence. Typically, a larger number of images is used to separate the different phase contributions, especially the topographic contribution, the atmospheric contribution, and the displacement contribution. The topographic contribution can be estimated rather easily, as it is the only part of the phase that is related to the baseline of the sensor acquisitions. Separating the atmospheric components from the displacement is normally achieved by modeling the displacement and the atmospheric components. For example the displacement can be modeled as linear in time and the atmosphere is typically defined to be related in space, but not in time, which allows to separate the atmospheric components by filtering in space and time.

In the proposed paper, we will compare different implementations of this multi-baseline D-InSAR using multiple sensor data acquired over Wuhan. Wuhan is a large traffic hub in central China and home to numerous universities in China. Actually, it is the city with the largest student population world wide. It is also a fast developing city, with various infrastructure projects underway. Several subway lines have been completed in recent years and more are currently under construction. Due to the different geological situations in the different city parts, these construction activities lead to different subsidence effects. Furthermore, due to the fast development cycle, the spatio-temporal patterns of the deformation change rapidly. Long-term observation of the subsidence and of the changes in the subsidence patterns is therefore necessary.

These fast changing patterns can be challenging for standard PS-InSAR approaches, as this leads to non-linear behavior of the deformation, especially if longer periods are considered. This has to be taken into consideration when processing the data.

In the final paper, we will show InSAR deformation estimations over Wuhan derived from several SAR systems. We will demonstrate the changing patterns of deformation and also discuss the influences of the different processing techniques on the estimated subsidence.

MULTI-PLATFORM MULTI-SCALE INSAR-BASED SURFACE DISPLACEMENT MEASUREMENTS OVER MEXICO CITY FOR SUPPORTING GROUND AND INFRASTRUCTURE STABILITY EVALUATIONS

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Abstract

Multi-platform multi-scale InSAR-based surface displacement measurements over Mexico City for supporting ground and infrastructure stability evaluations

Mexico City faces a severe groundwater-budget deficit, which has led to extremely fast land subsidence (>350 mm/yr) and widespread ground-stability problems. Groundwater is the main source to satisfy the hydric demand produced by the metropolitan's industry and population (>20 million inhabitants). However, longstanding groundwater over-pumping from the highly-compressible clay-rich aquifer system beneath the city has produced sustained pore-pressure loss and, consequently, very fast land subsidence. Additionally, the composition and thickness of the underground sediment layers conforming the aquifer system, as well as the groundwater-level lowering rates, vary greatly over short distances. Consequently, localized areas withstand pronounced differential subsidence. Such complex setting of surface displacements produced by subsidence and differential subsidence produces damage to the ground and man-made structures and represents a threat to their stability, often times exacerbated by sporadic events such as earthquakes. Thus, displacements monitoring in Mexico City requires observations at multiple scales and at different spatial resolutions, often times focused at specific time spans. Traditional field-leveling techniques, however, provide sparse displacements' measurements over relatively small areas, mainly determined by economic and human resources.

In this work, we present case examples of subsidence monitoring over Mexico City from satellite data for supporting ground and infrastructure stability evaluations. Our study is based on four Synthetic Aperture Radar (SAR) datasets from the Sentinel-1A/B, TerraSAR-X and COSMO-SkyMed satellites acquired between 2011 and 2018. We obtain displacements measurements by performing Interferometric SAR (InSAR) time-series processing. We exploit the large coverage and short repeat cycle (up to six days) of the Sentinel-1A/B dataset, as well as the high spatial resolution (~3 m) of the TerraSAR-X and COSMO-SkyMed scenes. We apply port-processing techniques to each InSAR velocity map we obtain from each dataset for enhancing the spatial characteristics of the subsidence signals' distribution. We observe the city-scale subsidence pattern over Mexico City from the Sentinel-1A/B dataset, as well as localized variations of the subsidence (i.e. differential subsidence) from the TerraSAR-X and COSMO-SkyMed datasets. The city-scale subsidence pattern reveals a correspondence of the fastest subsidence rates with the sediment layer's thickness distribution, as well as a sharp contrast of the subsidence rates along the transition from non-subsiding to highly-subsiding areas. The high-resolution results reveal variations at local scale in correspondence with local-scale changes of the underground sediments and large buildings and infrastructure features, as well as signals that correspond to the location of surface faulting. Our multi-platform multi-scale InSAR results reveal displacements information with potential application to the governmental management of groundwater resources as well as for geotechnical mapping, infrastructure monitoring and surface faulting detection.

NATIONAL SCALE P-SBAS DINSAR MAPPING WITHIN CLOUD COMPUTING INFRASTRUCTURES

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Abstract

The Big Data paradigm is bringing a revolution in the Earth Observation (EO) where it is opening promising investigation opportunities and facing new challenges. Indeed, the recent huge EO data availability provided by an increasing number of satellite constellations is moving the EO techniques towards their exploitation and application at large spatial and temporal scale. For instance, if we focus on Synthetic Aperture Radar (SAR) data, the current scenario is characterized by a huge increase on the EO data flow due to the C-band Sentinel-1 (S1) satellite constellation of the European Copernicus Programme, which acquires more than 10 TB per day of new images at a global scale with a free and open access data policy. In these terms, it is evident that the S1 constellation is significantly contributing to move EO toward a Big Data scenario.

One of the EO techniques that largely exploit SAR data is the Differential SAR Interferometry (DInSAR) [1] that is regarded as one of the key EO methods for its ability to investigate surface displacements affecting the Earth surface with centimetre to millimetre accuracy. Therefore, the possibility to exploit the currently available huge archives of SAR data by means of DInSAR techniques is widely envisaged, not only to detect large spatial scale deformation phenomena (as for instance the continental tectonic strain), but also to have a comprehensive view of the ground deformation status at wide (e.g. Country) scale for land management, urban monitoring and civil protection purposes. Accordingly, the application of DInSAR to the depicted Big SAR Data scenario represents a challenging task in terms of data volume management, processing velocity, computing power needs as well as result visualization, analysis and interpretation.

In this work we present the results obtained by implementing and exploiting, within a Cloud Computing (CC) environment, an interferometric processing chain based on the Parallel Small BAseline Subset (P-SBAS) [2] approach, to map the ground deformation of the entire Italian territory. The implemented P-SBAS chain permits to generate advanced DInSAR products by taking full benefit from parallel computing architectures, such as the Cloud Computing infrastructures provided by the Amazon Web Services (AWS) or by the ONDA DIAS [3]. Moreover, the P-SBAS chain supports both multi-node and multi-core scheduling policies and permits to generate surface deformation time series from large volumes of S1 data, thus allowing us to perform, as in this case, national-scale DInSAR analyses [4]. It is worth noting that the presented processing chain manages: i) the transfer of the input data from the S1 archives to the computing resources available within the CC environment; ii) the parallel processing of these data according to the SBAS algorithm; iii) the exploitation of external data, like GPS measurements, to make the processing totally automatic and robust; iv) the long term storage of the generated results within the CC environment; v) the possibility to access and visualize the generated deformation maps and time series on a GIS system located in the cloud environment. It is finally worth noting that the presented S1 P-SBAS chain can work with different S1 data mirrors and hub, and can be integrated within different CC platforms.

As experimental results we show the national-scale DInSAR processing performed over the whole Italian territory by exploiting the S1 data acquired from both ascending and descending orbits between March 2015 and August 2018. In particular, this analysis involved the processing of 6952 S1 slices acquired from ascending orbits and 6031 S1 slices acquired from the descending ones. The generated mean deformation velocity maps of the entire Italian peninsula and their analysis, together with the implications that such results can have with respect to policy makers and civil protection authorities, will be shown and discussed at the conference.

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NATIONWIDE SENTINEL-1 BASED PERSISTENT SCATTERER INTERFEROMETRY DATASETS AND PRODUCTS IN THE FRAMEWORK OF THE GROUND MOTION SERVICE GERMANY

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Abstract

Advanced interferometric SAR processing techniques are able to detect and monitor various surface displacements caused by e.g. soil compaction, soluble and swelling rock formations, groundwater extraction, natural gas extraction, mining, cavern storage operation and landslides. These processes can cause damage to buildings and infrastructure, affect ecosystems and agriculture or affect the economic use of the geological underground e.g. by influencing the hydrogeological setting. Despite the maturity of the PSI technology it is rarely used in operational workflows of the German user community (e.g. from responsible authorities). Nevertheless, SAR data availability is a precondition for the operational use. From this perspective, Copernicus Sentinel-1 is a game changer, ensuring SAR data availability for almost the entire Earth, until at least 2030. In order to support the operational use of this technique the “Ground Motion Service Germany” is currently established by the Federal Institute for Geosciences and Natural Resources (BGR).

The service uses Persistent Scatterer Interferometry (PSI) datasets of the entire nation (approx. 360, 000 km^2). The PSI datasets are based on Sentinel-1 ascending and descending acquisitions. Continuous Global Navigation Satellite System (cGNSS) measurements are used to calibrate and validate the PSI datasets. In order to cover the entire nation, the mapping coverage is increased by mosaicking PSI datasets from adjacent SAR image stacks. Numerous applications, pilot studies and in depth case studies are performed to verify the PSI datasets and to improve the usability. This presentation gives an overview of the Ground Motion Service Germany, shows the characteristics of the nationwide PSI datasets and finally highlights the main findings of selected case studies. With respect to the characteristics of the Sentinel-1 PSI datasets the precision of the Line of Sight velocity, the geocoding precision and the spatial sampling density are shown. The presented case studies involve the monitoring of subsidence caused by cavern storage operation and soil compaction in coastal lowland areas. Value added products are generated to support the usability of the Line-of-Sight measurements. For this reason 2D-motion decomposition to estimate the vertical and East-West velocity vectors and cluster analysis to automatically detect displacement areas are applied. These products are demonstrated and discussed with respect to the case studies.

WIDE-AREA OBSERVATIONS OF SURFACE DEFORMATION IN MEXICAN URBAN AREAS AND GEOTHERMAL FIELDS USING ENVISAT INSAR

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Abstract

There is an increasingly growing literature on the use of advanced multi-temporal InSAR to monitor surface deformation with millimeter precision in urban and rural environments, including applications over wide areas spanning hundreds to thousands sqkm. Over Mexico, some wide-area studies have characterized land instability in urban areas mainly due to exploitation of groundwater resources, volcanic activity and tectonics. Much rarer are studies focusing over regions encompassing Mexican geothermal fields to study the potential intermingle between the regional geological and tectonic setting, local groundwater management, seismicity, and geothermal energy production activities. In this work, we survey the 19, 000 km2 wide eastern sector of the Trans-Mexican Volcanic Belt, extending from the state of Hidalgo, through Tlaxcala, Puebla and up to Veracruz, and including both the Acoculco caldera complex and Los Humeros geothermal field, one of the largest of Mexico. Using the Small BAseline Subset (SBAS) InSAR method, we process the ENVISAT Advanced SAR (ASAR) IS2 archive acquired in 2003-2010 over the study area and extract over 300, 000 coherent radar targets. Estimated annual displacement rates span between -3.1 and +1.1 cm/year across the region, and a number of land deformation hotspots can be identified within urban areas such as Tulancingo, Tlaxcala and San Salvador Huixcolotla, as well as within the Los Humeros caldera. Through such a scientifically interesting test region, we provide a proof of concept on how to investigate natural and anthropogenic processes in urban and rural areas using big InSAR datasets.

SESSION:
Big Earth Data and Digital Earth

3D INDOOR PATH ANALYSIS IN DIGITAL EARTH SCIENCE PLATFORM: 3D MODELLING, PATH ROUTING AND VISUALIZATION

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Abstract

3D path network analysis for indoor space provides strong decision support for users in searching optimal routes on applications such as emergency services, disaster management, security, transportation and visitor guiding. Generating 3D path models (with textures) from indoor paths is a good way to improve the visualization performance of 3D indoor path analysis. In this paper a quaternion-based piecewise 3D modelling method was proposed to automatically generate highly recognizable 3D models for indoor paths. A height heuristic A* algorithm for 3D path analysis was introduced to calculate the shortest path from a 3D indoor path network, and a highlight blending procedure based on OpenGL Shading Language(GLSL) was implemented to visualize the shortest path models in the Digital Earth Science Platform(DESP). The test results showed that height heuristic A* algorithm could find the optimal path quickly and accurately, taking less than 2ms to find the shortest path from a network with 500 edges. The numerical comparison of 3D scene primitives in different visualization modes indicated that the proposed methods can generate detailed and irredundant models for indoor path network. The result of 3D path analysis in DESP showed that the indoor path models can improve the visualization performance of 3D indoor path network by displaying the paths with different shapes, textures and colours, and keep a high rendering efficiency (above 50 frames per second) in a 3D scene containing more than 50 thousand polygons and triangles.

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A MULTIPLE DAG WORKFLOW SCHEDULING AND EXECUTION METHOD BASED ON PREDICTED RUNTIME

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Abstract

Remote sensing technology has become one of the important ways for people to know and understand the earth [1]. To solve the problem of increasing computing tasks and complicated calculation process, a good method is scheduling the tasks of remote sensing retrieval process to be solved in collaborative execution of numerous computing resources in a distributed environment [2]. Workflow technology is generally studied and used at present. Workflow is a computational model that automates the operation of part or whole of business process in computer environment [3]. In the field of scientific computing, workflow is an accurate description of the scientific process and is a multi-step, collaborative process of multiple tasks. Each task represents the execution of a computing process that is well suited for large-scale remote sensing retrieval applications that require systematic, accurate and repetitive operation with various remote sensing data processing and analysis tasks [4].

Based on the current large amount of remote sensing data and the inefficiency of quantitative processing, this research studies how to carry out efficient remote sensing data processing and improve the efficiency of quantitative remote sensing processing. A method based on DAG workflow for remote sensing is adopted in this research. Workflow technology is a technology that automatically runs processing in a computer environment by building a task model [5]. This research is based on the remote sensing retrieval workflow for performing time prediction, and the realization of more efficient remote sensing tasks based on the predicted execution time. The main step of the job is to make runtime prediction based on one the task and multiple DAG remote sensing retrieval schedule and execution. The retrieval of aerosol optical thickness for remote sensing is the example in this research, and retrieval method is SRAP-MODIS algorithm [6], which introduces the main steps and data using algorithms, and then expounds the two methods execution time prediction which contain the least square method and instance transfer learning method. The time-based prediction is based on the historical execution time record information. The least squares or instance transfer learning is used to calculate the predicted execution time [7]. The aerosol optical thickness retrieval task is integrated into the DAG task model, and the task scheduling process and priority within the DAG model are defined and explained. The advantage of this research is that the multi-DAG workflow task and the sequential execution workflow task are compared in terms of total execution time, average execution time, system computing node resource utilization, etc., and multiple DAG workflow tasks are obtained. Substituting the least squares learning and the instance transfer learning into the scheduling and execution methods when the number of remote sensing retrieval workflows is less than or equal to the number of processors in the computer environment, the total execution time and average execution time are reduced by an average of 32%, and the utilization rate of system computing resources is increased by an average of 37.8%. And the results show that satisfactory predicting accuracy with an average relative error of 2.95% - 11.97% and 6.29% - 32.11% has been achieved. And the experiments reveal obvious advantages from the aspects of makespan, turn-around time, workload balance, and resource utilization. It is proved that multi-DAG workflow task scheduling improves the efficiency of aerosol optical thickness retrieval.

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BIG EARTH DATA FOR ASSESSING THE ECOENVIRONMENT ALONG CHINAPAKISTAN ECONOMIC CORRIDOR

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Abstract

The “Belt and Road Initiative” (B&R) is to jointly build the Silk Road Economic Belt and the 21st-Century Maritime Silk Road, which have attracted close attention from all over the world [1]. After proposed in 2013, the B&R has grown from a concept to a key platform for building a community with a shared future for humanity. As the flagship project of the B&R, the development and construction of the China Pakistan Economic Corridor (CPEC) plays an important demonstration and promotion role [2]. The construction of the CPEC is conducive to strengthening the connectivity between China and Pakistan and promoting the joint development of the two countries.

CPEC starts from Kashgar in China and ends at Gwadar port in Pakistan, covering a total distance of 3, 000 kilometers. It is a trade corridor covering "four-in-one" channel, including road, railway, oil and gas pipeline, and optical cable. The corridor runs from north to south across Pakistan, and the cooperation fields cover the building of infrastructure, power resource development, mineral, oil and gas resource development. However, the CPEC passes through mountainous area, cold and arid area. This region has diverse climate, frequent extreme weather and natural disasters, and fragile eco-environment, which not only restrict the development of local economy but also the smooth construction of the corridor. Generally, three kinds of eco-environment problems exist in the CPEC region. First, the mountainous areas in northern Pakistan are the confluence of the Himalayas, the Karakorum Mountain and the Pamirs plateau. The CPEC highway, which connects China and Pakistan, runs through this region with serious geological hazards. Second, in the middle part of CEPC, serious soil erosion and flood are frequently happened. Third, the whole CPEC regions are suffering serious water scarcity problem.

Monitoring and assessing the eco-environment along the CPEC is of great significance to the green growth and sustainable development of this corridor. In 2018, Chinese Academy of Science launched the Strategic Priority Research program “Big Earth Data Science Engineering (CASEarth)”. The Digital Belt and Road is one of the research components of CASEarth. The Digital Belt and Road is to better understand the spatial distribution of regional resources and environments, development potential and change trends by building a big Earth data integration and technology evaluation system and science database. Supported by CASEarth, focus on the CPEC, the objective of this study is (1) to develop the remote sensing technologies for the monitoring of typical eco-environment elements in the CPEC, (2) to produce the time series datasets of those typical eco-environment elements, (3) to assess the pattern, quality and ecological function of the ecosystems and (4) to diagnose the major eco-environment vulnerability and potential risks in different sections. The research is helpful to accumulate the dataset of CPEC eco-environment factors, find the vulnerable and sensitive areas of the eco-environment, and discriminate the potential risks and positive effects to the eco-environment security brought by the sustainable construction of the corridor, so as to serve the B&R decision-making.

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CASEARTH CHINA SUBSYSTEM AND CASE STUDIES

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Abstract

The HAQ-China reanalysis is the first and the latest high resolution air quality reanalysis dataset over China produced by the State Key Laboratory of Atmospheric Boundary Physics and Atmospheric Chemistry (LAPC). The HAQ-China reanalysis is supported by the CAS-EARTH Project to afford the 5kmx5km resolution gridded datasets of hourly SO2, NO2, CO, O3, PM2.5 and PM10 levels, the derived fields including transport flux, visibility and source contributions over China vertically from surface to 10 km high. It is expected to cover the period from 1 January 2013 to 31 December 2018, and continues to be extended backward to 1980, and forward in near-real time. This paper describes the forecast model, data assimilation method, and input datasets used to produce the HAQ-China, and discusses the performance of the system. In order to afford the high quality of the reanalysis products and the consistency in time of reanalyzed geophysical fields of air pollutants, we have made lots of efforts on quality control, bias correction, the better models, better input data and better data assimilation method.

The Global Nested Air Quality Prediction Modeling System (GNAQPMS) is the global version of the Nested Air Quality Prediction Modeling System (NAQPMS), which is a multi-scale chemical transport model used for air quality forecast and the base model for the reanalysis calculation. An on-line source-tagged model coupled with an air quality model (Nested Air Quality Prediction Model System, NAQPMS) was applied to estimate source contributions of primary and secondary pollutants for each grid. This source-tagged model system could simultaneously track spatial and temporal sources of each component, which were apportioned to their respective primary precursors in a simulation run. The model system has successfully applied and fully supports the establishment of the national weather and heavy pollution forecasting and warning system. The NAQPMS model has being operated in the National Environmental Quality Forecast and Warning Center, the Regional Centers of Beijing-Tianjin-Hebei, Yangtze River Delta, and the Pearl River Delta as well as most of the provinces and cities in China. Moreover, the models have served for air quality forecasts during number of international events including the Beijing Olympics, Shanghai World Expo, Guangzhou Asian Games, Nanjing Youth Olympic Games, Beijing APEC Summit, 9.3 military parade, and G20 conference. The results have been widely used in the prevention and control of air pollution in key areas such as the Beijing-Tianjin-Hebei, the Yangtze River Delta and the Pearl River Delta.

Through cross-species assimilation scheme co-constrained by multiple pollutants based on the ground observations, satellite observations and retrieval of pollution sources, we built and applied the ENKF assimilation system of atmospheric chemical data, to enable the cross-domain development of PM2.5 forecasting and reanalysis high resolution datasets over China. For the first time, the high-resolution hourly air quality reanalysis dataset over China was produced by the coupled model system for 6 years (from 2013 to 2018) over China. Generally, we showed that a 5 km resolution reanalysis datasets could accurately capture the spatial and temporal variations of air pollution levels PM2.5 concentration.

CASEARTH CLOUD: ARCHITECTURE AND SERVICES

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Abstract

On 12 Feb 2018, CAS announced the launch of a new project on Big Earth Data called “CASEarth”, mainly focusing on building a global big data network to study Earth and support research on climate change, as well as to predict and mitigate natural disasters. To realize the capability of collecting, storing, managing and analyzing Big Earth Data, one of the key missions is to design and develop a Big Earth Data Cloud (CASEarth Cloud) to integrate the cyber-infrastructure, research data, data analysis methods and tools, etc., providing transparent services for discovery and decision making.

When we started to implement the cloud, we faced many challenges: How to make cyber infrastructure and computing facilities be transparently and easily shared by multi applications and users? How to make data be FAIR (Findable, Accessible, Interoperable and Reusable)? How to share the scientific models, big data analysis methods and algorithms? An open and flexible architecture is needed to integrate so many distributed, diverse resources and services dynamically. This paper shared the CASEarth Cloud architecture in detail, including the key components and their relationships, the protocols and federated services mechanism.

Except for building a big computing and storage facility, we have to develop a software stack. This paper introduced several key components. The computing and storage system aggregate specific clusters and distributed computing resources, providing multiple storage interfaces, supporting elastic scaling out. The data system aims to construct a Big Earth Data Repository to provide data capability by collecting multi-source data of many domains like biology, ecology, and ingesting special data products produced by Big Earth Data research projects. The data process system develops multiple data process engines to meet diversified data processing requirements. By utilizing container and virtualization technology, we can pack-up computing engine logic for rapid deployment and hybrid deployment. The data analysis system provides a data intelligent analysis and development environment, sustaining an algorithm library, supporting online code editing and model sharing. We integrated all these services and develop a portal to provide unified public services of big data storing, computing, processing, analyzing, and application integrating for all kinds of users.

CHALLENGES AND OPPORTUNITIES IN ESTABLISHING CHINA INFRASTRUCTURE FOR BIG BIODIVERSITY DATA

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Abstract

High-quality biodiversity data are the scientific basis for understanding the origin and maintenance of biodiversity and dealing with its extinction risk. Currently, at least seven knowledge gaps in biodiversity science were identified, including the lack of knowledge on species descriptions [1], species geographic distributions [2], species abundance and population dynamics [3], evolutional history [4], functional traits [5], interactions between species and the abiotic environment [3], and biotic interactions [5]. The arrival of the current era of “big data” offers a potential solution to address these shortfalls. Gathering big data of biological sciences and mining novel discoveries cross disciplines will lead to the change of the way how life system should be understood, and how biodiversity resources should be utilized sustainably. Therefore, to establish an infrastructure for the big biodiversity data in China is urgently needed. It is also a challenge to overcome the barriers from the inter-disciplines and effectively improve the quantity of biodiversity data.

This infrastructure incorporates big biodiversity data from both macro and micro scales, and integrates data services and data mining system. In the bio-dataset subsystem, the big data from palaeontology and genomics, diversity of species and ecosystems are well integrated. Almost 1 billion data items including 30 rasterized datasets from Atlas of Paleoenvironment to Bio mappings of China, 98 Databases such as species functional traits, ecosystem assessment and ecological security patterns for China, and 121 data products will be newly released in four years as a comprehensive visualized big data infrastructure being available to the public. Currently, the bio-dataset includes more than 3.6 million items on China's biosphere, 420, 000 items on microbes and 490, 000 items on paleontology. It will update 2 million gigabytes of data every year, making sure users have the latest and most comprehensive data. The openness and sharing of scientific data have been major resources and driving forces for scientific development around the world. For example, a fossilized turtle in southwestern China that lived about 230 million years ago was discovered based on our big data. This finding, roughly 2-meter-long animal dubbed Eorhynchochelys sinensis, filled an evolutionary hole in how reptiles developed features such as beaks and shells publishing in Nature last year. In the bio-tool subsystem, high-quality data processing and organizing models will be developed, allowing the meta-analysis from "species-resources-genomics-functions" being examined through the complete life cycle at different spatial-tempo scales. Applications based on artificial intelligence for identifying species and a biosafety early-warning systems will be developed. The next-generation high-resolution vegetation map, generated by deep learning technologies based on the vast amount of field inventories and the remote sensing data from multiple sources, will be integrated into the most comprehensive online system with the description, photos and videos for vegetation classification units of China. This three-dimensional bio-mapping subsystem will not only provide online services for monitoring the change of vegetation, but also provide data for the conservation and proper utilization of the ecological resources. In the bio-service subsystem, the parameters obtained from the ground-based monitoring and remote sensing data will help with monitoring the land coverage and assessing the environment's carrying capacity, therefore, will contribute to the national ecological security.

These services will contribute greatly to data-driven discoveries and policy decisions, and promote the integration of different scientific disciplines as well as worldwide collaboration. We are more than happy to share our data and knowledge, collaborating with scientists overseas to tackle common challenges.

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CHANGE CHARACTERISTICS OF VEGETATION COVER IN GLOBAL COASTAL AREAS BASED ON GIMMS NDVI3G DATA

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Abstract

Based on GIMMS NDVI3g data from 1982 to 2014, pattern-process characteristics of vegetation cover were analyzed in global coastal areas, and furthermore, historical trends and future evolutions of vegetation cover change on pixel scale were studied by using Mann-Kendall trend test and Hurst index. Main findings are as follows: 1) vegetation cover in global coastal areas has dramatical differences, in specific, desert belt is mostly perennial non-vegetation cover or low vegetation cover, and tundra belt located in the northern coasts of North America and Eurasia is principally moderate vegetation cover or relatively dense vegetation cover, and moreover, temperate mixed forest and temperate deciduous broad-leaved forest belt, subtropical evergreen hardwood forest belt, subtropical evergreen broad-leaved forest belt, tropical grassland belt and tropical rainforest belt are mainly dense vegetation cover; 2) in global coastal areas, intra-annual variations of vegetation cover show a "∩" shaped curve with obvious peak from June to September (maximum in July or August), and inter-annual variations reveal a fluctuating but generally slowly increasing trend during the entire study period; accordingly, variation characteristics in different subregions have significant differences; 3) on monthly, seasonal and annual scales, change trend of vegetation cover is mostly increasing in global coastal areas, while areas with decreasing trend are relatively few, and change trends in most area have relatively strong positive persistence; 4) the increasing trend of high-latitude coastal tundra is extremely significant in growing season, and the reason lies in, vegetation in tundra belt is sensitive to the response of climate change; 5) areas with decresing trend of vegetation cover change exhibit pattern characteristics of aggregating in "Circum urban agglomerations" and "Nearby desert belt", that is, the decreasing trend of vegetation cover is relatively significant in coastal urban agglomeration areas and the periphery of desert belt. This study is expected to provide reference for vegetation conservation, ecosystem management, integrated coastal zone management and climate change adaptation in global coastal areas.

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DIGITAL EARTH SCIENCE PLATFORM OF CHINESE ACADEMY OF SCIENCES

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Abstract

In the past ten years, the fast development of Earth observation, wireless sensor network and communication technology have created huge amount of geo-information scientific data, which we name it as Big Earth Data. It is characterized by massive, multi-source, heterogeneous, multi-temporal, multi-scale, high-dimensional, highly complex, and unstructured which becomes impractical to be processed and analyzed by individual research groups (Kitchin, 2014; Guo, 2017a). Consequently, pooling the data resources and computing resources to construct a large scientific platform is essential that can organize, process and analyze big Earth data for the scientists and decision makers.

As a sub-project and also an key part of Big Earth Data Science Engineering (CASEarth) initiative (2018-2022), supported by the Strategic Priority Research Program of CAS, the new generation of Digital Earth Science Platform (CAS-DESP) has been set up to provide a new impetus at such an era of Big Data for three main objectives of data-driven scientific discovery, decision making, and dissemination of science to the public (Guo, 2017b).

CAS-DESP includes three sub-systems: digital earth foundation platform, information integration and services sub-system, global geo-spatial data production sub-system. Digital Earth foundation platform is the core set of components of the CAS-DESP capable of exploring massive amounts of geospatial data at global scale. Based on its high-performance 3D visualization engine, it provides the interactive ability to visualize complex scientific data, to real-time simulate natural phenomena and process of the dynamic oceans, atmosphere and biosphere. Information integration and services sub-system is a big data engine and service engine, which has integrated state-of-the-art big data components, such as Hadoop HDFS, Redis, and Docker, etc. The sub-system also provides many efficient big Earth data management functions. In order to guarantee the efficient utilization of the resources, two meaningful services of resource monitoring and value evaluation are additionally involved in this sub-system. The former is mainly used to mine the relationship between the particular cases and different resources; while the latter is mainly used to evaluate the values of both data and users. Through such system, the activities of scientific discovery and decision making can be supported indirectly. With its flexible plug-in framework and service-oriented architecture (SOA), the CAS-DESP could be extended by end users conveniently as well.

Integrated with high-performance algorithms and deep learning samples and models, the global data production sub-system provides land use, vegetation, water and atmosphere products with 7 spatial resolution (from 2 m to 5000 m) and 4 temporal duration (day, month, season and year) at a global scale. It enables fast and intelligent information extraction on remote sensing image archives at a global scale. These global products are the fundamental data to support the decision-making of CAS-DESP vitally.

The CAS-DESP has played important roles in many scientific and decision support fields. A global wheat pests and diseases monitoring report has been released based on the Platform. It showed the occurrence and development of typical wheat pests and diseases in many wheat production countries. Integrated with deep learning network sample bases in the CAS-DESP, the national steel plants and other industrial factories were extracted automatically using GF-2 high resolution remote sensing imagery while it had once been a huge challenge depending on traditional methods.

More efficient algorithms and models will be integrated into the CAS-DESP in the next three years, which will make the platform more intelligent. Applications of the platform in the fields, such as global change, natural disasters evaluation, and environment monitoring will be developed in the future to make our planet Earth more sustainable.

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EARTHDATAMINER: A CLOUD-BASED BIG EARTH DATA INTELLIGENCE ANALYSIS PLATFORM

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Abstract

Big Earth data has multi-domain crossover characteristics and diverse analytical processing requirements [1]. Big Earth data mining analysis involves complex data processing, analysis, pattern extraction and knowledge discovery processes, and requires easy to use integrated software tools to deal with large-scale data. With the support of Big Earth Data Science Engineering Project (CASEarth) of the Chinese Academy of Sciences Strategic Priority Research Program [2], our team are ongoing developing EarthDataMiner, a cloud-based big data mining and analysis system for scientists in the field of earth sciences, which brings together cross-domain common models, introduces advanced artificial intelligence algorithms, supports online satellite imagery visually interactive analysis， and achieves efficient task processing through a series of distributed execution systems.

At present, EarthDataMiner provides online analysis code development for remote-sensing data in a similar way to Google Earth Engine [3]. Meanwhile, EarthDataMiner has the following featured innovations: (1) Using EarthDataMiner, scientist can online analysis the data in CASEarth Databank, which will provide access services with about million gigabytes of data related to Earth sciences in the five-year CASEarth project.（2）The important cross-domain discoveries require not only data sharing, but also models and algorithm sharing. EarthDataMiner defines standard specifications to support scientist share well-trained models or algorithm codes, and to accumulate more and more excellent algorithm models through the power of the community. （3）Integrates advanced intelligent analysis technologies such as deep learning and automated machine learning (AutoML) to help scientists develop new algorithms and verification online [4].（4）Supports scientists to use the popular Python language for online algorithm development verification, and provide integrated tool support, including code management, data management, task management.（5）Provides machine learning workflow modeling tool for processing and analyzing various kinds of big earth data.(6) Provides general algorithms and visualization tools for latent correlation analysis with large scale cross domain scientific data.

Based on EarthDataMiner, some cases have been developed with the cooperation with scientists, such as forest detection, water bird identification, and remote sensing object recognition. EarthDataMiner is planned to be published as an online cloud service in 2019.

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FINE LAND-COVER MAPPING AT 30 M USING AN OPERATIONAL SPECLIB-BASED CLASSIFICATION APPROACH

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Abstract

Fine resolution land cover information is a vital foundation of Earth science, and the advent of free medium-resolution satellite data (e.g. Landsat and Sentinel-2 data) combined with improving computational and data-storage capabilities has greatly enhanced the ability to generate large-area 30-m land-cover products. Although previous studies have produced multiple representative global/regional 30-m land-cover products (such as: GlobeLand30, NLCD and so on) and achieved high accuracy, most of them are time-consuming and involves a lot of manual participation.

In this study, a novel SPECLib-based operational method for the classification of Landsat imagery using reflectance spectra from the spatial-temporal spectral library (SPECLib) for 30 m land-cover mapping for the whole of China is presented. First, the SPECLib is developed by extracting reference spectra for uniform, typical samples of each land-cover type by combining the MODIS Version 6 Nadir Bidirectional reflectance distribution function Adjusted Reflectance (NBAR) product and the European Space Agency (ESA) Climate Change Initiative global Land Cover (CCI_LC) product. Secondly, the multi-temporal Landsat imagery were then classified by using the normalized reference spectra from SPECLib in a multi-temporal random forest classification approach. Finally, an annual China land-cover map with 22 land-cover types was produced and achieved an overall accuracy of 0.713 and a kappa coefficient of 0.663 for the level-2 validation system (16 land-cover types) and an overall accuracy of 0.810 and kappa coefficient of 0.761 for the level-1 validation system (9 land-cover types). The results demonstrated the proposed method was suitable for fine land-cover mapping at a resolution of 30 m.

INTER-CALIBRATION OF NIGHTTIME LIGHT DATA BETWEEN DMSP/OLS AND NPP/VIIRS IN THE ECONOMIC CORRIDORS OF BELT AND ROAD INITIATIVE

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Abstract

After proposed in 2013, the Belt and Road Initiative (B&R) has grown from a concept to a key platform for building a community with a shared future for humanity [1]. Monitoring the urbanization process of B&R regions in a timely and cost-effective way is crucial for creating a sustainable development strategy for the B&R. Nighttime light sensors record visible light at night, which is an efficient means to map the global economic and human activities. It has becomes the major data sources for human social-economic activities and natural phenomenon and been widely used for the social-economic parameters estimation, urbanization monitoring, energy application and environment monitoring.

Traditionally, the nighttime light data is acquired by the U.S Air Force and archived by Defense Meteorological Satellite Program's Operational Linescan System, DMSP/OLS. Since 1992, there were a series of DMSP satellites (F10 - F18) imaging nighttime light. Although DMSP/OLS nighttime light imagery has shown strong capacity in evaluating economic distribution, it still has obvious weakness including no on-board radiomtric calibration and limited radiometric detection capability. The DMSP/OLS was stopped to acquire images on 2013 and the Visible Infrared Imaging Radiometer Suite (VIIRS) nighttime light imagery, a new successive nighttime light imagery, was emerged in 2012. The VIIRS images has the on-board calibration and wider radiometric detection range, can provide a more accurate nighttime light source for economic modeling. The operational DMSP/OLS and VIIRS provide the practical and long-term nighttime light data on economic evaluation over both global and regional scales.

The radiometric consistency of the long-term time series nighttime light data is an important prerequisite for economic evaluation. To date, radiometric calibration of nighttime light images has been widely studied. One strategy to calibrate the image is to directly correct the sensor degradation. In recent years, intercalibration based on the reference pixels with stable lights, which also called invariant pixels were developed. However, the intercalibration between DMSP/OLS and VIIRS images has received limited prior attention. On the above analysis, the objective of this study is to propose an automatic invariant pixel extraction method to intercalibrate the DMSP/OLS and VIIRS DNB for social-economic studies over the B&R regions. B&R regions was chosen given its importance for economic corridor's construction and to address the challenge of nighttime light intercalibration.

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MACHINE-LEARNING BASED LIDAR-AIDED DUAL-BASELINE POLINSAR METHOD FOR FOREST HEIGHT ESTIMATION

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Abstract

Forest height inversion using polarimetric synthetic aperture radar interferometry (PolInSAR) technique has the advantages of wide range of single-view image, high resolution, all-weather working all day [1]. However it is dependent on the adaptability of the scattering model (such as Random Volume over Ground (RVoG) model) to the measurement area, and is susceptible to signal noise and temporal decorrelation, which cannot guarantee the stability of the inversion performance [2]. LIDAR can obtain high-precision forest canopy height data in a small scale. Nevertheless, airborne system runs at a high cost but has limited coverage and spaceborne system (such as GEDI) has low resolution and is susceptible to rainy or cloud weather. Therefore, the effective fusion of the two techniques can theoretically improve the accuracy of the inversion [2].

Compared with traditional single-baseline three-stage inversion method, the dual-baseline PolInSAR inversion approach removes the conditional limitation of ground-to-volume amplitude ratio (GVR) in algorithm by introducing another baseline observation, which effectively improves the estimation accuracy of volume only coherence and extinction coefficient so that improves the performance of extracting the forest height [3]. The core problem in retrieving vegetation height by dual-baseline PolInSAR is to select the exact dual-baseline combinations that are most suitable for inverting the forest parameters of measurement unit or region from the numerous baselines of dataset obtained. Therefore, we consider the baseline selection as a supervised classification problem [4]. Support Vector Machine（SVM）is used as the classifier and a small amount of sparse LIDAR samples within the coverage of PolInSAR are chosen to assist the training of baseline classification, which can be fully met by future spaceborne LIDAR missions. In this paper, the airborne L-band SAR data obtained in the northern Swedish experimental area during the BioSAR-2008 campaign is used as the verification data. We simulate the LIDAR-aided samples according to the sampling resolution of the GEDI laser satellite, and prove that the accuracy of the proposed method is increased by 33.2%--85.2% compared to that of the conventional dual-baseline PolInSAR only method depending on baseline combination chosen.

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METHODS AND RESEARCH PROGRESS OF UNDERLYING TOPOGRAPHY ESTIMATION OVER FOREST AREAS BY INSAR

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Abstract

High-precision Digital Elevation Model (DEM) is an important strategic information resource of the country and an essential map for national economic construction, social development and national defense security. However, for some vegetation coverage areas, traditional aerial survey and optical remote sensing methods can only obtain the surface elevation information of the vegetation layer, and cannot map the true shape of the 'naked earth'. Therefore, how to accurately obtain the underlying topography has become a research hotspot in the field of microwave remote sensing. Interferometric synthetic aperture radar (InSAR) has been proved as one of the effective technical methods for regional and global scale topographic mapping because of its advantages of large-scale, high-resolution, high-precision and all-weather monitoring [1], [2]. This paper first introduces the principle of DEM extraction by synthetic aperture radar interferometry (InSAR) and the data acquisition methods. The second part of paper describes the principal methods of SAR for underlying topography estimation, including three categories based on InSAR, polarimetric synthetic aperture radar interferometry (PolInSAR) and Tomographic SAR (TomoSAR), respectively. The first class are inversion methods based on InSAR technology, which mainly includes: inversion method based on coherence scattering model [3], time-frequency analysis (TFA) [4], [5], etc. The second category is based on PolInSAR technology, which mainly includes: phase separation method based on coherence optimization theory [6], [7], inversion method based on coherence scattering model [8], scattering mechanism decomposition method based on coherence scattering matrix [9]. The third category is tomographic SAR (TomoSAR) technology based on multi-baseline data [10]. On this basis, the application progress of the corresponding methods is also introduced. Finally, the paper analyzes the problems faced in estimating underlying topography from three aspects [11], [12], which incorporates data acquisition, error correction and scattering model reconstruction, as well as introduces the challenges of mapping underlying topography based on InSAR.

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SEASONAL PREDICTION OF SUMMER HOT DAYS OVER CHINA AND INDOCHINA PENNISULA USING CAS-ESM COMPONENT MODELS

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Abstract

In view of the great impacts of extreme weather and climate disasters on the international economy, society and sustainable development, the seasonal to interannual prediction of extreme events has always been the frontier and hot topic in climate research. As one of the high impact extremes, the extreme hot days could negatively impact on human health, energy use and many other sectors over a vulnerable region (García-Herrera et al. 2010; Akihiko, Morioka, and Behera 2014; Bai et al. 2014). Therefore, study of the extreme temperature and its prediction has attracted considerable attention from researchers in recent years.

In this paper, the land-atmosphere couple model component from CAS-ESM has been adopted for the prediction of temperature extremes over China and Indochina peninsular, driven with the predicted tropical Pacific Ocean SST anomalies from IAP ENSO ensemble prediction system. Big hindcast dataset for climate anomalies has been generated from the 30-year ensemble hindcast integration using CAS-ESM components. Based on the hindcast data analysis, it's found CAS_ESM does show skill to predict summer hot days and extreme high-temperature events. The prediction skill of hot days based on 95th percentile relative temperature threshold is high in Huaihe River Basin, Northern China, Inner Mongolia and Northeast China. The correlation coefficients between hindcast results and observation is generally higher than 0.4 in these regions. Based on the monthly analysis results, high-skill regions locate in the south of the Yangtze River and Hetao region in June, where the TCC is near 0.5. The prediction skill of hot days in July is better than June and August in most of China, and the value of TCC in Huaihe River Basin and Northeast China can reach 0.5.

Meanwhile, the predictability of summer hot days over Indochina Peninsula (IP), located in the belt and road region, has also been investigated using the hindcast results. It's found that seasonal prediction skill of summer hot days is high in most part of Indochina Peninsula (IP), with TCC larger than 0.5 in central Myanmar, northern Thailand, southern Laos and southern Vietnam, but there is no skill over northern part of Myanmar. Meanwhile, the hot days prediction skill by the CAS-ESM differs from month to month, with higher prediction skill in June and July, but almost no skill in August. The model is also able to predict peaks of hot days in strong warm ENSOb year, with a perfect skill in Thailand but largely overestimates in Vietnam.

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THE CAS EARTH THREE POLES BIG DATA PROJECT

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Abstract

Unprecedented changes in the climate and environment have been observed in the three poles, including the North Pole, the South Pole, and the Third Pole-Tibetan Plateau. Although considerable data have been collected and several observation networks have been built in these polar regions, the three poles are relatively data-scarce regions due to inaccessible data acquisition, high-cost labor, and difficult living environments. To address the challenges of better understanding the unprecedented changes in the three poles on the global environment and humans, there is a pressing need for better data acquisition, integration, curation, service, and use these data to better support fundamental scientific research and sustainable development for the three poles. CASEarth Poles, a project within the framework of the "CAS Earth Big Data Science" program of the Chinese Academy of Sciences, aims to construct a big data platform for the three poles. CASEarth Poles will be devoted to (1) breaking the bottleneck of polar data integration, curation, and sharing, (2) developing high-resolution remote sensing products over the three poles, (3) generating atmospheric reanalysis datasets for the polar regions, (4) exploring the synchronization, asynchronization, and teleconnection of the environmental changes in the three poles, (5) investigating the climate, water cycle, and ecosystem dynamics and the interactions among the multispheres in the polar regions and their global effects, and (6) supporting decision making with regard to sea ice forecasting, infrastructure, and polar development and governance.

THE RESOURCE DISCIPLINE INNOVATION PLATFORM DRIVEN BY BIG DATA AND APPLICATION SCENARIOS

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Abstract

Resource science is the study of the formation, evolution, quality characteristics, spatial and temporal distribution of resources, and their relationship with the development of human society. With the increasing demand to coordinate overall resources and the environment, traditional resource science has limitations in solving the comprehensive problem of sustainable development of resources and the environment. The rapid development of big-data-driven and information technology makes it possible to solve this problem of comprehensive scientific research on resource science, promoting new development and innovative applications on the big data platform of resource science. Based on the development of resource science and national strategic needs, this paper analyzes the framework, system, technology, algorithms, and standards of the big-data-driven innovation platform for the resource discipline and big-data-driven scenarios for application of typical scientific research activities. The specific application scenarios include the following: (1) The prevention and control of ecological risks of traffic and pipelines in the China–Mongolia–Russia Economic Corridor. Focusing on the land degradation problem in the Sustainable Development Goal (SDG) 15.3, the application analyzed the land degradation pattern and risk along the China–Mongolian Railway in Mongolia. (2) The assessment of resources and environment carrying capability in the Beijing–Tianjin–Hebei region. Based on SDG 11 and the demand of urbanization development in China, the application analyzed the indicators framework of a beautiful city with a model and data. (3) The big-data-driven panoramic evaluation of beautiful China. Combined with the "Earth Big Data Science Engineering" project of the China Academy of Sciences, the application analyzed the data-driven demand and support system of the beautiful China panoramic evaluation. Through the above three typical applications, this presentation deeply explores a new scientific research model that uses big data to drive innovation discovery in the resource discipline.

TIBETAN PLATEAU AND ASIAN SUMMER MONSOON

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Abstract

Multi-source data have been utilized to identify the mechanisms responsible for the circulation anomaly produced by thermal forcing of the TP. Numerical simulations demonstrate that the thermal effects of large-scale orography, particularly the Tibetan Plateau, are crucial for the formation of the East Asian and South Asian summer monsoons (SASM) because the surface SH of the TIP is the major driver of the water vapor transport required for the genesis of the north branch of the SASM. The large-scale orography of the TP affects the Asian climate through thermal forcing in spring and summer, and mechanical forcing in winter. The TP forcing can also influence the Asian summer monsoon (ASM) onset over the Bay of Bengal (BOB) by enhancing the BOB warm pool at the surface and by modulating the South Asian High (SAH) in the upper troposphere. On intra-seasonal timescales, the TP thermal forcing significantly modulates spring rainfall in southern China and generates the biweekly oscillation of the SAH in summer. Despite climate warming, the atmospheric heat source over the TP, particularly the spring SH, exhibits a clear weakening trend from the 1980s to 2000s. This weakening of the spring SH contributed to the anomalous ‘dry in the north’ and ‘wet in the south’ rainfall pattern observed over East China.

VISUALIZATION METHOD OF OCEAN MULTI-LAYER TEMPERATURE DATA FIELD SUPERIMPOSED SEA SURFACE HEIGHT BASED ON DIGITAL EARTH

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Abstract

The traditional ray-casting algorithm uses a cube as the carrier of texture. In this paper, we proposes a hexahedral as proxy geometry which has the same curvature of the earth, so that the data can be well adhered to the surface of the earth.

In order to effectively display the sea surface height, it is assumed that the material above the sea surface height field in the proxy geometric is completely transparent, and the sampling point needs to be judged twice in the light projection. First, by rendering the front and back sides of the geometry to two textures, each pixel of the texture stores the world coordinates of the corresponding geometry segment, and by subtracting the corresponding pixel values of the two textures, a ray crossing inside the geometry can be obtained. After obtaining the coordinates of the sampling point, it is necessary to judge whether this point is below the sea surface, so it is necessary to pass the sea surface height into the shader. The sea surface height is organized into a two-dimensional texture, and each pixel stores the sea level corresponding to the position. Determine whether the height of the sampling point is greater than the corresponding sea surface height. If it is above the sea surface height, the point is considered to be fully transparent, that is, skipping this point without sampling; otherwise, calculating the coordinates of the sampling point in the three-dimensional texture.

In order to reduce the iterative steps of the ray-casting algorithm, only rough calculation is performed when the viewpoint is moved, and the fine drawing is performed when the viewpoint is stopped, thereby drastically reducing the calculation and increasing the rendering frame rate. Use cache management to keep the data near the current moment in memory, and to switch data as fast as possible when drawing dynamically. According to the prediction mechanism, multi-thread data can be fetched and read into the cache area and release long-time unused area, so as to realize the dynamic switching of multi-time data.

Earth sphere model is constructed based on OSG Earth; OpenGL and OSG are used as 3D rendering engine. Northwest Pacific reanalysis temperature and sea surface height data is chosen as experimental data with the grid resolution of 1/10 degrees. Experimental results prove that this method has better visualization effects, higher rendering efficiency and better scalability.

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SESSION:
Transforming society with Citizen Observatories

A CITIZEN OBSERVATORY IN KENYA THAT SUPPORTS BALANCING SUSTAINABLE LIVELIHOODS AND BIODIVERSITY MANAGEMENT

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Abstract

For an ecosystem such as the wider Maasai Mara region to be managed sustainably, a balance between biodiversity and livelihood of the citizens needs to be found and kept. The Maasai Mara citizen observatory (CO) is a multi-stakeholder platform for generating and sharing of data, information and knowledge to improve policy making and implementation for sustainable livelihoods and biodiversity management in the area. These main objectives were determined in co-design workshops:

1. To provide a monitoring system for biodiversity, livestock and crop, land and water resources, and climate across the Mara ecosystem.
2. To establish a repository on Mara biodiversity, livestock and crop, land and water resources and climate information that is accessible to all stakeholders.
3. To develop a platform for the engagement of citizens, government, research and the private sector to promote practices that create the balance between livelihoods and biodiversity in the Mara ecosystem.
4. To improve data, information and knowledge generation and sharing on biodiversity and livelihoods between citizens, practitioners, researchers and policy makers for informed policies and policy implementation

The tools being developed are made accessible through the CO platform (http://mara.info.ke) that integrates existing modules, partners, initiatives, data streams. The Maasai Mara CO Android App allows citizens to receive weather forecast data. The Mara Collect app allows trial entries of data collection for flood reporting, biodiversity sightings, human wildlife conflict locations. Through the platform also weather information from TAHMO stations and low cost equipment is made available.

A DATA QUALITY SERVICE FOR CITIZEN OBSERVATORIES

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Abstract

Determining the quality of a geospatial dataset and documenting it facilitate possible reuse of it for a purpose not initially planed when the requirements of the original measurement campaign were formulated. Citizen Observatories (and, by extension, Citizen Science) are particularly sensible to data quality because the number of contributors is bigger and more heterogeneous than in a traditional data survey campaign [1] [2]. An additional difficulty is that active Citizen Observatories are receiving continuous inputs and updates from citizens [3]. This abstract presents a tool done in the European Union H2020 project GroundTruth 2.0 that focus on user generated of data quality indicators for Citizen Science datasets from the QualityML list (mainly based on the ISO 19157). The tool requires that data is exposed in the Web as a service using Open Geospatial Consortium Service Observation Service (OGC SOS) [4]. It presents a set of tests (e.g. positional accuracy, attribute consistency, confusion matrix, etc) that can be applied to a complete datasets or an area the user is visualizing. Results include an overall quality indicator for the dataset and the highlight of the observations that were detected as less accurate. Once the result has been obtained and validated, the user can decide to publish the indicator in the NiMMbus Geospatial User Feedback (GUF) system developed in the EU H2020 NextGEOSS project and shared with others. GUF allows for rating, validation can commenting on geospatial data [5]. The quality module has been made available as part of the web based MiraMon Map Browser and is encoded in JavaScript.

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AN ITALIAN INTERDISCIPLINARY CITIZEN OBSERVATORY FOR THE PROTECTION AND PROMOTION OF NIGHT SKIES ON YEAR 12 OF ITS EVOLUTION: CHALLENGES AND OPPORTUNITIES FROM A DIGITAL EARTH PERSPECTIVE

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Abstract

The concept of citizen observatories (CO) and the shift in the paradigm for environmental monitoring and land planning that this is determining has been acknowledged for some years, and paramount governmental bodies, such as the European Union have defined explicit strands of research and technology transfer to develop them. The presentation will propose the case of an interdisciplinary citizen observatory with its roots in Tuscany and relations to other points in Italy and in other countries. The observatory is composed by a structured array of subjects, with a core currently composed by: two research institutions, two rural communities, a rock-blues band, and a professional photographer. This configuration was reached after twelve years of development centred on the topic of night sky protection and promotion. This issue entails first of all the monitoring of light pollution and night sky quality, which the CO is pursuing since 2008 by lending a small set of sensors for hand-held measurements, and since 2011 with a network of stations mostly deployed in amateur astronomer observatories, as well as investigating lighting systems in various locations and suggesting cases of non-compliance with respect to state-of-the-art guidelines on external lighting. Another task is the promotion of areas with low levels of light pollution (i.e. “dark sky places”). These are typically locations in rural area with low infrastructure levels and scarce population, where the night sky can become an asset for tourism and environmental education, as demonstrated by cases throughout the world, thus helping to sustain the local communities. A third level of action is awareness raising and outreach [1] on the excess of light as a source of negative impacts for environment, human health, safety and economy. These experiences have also led to provide input to global-level position papers and workshops [2, 3, 4].

After five years at the “roots” citizen level with the BuioMetria Partecipativa project, the team grew to engage two research organisations (Inst. of Biometeorology of the Italian Research Council [7], and Dept. Of Biology University of Pisa [8]), and a professional photographer specialized in nightscapes. This team has been active in Italy and at the European level (within an EU COST project) [5, 6]. In September 2018, the same group promoted the first international symposium in Italy on night sky protection and promotion, attracting 35 experts from three continents to the Island of Capraia, including Italian organisations which previously had not been in contact. Starting from 2017, the outreach line of activity was enriched by the entry of a professional rock band (Etruschi from Lakota), acting as the soundtrack for many outreach events, and also as citizens actually collecting night-sky quality measurements. On the other hand, one component of the scientific team of the CO started performing with the band, thus triggering a peculiar case where citizens (i.e. the musicians) are active in scientific data collection and a scIentist is active in live music. This combination actually led to the launch of a “geomusical” spin-off of the CO called the Metalliferous Hills Jug Band. The team is working on follow-up actions which are expected to further improve the operations of its citizen observatory, laying the foundation for yet more structured activities in the coming years.

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BUILDING A LAND USER MAPPER BASED ON CITIZEN CONTRIBUTIONS

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Abstract

Land-use maps are important for spatial planning and decision making. Typically, the required time series of land-use maps based on identical and consistent mapping methodologies, legends and scales are missing. Existing products lack the flexibility in terms of spatial, temporal and thematic resolution in order to be useful for many kinds of uses. Furthermore, remote sensing data are useful for deriving land-cover maps, but there are challenges in deriving land-use maps, which relates to the way people actually use the land.

The Land Use Mapper (LUM), envisioned in the Ground Truth 2.0 project, is a web-based tool to create land-use maps of any area selected by the user. The aims of the Land Use Mapper are (1) to improve the availability of land-use data, (2) improve the consistency of time series of land-use maps, and (3) improve the accessibility of land-use information. The LUM will use data derived from remote sensing and collected by citizens, such as OpenStreetMap.

The aim of station 5 in this session is to gather needs from the participants in terms of land-use products, data collection tools and experiences. Each iteration starts with a short explanation of the concept of the land-use mapper service as envisioned in the Ground Truth 2.0 project and the definition of land use. Then the participants can experience some tools developed in the different demo cases related to land use mapping. Feedback will be collected on a flip chart and presented at the plenary discussion.

CAPTURING GOVERNANCE IMPACT STORIES IN CITIZEN SCIENCE INITIATIVES, CITIZEN OBSERVATORIES AND COMMUNITY-BASED ENVIRONMENTAL MONITORING PROJECTS

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Abstract

Best practice in citizen science (CS) is evolving in response to societal-policy objectives based on the aspiration to bring together citizens, scientists and policy makers to advance science as well as to inform and improve policy making processes on environmental issues [1]. While capturing impacts is a standard objective for CS initiatives, including Citizen Observatories and community-based environmental monitoring projects, capturing governance impacts is often a challenge. The barriers to capturing governance success stories are time and conceptually related. Regarding timing, governance impacts often require longer timelines to materialise compared to the average length of CO projects, meaning any tangible changes often occur after the end of project activities. Furthermore, projects tackling environmental challenges through citizen science often focus on scientific over governance objectives, either due to stronger interest in the former and/or lack of expertise, resources and clarity in the latter [2, 3]. We refer to governance in the context of COs as the definition of goals by a range of actors on the thematic topic that a given observatory focuses on, e.g. water quality, soil, biodiversity, etc., as well as to related decision-making processes, e.g. decisions about the monitored resource.

This paper shares WeObserve's Governance Impact Community of Practice's methodological work on a tool that 1) has been tested to capture governance impact stories from existing CO projects 2) can support ongoing and new projects to plan ahead and build into their project design the resources and information needed to capture any potential governance impacts their activities might achieve. The template has been revised and piloted with experts in the area. Governance impact stories and insights from three case studies are shared: Making Sense, Groundtruth and WeSenseIt [4].

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CITIZEN OBSERVATORIES FILLING IN KNOWLEDGE GAPS IN LOCAL AND GLOBAL ENVIRONMENTAL MONITORING AND MANAGEMENT OBJECTIVES

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Abstract

Citizen science is the generation of new information and knowledge from the participation of 'non-scientists' in traditional scientific activities. In its best case, it is a collaborative endeavour with benefits for the participants, scientists and the society as a whole. With the advent of low cost information and communication technologies, the possibilities to expand participation in data gathering, exchange and analysis to other fields of environmental science has been greatly facilitated.

The engagement and training of community members in citizen science programmes has been shown to provide a number of benefits to the proponents: researchers, monitoring agencies and policy maker [Buteart et al. 2012]. These include direct and indirect effects of more informed and empowered communities and increased support for land use and resource decision making processes by governments, companies and institutions. Recent citizen science projects on hydrology, aquatic biodiversity and water quality have shown that productive partnerships between scientists and the public can provide increased (and reliable) information on ecosystem conditions [Castilla et al' 2015]. The increase in spatial and temporal resolution of environmental information made possible by citizen science initiatives are a potentially important complementary data source for local and global environmental monitoring and management objectives [Hadj-Hammou 2017].

However, citizen science is not without its limitations. From the scientific point of view, these are related to sampling bias and analytical shortcomings of non-laboratory methods [Bird et al. 2015]. From a programme development point of view, they are related to the cost of training and engagement, fundamental to insure that scientifically useful data are gathered in a robust and safe manner. In this station, we discuss these benefits and limitations from experiences in the Swedish case study of the GroundTruth programme as well as other programmes across the globe.

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CO-DESIGNING CITIZEN OBSERVATORIES FOR SUSTAINABILITY: THE GROUND TRUTH 2.0 METHODOLOGY

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Abstract

Citizen Observatories (COs) are particular examples of Citizen Science, consisting of dedicated communities of citizens, policy-makers and scientists, using ICTs to actively collaborate in the collection, exchange and use of information and knowledge for a shared purpose. A CO depends on the formation of a sustainable group of 'members', supporting its creation requires a design process that hands stakeholders control while preserving elements that make COs tools for positive change. The Ground Truth 2.0 project was tasked to develop locally relevant and sustainable citizen-based monitoring schemes that allow local ownership of the resulting processes, changing power relationships and improving decision-making in natural resource management. It set out to demonstrate and validate a co-design approach that 'starts with the last mile', grounding all resulting research and policy in stakeholder realities and ensuring their buy in. To demonstrate the feasibility and benefits of the envisioned citizen-based monitoring schemes in vastly different communities, the co-design methodology had to be adaptable to different geographical contexts, social settings and different thematic issues. The developed methododoly approaches co-design as an iterative process consisting of a series of 'interaction moments' with key stakeholders. Starting with a blank page regarding the purpose or scope of the future observatory, a sequence of steps facilitates collective identification of challenges, objectives and requirements, while actively supporting community-building as part of the process. The implementation of the co-design methodology in 4 European and 2 African cases has shown that effective co-design has to go beyond one-off consultation and facilitate active learning processes.

GROW CITIZENS' OBSERVATORY: LEVERAGING THE POWER OF CITIZENS, OPEN DATA AND TECHNOLOGY TO GENERATE ENGAGEMENT, INNOVATIVE DATASETS AND ACTION ON SOIL POLICY AND SOIL MOISTURE MONITORING.

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Abstract

Best practice in Citizen Science (CS) is changing in response to society-policy objectives and new widely available technologies that are acquiring an increased role in environmental monitoring. Data generated by these technologies have the potential to inform changes in practice and policy. A distinctive development in CS are citizens' observatories (COs), which seek to extend what is understood as conventional CS activity to address participation in data gathering to progress scientific knowledge and inform policy making processes. COs are a recent innovation connecting people, science and technologies to create collaborative data, knowledge and action around environmental issues, both local and global [1].

The GROW Observatory (GROW) is the first attempt to deliver an operational CO at a continental scale and with a long term, sustained commitment [2]. GROW demonstrates an operational CO system for sensing soil, in particular soil moisture, and its effects on climate and food growing practices. Soil moisture levels play an important role in regulating climate and triggering extreme weather events. GROW leverages the power of open and decentralised knowledge creation to ground truth Sentinel-1 satellites of the European Earth Observation Programme Copernicus, and create information and visualisations that can improve the way people grow food and care for soils. The validation of satellites gathering soil moisture data can in turn contribute to improving the accuracy of climate forecast information modelled on their data. Additionally there is an urgent need to support and disseminate best practice around food production techniques that regenerate soils.

GROW is connecting the planetary dimension of satellites with the hyperlocal context of farmers and their soil. GROW, similarly to other COs, faces three main interrelated challenges associated with each of the three core audiences of the observatory, namely citizens, scientists and policy makers: one is sustained citizen engagement in the generation of robust longitudinal datasets; the second one is quality assurance of citizen-generated data; a third one concerns the challenge to move from data to action in practice and policy. This paper presents the multilayered mechanisms the GROW Observatory has developed to tackle each of these challenges to support the distribution of 15, 000 low cost soil moisture sensors.

The novelty GROW contributes to CS and earth sensing lies in addressing the problem of amplifying scale, whilst supporting participation and engagement through a combination of place-based interactions across localised EU focus areas - named GROW Places - with online tools and learning opportunities [3]. Whilst the stewardship of soil is in common to GROW citizens and scientists alike, there are multiple underlying motivations across geographic locations and environmental contexts that must be acknowledged and incorporated into the design of project activities to foster engagement.

Technically, GROW builds on existing state-of-the-art platforms and components as well as in the application of established methodologies for collecting and analysing data on soil and land cover/land use through the use of mobile apps, DIY and consumer sensors, and data mulling infrastructure. A key challenge lies in evaluating and assuring the quality of the data collected by citizens. GROW's data quality strategy includes design mechanisms and checks at two stages, i.e. before and after data collection. In this paper, we move beyond CS to describe the full articulation of an end-to-end CO process and share GROW's results and outputs across four dimensions: 1) Contributing to satellite validation and enhancing the collective intelligence of GEOSS, 2) Dynamic maps and visualisations for growers, scientists and policy makers, 3) Social-technical innovations, and 4) Communicating GROW science through art for wider public engagement and uptake [4].

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RITMENATURA- A CITIZEN OBSERVATORY FOCUSED ON PHENOLOGY IN SPAIN TO BETTER PREPARE FOR CLIMATE CHANGE

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Abstract

RitmeNatura is one of the 6 citizen observatories in the GroundTruth2.0 project. This CO is focused on phenology observation in Catalonia as a proxy to monitor and understand climate change impact at local scale.

Phenology is the study of periodic plant and animal life cycle events (flowering, migrations, etc.). Although these periodic natural cycles fluctuate naturally, they have recently been shifting induced by changes in climate. Other methods and indicators have long studied such a phenomenon, but monitoring phenology requires decades of regular and strict observations.

In Catalonia, the Catalan Meteorological Agency (Meteocat) has its own network of highly engaged amateur observers who have been collecting, primarily, weather and, to a lesser extent, phenological observations from the beginning of the 20th century. Until now, observations were recorded by pen-and-paper or some computer-based spread sheets. Digital technology offers a plethora of tools to provide better reporting solutions and access to many potential observers through mobile technologies.

The Spanish citizen observatory has been co-designed with a range of relevant stakeholders with the following main mission: to be a place where phenological data, in particular that collected by citizens, will be stored and made accessible in real time, with the aim of influencing decision making. The CO has an online platform that is already functioning for any citizen to provide phenological observations (http://ritmenatura.cat). The data collected is intended to feed into relevant scientific work and to inform relevant authorities such as the Catalan regional government for better decision-making on climate change adaptation policies.

THE PIONEERS: CSEOL PILOT PROJECTS EXPLORING HOW CITIZEN SCIENCE CAN HELP VALIDATE EARTH OBSERVATIONS

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Abstract

The combination of both, space and in-situ components in Copernicus is crucial for global precise environmental monitoring. In addition, the space segment is providing data that require modelling to be translated to real physical information. Since the accuracy of the models can only be evaluated against ground truth data, in-situ information is crucial to support the Copernicus Space component.

The potential of using Citizen Science (CS) approaches and new digital technologies in a suitable setting for experimenting and generating new Earth Observation (EO) products and services is faced with social, scientific, technical and economic challenges. Innovative CS EO projects require a supportive yet flexible environment to facilitate creative exploration of innovative ideas for using EO data (e.g. new products and services, new mission concepts, public education, story telling) that involve a diverse range of actors (citizens, established CS communities, SMEs and private sector players, etc.) and deploy diverse and emerging digital technologies. The Citizen Science Earth Observation Lab (CSEOL) facilitates an open innovation process for generating multiple ideas on how to explore the CS potential for exploiting EO data towards concrete, implementable projects.

The first set of ‘pioneer’ CSEOL pilot projects have started, with the overall aim of demonstrating the benefits and value of CS for the exploitation of EO. The thematic focus of the pilots is based on existing ESA programs (e.g. CCI, EO4SD, Copernicus services, Sentinel missions) and usual EO data nomenclature (data levels), relating to the use and exploitation of EO for a) ESA missions, b) climate change & sustainable development, and c) downstream services. This thematic focus is complemented by topics on how CS can be used for EO exploitation in terms of linking with science, society, business and policy/decision making. This presentation includes details about the pioneer pilots, their thematic focus, specific objectives and innovative ways of involving Citizen Scientists in validating EO.

SESSION:
DIGITAL BELT and Road Programme

3D MEASUREMENTS OF GEOMORPHIC FAULT OFFSETS BASED ON HIGH-RESOLUTION SATELLITE IMAGES: IMPLICATION FOR SEISMOGENIC ACTIVE FAULTING

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Abstract

In many of the countries along the Belt and Road earthquakes are a major natural disaster. By sharing techniques, methodologies, best practices between the countries involved in the Belt and Road, we can share experiences and improve our undrestanding of earthquakes. In this paper, we study especially the role of active faults in seismic hazard assessment.

Detection of seismogenic active faults in continental regions is a delicate job because of slow slip rates and long recurrence times of great earthquakes. These characteristics disable short-term approaches such as seismology (instrumental and historical) and geodesy in the reconnaissance and evaluation of the seismic behavior of faults. The study of geomorphic signatures of past earthquakes proposes appropriate time windows in which several seismic cycles were recorded [1] [2] [3]. In this context, high-resolution DEMs are a key element to assess the amplitude of seismic displacements recorded along active faults. Moreover, the use of high spatial resolution imageries increases the detection ability of metric-scale geomorphic offsets (both cumulative and coseismic) and decreases the amounts of the associated uncertainties [1] [4]. Nowadays, it is possible to generate high-resolution DEMs based on Stereo and Tri-Stereo satellite images like Pleiades images. A High-resolution DEM is a powerful tool([4] [5])that complements classic active tectonic approaches and enables us the detection and measurement of 3D displacements along the faults.

Our study benefits of Pleiades satellite images which provide data in short periods and the resultant DEM is reliable [6] [8] [9] [10]. The agility of the tri-stereoscopic satellites enables multiple along-track acquisitions [7]. This aspect preclude producing latent areas in the 3D Model generation process.

The case study is the North Zanjan fault at the western limit of the Alborz Mountains in north of Iran. The N-trending North Zanjan fault is the main active fault directly affecting the city of Zanjan (with nearly 550000 inhabitants), with a recognized surface trace of about 50 km. Despite the existence of spectacular fault scarps and geomorphic offsets recorded by late Pleistocene and Holocene landforms, the region affected by the fault is characterized by a very low level of instrumental seismicity and a lack of historical seismicity. This highlights the importance of detailed active tectonic studies along the fault in order to recognize signatures of the last earthquake. The recognition, reconstruction, and behavior analysis will improve the assessment of seismic hazard in the city of Zanjan.

Our main goal is to describe the spatial distribution of cumulated coseismic displacements occurred along the North Zanjan fault. Our workflow consists of three steps:1) DEM generation using Tri-Stereo Pleiades images (performed using the open source MicMac package provided by IGN - France), which cover an area of 304 km2 around the fault zone, 2) Preparation of Pan-sharpened (0.5 m resolution) and ortho-rectified images using the generated DEM, 3) detection, measurement and statistical analysis of cumulative geomorphic offsets in order to find coseismic signatures of the last earthquake occurred along the fault.

The results contain accurate 3D measurements with limited uncertainties along the fault trace. Initial measurements show systematic metric dextral offsets accompanied by vertical displacement across the fault scarp which are consistent with field observations. These data show the reverse-dextral kinematic of the fault and provide convincing evidence of active faulting. Forthcoming displacement map in the scale of 1/500 will help us to define the seismotectonic behavior of the North Zanjan fault. These results will be the basis for the selection of sites to perform UAV data capturing over the areas containing coseismic rupture signatures which in turn, helps us to plan for future paleoseismological investigations.

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DIGITAL CULTURAL HERITAGE FOR THE BELT AND ROAD

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Abstract

There are very rich of cultural heritages at the Belt and Road. Prof. Fan Jinshi said: Cultural heritage is neither renewable nor eternal. Therefore only digital technology can let cultural heritage live forever in the cyber space！Taking digital protection work for Mogao Grottoes and Chi Lin Nunnery as an example, the presentation introduces techniques of using spatial information to protect cultural heritage, including building a comprehensive spatial information archive for Mogao Grottoes by using multi-platform equipped with multiple sensors; providing 3D model material of culture heritage to make high-definition program for large dome screen at Dunhuang Visitor Center by high-precision geometric reconstruction and high-fidelity texture reconstruction, making digital archive and exhibition of murals by positioning and correction technique; providing scientific data for the protection of cultural relics, such as the establishment of spatial position relations of caves, status investigation for large cultural heritage sites, deformation monitoring for cliffs, completing the construction supervision and digital visualization for Chi Lin Nunnery by using digital technology.

HIGH SPATIAL RESOLUTION SOIL ORGANIC MATTER CONTENT MAPPING IN DESERTIFIED LAND OF NORTHERN CHINA BASED ON SENTINEL-2 AND MACHINE LEARNING METHOD

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Abstract

Desertification is one of the most important environmental problems in China's arid regions, and the damage caused is very serious. Soil organic matter (SOM) content is an effective indicator for effectively reflecting the status of desertification. Monitoring large areas for organic matter content is of great significance for understanding the status and dynamics of desertification and for formulating scientific and effective prevention strategies. However, due to data limitations, vegetation signal interference, etc., large-area acquisition of SOM content information has proven challenging. In particular, in the sandy areas of northern China where the organic matter content is very low, the estimation of the organic matter content is more difficult. The purpose of this paper is to estimate the soil surface SOM content in desertified land in northern China by using Sentinel-2 data mainly based on the Google Earth Engine (GEE) platform. Two machine learning methods, classification and regression tree (CART) and support vector machine (SVM), were employed with different input variable combinations. The results show that the proposed approach could estimate SOM in desertified land effectively. The results show that the overall effect of the CART model is better than that of the SVM model, and the addition of remote sensing variables composed of Sentinel 2 spectral information can significantly improve the effect of the model. The R^2 for the best fitting model is 0.73, and the RMSE is 0.31. Also, the approach based on the GEE has the advantage of time efficiency (less than 1 hour is needed to finish the estimation of the SOM at a 10 m spatial resolution for the entire desertified land area in northern China) which means that it has great potential for high spatial resolution SOM mapping at the global scale.

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MONITORING THE IMPACT OF MOMBASA NAIROBI RAILROAD ENGINEERING ON THE ECOLOGICAL ENVIRONMENT BY REMOTE SENSING TECHNOLOGY

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Abstract

The impact of the Mombasa-Nairobi railway construction on the local natural ecological environment and on the socio-economic ecological environment in Kenya and even in East Africa were monitored using Remote sensing technology. Image with spatial resolution of 1m which were acquired in 2013 (before the construction) and 2017 (after the construction) were used for land cover and land use mapping in the 5km buffer area along the railway. These imagery acquired in 2017 were also used to mapping the location of bridge culvert which were used to protect the animals. The Visible Infrared Imaging Radiometer Suite (VIIRS) Nighttime Lights in June, 2014 and June, 2017, were used to monitor the change of Nighttime Lights which can reflect the economic development. The results showed that the construction Mombasa-Nairobi railway occupied 13.08 km2 land which were mainly grass land. Fourteen animal routes, 600 culverts and 61 bridges were built to protect the animals. The Nighttime Lights along the railway increased by 58.47%, indicating a rapid social and economic development in this region. The freight costs between Mombasa and Nairobi was reduced by about 60%, and the transport speed increased by about 1 times.

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OBSERVING WATER FLUXES AND WATER STRESS IN THE ECOSYSTEMS OF ASIA AND AFRICA BY SATELLITES

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Abstract

Information on land surface water fluxes in terrestrial ecosystems, i.e. water supply by precipitation and water consumption by evapotranspiration from – are of importance for understanding the regional water cycle. Large areas in Asia and Africa are water scarce so that challenges exist in allocating limited water resource to different sectors relevant to water and food security. Quantitative information on water availability and water use is also helpful to prevent from water stress due to drought. Rapid development of satellite remote sensing observations provides useful spatiotemporal data for quantifying the precipitation and evapotranspiration at continental scale which in turn can be used for assessing water resources, water use and water stress of ecosystems.

In this paper, a process-based model ETMonitor was used in combination with biophysical and hydrological parameters retrieved from space-borne observations to estimate the actual evapotranspiration, i.e. the agricultural and ecological water use. The total water use is also partitioned into its beneficial, e.g. plant transpiration, and non-beneficial fraction, e.g. soil evaporation and canopy rainfall interception, according to the water accounting framework. The ratio between the actual evapotranspiration and potential one was taken as an indicator to assess the water stress of ecosystem, the difference between the precipitation and the actual evapotranspiration was used to evaluate the water deficit or water gain of a region. The estimated water use show good agreements with the ground observation, indicating the ability of ETMonitor for global and continental scale water use estimation. Large water deficit was found in several agriculture zones in semi-arid region, which indicates large use of ground water for crop irrigation.

ODINWESTPAC MARINE DATA SHARING SYSTEM HELPS TO ACCELERATE DIGITAL BELT AND ROAD PROGRAME

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Abstract

Ocean Data and Information Network for the Western Pacific Region (ODINWESTPAC), under the framework of International Oceanographic Data and Information Exchange (IODE), was set up primarily to provide effective capacity building framework, and to promote regional collaboration in marine data sharing. The aim of ODINWESTPAC marine data sharing system is to integrate and share marine data, and facilitate the exchange of all marine data and information together for 21 member states.

Nations alongside the Belt and Road has complex geographic conditions and diversified ecosystems, and are facing challenges of environment, ecology, and natural disasters, etc. ODINWESTPAC system is the portal to share marine data in the Western Pacific Region. The system integrates marine observation data of China, Russia, Thailand and other countries, covering more than 10 oceanographic and marine meteorological parameters, including marine temperature, salinity, pressure, wave, etc., marine environmental real-time analysis and re-analysis data, marine economic statistical bulletins, and other 72 datasets, in addition to this, 3 marine features are developed to provide knowledge-based services for regional marine communications. The system realizes the two and three dimensional visualization of marine geographic information, illustrating the change regularities and trends of temperature, salinity, ocean currents and other marine parameters.

Meanwhile, China is always devoted to expanding the bilateral cooperation. Taking the Thailand-China marine cooperation as an example, the data obtained from scientific research cruise in Andaman Sea, Gulf of Thailand will be used widely in the fields of disaster risk, climate and environment, urban scientific heritage.

QUANTIFICATION AND ANALYSIS ON SDGS- 13.1.1 INDICATOR IN THE BELT AND ROAD AREA BASED ON MULTI-SOURCE DATA

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Abstract

Disaster risk reduction (DRR) cuts across different aspects and sectors of sustainable development goals (SDGs). Baseline data for SDGs indicators related to DRR (i.e., SDGs- 13.1.1), in most countries, are collected by relevant ministries and the national disaster loss databases. Developed countries, as well as international organizations, including the United Nations Development Programme (UNDP), European Union (EU), World Health Organization (WHO), United States, China, Japan, Canada, Australia, and Belgium, pay extensive attention to the disaster-related databases construction and data share [1] [2] [3]. It is reported that different kinds of disaster-related databases have well documented the geolocations, time, influencing extents, and loss estimates of disasters at the global or local scale.

Thus, it is of great significance to integrate the global disaster-related databases in order to provide more scientific data and constructive advice for decision-makers around the world in a timely manner [4]. Unfortunately, not every country has a comparable national disaster loss database [5]. In addition, the multi-faceted aggregation of existing disaster-related databases at various spatial and temporal scales requires consistency and standardization of data, minimizing biases and errors while increasing compatibility in quality and the frequency of data generation.

The CASearth Project integrates existing disaster databases globally, spatializes historical disaster data through semantic analysis combined with geospatial information, and employs satellite observation data to supplement missing data of disasters. Additionally, it adopts network crawling technology to collect multi-channel disaster information for quality control and has already completed a long time series of disaster information spatialization (1980-present) . Through an in-depth analysis of disaster data, we can grasp the changes in global disasters after the SDGs agenda is launched .

Funded by the CASearth Project, disaster data statistics and analysis techniques based on multi-source data can effectively fill the disaster data gap alongside the Belt and Road countries, especially underdeveloped areas, which are also the regions suffering the most from population loss induced by disasters and lack of official and well-documented disaster statistics databases [6]. In this case, we are able to have a better command of the disaster information related to SDGs- 13.1.1 indicators, and better serve the practice of SDGs using science and technology.

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STATUS AND DYNAMICS OF MANGROVE FORESTS IN THE ASEAN COUNTRIES USING MULTI-TEMPORAL LANDSAT DATA FROM 1990 TO 2015

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Abstract

Mangrove forests are distributed in the coastal wetlands of tropical and subtropical regions throughout the world [1]. They provide important ecological and economical ecosystem services such as coastal erosion protection, water purification, nursery habitats for many marine fish and shrimp breeding, provision of building materials and medicinal ingredients, and the attraction of tourists [2-6]. In recent years, the carbon sequestration potential and protective role of mangrove forests from natural disasters is being highlighted as an effective option for climate change adaptation and mitigation. At the same time, the forests belong to the most threatened and vulnerable ecosystems, and are under threat from both natural and anthropogenic forces [7-9]. However, it is difficult to obtain accurate, reliable, and timely information of the distribution and dynamics of mangrove forests. Remote sensing is the tool of choice to provide spatio-temporal information on mangrove forest distribution, species differentiation, health status, and dynamic changes [10-12].

In this study, the distribution and dynamics of mangrove forests in the Association of Southeast Asian Nations (ASEAN) countries, including Brunel, Cambodia, China, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam, are assessed with visual-interpretation techniques derived from Landsat images taken in 1990, 2000, 2010 and 2015. In the same time, our resultant mangrove forest maps are compared to the results estimated by the Food and Agriculture Organization (FAO) of the United Nations and Giri et al. [1, 13]. The dynamic maps of mangrove forests are likely to be useful for the sustainable management and ecological assessments of mangrove forests in the ASEAN countries.

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TREND ANALYSIS OF LAND SURFACE TEMPERATURE OVER TIBETAN PLATEAU BASED ON MODIS OBSERVATIONS

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Abstract

Land surface temperature (LST) and its diurnal variation are important variables for evaluating climate change, the land–atmosphere energy budget, and the global hydrological cycle. Majorly recorded by remote sensing instruments on board of satellites, remote sensed LST is intrinsically spatial and provides the spatial coverage that meteorological stations lack. As such, it is able to capture at greater detail local differences in temperature originating from varying meteorological conditions, environmental differences and/or active heat sources (e.g., urban areas, land cover classes). Therefore, LST has been frequently used in climate change studies to investigate the influences from human activity and climage change on surface thermal environment. The Tibetan Plateau has been well recognized as a special study area for climate change study, and numerious studies have been conducted to analyze the climatic warming effect from whole region to local scales. Among these analyses, near surface air temperature is commonly used to specify the effect. However, the importance of LST and its variation is fewly considered. In this study, a spatial-temporal variability analysis was conducted to this study based on the MODIS LST products for the period from 2000 to 2017. To reduce the high temporal variability in LST and the impact from cloud cover, an annual temperature cycling model was applied to daily LST observations to get the periodic information, including annual mean surface temperature, temperature changing maginitude, annual maximum and minimum temperature. A trend analysis based on the MK test was applied to detect the changing pattern related to each term and specify the major driving forces and potential impacts on local ecosystem.

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VARIABILITY OF THE SNOWLINE ALTITUDE AT DIFFERENT REGION IN THE EASTERN TIBETAN PLATEAU IN RECENT 10 YEARS

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Abstract

Glaciers are thought of as natural water reservoirs and are of vital importance to hydrological models and industrial production, and glacial changes act as significant indicators of climate change. The glacier snowline can be used as an indicator of the equilibrium line, which may be a key parameter to study the effect of climate change on glaciers. Using Google Earth Engine, we select optical satellite imageries and implement the Otsu thresholding method on a near-infrared band to detect snowline altitudes (SLAs) of 26 glaciers in three regions of the eastern Tibetan Plateau. Three different study regions in the eastern Tibetan Plateau have different climate regimes, which are Sepu Kangri (SK, maritime), Bu'Gyai Kangri (BK, continental) and west of Qiajajima (WQ, continental), along a latitudinal transect from south to north. We analysed the effects of climatic factors on the SLA changes from 1995 to 2016. SLAs are fluctuating upward, and the rising values are 100 m, 60 m and 34 m from south to north during the 22 years. We also observed that the climatic factor that affects the variability of SLA gradually changes from precipitation to temperature from south to north. The northern continental glaciers are mainly affected by temperature, and the southern maritime glaciers affected by precipitation. Owing to the influence of primary climatic factors, continental glaciers are found to have higher SLAs on the south slope, while maritime glaciers have higher SLAs on the north slope.

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SESSION:
Digital Data for Urban Scientific Heritage

DIGITAL REAL-TIME SHARING OF CULTURAL HERITAGE

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Abstract

Continuous technological advances in surveying, computing and digital-content delivery are strongly contributing to a change in the way Cultural Heritage is "perceived": new tools and methodologies for documentation, reconstruction and research are being created to assist not only scholars, but also to reach more potential users (e.g. students and tourists) willing to access more detailed information about art history and archaeology.

Virtual Web Reconstruction of cultural heritage (CH) is one of the most interesting and innovative tool to preserve historical, architectural and artistic memory of many sites, particularly those in danger of disappearing, and to promote territories and tourism development.

However, although processes have become automated, 3D scanning technologies such as laser scanners or photogrammetry, produce enormous amount of data, often exceeding hundreds of million or billions of points and polygons and rendering tens of millions of points in real time usually requires either high-nd graphics cards, or the use of spatial acceleration structures.

This requirement leads to three relevant problems: 1) the elaboration of high-poly and high-resolution models, 2) the management of these models, 3) their sharing and fruition.

This paper mainly focuses on two aspects: browser-based speed and Web simplification algorithms. The strategies to reach these goals are tested by examining and evaluating an implementation of an open source 3D Web browser that can be used by anyone, without installing additional software and having high-performance computers 3D reconstructed models that can be downloaded in standard formats or previewed directly on a web browser through an embedded visualization interface. All the modules are based on the open source Python TM Photogrammetric Toolbox (PPT) enabling a complete 3D reconstruction pipeline, with simplification, cleaning and accuracy assessment functions. In addition to reconstructing objects, the Web3D platform offers the possibility to reduce and simplify mesh through some algorithms tested a priori by analyzing the GPU computational performance and the visualization and rendering speed.

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DIGITAL SOLUTION FOR ENHANCING GEOTOURISM AROUND URBAN AREAS: GFOSS FOR GEOSITES PROMOTION IN ""QUEBRADA DE LAS CONCHAS"" (SALTA, NW ARGENTINA)

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Abstract

The geoheritage promotion is focused on the abiotic component of the landscape. Despite the geological aspect generally has its highest evidence in natural contexts; the closeness to cities offers good opportunities for touristic promotion. Cities, where Wi-Fi connections, facilities and accommodation are widespread are excellent starting points for extra-urban routes. The paper is focused on the geoheritage of Salta and Jujuy provinces (Argentina). Fluvial and gravitational features, together with structural landforms are the main evidences of the geological history and actual morphogenetic processes acting on the area.

The efficiency of the geomorphic agents due to climatic parameters too, creates unique features defined as geosites. In order to promote the knowledge of this heritage a webmap is produced by Lizmap and QGIS Server. To address the lack of network in some areas, data are uploaded in Qfield and Geopaparazzi to be used offline too. Twenty-five geosites are in the project with a summary sheet and a second one with a wider description of the sites. Moreover the possibility to assign a rank in the attribute table of the shape to each geosite, according to specific values (geomorphological, petrographic, structural and so on), allow the users to select only the geosites corresponding to their interests. The use of digital data and operating systems are the starting point for responding to new and modern needs for use.

FLOOD VULNERABILITY CALCULATION IN URBAN AREAS USING HIGH-RESOLUTION DIGITAL EARTH DATA AND MODEL

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Abstract

Floods are natural phenomena with high occurrence probability. In urban areas the risk assessment is of special importance because of high settlement density, population, buildings and other infrastructure. Thus, floods impact directly on both social and economical issues. High spatial resolution digital earth data provide us tools to investigate the flood risk based on several aspects such as population, economic damages, and critical infrastructure in cities.

Therefore, this study aims to provide a tool, based on high-resolution spatial data and GIS analyses, to support decision makers for managing risky areas in urban environments and enhance flood hazard and risk assessment. Do-Asb floodway is chosen as case study located in Zanjan city in the North-West of Iran.

To assess the risk in the study area, the following steps were conducted in this research. (a). Producing high-resolution spatial data sing terrestrial methods and land survey (b) Meteorological data processing to compute some characteristics of floods such as flow, inundation depth, potential flow density, the volume of flood events of different recurrence intervals up to 500 years and so on, (c) Estimation of inundation zones for flood events of different recurrence intervals using hydraulic models and high-resolution DEM (Digital Elevation Model), (d) Estimation of the resulting damages including areas, population, urban parcels with different land-uses, urban infrastructures etc., , using GIS modeling. Additionally, 5 scenarios are defined to calculate the risk. In this case, some critical parts of the floodway are selected and the risky areas are calculated in these parts.

The results indicate the high-risk areas around the floodway along with the risk of any object in the study area using the generated risk computation tool considering socio-economic parameters. Also, the results of the 5 scenarios show that if some parts of floodway have some problem, the risk is high. Hence, the floodways should always be maintained. The generated flood risk maps of this model can be used to reduce flood damage and ensure public safety.

GEOMORPHOLOGICAL MAP OF DOWNTOWN PERUGIA: DIGITAL DATA AS A TOOL TO EXPLORE HOW THE NATURAL ENVIRONMENT AFFECTS THE URBAN DEVELOPMENT

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Abstract

Perugia, the capital city of the Umbria region (central Italy), is located on the top of a hill characterized by a very particular morphological setting. The topographic trend consists of five flat ridges separated by small rivers, with the north-eastern sector steeper than the south-western one. Since ancient times (Etruscan, 6th-3rd century BC; Roman, from the 1st century BC) and constantly over the centuries, this topographic pattern and the associated geological problems resulted in the need for complex infrastructure and morphological adjustments aimed at stabilizing the terrain, and limited the urban development to the gentle areas along the drainage divide. We present a geomorphological map built for the downtown area of Perugia, with a focus on the urban particularities related to the coexistence of the anthropic landforms in the natural setting, which created a sort of "anthropic layering". The identification of the relevant landforms was carried out by using a Digital Elevation Model (DEM) with a 5x5 meter resolution built for the study area starting from the contour lines of the digital CTR map (Carta Tecnica Regionale, scale of 1:10000), in conjunction with the analysis of aerial photos and on-site surveys. Once identified, the landforms were digitized and properly classified in a dedicated Geodatabase in a GIS environment. The database collects about fifty feature classes for the landforms, as well as digital data such as historical buildings, walls and archaeological sites. This allows showing the superimposition of the man-made landforms over the natural, along with their spatial relationships.

GEOSPATIAL 3D MODELING FOR SUSTAINABLE SAFEGUARDING NATIVE MALAY URBAN ARCHITECTURAL IN MALAYSIA

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Abstract

Documentary works in all formats, including digital, are a key part of our cultural heritage in Malaysia. Working with, preserving, and safeguarding them in order to provide access to future generations is at the core of the work of libraries globally. The objective of this paper is to reconstruct a native Malay urban traditional settlement in one of selected prominent old traditional malay settlement in Malaysia for the purpose of preserving the native malay architectural in traditional malay settlement located at Kota Bahru, Malaysia. 3D modeling has been perfomed base on data collected through integration of drone and laser scanning approaches that effectively proven through the process perfom in collecting data, preprocessing and data analysis. 3D drone mapping and both static and mobile scanner approaches have been use in order to carry out the output. The process of reconstruction was based on the elements of urban form has been analysed consist of streets, facade and building at earlier stage. The finding shows that, the elements of urban forms has been proven as basic fundamental to recognize the pattern of native Malay urban architectural and its clearly proven through the 3D modeling reconstruction method that has been performed through drone and laser scanning data processing. This work shows the effectiveness of geospatial data in safeguarding our cultural heritage simultenously supporting the mission of sustainable goals developments in local and global.

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HUSH APP: DIGITAL TOOLS TO EXPLORE THE NATURAL PATRIMONY OF URBAN AREAS

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Abstract

In the past two decades increasing efforts have been devoted to diversify the tourism industry, such is the case with urban trekking and geotourism [1]. The recent advancements in Augmented Reality technologies as well as the increasing availability of 'born digital' data, create the basis for the development of immersive and customized touristic experiences. Urban scientific tourism, Augmented Reality and data mining are the key elements of the HUSH project. Its first focus is the identification of the naturalistic components in a given urban area (flora, fauna and geological features) through literature surveys and scientific research. These components come to be Points of Interest (PoIs) along touristic paths, where they are connected to the historical and artistic components of the area. Augmented Reality is the mechanism by which the user can access these contents by means of the HUSH mobile application. In the geodatabase, each PoI is defined by a target image. This allows the users to open the multimedia contents (e.g., text, images, and interactive 3D models) by framing the target element with their mobile device. The PoIs can be explored by choosing between predefined paths, paths suggested according to a keyword-based search, and "intelligent paths" based on a Deep Neural Network (DNN) [2], which uses the social information of the users to customize their touristic experience. In compliance with the "citizen science" paradigm, the user can act as a scientific reporter sending their feedback through the app, or submitting new contents for examination by the research group.

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MEASURING PUBLIC TRANSPORT ACCESSIBILITY BASED ON GOOGLE DIRECTION API

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Abstract

Accessibility is considered as important evaluation indicator of the public transport system. Usually, accessibility of a place is assessed by its distance to the transit access points such as bus stops and metro stations. Traditionally, measuring the trip distances to transit access points has relied too much on geographic information of transit facilities, built environments as well as pedestrian routes. Data collecting and data analyzing are tedious for researchers in traditional approaches. As cloud computing is on the rise, open services such as Google Cloud Platform may be helpful in simplifying the procedure of public transport accessibility measurement. But the effectiveness of the open computing services still needs to be tested and evaluated in measuring public transport accessibilities. This paper aims to evaluate a method of estimate public transport accessibilities based on Google Direction API rather than local data analyzing ways. A mechanism of API probing based on Google Direction API was designed. In a case study of Beijing metropolitan area, the area was sliced into gridded spaces, and the center coordinates of the cell spaces were calculated for Google Direction API. The API gave walking distances to transit service for the center coordinates in transit direction inquiries. And the walking distances in the API feedback were compared with numbers of public transport access points in each cell grid areas. It was found that Google Direction API generally gave short walking distances to public access points in those cell areas with better accessibilities. The conclusion was that open services such as Google Direction API could also serve as an alternative solution to public transport accessibility measurement. Transport researchers might take advantages of the open API services to avoid troubles of collecting and processing transit facility data.

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MONITORING URBANIZATION AT GLOBAL SCALE – THE WORLD SETTLEMENT FOOTPRINT

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Abstract

Reliably monitoring global urbanization is of key importance to accurately estimate the distribution of the continually expanding population, along with its effects on the use of resources, socioeconomic development, food security, etc. To this purpose, since the last decade several global maps outlining settlements have started being produced by means of satellite imagery. In this framework, the two currently most largely employed are JRC's Global Human Settlement Layer (GHSL) derived at 30m spatial resolution from Landsat optical data [1] and, especially, DLR's Global Urban footprint (GUF) derived at 12m spatial resolution from TanDEM-X/TerraSAR-X radar data [2]. However, it is worth noting that, despite generally accurate, these layers still exhibit both some over- and underestimation issues. Specifically, this is mostly due to the fact that they have been generated by means of: i) single-date scenes (which can be strongly affected by the specific acquisition conditions) and ii) solely using either optical or radar data, which are sensible to different structures on the ground.

In order to overcome these limitations, we have developed a novel methodology that jointly exploits for the first time mass multitemporal optical and radar data. In the light of its great robustness, the method has been recently used for generating the new World Settlement Footprint (WSF) 2015, i.e. a 10m resolution binary mask outlining the extent of human settlements globally derived by means of 2014-2015 multitemporal Landsat-8 and Sentinel-1 imagery (of which ~420, 000 and ~250, 000 scenes have been processed, respectively). Furthermore, to quantitatively assess the high accuracy and reliability of the layer we have carried out an unprecedented validation exercise based on a huge amount of ground-truth samples (i.e. 900, 000) labelled by crow-sourcing photointerpretation. In particular, a statistically robust and transparent protocol has been defined following the state-of-the-art practices currently recommended in the literature. Overall, results assess the great effectiveness of the WSF2015, which also outperforms all other currently existing similar global layers.

Nevertheless, to properly analyze and understand the complexity of human settlements and ensure their sustainable development, not only information about the current extent is sufficient. Rather, outlining their growth over time is also fundamental for modelling ongoing trends and implementing dedicated suitable planning strategies. However, so far the existing products are mostly available for few time steps in the past and their quality– yet by simple qualitative assessment against e.g. Google Earth historical imagery – appears rather poor. To address this issue, we designed and implemented a novel iterative technique for outlining the past settlement extent from Landsat multitemporal imagery available from late 1984 (indeed no comparable radar dataset is continuously and globally consistently available over the last 30 years). Extensive experimental analyses over several test sites assessed the great effectiveness and robustness of the methodology. Accordingly, it is currently being employed within the Google Earth Engine environment for generating the WSF Evolution, i.e. a novel dataset aimed at outlining ton a yearly basis from 1985 to 2015 the growth of settlement extent globally at 30m spatial resolution. The WSF Evolution is envisaged to be released open and free in the second half of 2019 and is expected to become a revolutionary product in support to a variety of end users in the framework of several thematic applications, helping to understand, as never before, how settlements evolved over three decades while capturing specific temporal trends.

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THE GREAT WALL DEFORMATION MONITORING RESEARCH AND APPLICATION BASED ON TLS

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Abstract

The Great Wall is not only Chinese but also the world's treasures. Due to the destruction of natural and human factors, the wall and foundation of the Great Wall appeared in varying degrees of damage in recent years. The TLS(Terrestrial Laser Scanning), as a new developing technology, has many new features and functionality. This technology introduced into the field of the Great Wall deformation monitoring, is of great practical significance. With the TLS, it can reflect to scan the overall condition of the Great Wall now. In the aspect of deformation monitoring of single point positioning for settlement analysis, it can sketch the contrast figure based on many times of scanning data. The results show the bulging, deformation and subsidence displacement deformation of Great Wall. According to the deformation trend analysis, the cultural relics departments can carry appropriate treatment.

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URBAN GEOMORPHOLOGICAL HERITAGE: DIGITAL DATA AND MANAGEMENT

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Abstract

Even if urbanization is a wide process, studies on urban geomorphological heritage are relatively scarce (Reynard et al., 2017). Urban geomorphological heritage refers to two fields of research: urban geomorphology and geomorphological heritage. Geomorphology interacts with urbanization in six ways: (i) geomorphology participates to the image of some cities; (ii) landforms may constitute a constraint to urban development; (iii) geomorphological processes may lead to natural hazards in cities; (iv) geomorphology provides cities with ecosytem goods and services; (v) urbanization being a vector of relief tranformations, new anthropogenic landforms may be created; (vi) urbanization is a factor of modification, and even destructions, of landforms and geomorphological heritage. Urban geomorphosites may be considered in two ways: (i) large sense: any geomorphosite situated within the limits of the urban space; (ii) strict sense: locality that helps understanding the relations between geomorphology and urban development.

This communication examines how digital tools can help addressing the management of urban geomorphological heritage. It presents several examples in various contexts (urban geomorphological mapping, geohistorical approaches, integrated management of various data, and addresses the six types of relationships and the two categories of urban geomorphosites.

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SESSION: Digital Earth contribution to Society through ISDE community collaboration

AN INTERNATIONAL COLLABORATION TOWARDS TRANSFORMED ENGINEERING PRACTICE IN DIGITAL EARTH

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Abstract

Life in the 21st Century is increasingly reliant on analysing and visualising digital and spatial information, with significant potential for planetary stewardship and environmental rejuvenation alongside urban development and urban renewal. Global initiatives such as the United Nations (UN) Sustainable Development Goals (SDGs) and the Sendai Framework for Disaster Risk Reduction, provide excellent context for monitoring and evaluating human endeavours towards sustainable development.

However, there is a significant disconnect between opportunities available though these initiatives, and capacity of current professionals and current education, to deliver the goods and services required. This paper presents an international initiative between two ISDE chapters – Australia and Japan – through Griffith University (Brisbane, Australia) and Chubu University (Nagoya, Japan) to transform engineering perspectives with regard to the use of 'Digital Earth' knowledge and skills. Specifically, the initiative focused on a course within an engineering minor called 'Digital and Spatial Innovation', and professional development pathways through internationalisation [1]. Drawing on lived experiences (2017-18), the authors analyse student performance, surveys, focus groups and assessment items.

Building on an appreciation of the 'Time Lag Dilemma' (previously published by the first author [2]), the authors use the Biggs 3P model [3] to discuss enabling the vision of the UN SDGs. Key findings consider the depth of engagement, shifts in student perspectives and appreciation of career pathways connected to geospatial enquiry. The authors also reflect on the benefits for academics in both universities to build capacity for embedding Digital Earth related knowledge and skills within their own coursework. These findings have immediate implications for ISDE community collaboration and capacity building within higher education, and more broadly bridging the gap between engineering and geospatial disciplines in the workplace. The conclusions are particularly relevant for the education sector and government in improving the use of digital and spatial information for meaningful enquiry and problem-solving.

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DIGITAL EARTH - THE NEXT PARADIGM

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Abstract

Digital Earth is a global initiative to collate rich information and construct a comprehensive virtual representation of the planet that deepens understanding of the complex interactions of the physical world and the bearing these may have on our daily lives. The initial scientific work, with a focus on the physical aspects of our habitat, has revealed clearly the impact of large human populations and their activity. Scientists now call the 21st century the Anthropocene Era because their published research shows that human activity is rapidly changing the ecosystem in alarming and unsustainable ways not experienced before in history. There is a need for substantial change in human activity.

However, although digital technologies are now highly advanced they are not yet well integrated into cultures globally. The warnings about over consumption, climate change and ecological degradation have been largely ignored or contested by people who have little knowledge of, or trust in, research via satellites and sensors, data management, modelling techniques and the reports of an elite group of scientists. Historically, scientific knowledge has not been shared with most people in ways that inform and include them enough to enable deep learning, cultural change and access to emerging opportunities It is therefore not surprising that democratically elected governments still subsidise and make war over fossil fuels, economic modelling usually externalises the ecological costs of human activity, and the opportunities afforded by emerging technologies and richer understanding of the complexity of our habitat are being ignored by most.

We live in an unprecidented and pivotal time, there is exciting potential for Digital Earth to become a enabling and critical project for humanity to grow a more widely shared and inclusive knowledge economy, in which many more people are collaboratively engaged in deep learning and participate actively to create a shared representation of their part of the planet, the value of the Digital Earth initiative will be understood and better supported globally. An expanded global initiative, supported by shared and accessible technologies, to enable people to collaborate, apply their knowledge and use it creatively to make decisions, address issues that concern them and participate in sustainable economic activity would underpin the advanced scientific enterprise. One aim of such a project would be that the value of a richer understanding of the physical aspects of the planet, and its complex systems, is recognised by most people and enriched by parallel insights, understanding and evolution of the social and cultural aspects of a widely shared human consciousness.

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GRASPING THE GLOBAL WITH DIGITAL EARTH

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Abstract

At a time when our planet faces unprecedented changes in both its physical and human systems, acquiring knowledge and understanding of the global is a critical element of high quality geography scholarship. This paper explores the connections between the use of contemporary geographic information systems (GIS) and developing young people's understanding of their world at a planetary level. Despite rapid and widespread developments in new geographical information system applications, their use in overtly teaching the global in this way remains surprisingly under-explored. This paper addresses this gap by addressing what powerful geography knowledge about the global looks like in GIS and discusses how educators could employ powerful pedagogies to teach the global with it. Via critical synopsis, the paper provides new perspectives on the ways in geographical analysis, explanation and generalisation about the global can be enhanced with GIS. The paper concludes with recommendations for educators wanting to capitalise on the potential of GIS as a powerful tool for teaching and learning about the global in geography education.

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INNOVATION JOURNEY OF THE DIGITAL EARTH NODE (DEN): EXPERIENCES, IDEAS AND FUTURE OPPORTUNITIES

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Abstract

With the advancement of digital and geospatial technology everyone and everything in the world is connected. Within this realm there is an increasing need for readily-accessible virtual meeting spaces to connect decision-makers from different geographic locations and share spatial data for timely decision making. Building on our previous research in Phase 1 - pre-totyping and prototyping a Digital Earth Node' (DEN) [1] – we have now further developed this this innovative tool in 'Phase 2' of our program, to support learning, creating, and developing spatial capabilities to with a one-touch "all-in" feature.

This system enables interaction with 10 different screens using a mobile device with low bandwidth internet connection in contrast to high-powered computers with ultra-high bandwidth cabled internet connection. DEN creates a global platform for people to connect and interact while providing comprehensive visual representation of real data to improving disaster mitigation, preparedness, and recovery. Interaction between collaborators is passed as event packets and data is not stored on servers. This innovative digital collaboration method creates a secure, private and fast experience that makes accessibility of multiple data sets and monitors possible over low bandwidth mobile networks. This uncovers opportunities for field applications that include mobile vehicle data centres with modular mobile bandwidth leverage. This would create a high redundancy network and large-scale collaboration offering.

In 'Phase 3', the authors plan to collaborate with ISDE colleagues in Japan and elsewhere, to set up other localised but globally connected nodes. In this paper, the authors report on progress since ISDE 2018, and potential to include community-driven, cross-sectoral research to provide tangible, creative solutions for disaster management. We discuss insights into improved decision-making and integrated policies, including the potential for programs that support engagement and collaboration between government, industry and academic researchers globally. The findings have immediately implications to solve time-scale challenges, from dealing with immediate disaster response and recovery, through to planning and governance for future resilience.

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THREE-DIMENSIONAL MAPPING – WHEN 3D MODELS OF REAL ENVIRONMENT BECOME 3D MAPS

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Abstract

Cartography is one of the most ancient and in the same time one of the most modern science. The new three-dimensional (3D) technologies and the application of modern techniques give us evidences for development of cartography. On this way the modern cartography will supply Digital Earth (DE) ideas with the most suitable and understandable visualization of the real word. DE with its global dimension and multiple applications and themes has a strong technological component and provides a flexible framework to adapt to evolving technologies [3].

The major advantage in 3D cartographic modelling is that once created 3D model / map can be used for different purposes. It can be considered as database and source for creation of various applications with different functionalities used in different areas of interest.

The report considers the cartographical elements applied in 3D mapping: user requirements, map contents, symbol system, accuracy, scale and generalization (different levels of details). The new cartographical elements are added to improve the 3D maps: virtual camera, shades, lights, animation.

The report describes complex technology that tracks the creation of several 3D mapping applications based on a 3D model. It will be considered three types of applications: 3D printing map, virtual flight (animation map) and 3D maps with an interactive web application. Each application according to its type and method of creation requires certain features of the 3D model. These features depend on the purpose and the user of the map, on its way of visualization and publication, on the software which will be used for creation of different 3D maps and on the technical requirements and hardware capacities of the computers.

Many authors speak about 3D maps and give different definitions: Jenny H. M. speaks about 3D maps as “commonly known as landscape panoramas or bird’s-eye views” [2]. Artimo K. defines 3D map as combination of digital cartographic data and methods for representation [4].

Another definition says that 3D map is a computer, mathematically defined, three-dimensional virtual representation of the Earth surface or another celestial body, objects and phenomena in nature and society. Represented objects and phenomena are classified, designed and visualized under particular purpose [1].

The concrete content of the 3D map is designed after the definition of objects and phenomena that will be included. It could be subdivided into three themes:

- Main content - large topographic or landscape objects such as relief bodies, roads, buildings etc. Most designed 3D maps, presented by different companies in the world, represent it.
- Secondary content, carrying the basic information. For example in 3D urban maps – objects, represented by symbols – traffic signs, facilities, transport elements, information signs, trees, etc.
- Additional content, providing the quality and quantity information about objects, often created as a textual database, regarding each of designed objects or the map as a whole.

Every map consist 3D geometry, topographic information and photo-realistic texturing , 3D symbols, which contain quantitative and qualitative information about the objects, direction and coordinate datum, scale, level of details, generalization, accuracy, toponyms, legend and title. All these cartographical elemens will make possible 3D model of real environment to become 3D map.

This research shows that cartographic science with the latest modern technologies and appropriate visualization will find its place in the large aspects of tasks of Digital Earth, early warning and disaster management, climate changes visualization, touristic presentations, geo-science development. The next task is connected to find more applications and reduce the time and all machine and human sources for final model creation and visualization.

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UNLOCK AND USE EO/GEOSPATIAL DATA FOR SDG BY EMPOWERING STAKEHOLDER ENGAGEMENT IN A TRANSFORMED SOCIETY

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Abstract

The team of the co-authors within the Hungarian Society of Surveying, Mapping and Remote Sensing (MFTTT) was recently acredited as Working Group on EO/GI for Sustainable Development Goals (WG4SDG). Its mission goal is to facilitate unlock the power of the use of the steadily developed EO/Geospatial data infrastructures and services for SDGs by strengthen the engagements of the stakeholders from government, academia/education, private sector/industry and learned societies on national level. Furthermore, the just established direct link with the forum of the EO downlink and ground segment industry represented by the Hungarian Space Cluster HUNSPACE will further leverage the knowledge and experiences gained in EO and SDI communities, using long-life connections also with the national GI association HUNAGI and international learned societies such as FIG, ISPRS, ICA and ISDE.

Monitoring and reporting of the targets and their indicators of the Sustainable Development Goals of the UN 2030 Agenda (2016-2030) requires innovative and cost-effective support provided by the Digital Earth technologies including EO/ICT/SDI. Considering the spatial nature of the majority of indicators to be monitored, the need for spatiotemporal analysis capabilities is imperative and the fact, they have to be disaggregated also by geographic location where appropriate, it upgrades the value of EO/Geospatial Data Infrastructures, related interoperable services and calls for coordinated, interdisciplinary collaboration with special emphasis on the link to be enhanced with the national statistics.

The early engagement of the stakeholders from Academia, Private sector, NGOs and Governmental agencies is critical. Awareness raising actions addressing the data custodians, value added products providers and the scientific/educational institutions with the aim to bring the potential cooperating organisations together will facilitate the achievement of the UN Sustainable Development Goals (SDGs).

Started in February 2017, awareness raising campaign was setting up on national level by volunteer and ad-hoc team members of the Hungarian Society of Surveying, Mapping and Remote Sensing (MFTTT) by the former and the present national INSPIRE delegates as well as by the national correspondent to the Group of Earth Observations (GEO) and liaison of the Global Spatial Data Infrastructure Association (GSDI) later of the Hungarian Space Office to the Working Group of Information Systems and Services (WGISS) of the Committee of Earth Observation Systems (CEOS). The achievements of the first two years were published in domestic and international journals (Geodézia és Kartográfia [1], MMM Geo Information [2], GIM [3]) and proceedings (7thICC&GIS [4], EFGS [5]) and were submitted in form of written report [6] to the EO4SDG Initiative at the GEO Week held in Kyoto, October 2018 as well.

The presentation will share the conclusions and major considerations based on the experiences of the first two years, describe the proposed way ahead as approved by the Executive Committee of MFTTT (Res.No. 16/2018.(XII.10.)), will provide an introduction of the potential stakeholders capable to engage in the UN 2030 Agenda related implementation of SDGs. This inventory will cover selected major service and solution providers who can or could play active role in EO/Geospatial applications supporting the achievement of SDGs.

Emphasis will be given to the capacity building, education, cooperation and coordination aspects due to the necessity of adoption of SDGs-related capacity building on how to use emerging Digital Earth technologies and innovative approach in the field of EO/ICT/SDI and the imperative need for cooperation and collaboration in line with the UN guidelines and the respective national strategy on SDGs taking into account the national programmes associated with the digital transformation of the society.

Finally, some achievements of the work accomplished in 2019 will be addressed.

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SESSION:
Digital Ocean information from Satellite Remote Sensing

(SUB)MESOSCALE OCEANIC EDDY DETECTION AND ANALYSIS BASED ON ARTIFICIAL INTELLIGENCE（AI）

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Abstract

Oceanic eddies are ubiquitous in the ocean and are important parts of the ocean. Oceanic eddies carry enormous kinetic energy and move faster than the average ocean current several times or even an order of magnitude. The vertical depth of the oceanic eddies can affect underwater tens to hundreds of meters, even thousands of meters. They bring cold water and nutrients from deep in the ocean to the surface, or bring surface warm water into the deeper oceans. This process affects the upper mixing layer, the temperature/density thermocline, and even deeper oceans. The high rotational velocity and the accompanying strong shearing force of the eddy makes it highly nonlinear and thus maintain the characteristics of the eddy itself. Oceanic eddies play an important role in the transportation and distribution of marine materials, energy, heat and fresh water. Therefore, The detection and analysis of oceanic eddy have very important scientific and applied value. The detection and analysis of oceanic eddy strongly depends on the physical characteristics of real ocean eddy provided by actual observations. The appearance and rapid development of high resolution ocean satellites (especially altimeter) provide a lot of observation datasets and numerical products for the detection of oceanic eddy [1]. According to the size of oceanic eddies, oceanic eddies can be divided into mesoscale and submesoscale eddies. Existing high resolution satellite data has the ability to capture oceanic eddies in the mesoscale (~100 km). However, for the smaller eddies in the submesoscale (~10 km), there is no impotence. Therefore the new satellite plan of wide swath interferometric imaging altimeter with higher resolution is proposed, e.g., SWOT and Guanlan satellites, they provide a possibility for the detection of oceanic submesoscale eddies [2]. Unfortunately, higher resolution satellite data means a larger and more intensive volume of data per unit of time. The processing efficiency and accuracy of traditional detection methods will be affected. So it is necessary to study the new methods of oceanic eddy automatic detection. In this respect, artificial intelligence deep learning technology has incomparable advantages over traditional methods [3]. Deep learning technology doesn't require a lot of deep professional knowledge and expert experience, and conduct automatic training and learning according to the main morphological characteristics of oceanic eddy, and close the ability to the expert system in a very short time. Therefore, the combination of new technologies, new data, and new methods presents demands and challenges for (sub)mesoscale oceanic eddies detection.

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A NOVEL PROCESS-ORIENTED GRAPH STORAGE FOR DYNAMIC GEOGRAPHIC PHENOMENA

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Abstract

There exists a sort of dynamic geographic phenomena in a real world with a property from production through development to death [1-3]. The traditional storage units, e.g. point, line, polygon, have great challenges to explore the evolution behaviors among the dynamic phenomenon during its lifespan. Thus, this paper combines a process semantic [4] and a graph concept [5] to propos a process-oriented two-tier graph model to store the dynamic geographic phenomena. The core ideas of the model are as follows. 1) A dynamic geographic phenomenon is abstracted into a process with a property from production through development to death. A process consists of evolution sequences, which includes instantaneous states. 2) The model integrates a process graph and a sequence graph using a node-edge structure, in which there are four types of nodes, i.e. a process node, a sequence node, a state node and a linked node, and two types of edges, i.e. an including edge and an evolution edge. 3) A node stores an object, i.e. a process object, a sequence object or a state object, and an edge stores a relationship, i.e. an including or evolution relationship between two objects. Experiments on simulated datasets are used to demonstrate one order of magnitude performance of our model on relationships querying compared with Oracle spatial database. The applications on global sea surface temperature show that our model can effectively explore marine objects, as well as the evolution behaviors, and these behaviors may provide new references for global change research.

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A PROCESS-ORIENTED APPROACH FOR MINING GLOBAL SEA SURFACE TEMPERATURE ABNORMAL VARIATIONS

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Abstract

A marine abnormal variation object means a spatiotemporal object within a given spatiotemporal domain, its spatial location and geometric features change over time. That is, the object has a property of an evolution from production through developing to death. Many literatures have shown that an evolution of sea surface temperature abnormal variation object (SSTAO) has an aspiring relationship with a signal of climate change, e.g. El Niño Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), North Pacific Oscillation (NPO) [1-3]. Advanced earth-observing technologies make it possible to acquire lengthy time series of marine remote sensing products, and offer new opportunities for mining SSTAO with an evolution [4-5]. Thus, we propose a Process-Oriented Approach for mining global SSTAO with a time-series of remote sensing products, named as POA-SSTAO. The POA-SSTAO consists of three key steps. The first step combines a temporal evolution and spatial proximity to identify an independent spatial abnormal object at each snapshot; the second step adopts prior-knowledge to match the same spatial objects at the successive snapshots, and track them into an evolution process; the third stores the process objects using a graph model, and finds the dynamic behaviors between the spatial objects at the successive snapshots. Finally, the marine abnormal variation objects with evolutions of monthly global sea surface temperature during a period of Jan 1982 to Dec 2017 are discovered, a relationship between a specified evolution and an ENSO index is analyzed, and the result proves an effectiveness and an efficiency of our proposed algorithm.

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A STUDY OF SST FEATURES OFF THE COAST OF RONGCHENG, CHINA USING AVHRR DATA

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Abstract

Rongcheng is at the east tip of Shandong Peninsula in North China. It is the world’s largest kelp seaweed farming zone. Water temperature is an important factor for kelp. The sea surface temperature off the coast of Rongcheng is relatively lower than the adjacent waters, which is in favor of the kelp seaweed farming. SST is a main controlling factor affecting the production of kelp. It is of importance to know the interannual and seasonal variability features in this area. In this study, remote sensing SST data provided by AVHRR (Advanced Very High Resolution Radiometer) from 2005 to 2018 are used to investigate the SST features. SST in the study area shows significant seasonal variation and it gets to maximum in August, which is about 24℃. The 3-D hydrodynamic model FVCOM is used to investigate the mechanism of water temperature variablity. It is found that the strong tidal current is the main driving force controlling the low SST in this area. Tidal current generates strong tidal mixing. The cold bottom water can be stirred upwards and makes the surface temperature decreased significantly. The weather conditions are the main driving force of interannual variability. The strength of frequency of summer storm could change the SST in summer.

ACOUSTIC MAPPING AND CLASSIFICATION OF BENTHIC HABITAT USING UNSUPERVISED LEARNING

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Abstract

In recent decades, acoustic techniques have been utilized to improve our ability to map the spatial characterization of benthic habitat in the presence of artificial structures (Kang et al., 2011). Acoustic habitat mapping has become a major tool for evaluating the status of coastal ecosystems. This technique is also commonly used in marine spatial planning, resource assessment and offshore engineering (Micallef et al., 2012). Traditional sampling methods can only provide a snapshot that covers a fraction of the seafloor area (Harper et al., 2010), while acoustic mapping technologies are capable of efficiently capturing images across large areas of the seabed (Huang et al., 2014). Advances in acoustic technologies, particularly multibeam echosounders (MBES), have enhanced our ability to characterize physical aspects of the benthic environment at fine scales (Brown and Blondel, 2009; Pickrill and Todd, 2003). Bathymetry data, together with acoustic backscatter data, depict the compositional characteristics of the seafloor surface and can provide important insights into the distribution and complexity of benthic habitats. Conventionally, MBES data sets of seabed geological features have been manually interpreted by experts or using simplified substrate classification methods developed for single beam echosounder. Recently developed quantitative computational techniques can transform spatially complex bathymetric and backscatter data of large areas into simple, easily visualized maps that provide the end users with abundant information (Micallef et al., 2012). Driven by the advances in objective classification algorithms, a variety of automated methods have been developed and tested (Brown et al., 2011). These approaches fall into two categories: unsupervised or supervised classification (Stephens and Diesing, 2014). Typical unsupervised methods consist of clustering techniques (e.g., k-means and ISODATA) that classify regularities in data sets into seabed acoustic classes (Brown and Collier, 2008; McGonigle et al., 2009). Supervised classification techniques (e.g., artificial neural networks and support vector machines) use ground-truth data to develop a predictive model (Hasan et al., 2012; Huang et al., 2014; Stephens and Diesing, 2014). Artificial reefs (ARs) are effective means to maintain fishery resources and to restore ecological environment in coastal waters. ARs have been widely constructed along the Chinese coast. However, understanding of benthic habitats in the vicinity of ARs is limited, hindering effective fisheries and aquacultural management. The objective of this study is to develop a technical approach to characterize, classify, and map shallow coastal areas with ARs using an MBES. An automated classification method is designed and tested to process bathymetric and backscatter data from MBES and transform the variables into simple, easily visualized maps. To reduce the redundancy in acoustic variables, a principal component analysis (PCA) is used to condense the highly collinear dataset. An acoustic benthic map of bottom sediments is classified using an iterative self-organizing data analysis technique (ISODATA). The approach is tested with MBES surveys in a 1.15 km2 fish farm with a high density of ARs off the Yantai coast in northern China. Using this method, 3 basic benthic habitats (sandy bottom, muddy sediments, and ARs) are distinguished. The results of the classification are validated using sediment samples and underwater surveys. Our study shows that the use of MBES is an effective method for acoustic mapping and classification of ARs.

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ASSIMILATION OF SATELLITE REMOTELY SENSED WINDS FOR TYPHOON FORECASTING: PROGRESS AND PERSPECTIVE

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Abstract

Typhoon is one of the most powerful and destructive natural disasters. Accurate forecasting of Typhoon track and intensity is very important to disaster prevention and reduction. Satellite observations can effectively compensate for the shortcomings of traditional methods of sea surface measurement and provide all-weather observation over the sea surface, which is of great significance to improve the numerical prediction of strong convective weather over ocean. The space-borne radar observes the backscattering caused by the sea surface roughness, and then, the sea surface wind can be retrieved. The Synthetic Aperture Radar (SAR) is an important data source for sea surface monitoring [1]. A variety of meteorological hydrological elements can be retrieved by SAR observation, and it has been used in data assimilation in recent years [2]. SAR imagery is also used to monitor strength and structure of typhoons [3]. The high resolution sea surface winds retrieved from SAR can be used with a data assimilation system to provide the initial conditions for the numerical weather prediction (NWP) model.

Quality control of observation is an indispensable process for data assimilation. It ensures that the wrong observations are removed before assimilation, which would otherwise result in inaccurate analysis. In general, the deviation of background (b) and observation (o) is used as a basis for evaluating the quality of the data. It is generally believed that the observation error distribution satisfies the Gaussian distribution, assuming that the background error is a Gaussian distribution, and then, the distribution of deviation should also be satisfied with the Gaussian distribution. However, according to the statistical results, the distribution of deviation for many observations does not strictly follow the Gaussian distribution. The traditional Gaussian distribution QC method carries out strict threshold control by the magnitude of the deviation. However, large deviation between the observation and background does not mean that the observation is wrong. In typhoon conditions, observation and background tend to have a larger deviation, and the use of traditional Gaussian distribution QC will result in rejection of a large number of effective observations. In our recent studies, a new QC scheme based on Huber norm distribution is proposed. Unlike traditional QC methods, this method takes appropriate weights based on the magnitude of deviation from the observation and background, making it possible to utilize more observations. It can calculate the transition point of the Huber norm distribution and adjusts the weight of the observation error for the satellite observed wind data.

In this presentation, a data assimilation scheme is presented to assimilate the high resolution remotely sensed winds into the typhoon forecasting model. Numerical simulation experiments of severe powerful typhoons are conducted to test and compare different data assimilation methods. This presentation will also provide a brief overview on typhoon remote sensing by space-borne radar, and reviews the past and current research activities on satellite data assimilation in typhoon forecasting, current status of typhoon research using numerical weather prediction, gaps identified and relevant measures taken by different agencies in this direction, along with future directions in order to improve the understanding and predictability of typhoon over the Northwest Pacific region.

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EAST ANTARCTICA VELOCITY MAP OF 1963-1989 BASED ON HISTORICAL IMAGES

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Abstract

Antarctic surface velocity is one of the most important parameters to estimate the mass balance of the Antarctic ice sheet and further, the contribution to the global sea level change. Changes of ice flow velocity are closely associated with the mass balance of the ice sheet and stability of ice shelves. However, there is a lack of historical continental scale velocity maps of Antarctica before the 1990s. Historical optical images such as ARGON and Landsat images before 1990s are difficult to be used for ice flow velocity mapping, due to the fact that they are mostly not strictly geo-processed (e.g., ortho-rectified) and the image quality is lower than those of recent sensors.

This paper presents a systematic framework for developing a surface velocity map of East Antarctica from 1963 to 1989 based on historical ARGON and Landsat images, including selecting appropriate image pairs, matching corresponding points, eliminating mismatches, and compiling mapping results. The resolution of this velocity map is 500 m, which was given by average point density in the whole region [1-2].

A preliminary comparison among our map (1963-1989) and existing velocity products like RAMP velocity map (1997-2000) [3], MEaSUREs velocity map (1996-2009) [4] and LISA velocity map (2015-2016)) [5] suggests that the glaciers in Wilkes Land experienced an increasing trend with obvious fluctuations during the past ~50 years, such as Totten, Dibble and Cook glacier, while glaciers near Transantarctic Mountains like Byrd and David glacier tend to be stable or slightly fluctuating during this period.

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ESTABLISHMENT AND APPLICATION OF MARINE SCIENTIFIC DATA SHARING SERVICE SYSTEM OF CHINA

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Abstract

Marine scientific data is not only the basic strategic resources, but also the essential information base in understanding and exploiting ocean. Open data sharing is needed for the development of marine science itself. Open communication and discovery guarantees the capacity of marine science’s self-correction and perpetual progress, and is the necessary requirement of carrying forward Marine Economic Powerful Nation Strategy and Maritime Silk Road Strategy.

In China, marine data resources system has begun to take shape, and the competence of data integrating and processing, and the sharing service is improving steadily. The benefit of marine information resources has brought with sufficient release, with the persistent exploring and trials in marine scientific data management and open sharing. With the joint support of the Ministry of Science and Technology and the Ministry of Finance of the People’s Republic of China, National Marine Data and Information Service (NMDIS), that is affiliated to the Ministry of Natural Resources of the People’s Republic of China, took the lead in national marine scientific data center establishment with other ocean-based scientific and research institutions and colleges and universities. This paper summarizes the establishing progress of China’s Marine Scientific Data Sharing Service System from the following 5 perspectives: research of sharing policy and theory, data integration and management, sharing service platform construction, key techniques study and mechanism guarantees. How to provide information services in facing demands of accelerating the construction of Marine Economic Powerful Nation and innovation in global marine governance is also talked about in this paper.

LONG-TERM INFLUENCE OF ANTHROPOGENIC ACTIVITIES IN THE COASTAL WETLANDS IN CHINA

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Abstract

Coastal wetlands include sensitive vegetated areas and tidal flats, which are important transitional areas, bridging the terrestrial and ocean ecosystem. Due to their geographic location, coastal wetlands are vulnerable to both anthropogenic activities and to natural disturbances. In China, human activities have increased in the coastal areas in the last few decades. For instance, there has been unprecedented accretion of land in the shoreline to support economic activities. Such land use changes are the main drivers of degradation of the coastal wetlands hence reducing the benefits that could be accrued from the coastal ecosystems. Assessing and monitoring of the human-induced changes in the coastal wetlands requires efficient and multi-variate analysis of long-term earth observation data from different sources. In this research, we quantify human settlement characteristics in coastal areas of mainland China from a combination of long-term nighttime light data, vegetation indices and land cover change characteristics. Thereafter, we combine the human settlement characteristics with spatial and temporal changes in tidal flats and wetlands in the coastal zones to quantify the relationship between human settlements and changes in the coastal wetlands. The computation is implemented in Google Earth Engine (GEE), which provides both the long-term data for the analysis and the functionalities for automated data retrieval and analysis. The results from this work highlight the potential hot and cold spots of human-induced degradation of coastal wetlands. The output could contribute to the development of sustainable plans and policy for the management and conservation of coastal wetlands and ecosystems.

POST-HURRICANE COASTAL INUNDATION AREA MAPPING FROM BI-TEMPORAL SAR IMAGES BASED ON DEEP CONVOLUTIONAL NEURAL NETWORKS

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Abstract

1. Background

Synthetic aperture radar (SAR) images provide high-resolution land, coastal, and ocean mapping under all-weather condition, day and night. Pixel-wise image classification algorithms have been developed to classify patterns in SAR imagery. Recently, SAR image classification applications have been extended to coastal inundation mapping [1]. Traditionally, researchers exploit multi-dimensional (MD) information by extracting human-crafted features. However, there are problems with this type of algorithms: 1) it is difficult to fuse the MD information in an effective way; and 2) the performance of the human-crafted features is not robust. In this research, we propose to use an appealing artificial intelligence (AI) method, the deep convolutional neural network (DCNN) [2, 3], to solve these problems. The DCNN integrates the MD information in a unified framework, and provides an end-to-end classification solution. The most prominent classification features are not pre-designed by human but rather learned from the data. This image classification idea provides much more robust performance than the human-crafted features, which has already been verified by studies in the computer vision community [4]. Specifically, motivated by the successful employment of the U-Net framework [3], we specially tailored this framework to exploit bi-temporal SAR data for coastal inundation mapping. The Sentinel-1 SAR images have been analyzed and validated against the Copernicus Emergency Management Service (EMS) rapid mapping products [5]. Taking 2016 Hurricane Matthew as an example, our inundation area classification accuracy in Goldsboro, North Carolina is 98.80%. In the proposed research, we plan to fine-tune the DCNN inundation mapping algorithm and apply this AI-based method to available bi-temporal Sentinel-1 SAR images acquired in coastal areas in recent years during influential hurricanes. These bi-temporal SAR images with ground truth maps will provide a dataset for validating and comparing algorithms of flood mapping for management.

2. Methodology

2.1 Preprocessing

The aims of the data preprocessing are radiometric calibration and geometric correction. After the preprocessing, we use the spatial information to match the bi-temporal SAR images with ground truth from Copernicus EMS products to train and validate the developed model. It is worth mentioning that, if the matched scene with the Copernicus EMS product is covered by two or more SAR images, image mosaicing is also performed.

2.2 Model Design

The model is adopted from a DCNN, U-Net [3]. We currently use only the VV polarization. The input data include two temporal SAR images, acquired pre- and post-flooding, respectively. Basically, the design performs pixel-level classification. The output layer is composed of 1 × 1 convolution and Sigmoid activation. The loss is calculated using the binary cross entropy for binary classification. The performance evaluation metric is classification accuracy at the pixel level.

3. Preliminary Results

Currently, we used six pairs of Sentinel-1 SAR images acquired pre and post the passages of Hurricanes Florence and Ava as the training data set. There are a total of 1031 samples and each sample contains a pair of bi-temporal 256 × 256 sub-images. The training process is composed of 100 epochs, and the batch size is 32. After training, we applied the algorithm to the image pairs acquired during the 2016 Hurricane Matthew to validate the algorithm performance. The classification accuracy of inundation mapping for Goldsboro, North Carolina is 98.80%.

4. Conclusion

In this study, we show the DCNN framework is promising for high-performance coastal inundation mapping after hurricanes. In the future, we will evaluate and improve the performance of the DCNN method with the help of physical information: 1) to test and probably revise the loss function and metric evaluation; and (2) to add more input information, e.g., the cross-polarization data.

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PROPOSALS ON THE DEVELOPMENT OF CHINA'S SMART OCEAN

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Abstract

China has jurisdictional sea with the area of more than 3 million square kilometers, and the coastline of Chinese mainland covers approximately 18, 000 km from the Yalu River at the north to the Beilun River at the south. Forty percent of the population is living in coastal areas. Ocean is playing an important role in Chinese modern society. Over the past years, China has always working on marine development, the implementation of Smart Ocean Program is essential to promote Maritime Power Strategy and accelerate China's marine information construction.

It is quite essential to take advantages of the state-of-the-art information technologies to establish the marine information system and accelerate the process of innovation and research. Comprehensive data access, convenient communication guarantee, and precise decision-supporting services should be provided to support the marine resources exploitation, marine economy development, and marine environment protection.

On the basis of background introduction, this paper expounds the conception of the Smart Ocean, and analyzes the status of marine informatization development at home and abroad, describes the conception and framework of the Smart Ocean in China. Finally, suggestions on the future development of the Smart Ocean are put forward, including institutional construction and improvement, data accessing and sharing, key technologies and standards and so on.

SATELLITE TIME SERIES TO DETECT MARSH DIEBACK EVENTS AND POTENTIAL ENVIRONMENTAL INFLUENCES ALONG COASTAL SOUTH CAROLINA, USA

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Abstract

Long-time satellite observations on coasts are an important facet of Big Earth Data on monitoring environmental changes and decision making for coastal resilience. South Carolina (SC) in the United States has over 340, 000 acres of salt marsh, the largest marsh extents among all Atlantic coast states. Marsh habitats provide numerous ecosystem services as nutrient filtering and cycling corridors and are extremely valuable to the state's commercial seafood and recreational industry. Various natural and anthropogenic disturbances in the coastal zone have caused substantial negative effects on marsh healthiness. Studies have reported multiple dieback events in the U.S. Southeast (as reviewed by Alber et al. 2008). Investigations of marsh dieback in SC, however, have been limited in lack of field observations on its remote, intertidal wetlands (Miller et al. 2017). The most pristine along the east coast, the SC marshes and dieback-recovery pathways deserve critical research. Satellite remote sensing, owning to its synoptic view and re-visit cycles, provide a spatially and temporally continuous method to identify the thinning and dead marsh patches.

Supported by the NASA EPSCoR program, this study identifies the marsh dieback events and recovery pathways in SC via a series of Landsat observations. The study area is focused on the North Inlet Estuary within the North Inlet-Winyah Bay Reserve, one of the National Estuarine Research Reserves (NERR) managed by the U.S. National Oceanic and Atmospheric Administration (NOAA). Salt marshes in SC are dominated by smooth cordgrass (Spartina alterniflora) in the regularly flooded low marsh and rush (mostly Juncus roemerianus) in brackish high marsh toward the inland. In the period of 1998-2018, all low-tide Landsat images in June-September (one image per year) are collected. Firstly, the normalized difference vegetation index (NDVI) is extracted from the NIR and Red bands to represent vegetation greenness. Then each NDVI image is normalized across the estuarine wetlands to reduce spectral differences from seasonality and atmospheric variations along the trajectory. At a pixel of healthy marsh, its 21-point NDVI trajectory remains relatively stable. A sudden and significant drop (at 95% confidence level) often indicates marsh dieback. Finally, the dieback patches in the corresponding years are extracted in the corresponding years.

Statistical analysis revealed four marsh dieback events in the study area: 1998, 2000, 2002, and 2016. Specifically, the events in 2002 and 2016 reflected opposite environmental impacts. Agreeing with those studies in nearby states such as Georgia (Ogburn and Alber 2006), we found the most influencing factor of the 2012 event was a severe, widespread drought in this region, which caused water and salinity stress in relatively higher elevations. On the other hand, the 2016 event was struck by the state-wide, 1000-year flood from Hurricane Joaquin in 2015. Storm surges in ocean side and freshwater floods landward jointly affected the low-elevation areas of the estuary. Elevation distributions in the DEM map agree with the spatial patterns of both dieback events. Most dieback patches recovered next year. Correlation analysis as also performed with other environmental factors such as water height, salinity and temperature at the 6 NERR Sampling Stations. Preliminary results were extracted to inventory the influencing environmental anomalies that play a role on marsh dieback in SC.

Marsh dieback is a complex process. Aside from intensive field studies in various sites, its environmental stressors have not been clarified and agreed within global coastal community. This study demonstrates the feasibility of Big Earth Data for supporting coastal sustainability. Time-series satellite observations extract spatially and temporally continuous information, which helps to build a systematic, comparable framework to fight for this environmental problem on global coasts.

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SEA ICE AND SNOW INTERACTION REVEALED BY COMBINED RETRIEVAL OF SEA ICE THICKNESS AND SNOW DEPTH WITH CRYOSAT-2 AND SMOS

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Abstract

Sea ice and its snow cover is an integral component of the polar and global climate system. Sea ice is a direct indicator of polar air-sea interaction through its volume, and snow enforces important control over the sea ice through processes such as thermal insulation and change of surface albedo. By physical synergy of satellite data including altimetry (CryoSat-2) and passive radiometry (SMOS), the sea ice thickness and snow depth can both be retrieved for Arctic winter seasons. Through analysis of winter ice growth and thermodynamic atmospheric and snow-induced forcings, we demonstrate quantitative results of snow's active roles during the winter months. Projections to future change of sea ice and snow are also made through climate modeling studies and Coupled Model Inter-comparison Project (CMIP5) data.

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THE ROLE OF GEOMATICS IN OCEAN SCIENCE

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Abstract

The Oceans are the last frontier on Earth. We know more about Mars and Moon than about our Oceans. At the same time the Oceans are very important for the future of humanity, in terms of utilization of its resources, the influence on weather and environmental conditions, and their use for transportation, communication, storage and even living.

The various techniques and procedures of Geomatics, encompassing Geodesy, Surveying, Photogrammetry and Remote Sensing, GIS, Cartography, play a decisive role in the recording, modeling, functional understanding, analysis and exploration of the Oceans. In this presentation we will focus on the role that Geomatics plays in the Moorea Island Digital Ecosystem Avatar (IDEA) project. This international and highly interdisciplinary project has been initiated by several universities and research institutes (UC Berkeley, CNRS-EPHE, ETH Zürich, Oxford University, UC Santa Barbara and MCR LTER) in 2013. The Moorea IDEA Consortium currently involves more than 20 research groups with approximately 80 participants. The Moorea Island is one of the most researched islands in the world (Cressey, 2015; Davies et al., 2016). One of the main goals of the project is to transform data collected with many different sensors and other data sources into a virtual lab and test different scenarios to analyze the changes and the effect of human activities to our ecosystem. The island avatar shall include all sorts of data related to land, the marine environment and air, including climate, vegetation, geological and biological data, etc.

The 2030 Goals Agenda of United Nations (2016) also emphasizes the importance of strong collaboration among scientists, governments and the societies. The Moorea IDEA project aims at offering an approach which can serve for the achievement of many of these goals, especially the ones related to sustainable management of the water and energy resources, taking action for climate change and its impacts, conservation and sustainably use of the marine resources, protecting and restoring the terrestrial ecosystems, managing forests, and promoting peaceful and inclusive societies for sustainable development.

The main motivations for choosing the Moorea Island for this study are its location far from the continents, with not too many external effects, relatively small size with 13 km x 15 km, with a small number of inhabitants (ca. 17 000), and a large amount of data which has been collected since 1970 within several research projects. Besides the underwater, coral reefs and underwater species, the Moorea Biocode project codes all species larger than one millimeter living on the island (Moorea Biocode, 2017). When the project is completed, it will bring important novelties in ecosystem modelling (Cressey, 2015).

The models used within the Moorea IDEA Project can be categorized as:

- Weather and climate
- Physical oceanography
- Hydrological
- Land- and Seascape
- Ecological
- Social-ecological

Extensive description of the models and the research groups working on them can be found in the project website (mooreaidea.org).

This presentation describes some of the aspects of the project in detail and addresses the processing methods and the problems encountered during the processing of multi-sensor and multi-resolution data

The final physical 3D model, amended by landuse data and other semantic information will provide a presentation and a geospatial analysis platform to the project participants from many other disciplines.

Building on the Moorea Island Digital Ecosystem Avatar (IDEA) platform (http://mooreaidea.ethz.ch), our overall goal is to develop data-driven models of the spatio-temporal dynamics of all processes of relevance on land and in the sea. Advanced computatiocomputational simulations will be developed.

Through this presentation the value of Geomatics techniques for Ocean Science becomes very evident.

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THE STUDY AND APPLICATION OF MARINE ENVIRONMENTAL VISUALIZATION BASED ON WEBGL

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Abstract

The establishment of virtual marine environment simulation, facilitates to have a better understanding of the characteristics of marine spatial-temporal changes. With the support of WebGL and visualization techniques, this paper carries out technical research on aquatic and terrain environment, and eventually develops and issues a 3-dimensional model as an achievement.

Firstly, the visual models of marine environmental scalar and vector fields are constructed, this paper realizes the visual representation of marine temperature, salinity, ocean currents, and sea level height and other marine parameters' spatial-temporal histories from 1958 to 2017, taking advantages of marine environmental re-analysis data, based on the technology of isolines and isosurfaces, time series chart, and profile analysis. Meanwhile, by conducting a series of experiments on submarine topography rendering and information extraction, this paper also realizes the exposure analysis, isoline analysis, max/min-value analysis, stretched analysis on partial waters terrain by using the Digital Elevation Model.

It is proved that, this application has the capacity of illustrating the spatial-temporal change conditions of marine environmental information, and thus provides technical supports for further research on discovers of change regularities and tendencies.

USING SATELLITE DATA TO STUDY THE DISTRIBUTION AND PROPAGATION CHARACTERISTICS OF INTERNAL WAVES IN THE ANDAMAN SEA

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Abstract

The Andaman Sea is a marginal sea of the Northeast Indian Ocean. Due to its stable stratification and special seabed topography, internal waves are frequently generated in this area. Remote sensing is an effective way for large-scale observation of internal waves and it has been widely used in internal wave's research. In this study, we used satellite data to study the distribution and propagation characteristics of internal wave in the Andaman Sea. Statistical results show the internal waves of the Andaman Sea are mainly distributed in the following four regions, including northern region of Sumatra, the western region of Peninsular Malaysia, the surrounding regions of Nicobar Islands and Andaman Islands in the Northeast. We used multi-source satellite data, including MODIS, GF-1, HJ-1A/1B to study of the velocity of the internal wave in the Andaman. A total of 5 pairs of satellite data with imaging time within two hours were found in the eastern part of the Andaman Sea from January to April, when the internal waves appeared frequently. Due to background flow field, stratification and topographic changes, the internal wave propagation velocity in the northern Andaman Sea is smaller than that in the southern sea and the propagation velocity in the central deeper water the sea is greater than that in the eastern shallow water. The maximum propagation speed is about 2.27m/s, and the minimum propagation speed is only 1.29m/s in northern region of the Andaman Sea.

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USING SATELLITE REMOTE SENSING TO STUDY THE EFFECT OF SAND EXCAVATION ON THE SUSPENDED SEDIMENT IN THE HONG KONG-ZHUHAI-MACAU BRIDGE REGION

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Abstract

Sand excavation can transport sediments into surrounding waters and thus raise the suspended sediment concentration. However, assessment of the area that is influenced by sand excavation and the strength of this influence is not easy due to the temporal and spatial variability of the background suspended sediment concentrations. Remote sensing can provide data before and after sand excavation activities and thus provides a possibility to estimate the variation in suspended sediment resulting from sand excavation. Sand excavation generally occurs in rivers or estuaries. The medium resolution of ocean color satellite data makes it difficult to obtain appropriate information in estuaries or rivers because of the spatial resolution of the sensors, the narrow spans of the rivers and the effects from the adjacent land. Sand excavation in the Pearl River Estuary has become frequent in recent years due to the development of urbanization in China. The Hong Kong-Zhuhai-Macau Bridge crosses the Pearl River Estuary and is the largest bridge and tunnel project in the world. The suspended sediment generated by upstream sand excavation was doubted to have a significant impact on the suspended sediment in the tunnel region. In this paper, we assessed the impact of upstream sand excavation on the suspended sediment in the Hong Kong-Zhuhai-Macau Bridge construction area using Landsat OLI, ETM+ and TM data. Regional suspended sediment algorithms were developed for Landsat using a symbolic regression method based on data from 25 cruises in the study area from 2003 to 2014. A band shift was conducted on the remote sensing reflectance data from Landsat ETM+ and OLI to produce a time series of suspended sediment that was internally consistent with that of Landsat TM data. The suspended sediment distribution was extracted and used to compare two different conditions, with and without sand excavation. The correlation of suspended sediment in different regions in the surrounding waters, including the correlation between the construction regions and the sand excavation regions, was calculated. Our results indicate that the sand excavation in the upstream region of the Pearl River Estuary has limited impact on the surface suspended sediment concentrations in the Hong Kong-Zhuhai-Macau Bridge tunnel area.

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SESSION:
Twin Cities

DATA CITIES AND ASTROSPATIAL ARCHITECTURE: AN URBAN ETHOS FROM ELECTROMAGNETIC FLUXES

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Abstract

Light remains the origin and sustenance of all forms of life on Earth—but human living is being transformed by ingenious applications of astrospatial technologies that were devised to fly to other planets. This century's networked architectures of semiconductors, satellites, scanners and sensors manipulate diverse electromagnetic frequencies to convert light into unprecedented formats and contents of data that are destined to inform most human behaviours in future. Telematics and informatics are taking our civilisation far beyond the milieu of modernism enabled by Edison's 1879 demonstration of electric incandescence and the transmillennial 'digital age' underpinned by portable computers and mobile telephony. In today's 'electroluminescent era' (Schielke and Jackson, 2015)—humanity's third major period of lighting technology, catalysed by semiconductor-enabled RGB LED systems—we next expect a ubiquitous 'internet of light', pulsing data through buildings, cities, devices and apparel via the semiconductors which activate LEDs and solar cells (Haas, 2011). Tomorrow's ultra-fast, high-capacity and energy-efficient li-fi networks seem destined to transcend wi-fi and radio telephony as the massively parallel electronic infrastructure needed to underpin 'the new space economy' (OECD, 2007) and the vast science vision named the Global Earth Observation System of Systems (GEOSS: GEO, 2005). Although neglected by the mainstream media so far, these are today's most ambitious intergovernmental projects to reform the world's economic and environmental management systems—and thus our societies and ways of life in future. Today's ubiquitous earth observations (EO) movement updates Richard Buckminster Fuller's concepts towards auto-piloting our planet's complex operations like a 'Spaceship Earth' (Boulding, 1965; Ward, 1966; Fuller, 1968). Exploiting all flickering frequencies of the electromagnetic spectrum, this satellite-enabled paradigm challenges (by vastly expanding) architecture's classical ethos to build static, permanent monuments. It invokes a new scenario of responsive interactions between people and environments in relentless flux.

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DIGITAL TWIN OF PAST CITYSCAPES

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Abstract

Reality-based 3D recording and modelling allow nowadays the accurate documentation of heritage sites. These digital models act as data integration platforms for research, heritage preservation, remote access, and simulations of what-if scenarios. Since we are dealing with sites that are archaeologically and historically documented, however, only fragments of the original urban system are still preserved, while others can be reconstructed with varying degrees of certainty through comparisons and inferences. So to what extent can we talk about digital twins for cities of the past, and what are their purposes? This paper will discuss these aspects through a selection of case studies related to the 3D digital documentation and "reconstruction" of ancient sites, which show various methodological approaches to address the complexity and challenges of this task.

DIGITAL TWIN OF THE LEKDIJK

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Abstract

When it comes to dike reinforcement, the subsoil is very important and forms one of the greatest risk. A multidisciplinary team of Geoscientists (TNO Geological Survey of the Netherlands, Deltares, University Utrecht and Wageningen University), Geo Information specialist (Geodan), Civil Engineering (HDSR) and Value Management (Arcadis) have created on behalf of the of Ministry of the Interior and Kingdom Relations of the Netherlands a digital twin of the current dikes at the river Lek and the surrounding area. A digital twin is a virtual copy of the reality, created by bringing together, integrating and visualizing all available location-specific data above and below the surface. Because of the high volume of available location, sensor and subsurface data for the Sterke Lek dike area offers this digital twin one coherent three-dimensional virtual view of both the surface and the subsurface. The Subsurface Key Registry (BRO) combines all subsurface data and is one of the digital national information sources named key registries of the Netherlands that feeds the digital twin.

THE DIGITAL TWIN AND SMART CITY DASHBOARD OF AMSTERDAM: A DIGITRANSCOPE EXPERIMENT

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Abstract

Worldwide, on a daily basis over 200.000 people move to urban areas with the hope of finding better job opportunities as well as a better standard of living. In Amsterdam for example, in the coming 7 years over 50.000 extra houses are planned to accommodate for its new inhabitants. It is estimated that in 2050, over 70% of all people worldwide will be living in an urban environment. As a result, the cities of tomorrow face intertwined enduring challenges.

The increasing number of people migrating to urban areas leads to complex issues in a number of fields, amongst which mobility, liveability and energy supply. Since we entered the era of the Internet of Things (IoT), Big Data, and emerging technologies such as Artificial Intelligence (AI) and Machine Learning, we can call upon information and communication technologies (ICTs) to provide ways to address the above challenges.

In order to structure this process we have developed the concept of a Digital Twin and a Smart City Dashboard and applied this for the City of Amsterdam

A digital twin of a city is a virtual representation, it is 3D, if volumes and areas are reproduced, or 4D when the temporal dimension is included. In general, digital representations are based on multiple and overlapping layers of data originating from different sources: these might include administrative datasets (such as the Land Registry), but could also comprehend privately held data, such as AirBnB information or energy consumption data and even citizens generated.

The collected intelligence available is much bigger than any individual can be aware of. This calls for the development of smart ways to access, select, analyse and provide the available data. Inclusive Smart Cities are required to adapt themselves to the user needs and to provide customized interfaces. The Smart City Dashboard AmsterdamSCDA automatically collects big data from a large number of data sources and real time sensor services, and is digitally transforming data into custom information services for stakeholders in real time.

The data provisioned by SCDA is integrated in a spatial data information structure (SDI) that comprises data from different domains: for example building information as well as environmental information are seamlessly merged. This way, city processes can be monitored within their relevant context.

In order to support and optimize city processes, we have to understand which data is most relevant. Ongoing research and technological developments help us to do so. By analyzing ongoing concurrent processes, as monitored by SCDA, the interacting system as a whole can be better understood, predicted, handled and tuned. Machine learning enables us to determine usual patterns in a variety of data flows. This opens the possibility to discern deviations of the expected situation and call upon expedient action.

In the project we utilize open standards from the Open Geospatial Consortium (OGC). The OGC is the standardisation organisation for geospatial data and services, including IoT. Many of the OGC specifications are available as ISO standards.

A growing wealth of sensor data is becoming available and more so every day. Any type of sensor can be connected to any solution or application supporting the open standards. As IDA implements open standards, you are not limited to a specific provider or vendor. To process sensordata, Geodan developed GOST, an OGC certified implementation of the OGC SensorThings API

The experiment is part of the research project DigiTranScope: Digital Transformation and the Governance of Human Society, established at the JRC Centre for Advanced Studies in 2018. The three-year project investigates the governance questions of digitally transforming societies with a long-term perspective, looking at the transversal issues that will be important in the development of the European society over the next 10 years and beyond. The research is explorative and aims at identifying opportunities and threats for both economic growth and social innovations. The project aims at helping policy developers and decision makers understand the digital transformation and connect it to finding answers to the challenges Europe's societies will face over the next decades.

Within DigiTranScope, various experiments are currently being prepared and partly already undertaken in various European cities to use existing data and innovative ICT solutions for new ways of local and regional policy-making and policy implementation.

The developments of the Digital Twin and the Smart Dashboard of Amsterdam are based on a 5 year contract between the City of Amsterdam and the Dutch company Geodan. Both stakeholders are participating in the DigiTranScope project.

SESSION:
Earth Observation Data to Knowledge Value Chains

A FAST TERRAIN CRACK LOCALIZATION METHOD ACCOUNTING FOR ADJACENCY RELATIONSHIPS

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Abstract

The repair of terrain cracks is an important process in multiresolution three-dimensional (3D) terrain visualization, and this involves two processes: the pinpointing of cracks between terrain blocks and the elimination of crack vertices. Since crack localization is a prerequisite to the terrain crack repair, a fast and accurate method for terrain crack localization is of great importance to the repair of terrain cracks.

Multiresolution 3D terrain visualization techniques generally include quadtree-based Level of Detail (LoD) algorithms and triangle binary tree-based LoD algorithms. As quadtree-based LoD algorithms are structurally simple, small, easy to modify/simplify, and are amenable to dynamic management, they are the most commonly used type of algorithm for multiresolution 3D terrain visualization. Quadtree-based methods for terrain crack localization are also a hotspot for research in the field of terrain visualization techniques. However, the existing quadtree-based crack localization methods generally require quadtree traversal to obtain the adjacency information of terrain nodes. Consequently, these methods are time-intensive and inefficient. To address these issues, this paper proposes a fast method for locating terrain cracks that effectively increases the efficiency of terrain crack localization, based on the analysis of dynamic quadtree structures and LoD control rules, which consists of three parts:

(1) The construction of terrain quadtrees that contain adjacency relationships. To acquire neighboring nodes for each node quickly, this paper proposes a quadtree structure that contains adjacency relationships. In the quadtree structure of this paper, each tile node contains information about its parent and (four) child nodes, and information about its neighbors; as these neighbors are also leaf nodes that are used in terrain rendering, they can be directly used to determine the location of terrain cracks. Terrain quadtrees are constructed during the initialization of a terrain scene . The construction of a quadtree structure begins with the determination of the number of subdivisions at each node by a node evaluation system, which gives the model resolution of the quadtree nodes. This is followed by resolution evaluations on each branch and node of the quadtree .

(2) The dynamic updating of quadtrees and adjacency relationships. As the point of view roams around a terrain scene, the leaf nodes of the quadtrees will be split or merged according to LoD control rules, thus resulting in the dynamic updating of quadtree structures. The adjacency relationships of the nodes in the quadtree also need to be dynamically updated during this process. Since each node in the quadtree could be split or merged, two different algorithms are used during the dynamic adjacency updating process: an algorithm for processing the adjacency information of split leaf nodes, and an algorithm for processing the adjacency information of merged leaf nodes.

(3) Terrain cracks quick location by using node adjacencies. Since adjacency information is stored in leaf nodes and constantly updated according to the dynamics of the terrain quadtree, this adjacency information is always up-to-date and effective. When crack localization is being performed at some leaf node of a quadtree, the elevations of its boundary vertices may then be compared by using the adjacency information stored within the leaf node's data structure, without re-traversing the quadtree.

The method was experimentally validated via the terrain data of a mountainous region in Sichuan, China. The experimental results prove that:

(1) For the efficiency of adjacency information searching, our method consumes a much smaller amount of time than the traditional method. The time consumption of our method during searches for adjacency information are not correlated with the depth of the quadtree structure, thus resulting in highly uniform time consumption levels. The time consumed by our method and the traditional method in searches for neighboring nodes both increase with increases in the number of neighboring nodes; nonetheless, the time consumption of our method is still much lower than that of the conventional method.

(2) For the efficiency of overall crack localization, our method is, on average, 8.37 times faster than the conventional method in pinpointing the cracks of all nodes in the cone of vision. Furthermore, the advantage of our method becomes more pronounced with increases in the maximum tile level (i.e., quadtree structure depth) or total number of tiles.

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A NEW APPROACH FOR DEALING WITH GEO-SPATIAL INTELLIGENCE DATA IN THE SPACE AND SECURITY DOMAIN

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Abstract

The European Union Satellite Centre (SatCen) has unique expertise and capabilities to analyse satellite EO data and produce Geospatial Intelligence (GEOINT) information that is key in the decision-making process of the EU and its Member States in the field of the Common Foreign and Security Policy (CFSP). The SatCen knowledge value chain for GEOINT, where EO data is the main data input, is consolidated thanks to more than 26 years of relevant experience in the field.

However, the current GEOINT landscape is being challenged in the recent years due to several facts: the increase in volume and variety of remote sensing EO data (1), the possibility of geolocate other data sources acquisitions, and the increase in the processing capacity given by technology advances such as big data management tools, cloud computing architectures or related developments.

From its Research, Technology Development and Innovation unit, SatCen is addressing these challenges moving from the conventional analysis process towards a platform approach that allows fast, simple, yet secure, access to relevant data sources and that employs high-capacity distributed processing resources (2). This platform will allow the development of applications that combine remote sensing EO data with other types of geolocated data to produce new information that could be injected to the actual knowledge value chain, unlocking in the near future new potential capabilities for GEOINT operational analyses.

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A PROCESS FOR THE ACCURATE RECONSTRUCTION OF PRE-FILTERED AND COMPRESSED DIGITAL AERIAL IMAGES

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Abstract

The proposed work aims to increment the compression ratio (CR) of aerial digital images. The study of compression and decompression methods is crucial for storage and/or transmission over digital links of large numbers of image information which is also required for archiving aerial photographs, satellite images and digital ortho-photos.

The process described here involves the application of pre-defined low-pass filters (i.e. kernels) prior to applying standard image compression encoders. Low-pass filters have the effect of increasing the dependence between neighbouring pixels which can be used to improve the CR. However, for this pre-filtering process to be considered as a compression instrument, it should allow for the original image to be accurately restored from its pre-filtered counterpart.

The development of the restoration process presented in this study is based on the theory of least squares and assumes the knowledge of the filtered image and the low-pass filter applied to the original image. The process is a variation of a super-resolution algorithm previously described, but its application and adaptation to the filtering and restoration of images of objects, in this case aerial imagery, using a variety of scales and filter dimensions is the extension and novelty detailed here. The accuracy and performance of the proposed process are evaluated in a number of indicative tests. These tests involved a diversity of images of different entropies and coded in a lossy or lossless mode.

In addition, a discussion related to the application of the proposed process to satellite imagery is inlcuded.

A VEHICLE EMISSION DISPERSION SIMULATION METHOD BASED ON 3D GIS

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Abstract

Vehicle exhaust emission is one of the main factors of urban air pollution. Emission simulation has always been a hot and difficult research topic that explores the law of vehicle emission dispersion and seeks a control strategy to minimize its impact on the environment (Rajiv et al., 2009). Among the air pollution dispersion models, the The California line source dispersion (CALINE4) model has been widely used because of the convenience of parameter calibration, good accuracy and the characteristics of adaptive adjustment for different regions.

CALINE4 is a line source pollution dispersion model based on the Gaussian dispersion equation and the concept of a mixed region, which also takes into account the deposition and settlement rate of pollutants. This model can be used to predict the concentration level of pollutants in the range of 150 m on both sides of the highway (Sharma, 2001). Marmur et al. (2003) used this model to simulate the CO and NOx concentrations in some regions of Israel. Broderick et al. (2005) applied this model to simulate CO concentrations in Ireland.

When calculating the pollutant concentration using the CALINE4 model in existing studies, it is always assumed that the area between the monitoring point and the road is open and the vehicle emission forms a continuous and stable dispersion source in the mixed area and diffuses directly and vertically to the monitoring point without obstruction. In a specific calculation, the basic idea of the model is to divide the road into a series of line source units, calculate the contribution of pollutants emitted by each line source unit to the concentration of the receptor, and then calculate the sum of the pollution concentrations produced by the line sources of the whole road at the receptor.

Different from the assumptions set in a traditional model calculation, in fact, in a real 3D scene, there are usually obstruction objects between the monitoring point and the road, such as buildings and trees. When the monitoring point is outside the obstruction range of these objects, the CALINE4 model can be directly applied to simulate the vehicle emission dispersion concentration at the monitoring point. When the monitoring point is within the obstruction range of these objects, the application of this model to simulate the vehicle emission dispersion concentration at the monitoring point will make the calculation result larger.

To render the CALINE4 model more accordant with the emission dispersion law in a 3D scene, this paper introduces an obstruction coefficient to optimize the original CALINE4 line source pollution dispersion simulation equation. For a divided series of line source units of roads, if there is no obstruction between the line source and the monitoring point, i.e., visibility, then the vehicle emission generated by the line source can normally diffuse to the monitoring point. This line source is called an effective line source. Otherwise, if there is an obstruction between the line source and monitoring point, i.e., no visibility, then the vehicle emission generated by the line source has no effect on the monitoring point. This line source is called an ineffective line source.

To more accurately express the influence of a finite line source on emission dispersion, in this paper, the finite line source is further divided into n segments. The pollution concentration produced by a single finite line source at the monitoring point is the sum of the pollution concentration produced by each segment of the line source.

The proposed approach is experimentally validated using an expressway in a Beijing suburb. The experimental validation indicates that (1) Compared with the traditional CALINE4 model, this method considers the influence of obstruction objects, such as buildings and trees, on vehicle emission dispersion in a 3D scene. The simulation results of pollutants from the global perspective are more in line with the real transport and dispersion law of pollutants.(2) From local details, when using this method to simulate vehicle emission dispersion, the pollutant concentration at the periphery of the building is obviously blocked, and the degree of concentration change is obviously affected by the degree of obstruction.

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ACHIEVEMENTS AND CHALLENGES OF THE NEW URBAN CENTRE DATABASE DERIVED FROM THE GLOBAL HUMAN SETTLEMENT LAYER DATA

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Abstract

In this paper, the main characteristics of the new Urban Centre Database (GHS-UCDB) are described. The GHS-UCDB it is released by the Global Human Settlement Layer project supported by the Joint Research Centre (JRC) and the DG for Regional Development (DG REGIO) of the European Commission, together with the international partnership GEO Human Planet Initiative. The Global Human Settlement Layer (GHSL) produces new global spatial information, evidence-based analytics describing the human presence on Earth. The GHSL information contents are based on two main quantitative components: i) the spatial distribution (density) of built-up structures and ii) the spatial distribution (density) of resident people. Both components are observed in the long-term temporal domain and per uniform area units, in order to support the analysis of the trends and indicators for monitoring the implementation of the 2030 Development Agenda and the related thematic agreements. The GHSL information is derived from various open input data automatically harmonized in the spatial, temporal, and knowledge components by intensive use of automatic information processing including AI, data mining and inductive learning techniques. Sources of the GHSL include global, multi-temporal archives of high-resolution satellite imagery, census data, land cover maps and volunteered geographic information.

The GHS-UCDB is the most complete database on cities to date, publicly released by the JRC open Data Catalogue (https://data.jrc.ec.europa.eu/) under the title “GHS Urban Centre Database 2015, multitemporal and multidimensional attributes, R2019A”. The database represents the global status on more than 10, 000 Urban Centres identified in 2015 including cities’ location, their extent (surface, shape), and describing each city with a set of geographical, socio-economic and environmental attributes, many of them going back 25 or even 40 years in time. Urban Centres are spatially defined in a consistent way across geographical locations and over time, applying the “Degree of Urbanization” (DEGURBA) classification schema to the baseline GHSL data on population and built-up areas. The DEGURBA model is developed by a joint effort of the European Commission, the Organisation for Economic Co-operation and Development (OECD), the Food and Agricultural Organization of the United Nations (FAO), the United Nations Human Settlements Programme (UN -Habitat), and the World Bank.

The GHS-UCDB contents are organized in seven principal thematic areas, namely: 1) General Information (identification, extension, location, name); 2) Spatial Dynamics (number and area of intersecting urban centres in previous epochs); 3) Geography (elevation, biome, climate, soil, river basin, temperature, precipitation); 4) Socio-Economic (resident population, built-up area, night-time light emission, downscaled gross domestic product, development, accessibility and remoteness); 5) Environment (greenness, pollutant’s emissions, pollutant’s concentration); 6) Disaster Risk Reduction (exposure to floods, earthquake hazard estimate, exposure to storm surge, heatwave magnitude); and 7) Sustainable Development Goals (Land Use Efficiency, Open Spaces).

The use of GHS-USCB in support to the monitoring of international policy frameworks is illustrated through the assessment of a set of indicators relevant to: the 2030 Agenda for Sustainable Development (SDGs), the Sendai Framework for Disaster Risk Reduction 2015-2030, and the Habitat III (2016) New Urban Agenda. The way forward and the next challenges addressed by the GHSL and the derived UCDB are shortly illustrated in the closure, and linkages with the Digital Earth conceptual framework are highlighted.

ADAM - ADVANCED GEOSPATIAL DATA MANAGEMENT DATA CUBE PLATFORM FOR ENVIRONMENTAL DATA

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Abstract

Digitalisation is crucial in many aspects of our daily lives nowadays – and so is access to data. The concept of 'Digital Earth' (DE), as outlined in 1999 by the former US Vice-President Al Gore, foresees a "multi-resolution, three-dimensional representation of the planet that would make it possible to find, visualise and make sense of vast amounts of geo-referenced information on physical and social environments" (Gore, A , The Digital Earth: understanding our planet in the 21st century, Photogrammetric Engineering and Remote Sensing, 65 (5), 528).

The DE concept is quickly becoming reality, with the Copernicus programme providing a fundamental contribution. The challenge is now how to access and extract information from the decades of global and local environmental data generated by in-situ sensors, numerical models, satellites, and, more recently, by individuals. This implies a change in the data exploitation paradigm, moving towards a massive data analysis approach. One of the main issues to face is the inhomogeneity of data types, formats, geographic projections or, in one word, the variety of the data that describe our planet.

The Advanced geospatial Data Management platform (ADAM, https://adamplatform.eu) aims at providing a single point of access to a large variety of geospatial data, offering a web-based application interface for most of the users, a Jupyter notebook environment for experts who want to write code using all available data, and a set of APIs for developers to connect to external applications, such as GIS tools and mobile apps.

With the users' interfaces being the visible part of this technology, the strength of ADAM lies in the Data Access Service (DAS) module, which allows accessing to different types of products directly from their original location and in their native format, avoiding data replication or duplication. All operations are performed on the fly, following the concept that processing is less expensive than storage.

ADAM implements and provides data cube data access and processing services, namely it exposes multi-dimensional (spatial, temporal, spectral …) subsetting capabilities as well as basic on-the-fly processing functions, so that the consumer (human or machine) gets only the piece of data wherever and whenever needed, avoiding transferring large amounts of useless bytes via the Internet or massive local processing.

ADAM is a "horizontal" layer to support a large variety of vertical (thematic) applications such as climate change monitoring and mitigation, cultural heritage safeguard, air quality assessment and monitoring, agricultural applications and (re-)insurance in agriculture, security applications, education, and many others.

In summary, ADAM facilitates access to geospatial environmental data (mainly EO data) by removing data access barriers with the final aims of making geospatial data as a commodity, implement a new technology transfer model, thus, in short, to move away from data availability towards data usability.

Within this paper a description of ADAM and distributed data access and exploitation platform is provided; moreover examples of real time information extraction from data cubes of environmental data are provided in the fields of Earth Observation for Sustainable Development (EO4SD), cultural heritage and critical infrastructures safeguards.

AI IN PHOTOGRAMMETRY AND REMOTE SENSING FOR DIGITAL EARTH

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Abstract

This paper mainly describes the recent development of AI in photogrammetry and remote sensing at LIESMARS for Digital Earth. Use the high resolution satellite images huge scale block adjustment technology with automatic image matching and gross error detection has been developed to realize the 1:50000 national mapping of DOQ and DSM without ground control points by using ZY-3 satellite images and to generate the national SAR Ortho-Map with 10 meter resolution data from GF3 automatically. To realize automatic object retrieval on large-scale tiled RS image databases fast, accurately and conveniently, a deep learning method on cloud computing and image understanding is developed. A new concept of spatial cognition brain is proposed which includes earth observation brain, smart city management brain and smart phone brain. The new AI technology will bring a brilliant future of photogrammetry and remote sensing.

AN ADAPTED CONNECTED COMPONENT LABELING FOR CLUSTERING NON-PLANAR OBJECTS FROM AIRBORNE LIDAR POINT CLOUD.

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Abstract

Light Detection and Ranging (LiDAR) is an active remote sensing technology used for several applications. A segmentation of Airborne Laser Scanning (ALS) point cloud is very important task that still interest many scientists. Most of point clouds segmentation methods are typically adapted to extract planar surfaces as roof faces and other surfaces from airborne laser scanning data. For this purpose, different segmentation methods have been developed based, for example, on Hough transform [1], RANSAC [2], or surface growing [3]. Although the planar segmentation methods of point clouds often serve their purpose, those methods are not suited to segment non-planar objects like trees, cars or power lines and any object with free form shape. There is less works related to non-planar objects segmentation from point clouds. In the literature, the point clouds clustering methods are usually used for clustering multi-planar segments and 3D building facades. Clustering is the process of grouping points with similar feature vectors into a single cluster separate from points with dissimilar feature vectors [4]. The Connected Component Analysis, or Labelling (CCA), is a known method of clustering that was widely used in image processing. In this poster, the CCA is exploited for clustering non-planar objects from Airbone Laser Scaning (ALS) LiDAR point cloud. The proposed method does not take only k nearest neighbors point, but rather all points that the distance from each one is less than a fixed distance beforehand. Starting from a random point belonging to initial set of points, this point is labelled with the current label symbol and is removed thereafter from the set. It is different compared from that proposed in the literature [5]. Our method does not stop at immediate neighbours of the interest points, but continues until no further neighbours are found. The exploited LiDAR is provided by the German Society for Photogrammetry, Remote Sensing and Geoinformation. The ALS data used is characterized by a low density (4-6 points/m²), and is covering an urban area, located in residential parts of the city Vaihingen in southern Germany. Different types of metrics was tested. The visualization of the results shown the great potential of connected component analysis when using Euclidian metric for clustering non-planar surfaces such as roof superstructures.

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APPLICATION OF INPAINTING TECHNIQUE FOR RECONSTRUCTION OF PARTIALLY DETECTED CURVILIENT FEATURES DERIVED FROM THE PROCESS OF EXTRACTION OF CARTOGRAPHIC FEATURES

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Abstract

Methodologies proposals to perform cartographic feature extraction from digital images have been of great importance in the Cartographic area. These methodologies are focused on the identification of existing targets in the terrestrial surface and its results allow the detection and identification of changes caused by anthropic actions and/or by nature. Several image processing techniques can be used to perform the extraction, nevertheless, the results obtained usually contain features partially detected and, consequently, it culminates in quality loss of the extraction results. In this sense, this work presents an approach to improve the quality of extraction results applying an inpainting based technique proposed by Liang-Jian Deng et al. The inpainting concept has as its main purpose image restoration and removal of occlusions. In other words, it consists of gathering information around the damaged area and making a subtle junction of this information with the interest area. The use of inpainting techniques in the Cartography area is unusual, which contributes as an innovation for the topic. The chosen technique is defined as an exemplar-based inpainting, which means that the algorithm tends to fill the areas of interest by copying and pasting high-priority patches from the original area and keeping its texture. The priority of each patch consists of two attributes: the confidence and the data terms. The confidence term is responsible for textures propagating, and the data term propagates geometry. The algorithm has two phases, one that propagates image geometry into the area of interest, using the data term, and the other that synthesizes textures with the confidence term. The algorithm also assures that the number of steps for each phase is calculated automatically. For this work, it was decided to use the metric SSIM (Structural Similarity) to analyse the quality improvement. SSIM is an image processing metric and acts as an index that predicts the quality of images and videos, by measuring the structural similarity between two images. SSIM was created as an enhancement of the traditional methods MSE (Mean Squared Error) and PSNR (Peak signal-to-noise ratio). The main difference between SSIM and its predecessors is that SSIM is a method based on visual perception. SSIM is more efficient than MSE and PSNR because both of them do not detect distortions perceptible by the human visual system, only considering the individual state of each pixel and not its structural information, as opposed to what happens in SSIM. In addition, MSE and PSNR are not suitable for binary images. In this case, the MSE represents the number of differences between two images, and the large number of different pixels does not always result in a large structural difference, because binary images do not have many texture details and their pixel distribution is simpler. Thus, the first step in this work was to select four results of extraction methodologies that contained partially detected features. For each result selected, a reference image was manually created, based on the original satellite image and the SSIM between the reference and the result of the extraction was calculated. After that, all the results were reconstructed using the presented inpainting technique. The post-reconstruction image was also compared with the reference image using SSIM. The pre-reconstruction SSIM values for the four cases were 88.77%, 94.51%, 94.21% and 87.28. After the reconstruction the SSIM were recalculated and the values obtained were respectively 98.25%, 97.25%, 96.91% and 98.71%. The mean SSIM for pre-reconstruction is 91.19%, and for post-reconstruction 97.78%, which means the inpainting algorithm shows an improvement of 6.59% in average quality of the extracted features. Therefore, the use of this algorithm may contribute greatly to increasing quality of the process of extraction of cartographic features partially detected in digital images and can be used in the area of cartography, supporting processes to update cartographic products.

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ARTIFICIAL INTELLIGENCE AT THE SERVICE OF GEOSPATIAL INFORMATION (AI4GEO)

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Abstract

Artificial Intelligence at the service of Geospatial Information (AI4GEO)

The availability of 3D Geospatial information is a key stake for many soaring sectors: Sustainable and Smart Cities, Ecological Mobility, Autonomous cars, Economic Intelligence and consumer markets …

Its production is now possible and highly scalable thanks to the abundance of available data (Open Data and satellite constellations). It needs nonetheless a certain level of skilled manual intervention to secure a certain level of quality, which prevents mass production.

The new technologies involving AI and Big Data are key in lifting these obstacles. Today, this situation puts the GAFAM in a leading position to cease these new market opportunities and puts the French and European sectors at risk.

The AI4GEO project aims at developing a 3D Geospatial information production software and developing new high added-value services. This solution, based on innovative AI techniques adapted to 3D imagery and Big Data technologies, will reinforce French autonomy in this domain, create leaders on new markets and facilitate access to these technologies for SME.

The AI4GEO consortium is constituted with Institutions and Industrial groups (Large and medium companies, SMEs) covering the whole value chain of Geospatial Information.

With a 4 years' timeline, the project is structured around 2 R&D axes which will progress simultaneously and feed each other.

The first axis will consist in developing a set of technological bricks allowing the automatic production of qualified 3D maps and additional layers of information (3D objects and associated semantics). This collaborative work will benefit from the latest research from all partners in the field of AI and Big Data technologies as well as from an unprecedented database (satellite and airborne data (optics, radars, lidars) combined with cartographic and in-situ data).

The second axis will consist in deriving from these technological bricks a variety of services for different fields: 3D semantic mapping of cities, macroeconomic indicators, decision support for water management, autonomous transport, consumer search engine and IT platform.

The project is intended to be evolutive and could also contribute other fields (e. g. Precision Agriculture, or Robotics)

Finally, the AI4GEO project plans the commercial development of new services that will generate strong economic returns for all of the concerned sectors.

ASSESSING BELOW-GROUND CARBON DYNAMICS OF GREEN INFRASTRUCTURE USING ARTIFICIAL INTELLIGENCE, TARGETING SUB-TROPICAL BIORETENTION BASINS

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Abstract

Bioretention basins are well-established green infrastructure devices for managing stormwater quality in urban cities around the world. They also provide a mesocosm for studying soil behaviour in sandy loam/ loamy sands regarding behaviour over time in accumulating carbon. As constructed basins with supplied substrate mixture, they can be made to represent the carbon dynamic of a controlled young basin (immediately post-construction). In this way they provide green solutions to counteract the impacts of rapid development and urbanisation of cities, and the potential to assist with carbon capture and long-term climate change mitigation strategies. In this paper the authors present an assessment of below-ground carbon dynamics of green infrastructure using artificial intelligence, targeting sub-tropical bioretention basins case study of bioretention basins in South East Queensland (Australia). The paper describes the context for the study and the significance of the work, which was recognised and enabled through the international Microsoft Artificial Intelligence (AI) for Earth Grants (2018 winner). The paper will include a brief outline of the machine-learning methods used for developing AI algorithms, preliminary results of applying the machine learning on below-ground carbon accumulation over time in 25 Australian sub-tropical bioretention basins, and justification of the results with previously established empirical data. The study has immediate implications for accounting for the value of green infrastructure projects in cities, relating to achieving climate change mitigation targets (for example the UN SDGs). The results have potential to play a pivotal role in building a model of above and below-ground carbon interchange.

ASSESSMENT AND COMPARISON OF LANDSLIDE SUSCEPTIBILITY AT OPEN-PIT MINES IN NORTH KOREA USING GIS

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Abstract

Although North Korea has abundnat mineral resources and significant number of mines, their infrastructures need to be renewed because they are old and inefficient. Before constructing new infrastructures or renovating existing ones near thes mines, it is essential to assess the landslide susceptibility in order to prepare for the danger of landslides. Satellite images and digital elevation map (DEM) could be an effective tool to estimate landslide risk [1] [2]. In this study, the slope stabilities of various open-pit mines in North Korea are assessed from satellite images and DEM data. First, five representative open-pit mines in North Korea are selected; Musan mine (iron), Ryongang mine (magnesite), Daeheung mine (magnesite), Sangnong mine (gold), and Eunryul mine (iron). The exact locations of the mines and their infrastructures are detected from natural color satellite images. Then, spatial data near the mines are acquired. Digital Elevation Map (DEM) data from ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiameter) and ALOS (Advanced Land Observation Satellite) PalSAR are used to calculate degree and aspect of slope. After flow direction and flow accumulation are calculated from these DEM-derived products, landslide susceptibility and dangerous area are assessed. In addition, landslide damages on transportation infrastructures are predicted by founding out railways and roads around the mines from Open Street Map data. Landsat 8 OLI (Operational Land Imager) images are also classified into several landcovers in order to compare the types of landcover where danger of landslide is expected. From these multi-criteria GIS anlaysis, relative slope stabilities and landslide susceptibilities of each mine is estimated and compared. Which spatial factor influences on the relative slope stability most is determined by comparing the value and distribution of each spatial factor. This study is expected to be utilized as fundamental information when planning for development of infrastructures near the open-pit mines in North Korea.

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DIGITAL IMAGE IMPROVEMENT BY INTEGRATING IMAGES OF DIFFERENT RESOLUTIONS

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Abstract

This proof of concept work evaluates the performance of super-resolution (SR) imaging when combining a sequence of low-resolution images of different resolutions. SR refers to the process of producing a higher resolution image from several low-resolution and shifted observations of the same scene. Traditional work in SR requires accurate image sub-pixel registration and/or alignment techniques, and it is also based on the assumption that all the low-resolution frames in the sequence are captured at the same spatial resolution.

However, if there is no relative motion between the scene of interest and the sensor, the SR problem can be approached by integrating images of different resolutions. One method of achieving this is by capturing said scene using differing zoom levels.

In other words, given a sequence of images with different zoom factors of a static scene, the problem is to obtain an image of the said scene at a resolution corresponding to the most zoomed image in the scene.

Preliminary results of controlled tests using synthetic and real data (scanned images) are presented. In both cases the process under-samples an original image of an object of interest within a scene at different resolutions. By reversing the process and integrating these images using an algebraic process an improved and accurate composite is obtained containing more spatial information (pixels) than that provided by simply interpolating on a single low-resolution image.

The accuracy of this process is assessed by way of calculating the Root Mean Square Error (RMSE) of the differences between the original image and the integrated composite. Tests including grey-scale images show that RMSE values in the vicinity of +/- 3 intensity values can be achieved with a maximum and minimum difference of +/-1 and +/-4 pixel intensity values.

EO EXPLOITATION PLATFORM COMMON ARCHITECTURE

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Abstract

The availability of free and open data, such as that provided by the Copernicus Sentinel fleet, together with the availability of affordable computing resources, create an opportunity for the wide adoption and use of Earth Observation (EO) data in all fields of our society. ESA's "EO Exploitation Platforms" initiative aims at facilitating adoption with the paradigm shift from "bring the data to the user" (i.e. user downloads data locally) to "bring the user to the data" (i.e. move user exploitation to hosted environments with collocated computing and storage). This leads to a platform-based ecosystem that provides infrastructure, data, compute and software as a service. The resulting Exploitation Platform is where scientific and value adding activities are conducted, to generate targeted outputs for end-users.

The goal of the "Common Architecture" is to define and agree the technical interfaces for the future exploitation of Earth Observation data in a distributed environment. The Common Architecture will thus provide the interfaces to facilitate the federation of different EO resources into a "Network of EO Resources". The "Common Architecture" will be defined using open interfaces that link the different resources (building blocks) so that a user can efficiently access and consume the disparate services of the "Network of EO Resources".

Telespazio VEGA UK - a Leonardo and Thales company will lead the definition of the Common Architecture through an open process of public discussion and consensus building with the EO community. It will be promoted as a Reference Architecture that will be designed to meet a broad set of use cases that cover Federated Identity Management, Processing & Chaining, and Data Access and Management. Leveraging free and open source software, a reusable Reference Implementation will be developed and deployed operationally, to act as a validation of the architecture and to provide an existing solution to third-parties.

EUMETSAT – EFFECTIVE SEARCH AND ACCESS APIS FOR EO DATA TO KNOWLEDGE VALUE CHAINS

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Abstract

EUMETSAT Data Services Roadmap included the development of an EO On-Line Data Access (OLDA) service related to satellite data discovery/search and visualization. This paper specifically elaborates on the developments conterra/N52 have done (as part of a consortium led by CGI) in the context of browsing, search and discovery for EO products.

A pre-condition for search and discovery of EO products is the availability of metadata which can be indexed. In OLDA product metadata is distinguished from collection metadata. It is identified by parameters like spatial and temporal extent, details of the acquisition process etc. The product metadata model is defined as profile of OGC 10-157r4. Every EO Product is linked to a description of a whole set of EO Products, the EO Collection. Collection metadata is focused on the general application area, the acquisition type (e.g. satellite and instrument), dissemination channels etc. It is defined as profile of the ISO 19115-2 standard.

In the OLDA Catalogue, the products are ingested and provided in the form of a EUMETSAT Submission Information Package (SIP). The SIP files are stored in a cloud-based storage system using object storage technology. A SIP file includes a manifest with structural information about the SIP itself, the data object(s) (product, browse image etc) and the EO product metadata. Upon storing a SIP file, the accompanied metadata is stored and indexed by ElasticSearch [6]. To support spatial searches, the spatial information is indexed based on Equi7 Grid [7]. Collection metadata is managed within an ElasticSearch based Collection Catalogue implementing an OpenSearch-EO interface.

The OLDA EO Data Access API provides a set of modern service interfaces to allow an easy and efficient access to browse, search, discover and access the EO products. The API is defined in OpenAPI and consists of a REST-EO API, an OpenSearch-EO API and a Download API (not considered here).

The REST-EO API is a simple to use API for browsing OLDA products by humans (web browser) or by machine clients (GeoJSON). At its basic path it provides the available collections. Starting from a collection a client can browse through the assigned products based on a predefined set of axes (temporal and spatial). During this navigation, the set of remaining products is narrowed step by step by drilling into hierarchically organized, named value ranges of the axes. Just for fine grained value ranges with a manageable amount of remaining products links to the remaining products are provided. By following these links metadata details and data access (e.g. download) is provided.

Within a data to knowledge value chain (e.g. hosted processing environment using JupyterNotebook) where simple iterations through “virtual directories” providing huge amounts of products are required, such a simple REST-API is beneficial. The API is aligned with W3C´s Spatial Data on the Web Best Practices [5] and follows principles as known from API´s like Amazon´s S3.

For flexible searches along varying parameters (axes) the Open-Search [1] EO API is more suitable. Open-Search provides a search interface description, called OpenSearch Description Document (OSDD), offering an URL template per supported response format (e.g. Atom, JSON) and includes key-value-pair parameters to constrain the search. The resultset of a search includes the search entries, information about the current search and means for pagination. Usually the entries include links to external information (e.g. metadata details, data access endpoints).

OpenSearch can be extended to support new search parameters and response formats. The OGC specification OpenSearch-EO 1.1 defines extensions which are partly implemented in the Open-Search-EO API. It consists of EO specific query parameters and Atom response encoding [2], a GeoJSON(-LD) response encoding [3] and an EO Dataset Metadata GeoJSON(-LD) Encoding (offering an EO vocabulary defined in RDF Schema) [4].

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EUROPEAN SPACE AGENCY STEAM (SATELLITE EARTH OBSERVATION FOR ATMOSPHERIC MODELING) PROJECT: NEXT ADVANCES IN THE SYNERGISTIC USE OF HIGH-RESOLUTION NUMERICAL ATMOSPHERE MODELS WITH SPACEBORNE SYSTEMS

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Abstract

The advance of numerical atmosphere models to increasingly higher spatial resolutions (km for NWPs, few hundred-tens of meters for LES), leads to new grounds addressed for what concerns their potential synergy with spaceborne systems:

- to feed NWPs, higher resolution input data and boundary conditions are needed which could be provided by recently available spaceborne Earth Observation products
- the ability to model the atmosphere physics with high spatio-temporal resolution will allow to provide insight into physical mechanisms critical to some spaceborne techniques

The availability of these high-resolution models coincides with the start of the era of the ESA Sentinels 1, 2 and 3, able to provide high spatio-temporal resolution information over the surface boundary as well as – through S1 inSAR – the potential to retrieve high-resolution – albeit low-temporal – information on the spatially and temporally highly variable atmospheric water vapor.

The STEAM project aims at investigating new areas of synergy between atmospheric models and data from spaceborne systems such as the use of surface information to constrain and evaluate high-resolution NWPs, and the use of LES for a high-resolution description of atmospheric turbulence.

STEAM demonstrates the impact of using high-resolution atmospheric models in conjunction with spaceborne systems through

- ingestion of high-resolution ESA Sentinel (soil moisture, land and sea surface temperature, wind over ocean, water vapour content) and GNSS products in numerical weather models to improve severe weather prediction
- assessment and improvement of the capability of current high-resolution NWP and LES models to characterize the effect of tropospheric turbulence and spatial inhomogeneity of water vapor fields on propagation parameters relevant for SatCom services.

FAST OBJECT DETECTION IN OPTICAL REMOTE SENSING IMAGES WITH LIGHTWEIGHT NETWORK

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Abstract

Automatically detecting objects in optical remote sensing (RS) images is a fundamental problem in a wide range of applications such as disaster reduction, emergency management and sea status monitoring. Since most traditional detection methods adopt hand-crafted low-level feature representation, and their accuracy and time efficiency is limited, considerable efforts have been made to develop deep convolutional neural networks (DCNN) based detection methods in recent years [1], for example, Faster-RCNN [2] framework variants etc. Most existing DCNN methods in remote sensing community adopt large network backbones such as VGGNet and ResNet [3] which include tens to hundreds of millions of parameters to obtain higher accuracy, thus increasing the computational complexity and model size. However, achieving high speed is as important as improving accuracy for most operational detection systems. In this paper, we focus on fast object detecion in optical remote sensing images by using lightweight networks. The robust Faster-RCNN approach is used in this work and a popular lightweight network MobileNet [4] is evaluated as the feature extraction network. Our retrianed network is verified on the public remote sensing dataset NWPU-10. The experimental results show that the Faster-RCNN combined with MobileNet network can achieve much smaller model size and detection speed compared with backbone networks using VGGNet and Inception V2 while maintaining comparable detection accuracy.

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FROM DATA TO KNOWLEDGE USING THE THE GEOSS PLATFORM TO SUPPORT SUSTAINABLE DEVELOPMENT GOALS

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Abstract

Avoiding, reducing and reversing land degradation and restoring degraded land is an urgent priority to protect the biodiversity and ecosystem services that are vital to life on Earth. The latest Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Landmark Assessment Report highlighted that land degradation through human activities is undermining the well-being of at least 3.2 billion people. Currently, more than 75 % of Earth’s land areas are substantially degraded. If this trend continues, more than 90 % of land areas could become degraded by 2050, potentially exacerbating climate change, biodiversity loss and leading to mass migration, conflict and major food security issues.

To halt and reverse the current trends in land degradation, there is an immediate need to enhance national capacities to undertake quantitative assessments and mapping of their degraded lands, as required by the Sustainable Development Goals (SDGs), in particular the SDG indicator 15.3.1 (“proportion of land that is degraded over total land area”). Earth Observations (EO) can play an important role both for generating this indicator as well as complementing or enhancing national official data sources.

We will present a workflow using the Global Earth Observation System of Systems (GEOSS) platform to leverage EO resources for informing SDG 15.3.1. This workflow follows the Data-Information-Knowledge pattern using the Trends.Earth model and various data sources (e.g., Google Earth Engine, Swiss Data Cube) to generate the indicator. It implements components for model execution and orchestration (GEOEssential Virtual Laboratory), Knowledge management (GEOEssential Knowledge Base), and visualization (GEOEssential Dashboard).

HOW CITIZEN SCIENCE AND ARTIFICIAL INTELLIGENCE CAN SUPPORT DIGITAL EARTH

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Abstract

Today, Earth Observation embraces a rich set of diverse data sources, including – among other – satellite imagery, pictures and videos taken by drones, in-situ measurements from sensor systems, and observations from citizens. We are challenged to meaningfully combine these sources and to analyse them so that timely and useful knowledge is extracted. Whereas the Digital Earth vision [1] and concepts such as the Digital Earth Nervous System [2] do provide us with the frameworks and theory that is required to develop sensible solutions, we usually see only few specific applications that put high-level concepts into practice. Examples include the monitoring of seasonal and daytime population density, identification of migration flows, damage assessments after natural disasters.

In between the overall frameworks, and the concrete applications, we see a lack of a more structured investigation and reflection on how particular approaches can be applied. In our work we focus on two such approaches, which are both widely discussed in the past few years: Citizen Science and Artificial Intelligence.

Citizen Science embraces a suite of tools and methodologies for public participation in scientific research, including – for example – the contribution of volunteers in data gathering, provision of computing power, human cognition, dissemination of scientific results, as well as, the framing of research questions, methodologies and tools [3].

Following earlier research of the European Commission, we understand Artificial Intelligence (AI) as ‘a generic term that re¬fers to any machine or algorithm that is capable of observing its environment, learning, and based on the knowledge and experience gained, take in¬telligent actions or propose decisions. Autonomy of decision processes and interaction with other machines and humans are other dimensions that need to be considered’ [4].

Citizen Science and AI can be applied in many useful combinations. On the one hand, Citizen Scientists generated data can be ground truth for AI algorithms, a new dataset, support of (crowd-based) semantic annotation of Earth Observation imagery. For example, motivated through gamification – it helps to gather additional knowledge about geographic areas that are not sufficiently covered by digital models from other sources. On the other hand, AI can help in EO imagery processing, identify data gaps, and data capturing requirements that can help to shape Citizen Science actions in a way that would benefit the optional combination of human intelligence and computational power.

Whereas the arising possibilities are manifold, it should not be forgotten that such an implementation of the Digital Earth vision also comes with its challenges. Among other, ethical considerations and matters of trust should be highlighted. People might not be particularly keen to be guided (or ‘controlled’) by AI algorithms. Furthermore, citizens might not support the vision that the data they produce is handled by systems that are basically black boxes.

Overall, we see a strong need to address both the opportunities and challenges in combining the two approaches. In this oral presentation, we will introduce the overall discourse, illustrate the potentials and challenges of combining Citizen Science and AI with two examples – one using Copernicus data in combination with in-situ observations from mobile devices, and another on the self-learning recognition of invasive alien species based on geo-located photographs. We will conclude by outlining the potentials for generalizing the approach. With this contribution to the 20th Anniversary of the International Society for Digital Earth, we explore a novel area for Digital Earth Research and hope to stimulate a constructive debate about the most urgent research questions in this area.

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INTEGRATED CAPACITY BUILDING FOR FASTER UP-TAKE OF EARTH OBSERVATION DATA IN KNOWLEDGE VALUE CHAINS

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Abstract

The Sustainable Development Goals encapsulate the main challenges of our society. Ranging from access to fresh water, food and energy to health, security and economic growth. Earth observations play a central role in supporting these Goals. Europe is investing in it's flagship Earth observation programme, Copernicus, and other initiatives, providing enormous amounts of open data and information. A major challenge is still in front of us: access to data and resources supporting service developers is still fragmented, slowing down the transformation of Earth observations to valuable knowledge for society. The European H2020 project NextGEOSS* solution is to create a collaborative and standardised ecosystem where developers can find their way to build Earth observation based applications and services.

In this presentation we focus on the training and capacity building that is necessary to transform Earth observation data to knowledge on the NextGEOSS data hub and platform. The procedures have been developed based on experience from all 10 internal pilots built on NextGEOSS: Agricultural Monitoring, Biodiversity, Space & Security, Cold Regions, Air Polltion in Mega Cities, Disaster Risk Reduction, Territorial Planning, Food Security, Smart Cities, and Energy (Grid Operations and Urban Solar Mapping). We will explain the capacity building strategy, how it has been implemented for the internal pilots, and how NextGEOSS also offer training and capacity building throughout all of it's services: integration of external pilots, showcasing applications, and linking data.

Training and capacity building as part of an onboarding process contribute to speed up the up-take of Earth observation data.The procedures are the same for all types of value chains and contributes thus to transformation of Earth observation data to valuable information and knowledge in a multitude of societal benefit areas.

*NextGEOSS is a H2020 Research and Development Project from the European Community under grant agreement 730329. www.nextgeoss.eu

KNOWLEDGE EXTRACTED FROM COPERNICUS SATELLITE DATA

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Abstract

ExtremeEarth is a European H2020 project; it aims at developing analytics techniques and technologies that combine Copernicus satellite data with information and knowledge extraction, and exploiting them on ESA's Food Security and Polar Thematic Exploitation Platforms.

In this publication, we focus on the Polar case which requires the selection of validation areas, the generation of a training dataset, the development and testing of deep learning algorithms, and the demonstration of regional results.

During the development of deep learning algorithms, a key activity is to establish a large amount of referenced Earth Observation data. They need to be sufficiently diverse to cover the major target areas of satellite images under varying imaging conditions and across all seasons. For doing this, we propose to select overlapping target areas from Synthetic Aperture Radar and multispectral images acquired with rapid succession. Such a combination approach already demonstrated its applicability for monitoring seasonal snow cover [1].

By applying an already established active learning approach based on a Support Vector Machine with relevance feedback [2], we can limit ourselves to a limited number of typical satellite images to extract their information content, and to generate semantic annotations for them.

This approach is also a simple way to generate benchmarking datasets that can be used for testing and validating different algorithms, and for creating additional bigger datasets for large-scale demonstrations. The proposed methodology uses new paradigms from Recurrent Neural Networks and Generative Adversarial Networks, supported by Bayesian and Information Bottleneck concepts.

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LIDAR BASED MEDIEVAL ARCHAEOLOGY UNDER THE CANOPY: WITH LIDAR. FROM VISUAL INTERPRETATION TO MACHINE LEARNING APPROACH

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Abstract

LiDAR capability for archaeological prospection could be strongly limited in areas covered by dense vegetation for the detection of subtle remains scattered over morphologically complex areas [1]. In these cases, an important contribution to improve the identification of topographic variations of archaeological interest is provided by LiDAR -Derived Models (LDMs) based on relief visualization techniques. In this paper, diverse LDMS were herein applied to a medieval site in Basilicata (Southern Italy) located on a hilly area with complex topography and thick vegetation cover [2]. To improve the discrimination/extraction capability of archaeological micro-relief, noise filtering was applied to Digital Terrain Model (DTM) before obtaining the LDMs. An automatic procedure allowed us to extract the most significant and typical features of a fortified settlement such as, the city walls and a tower castle. Other small, subtle features referable to possible buried buildings of a habitation area have been identified by visual inspection of LDMs. Finally, field surveys and in-situ inspections were carried out to verify the archaeological interest of micro-topographical features observed from the LDMs. As a whole, the investigations allowed (i) the rediscovery of a fortified settlement attested since the 11th century and (ii) the detection of an unknown urban area abandoned in the Middle Ages.

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LINKED DATA APPROACH TO WATER RESOURCES MANAGEMENT OF HYDROPOWER RESERVOIRS

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Abstract

The exploitation of hydropower reservoirs involves daily and strict water resources management that addresses the need of water resources managers to know the status of the hydropower reservoirs and their nature environment in order to plan water discharge activities and make informed decisions for maintenance, routine exploitation and emergency situations. To do this they consult periodically collected information from different sources, such as: detailed data about the condition of the distinct hydropower reservoirs, water economic data, meteorological data and forecasts, geographical and geospatial information about the water reservoirs and their contingent environment. These data are heterogeneous and usually looked at separately requiring precise and detailed expert work effort from the water resources managers who analyze, summarize the evidence, and come up with the adequate conclusions and action plans. To make this process easier and more effective, information and decision support systems that allow the inspection of the different sources of information, including satellite data, from a single interface and provide analytics based on numeric data from different sources have been put in place [1], [2], [3]. However, capabilities of federated and integrated representation of spatial, numeric, symbolic data, images and metadata in their interconnectedness that can benefit from logical and numeric reasoning and operate in an open, easy to maintain, update and rely on information infrastructure of interoperable heterogeneous data have not been put in place yet. These capabilities break the data silos and enable the creation of a knowledge value chain converting the data into insight and providing a powerful instrument to help this domain of significant societal and environmental impact. Linked data technologies [4] offer an optimal standardized framework to deal with this issue, as they allow easy data integration, resource economy and seamless extendibility of the required information. We propose a linked data approach to obtain data interoperability between spatial information of GIS systems, remote sensing information, symbolic and numerical data like meteorological data and proprietary measurements and create knowledge value chain for the needs of hydropower reservoirs exploitation, based on semantic integration of earth observation data with other data in an open, easily extendable and maintainable information infrastructure. The linked data information infrastructure employs a crafted for the purpose ontology built on top of INSPIRE Data Specification on Hydrography [5], that includes semantic elements from GIS, satellite data, proprietary measurement data and domain knowledge. It allows interconnection of and logical reasoning over the introduced semantic elements and generation of additional relevant related facts that become available for querying. The linked data information infrastructure applies intelligence that mixes numeric with symbolic reasoning, and exposes the federated heterogeneous information in an easy to grasp manner. We demonstrate this on the example of water balance calculation for dams and cascades. To calculate the water balance we employ information from 6-7 satellite sources, e.g. meteorological data, sunshine intensity, precipitation, soil moisture, air temperature, vegetation index, etc., and in-situ measurements and apply neural network models [6], to forecast the water level and the water volumes based on historic data. We demonstrate how the results of the forecasts interoperate with the linked data infrastructure, how dangerous situations and harmful impacts on the contingent areas of the water reservoirs can be identified and how signals about risks of dam overflow or recommendations for the water quantities available for discharge can be produced. We show the advantages of the proposed approach with respect to non-semantic solutions and standalone GIS applications.

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MAPPING OF WILDFIRE OCCURRENCE AND ANALYSIS OF ITS YEARLY VARIATION FACTORS THE PEAT SWAMP FOREST IN INDONESIA

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Abstract

Peat swamp forest of southeast Asia is acting the important role as huge carbon sink (Page et al., 2011), but, in recent, massive carbon dioxide emitting and respiratory disease with haze have become serious social problems due to frequent occurrences of wildfire. It is not easy that taking effective fire-fighting by rapid detection of wildfire, because wildfires of peat swamp land will often occur simultaneous multiple. We have done, in this study, mapping of a frequency of wildfire occurring from 1997 to present by using Landsat satellite archive data, in the peat swamp forest of Indonesia. We analyzed the variability of wildfire occurrence probability, spatiotemporally, and tried to associate with several risk factors such as climatic or geographical condition.

As a result of in the study, large paddy field area along Barito river in the north of Kualakapuas City of central Kalimantan where developed by the Mega-Rice-Project have been classified as the bare soil area in the scene of June-8, 2018. It indicates the possibility of land degradation due to abandoned cultivation or of replacement for dry farm land. Pixels classified as the suspected place of wildfire have been detected along road near city area, annually. On the other hand, in the period when a lot of severe wildfire occurred from 2015 to 2016 owing to onset of El-Nino phenomenon, the detection ratio of suspected wildfire place, became higher around plantation of oil-palm. It can consider that aridity weather condition let a risk of wildfire increase.

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MAPPING THE SUCCESSION RATE OF MANGROVES FROM NYPA FRUTICANS USING LANDSAT AND NIGERIASAT-X: A SUSTAINABILITY DISCOURSE

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Abstract

Oil exploration commenced since 1952 (and is still on-going) within the extensive belt of mangrove forests in the Niger Delta region, a major habitat and ecosystem that sustains over 30 million inhabitants. It is the largest single deep belt of mangrove forest belt in Africa, measuring about 8500 km3 and protects vast areas of freshwater swampland in the Inner Delta to provide rich habitats for a wide range of flora and fauna, much of which is yet to be fully understood. However, with an estimated 240, 000 barrels of crude oil spilled every year, polluting waterways, contaminating crops, and releasing toxic chemicals into the air, the Niger Delta has become one of the most polluted ecosystems in the world. As a result, this huge ecosystem of global significance is undergoing accelerated degradation both from anthropogenic and natural causes - the nature and extent which are least understood. Of particular concern to this study is the succession of the original mangrove forests species by Nypa Fructicans, which presents major threats to the ecosystem and local communities by deepening the challenges of adapting to climate change. The study employs a satellite remote sensing methodology, using Landsat images for 1986, 1996, 2006 and 2015 and NigeriaSat-X image of 2011. This study is significant on many fronts; not much is known about the rate and nature of change of the Niger Delta mangrove forests, opportunities presented by the availability of US Landsat and NigeriaSat-X platforms did not exist previously, the period of 30 years that this study hopes to cover is the longest period of sustained investigation carried out on the Niger Delta mangrove ecosystem, and finally, sophisticated analytical tools such as Bid Data Analytics that allow huge and diversified data to be pooled and analysed to greater policy effects. Such detailed understandings and insights are necessary for effective policies and strategies for achieving the United Nations Sustainable Development Goal 15 (SDG): "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss" to be developed. Noting that mangrove forest ecosystems are a major carbon sink, understanding the dynamics and enhancing the sustainability through effective policies and strategies contributes to global efforts at reducing CO2 emissions. Findings from this study will be of benefits to local and national governments and also to multilateral and unilateral bodies contending with global environmental degradations and attending climate change effects.

MATHEMATICAL MORPHOLOGY APPLIED TO THE EXTRACTION OF AIRPORT TRACKS IN DIGITAL IMAGES

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Abstract

Methodologies proposals to perform cartographic feature extraction from digital images have been of great importance in the Cartographic area. These methodologies are focused on the identification of existing targets in the terrestrial surface and its results allow the detection and identification of changes caused by anthropic actions and/or by nature. Several image processing techniques can be used to perform the extraction, nevertheless, the results obtained usually contain features partially detected and, consequently, it culminates in quality loss of the extraction results. In this sense, this work presents an approach to improve the quality of extraction results applying an inpainting based technique proposed by Liang-Jian Deng et al. The inpainting concept has as its main purpose image restoration and removal of occlusions. In other words, it consists of gathering information around the damaged area and making a subtle junction of this information with the interest area. The use of inpainting techniques in the Cartography area is unusual, which contributes as an innovation for the topic. The chosen technique is defined as an exemplar-based inpainting, which means that the algorithm tends to fill the areas of interest by copying and pasting high-priority patches from the original area and keeping its texture. The priority of each patch consists of two attributes: the confidence and the data terms. The confidence term is responsible for textures propagating, and the data term propagates geometry. The algorithm has two phases, one that propagates image geometry into the area of interest, using the data term, and the other that synthesizes textures with the confidence term. The algorithm also assures that the number of steps for each phase is calculated automatically. For this work, it was decided to use the metric SSIM (Structural Similarity) to analyse the quality improvement. SSIM is an image processing metric and acts as an index that predicts the quality of images and videos, by measuring the structural similarity between two images. SSIM was created as an enhancement of the traditional methods MSE (Mean Squared Error) and PSNR (Peak signal-to-noise ratio). The main difference between SSIM and its predecessors is that SSIM is a method based on visual perception. SSIM is more efficient than MSE and PSNR because both of them do not detect distortions perceptible by the human visual system, only considering the individual state of each pixel and not its structural information, as opposed to what happens in SSIM. In addition, MSE and PSNR are not suitable for binary images. In this case, the MSE represents the number of differences between two images, and the large number of different pixels does not always result in a large structural difference, because binary images do not have many texture details and their pixel distribution is simpler. Thus, the first step in this work was to select four results of extraction methodologies that contained partially detected features. For each result selected, a reference image was manually created, based on the original satellite image and the SSIM between the reference and the result of the extraction was calculated. After that, all the results were reconstructed using the presented inpainting technique. The post-reconstruction image was also compared with the reference image using SSIM. The pre-reconstruction SSIM values for the four cases were 88.77%, 94.51%, 94.21% and 87.28. After the reconstruction the SSIM were recalculated and the values obtained were respectively 98.25%, 97.25%, 96.91% and 98.71%. The mean SSIM for pre-reconstruction is 91.19%, and for post-reconstruction 97.78%, which means the inpainting algorithm shows an improvement of 6.59% in average quality of the extracted features. Therefore, the use of this algorithm may contribute greatly to increasing quality of the process of extraction of cartographic features partially detected in digital images and can be used in the area of cartography, supporting processes to update cartographic products.

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MEASURING THE DIFFUSION OF INFLUENCE AMONG PORTS USING REAL TIME DATA

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Abstract

Network analysis has provided a useful heuristic for examining oil and other energy flows. Previous studies highlight the advantages of networks in identification of major players in world oil trade, coordination of oil production, oil import risks implications, and stabilization of oil trade communities. More recently, the availability of large datasets, including big data and real-time data collected from sensors and tracking technologies, has opened up opportunities to study network influence, and the latter's diffusion and maximization. As a network consists of structural properties, certain nodes can command and exert disproportionate influence on other nodes in the network. While traditional network measures of centrality and connectedness implicate nodal influence, more recent work is distinguished by its attention to the propagation mechanism. However, port influence also consists of both a spreading and cumulative process which is not examined in the recently literature. Much of the theoretical development behind this comes from the information diffusion scholarship, and has been applied largely to marketing and social media networks. Some scholars describe how activating a few "influencers" on social media by companies can result in maximization of information diffusion that reaches many users while minimizing inefficient carriers.

In this paper, we seek to shed light on how ports spread their influence through propagatory activation of other ports in the global oil traffic network from 2009 to 2016. By designing a modified linear threshold model, we do not attempt to identify a few fixed ports that served as "seeds" for propagation and influence maximization. Instead we identify active seed port hubs via their diffusion patterns and the number of ports in the networks that become influenced as a result.

The computations show that diffusion is highly uneven but Rotterdam, Antwerp and Singapore emerged as the three most influential seed ports particularly in 2013 and 2016. Whereas over half of the ports in the networks were able to influence just one other port, Rotterdam and Antwerp influenced ports in the entire network. Singapore's spread of influence is smaller but its activation rate is more rapid because the port-city's influence tends to be much more regionally confined. Rotterdam's propagation occurs in fewer stages than Antwerp's suggesting that information and innovation spread more readily from the former city-port. Taken together, the analysis points to the above three city-ports as the most effective hubs for dissemination of information in the oil, including tanker, industry.

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NEAR REAL-TIME DETECTION OF ABNORMAL VESSELS' BEHAVIORS AND VESSEL SOURCED POLLUTION IN SRI LANKA'S MARITIME ZONES: AN INVESTIGATION

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Abstract

The largest ecosystems on Earth are the oceans and it is essential to conserve and sustainably use these vital resources. Waste created by the activities on land and sea, leads to the destruction of the ecosystems. Therefore, present and future generations' needs, have to be met, in a continuously improved way, contributing to the sustainable use of limited Earth resources. As Sri Lanka is an island in the Indian Ocean, with rights to a vast sea area that extends from the shores, it is mandatory to sustainably manage its marine environment. Regular, systematic reviews of the state of marine environment provide an understanding of the various aspects of marine environment change and the implications for sustainability. Space borne platforms provide Earth observation data collected by different types of sensors, at regular intervals for the management of Earth environment. Earth observation data acquired with Synthetic Aperture Radar (SAR) technology has become useful for the detection of marine pollution during the day and night, regardless of cloud covers. However, availability of near real-time data is important for prompt detection and response. Copernicus Sentinel -1 satellites that provide SAR data with 12-days revisit time, have been designed to monitor land and sea, and the constellation of the satellites further improves the revisit time. Through the ground receiving station to be built, with the assistance from the Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences and the Government of the People's Republic of China; it is possible to downlink data from satellites. The research aims to explore the feasibility of automating the downloading and combining of satellite data in near real-time to facilitate early detection of abnormal vessels' behaviors and vessel sourced pollution in Sri Lanka's maritime zones.

PARAMETERS SELECTION FOR THE OPTIMIZATION OF SVM CLASSIFICATION OF AN AIRBORNE LIDAR POINT CLOUD

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Abstract

Light Detection and Ranging (LiDAR) is an active remote sensing technology used for several applications. Airborne LiDAR is becoming an important technology for the acquisition of highly accurate dense point cloud. A classification of Airborne Laser Scanning (ALS) point cloud is very important task that still remains a real challenge for many scientists. Support Vector Machine (SVM) is one of the most used statistical learning algorithm based on kernels. SVM is a non-parametric method and it is recommended to be used in cases where the data distribution cannot be well modeled by a standard parametric probability density function. Using a kernel, it performs a robust non-linear classification of samples. Often, the data are rarely linearly separable. SVMs are able to map the data into a higher dimensional space to become linearly separable, which allows performing all the computations in the original space. This is one of the main reason that SVMs are well suited for high dimensional classification problems [1]. Only a few training samples, called support vectors, are required. SVM has also shown its potential to cope with uncertainty in data caused by noise and fluctuation and it is computationally efficient as compared to several other methods [2].

Such properties are particularly suited for remote sensing classification problems and explains their recent adoption [3]. In this poster, SVM classification of ALS LiDAR data is proposed. Firstly, connected component analysis is applied for clustering the point cloud. Secondly the resulting clusters are incorporated in SVM classifier. Radial Basic Function (RFB) Kernel is used due to the few number of parameters (C and γ) that needs to be chosen which decreases the computation time. In order to optimize the classification rates, the parameter selection is explored. It consists to find the parameters (C and γ) leading to best overall accuracy using grid search and v-fold cross validation. More details can be found in [4]. The exploited LiDAR point cloud is provided by the German Society for Photogrammetry, Remote Sensing and Geoinformation. The ALS data used is characterized by a low density (4-6 points/m^2), and is covering an urban area, located in residential parts of the city Vaihingen in southern Germany. The class Ground and three other classes belonging to roof superstructures are considered, i.e. a total of 4 classes. The training and test sets are selected randomly several times. The obtained results demonstrated that a parameters selection can orient the selection in a restricted interval of (C and γ) that can be further explored, but does not systematically lead to the optimal rates.

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PRACTICES OF OCEAN INFORMATION RESOURCE SHARING AT SCSIO

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Abstract

Ocean Information Service (OIS) of South China Sea Institute of Oceanology (SCSIO) was formally established in 1999. The OIS currently includes library, editorial department, network center, and data center four parts. The OIS's mission is to build network platforms and cloud environment for integration and sharing of key science and technology information resources, and to support research activities in SCSIO and marine scientific communities. The OIS concerns to accelerate open and co-sharing of marine literature, institutional knowledge, ocean data, and popular science resources.

The data center is responsible for ocean data collection, management, processing and service. It makes ocean data easier to use with OPeNDAP(Open-source Project for a Network Data Access Protocol), providing machine-to-machine interoperability with semantic meaning in a highly distributed environment of heterogeneous datasets. It realizes web-based dynamic and interactive visualization of ocean data with DChart (the Dapper Viewer) and LAS(the Live Access Server). The data center also makes use of SKE (Subject Knowledge Environment) to implement the effective integration and sharing of marine popular science resource.

The practices of information resource management and sharing, key technologies and functionality of application software are discussed briefly in this paper. It is shown that OIS is able to implement web visualization sharing and seamless access to ocean data, information, and knowledge in a distributed and heterogeneous environment.

QUALITY ASSESSMENT OF SEMANTIC TAGS IN OPENSTREETMAP

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Abstract

A comprehensive understanding of urban areas includes deep knowledge about locations and functions of buildings within. Yet, building locations, i.e. their geocoded building footprint polygons, can be obtained from remote sensing imagery. Estimating their function remains, however, a challenging task using data acquired in an aerial perspective. Approaches for solving this task mostly involve deep learning methods and require vast amount of training data. While aerial imagery is available in large quantities, respective correct labels to train on are scarce. A limited amount of cadastral data is available for research, but from a global perspective the only free and comprehensive source for this kind of data is OpenStreetMap (OSM).

OSM was founded in 2004 based on the idea to map the world in Wikipedia style with each user being a potential contributor. Since then it evolved rapidly and became a rich source of geospatial information for users around the world. Especially for researchers the open character of OSM is of high value allowing unrestricted data access [1].

For this study we selected 42 cities across the globe covering a wide range of climates and cultures and assess the accuracy of building function labels in OSM indirectly by comparing them to Google Places. We state that points-of-interest are reasonably covered in Google Places due to the large number of users and business perspective driving its development. We first discuss OSM data and Google Places data individually before comparing them with each other. Our analysis on OSM data shows that Jakarta, Los Angeles, and Tokyo have the highest density in the number of buildings per square kilometer. Moreover, we study how many semantic building tags are in accordance with the proposed scheme by OSM. In this regard Los Angeles has the best coverage on OSM, followed by Amsterdam and Cologne.

In our study areas we found the most points of interest from Google Places in London, New York, and Jakarta. In Melbourne, Paris, and Sydney we find the most matching building functions of OSM and Google Places. In summary, we conclude that OSM is not ready to provide ground truth labels for each place on the globe, but can serve as a powerful and rich label source in selected study areas. Our study gives a first insight where obtaining training labels from OSM is a valid and reliable approach.

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SPATIO-TEMPORAL MONITORING OF GRASSLAND DEGRADATION IN THE QINGHAI-TIBET PLATEAU OVER PAST 3 DECADES

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Abstract

Alpine grassland is the major ecosystem in the Qinghai-Tibet Plateau (QTP), accouting for 60% area of QTP. Due to climate change and anthropogenic activities, diverse forms and differing intensities of grassland degradation have been reported in several regions of the Plateau, explicit mornitoring is crucial to analysis the temporal and spatial variations of graasland degradition for both researchers and policy makers. In this study, 27-year longterm AVHRR and MODIS data were used to developed grassland degradation classification indices based on net primary productiviy (NPP) and fraction vegetation coverage (FVC), two most important indicators for grassland ecosystem quality and functioning. The result of this study indicated the both the area and degree of degradation were significantly decreasing and improving for the whole QTP and sub six eco-geographic region over three periods (1990-1999, 2000-2009 and 2010-2017). The degradation area of grassland was 1, 096, 866 km2, accounting for 80.90% of the entire grassland during 1990-1999, slightly, moderately, and severely degradation accounted for 19.37%, 25.59% and 55.05% of degradation grassland, respectively. During 2000-2009 and 2010-2017 period, degradation area reduced to 453, 156.69 km2 and 266, 036.31 km2, respectively, and severely degradation degree area were also decreased to 4.3% and 7.28%, respectively. The general situation was improving, however the improve in some area such as south Qinghai and North Tibet was still limited, which need more attention.

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REMOTE SENSING BASED APPROACHES FOR THE STUDY OF HUMAN PAST IN INCA PERIOD IN PERU

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Abstract

Even if in the last decades the use of remote sensing technologies (from satellite, aerial and ground) for archaeology is stepping in its golden age, in Southern America, is more recent and less used compared to Europe, Central America, and Middle East. . In this paper, we provide a brief overview, and show the preliminary results obtained from the investigations conducted in Chachabamba and Machu Picchu in Peru . Chachabamba is located on a strategic terrace overlooking three Inca roads, which served the most important ceremonial centres (including Machu Picchu) of the Urubamba Valley also known as the Sacred Valley. Machu Picchu is located 2, 430 m above sea level in the middle of a tropical mountain forest on the eastern slope of the Andes, which dominates the Urubamba River, in a canyon between the Machu Picchu and Huaynapicchu mountains, caused by a fault natural. Seen in the collective imagination as the remains of an ancient and fascinating lost city, Machu Picchu is an Inca sanctuary, probably built by the Inca Pachacútec emperor around the year 1440 and inhabited until the Spanish conquest of 1532. Rediscovered by Bingham in 1902, today it is universally known both for its imposing and original ruins, and for the impressive weighing on the Urubamba valley below.

In particular, Chachabamba and Machu Picchu investigations were conducted with two principal aims :

1) to give new impetus to archaeological research with targeted investigations aimed at improving and completing the site's knowledge framework;

2) to experiment and validate new approaches to fusion and integration of satellite and geophysical data for the extraction of features of archaeological interest, to be re-applied in other Inca sites of the Urubamba valley, having similar characteristics as those found in Chachabamba and Machu Picchu

REMOTE SENSING DATA FOR THE INVESTIGATION OF GEO-HAZARD: EO4GEO PROJECT AND THE KNOWLEDGE SHARING CHALLENGES

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Abstract

During the past decades the use of satellite remote sensing data has reached an high degree of development for the investigation of natural hazards, but it is still growing quite fast. The improved capabilities of Earth Observation (EO) data acquisition, analysis and the implementation of standardized products lead decision makers and managers to a better understanding and assessment against geo-hazard. The crucial role of the Remote Sensing application to disaster risk management chain (preparation, disaster response, recovery and mitigation), especially in the preparation and disaster response, has been widely documented, but since geo-hazard pose potential risks to people safety, assets and the environment, as well the urban settlement, the better knowledge to deal with the huge amount and the high quality of EO data is required. The latest challenge is to define a standard methodology to use, satellite data and techniques (e.g. Synthetic Aperture Radar Interferometry - InSAR), to carry out geo-hazard risk assessment, monitoring and mitigation options and future scenarios. Available EO data provided from different satellite missions, both European and international (e.g. Sentinel from Copernicus program, COSMO-SkyMed from ASI), will be tested to evaluate their effectiveness and efficiency in the field of geo-hazard monitoring and risk assessment. The present summary is focused on the ISPRA contribution to the EO4GEO project, in the context of the Copernicus User Uptake program. EO4GEO is a Erasmus+ project aiming at applying innovative solutions for education and training actions, it will define a long-term and sustainable strategy to fill the gap between supply of and demand for space/geospatial education and training, taking into account the current and expected technological and non-technological developments in the space/geospatial and related sectors (e.g. ICT). The general project strategy will be implemented by: creating and maintaining an ontology-based Body of Knowledge for the space/geospatial sector; developing and integrating a dynamic collaborative platform; designing and developing a series of curricula and a rich portfolio of training modules directly usable in the context of Copernicus and other relevant programs; conducting a series of training actions for a selected set of scenarios, to test and validate the approach, in three main sub-sectors :1) integrated applications; 2) smart cities and 3) climate change. In this contest ISPRA will contribute significantly to the implementation of the case studies by depicting geo-hazard risk scenarios concerning three different categories of exposed elements: 1) linear infrastructure and transportation network, 2) cultural heritage and 3) urban area. One of the target of the project is to define a standard methodology to use EO data and services (possibly open and free) to carry out risk assessment, monitoring and mitigation policies. The geo-hazard risk scenarios will be selected taking into account data availability and different typologies of phenomena (e.g. slow and very slow landslide, shallow and deep) as well as different vulnerable elements. Stakeholders, final users and geo-hazard experts community (public and private) will be involved during the scenarios implementation. The project target groups are constituted by stakeholders from across knowledge triangle including academia (primarily High Education Institutions), enterprises (SMEs) and public bodies, active both in the education/training and in the space/geospatial sectors applied to natural risk assessment. More in detail the international geo-hazard community will benefit of the three risk scenarios as a standard methodology for the use of open and free satellite data (e.g. Sentinel, COSMO-SkyMed) in the field of geo-hazard risk assessment, monitoring and mitigation. The main expected results (especially from ISPRA activities) will be standard methodologies to implement risk scenarios.

SPATIO-TEMPORAL MAPPING OF WATER CONSUMPTION AT PUBLIC INSTITUTIONS: CASE OF THE UNITED ARAB EMIRATES UNIVERSITY

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Abstract

In this study, indoor water consumption at the UAEU is assessed for the period 2016-2017. Geographic Information System (GIS) is utilized to answer where water is highly consumed within the university (hot spots), when (time), who consume it, why (causes), and how to minimize consumption. It assembles diverse data reside at various departments to gain a better knowledge about the broad patterns of water consumption in the university. The assumption made here is that water consumption is directly proportional to population density and less during winter. The relationship between water consumption and number of students is modeled using least square. The results indicated low correlation between water consumption and number of students. This may be due to the centralized usage of buildings and movement of students between buildings. Temporal variation showed sharp decrease during July of 2016 and 2017 irrespective of the building type/size and this is associated with summer holidays. The hypothesis of activity-driven consumption showed that the highest water consumption is found at residential buildings due to the longer stay time at hostels. A survey for students revealed that half of the respondents are not aware of the water issues. Majority of respondents prefer to drink bottled water than tap water and majority are not willing to use grey water or urinals as ways to conserve water due to the lack of knowledge. Yet, they are willing to take a course and participate in competitions designed to teach them how to conserve water.

STUDY ON THE ZONING OF THE PRODUCTION-LIVING-ECOLOGICAL SPACE FUNCTIONS—TAKE CHONGQING CITY AS AN EXAMPLE

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Abstract

Land is an important material basis for the survival and development of human beings. In order to satisfy their own interests, people are unrestrained to get land resources from nature, which has made problems such as man-land relationship tense, space development disorder and spatial structure imbalanced. The current land use classification system emphasizes the industrial and living function of lands but insufficiently considers ecological function [1]. The reasonable and orderly development of production-living-ecological spaces is of great significance for land function combination, ordering spatial development, guiding population resource environments and ensuring socio-economic sustainable development in urban areas [2].

The zoning of the production-living-ecological space function makes effort to solve a series of regional problems brought by the rapid development, improve the overall competition level of land space, while preserving the diversity of land space, and implementing the differentiated management of land space. At present, the study on the zoning of the production-living-ecological function in China is in its initial stage. Most of the qualitative studies on the classification of the production-living-ecological space are based on the macro-scale land use planning [1], and lack the support of high-precision basic data. The accuracy of the classification results to be investigated.

Based on the first census of China geographical conditions and relied on the comprehensive statistics and analysis project of national geographical conditions, this paper used high accuracy data obtained from the census, and selected Chongqing city as the study area. Qualitative and quantitative methods were used to classify and evaluate the production-living-ecological space, so as to realize the zoning of the production-living-ecological function of national space.

The research results can serve the implementation of land spatial planning and related policies in Chongqing city, and provide important reference for the development of other regional planning (zoning) work, and promote the popularization and application of the survey results of geographical conditions.

The main contents of this paper are as follows:

1. The classification of the production-living-ecological spaces of land [1-4]. This paper studied content and indicators of the census of geographical conditions [5-6], clarified the features of production, living and ecological functions of land space, built the classification system of the production-living-ecological space based on geographical national census, and divided land space into 7 categories. Then the kernel density method based on grid was proposed, and the spatial pattern of various land was analyzed by this method.

2. The evaluation of the production-living-ecological function. This paper integrated the other professional department survey data and social economic statistic data, and built the evaluation index system of the production-living-ecological function based on production, living and ecological functions. This evaluation system contained 25 evaluation indexes. The county administrative region was selected as standard regional evaluation unit, and the production-living-ecological function of evaluation unit was described as a percentage. Then, the production function, living function and ecological function of each standard regional unit were evaluated by BP neural network model.

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THE ICOS ATMOSPHERE USE CASE: FROM RAW DATA TO KNOWLEDGE OF SOCIETAL RELEVANCE

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Abstract

Perhaps the biggest challenges facing human civilization today is the ongoing global climate change. On top of anthropogenic modifications, like deforestation and pollution, our environment is now also being affected by climate-driven changes including rising sea levels and increasing risks of extreme weather events, affecting millions of people. Stakeholders and policy makers across the globe must work hard to come up with effective strategies towards mitigation of these negative effects. But to do so, they need timely and accurate information they can trust, on topics ranging from demographics, socio-economic development, and land usage to the environment. However, this task poses considerable challenges, including 1) dealing with a multitude of sources, often with unclear provenance of the information, such as lack of details of how data were collected, analyzed and interpreted; 2) combining data with varying spatial and temporal resolution and coverage; and 3) judging quality and fitness-for-purpose of data, information and knowledge.

In this presentation we take a closer look at atmospheric research in Europe, examining how observational data collected from a network of measurement stations scattered across the continent are fed into advanced numerical models of how emission and uptake of greenhouse gases vary over time and space, and how interpretations of this output contributes to knowledge that can be used by decision makers.

Integrated Carbon Observation System, ICOS, is a pan-European research infrastructure with a mission to provide standardized, long term, high precision and high quality observations on the Carbon Cycle and Greenhouse Gas (GHG) budgets and their perturbations. ICOS is built around over 130 field sites, each related to one or more of the three domains Atmosphere, Ecosystem and Ocean, and operated by ICOS 12 member countries. At the stations, observations of e.g. concentrations or exchange fluxes of greenhouse gases and meteorological variables are collected following strict standardized protocols. All collected raw data are then processed and quality controlled, again using highly standardized processing chains, at ICOS Thematic Centres (one for each domain), before being distributed via the Carbon Portal, the data centre of ICOS.

Although ICOS Carbon Portal offers discovery services allowing anyone to visualize these observational data products, they cannot however be readily used or interpreted by non-experts. A second data processing step, performed by atmospheric scientists with an understanding of the processes that underlie the emission and uptake of greenhouse gases are needed. Indeed, the perhaps most important end user groups for ICOS are researchers specializing in so-called atmospheric inversion and data assimilation models. These combine observations with data from emissions inventories (anthropogenic sources), outputs of ecosystem and marine models (contributions from vegetation and the oceans), and atmospheric transport calculations (showing the 3D-movement of air packets over time) to calculate – as a function of time and location on the Earth's surface – the strengths of GHG sources and sinks. Importantly, the models also allow to assess the uncertainties of the results.

The model outputs, typically time series of maps with a relatively coarse spatial resolution, may now be used as the basis for estimates of for example the yearly net emissions of CO2, CH4 and other GHGs of different regions, such as northern or southern Europe, Eurasia etc. One can thus claim that at this level, data has been turned into information. ICOS provides tools, in the form of scripting environments based on VRE technology, to work with the emission maps and for example apply geographical filters to extract time trends of emissions. (It must however be noted that the uncertainties of the outputs in combination with quite large grid cells makes any statistics extracted for individual countries, or even small regions, highly questionable from a scientific viewpoint!)

The final step, to produce knowledge from information, requires further actions by experts – not only from the atmospheric sciences, but also involving specialists on climatology, land use, economics, industrialization, and society. Together, these specialists can interpret the model outputs, put the results into context, and further analyze the overall uncertainties, before comparing with other sources of data on net emissions based on other methods. The final results, often known as synthesis reports, can then be handed over to policy makers and their associated experts to be used as the basis for political decisions.

THE IMPACT OF EARTHQUAKE ON POVERTY: LEARNING FROM THE 12 MAY 2008 WENCHUAN EARTHQUAKE

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Abstract

How to combine disaster prevention and mitigation, post-disaster reconstruction and poverty alleviation has become a new hot issue. On 12 May 2008, a major earthquake devastated the Wenchuan area in Sichuan Province in the heartland of China. After ten-years have passed, it is a good time to review what we learned from the Great Wenchuan earthquake. The impact of Wenchuan earthquake on poverty-stricken counties, poverty-stricken villages, and poverty-stricken households was analyzed. Suggestions for improving the method of combining disaster prevention, post-disaster reconstruction, and poverty alleviation were proposed. The results from this research could serve as an important reference for formulation of the poverty alleviation and development program after a major earthquake.

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THE MINAMATA KNOWLEDGE PLATFORM: FROM DATA TOKNOWLEDGE SUPPORTING MINAMATA CONVENTION ONMERCURY

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Abstract

Atmospheric mercury (Hg) emissions are significant component of the global Hg cycle. As the Minamata Convention on Mercury comes into effect, controlling atmospheric mercury (Hg) emissions has become a compulsory goal. Decision-maker initiatives process the scientific data and information within a milieu encompassing many economic, political, social, and cultural concerns. A knowledge platform oriented to support Minamata Convention aims to give stakeholders the answer to the question: how will change the Hg deposition fluxes over one/some/all of the receptor regions following the alteration of Hg anthropogenic emissions? In this paper we present the issues and solutions to realize a knowledge platform in order to support Minamata Convention and stakeholders to take better decisions from data. The process to learn from data are discussed and presented from an user point of view, proposing features and tools to be included in a knowledge platform oriented to earth observation.

TOWARDS A WEB SERVICE FOR RAPID LANDSLIDE MAPPING BASED ON COPERNICUS DATA

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Abstract

Each year, landslides cause numerous deaths and significant damages in mountainous regions worldwide. Europe experienced 476 fatal landslides between 1995 and 2014 and had an average economic loss of 4.7 billion Euro per year. A global documentation of landslides counted 55, 997 fatalities in total from 2004 to 2016 and thereby emphasises the global impact of landslides. Information about landslides is a key issue to the entire cycle from disaster response over recovery and mitigation to preparation. An improved documentation of where landslides have occurred in the past allows better estimates where to expect future events, i.e. where mitigation and preparation is primarily necessary. In addition, information about landslide locations has to be timely available, if it shall be valuable in the disaster response phase. Readily available landslide maps allow authorities to prioritize their emergency response activities to areas with the most severe problems. Additionally, they enable them to organize fast and efficient restoration of infrastructure.

During disaster response, authorities mainly collect landslide information by time-consuming and expensive in-field assessments and, if possible, by information from affected people. Earth observation (EO) data has a strong potential to be valuable in response to landslide events, because it is capable to sense potentially affected areas quickly and comprehensively. In addition, EO data is already used in emergency response. For example, authorities can trigger the Copernicus Emergency Mapping Service (EMS) that provides EO-based maps for different types of disasters. For landslides, however, only three EMS activations occurred since its start of operation in 2012 (as of February 2019). Most of the time, floods were the cause for EMS activations, i.e. 115 times out of 307 activations in total.

A major challenge in rapid landslide mapping is the efficient information extraction from EO data. The appearance of landslides is very variable, the rough topography in mountainous areas brings difficulties (e.g. shadows, different illumination conditions), and clouds may be an issue especially when heavy rainfall caused the landslides. With the additional need for timely delivery, rapid landslide mapping requires a reliable and fast provision process that addresses all workflow components from EO data acquisition and access over image interpretation to landslide information delivery. Moreover, an appropriate integration of the information products into the workflows and working environment of first responders that use the data is essential.

In the research project Land@Slide (http://landslide.sbg.ac.at), we developed a pre-operational web service for EO-based landslide mapping that has the potential to evolve into a rapid mapping service for emergency response. The web service can handle different types of optical EO data and allows users to extract landslide information interactively. Further development steps for strengthening the web service's functionality for the rapid mapping use case are necessary. They comprise the linkage to the Copernicus data hub to speed up and ease the integration of Sentinel-1 and Sentinel-2 data and the use of tested automated algorithms for landslide information extraction. These requirements enable rapid mapping and effective documentation of areas affected by landslides. Such a development relies on web service functionalities for access to, integration of and processing of EO data and for the visualisation of results. In addition, machine-learning technologies support the process for automating landslide detection.

Apart from implementing these technologies, the service development requires an appropriate testing of user interaction with the service. In addition, we explore the commercial issues of such a service that allow it to become sustainable.

URBAN LAND-USE MAPPING USING LSTM AND DTW WITH MODIS EVI TIME SERIES IMAGES

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Abstract

Through data cleaning, data segmentation and data index, remote sensing observation data collected in Wuhan from 2001 to 2018, are organized into a data cube with time series as the Z-axis. Then, about 414 tile images of MODIS-NDVI data were extracted. Select the classification results of Wuhan in 2001, 2005 and 2010 as prior knowledge and five types of regions of interest (ROI). Then the LSTM was used to detect change points in the time series dimension, and DTW and KNN were used to make classification. In space dimension, the mean value and standard deviation value of the tile matrix were calculated to detect the areas with frequent changes in vegetation coverage in Wuhan during the 18 consecutive years. The vegetation coverage curve was extracted using the time series as the z-axis to further explore the specific time nodes and change process of vegetation coverage. The experiment results show that: (1) From 2001 to 2010, the area of Wuhan's vegetation-covered area decreased sharply in the urban expansion stage; (2) After 2010, due to the follow-up of greening and other work in the later stage of urban development, the green space area of wuhan resumed its scale; (3) In recent years, with the large-scale development of Wuhan's urban transportation project, the existing greening work has been affected to some extent.

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USING A STRATEGY WITH TERRAIN SHADOW ELIMINATED VEGETATION INDEX (TSEVI) IN FOREST COVER CHANGE MONITORING

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Abstract

As an important terrestrial ecosystem, the forest plays a critical role in biodiversity conservation, ecological sustainability, and climate change adaption and mitigation. In order to protect the forest ecosystem, remotely sensed measures have become an efficient and effective technology in forest cover monitoring and change detection. However, most forest is located in rugged terrain, so the terrain shadow effect, including self and cast shadows, is a major obstacle in obtaining accurate forest cover information by remote sensing. Therefore, a strategy of terrain shadow eliminated vegetation index (TSEVI) with the rate of change of TSEVI (ROC_TSEVI) detection method was developed to monitor the forest cover change. The Wuyishan Nature Reserve, located in China's southeast province of Fujian, was selected to test the effect of the new TSEVI strategy. The Reserve has a total area of 232.74 Km2, ranging from about 280 to 2158 meters in elevation, and is covered with predominant terrain shadows.

The TSEVI is composed of ratio vegetation index (RVI), shadow vegetation index (SVI) and the adjustment factor (f(△)). The optimal algorithms of f(△), including the coefficient of variance (CV) algorithm, coefficient of correlation (r) algorithm, maximum values matching algorithm and the method of equal samples between shadow and sunny areas, were used individually or together to calculate the accurate TSEVI information. After monitoring with the normalized TSEVI from multi-temporal Landsat images acquired in 2001, 2010 and 2016, the forest gain and loss in the Reserve was detected in three periods of 2001-2010, 2010-2016 and 2001-2016. The analysis of the detection results shows that (a) forest cover was maintained well across the Reserve over the total fifteen years period from 2001 to 2016, except nearly 3.60% forest gain and about 0.52% forest loss; (b) except for Mount Huanggang, the reservoir, settlements, roads and boundary area, more than 91.23% of the Reserve was covered with dense forests (TSEVI >0.50); (c) the mean TSEVI in the Reserve was 0.627 in 2001, 0.635 in 2010, and 0.638 in 2016, indicating a possible growing trend of the forest cover overall in the Reserve with an annual growth rate of about 0.088% in TSEVI from 2001 to 2010 and 0.077% from 2001 to 2016. These forest cover characteristics in the Reserve were attributed to the international and national support and the balanced local economic structure and development model.

The research result indicates that the strategy of TSEVI with the ROC_TSEVI method has great potential application in forest cover change monitoring in other dense forest areas with rugged terrain.

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USING OPEN REMOTE SENSING AND GEOGRAPHIC DATA FOR SMART MONITORING OF NATURE-BASED TOURISM IN THE AZORES ISLANDS NATURAL PARKS: TOWARDS (MORE) SUSTAINABILITY

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Abstract

Protected Areas in oceanic islands as the Azores (Portugal) face particular socioeconomic and environmental challenges, which increase their vulnerability to threats such as climate variability, biodiversity loss, biological invasions, environmental degradation, natural hazards and overexploitation of resources. At the same time, economic and social development is a major concern in these territories with economies seriously dependent on external markets and limited populations (and resources). Tourism plays an important and undeniable role in these territories (e.g. job creation, tax revenues and increased value of local products). Nature-based tourism has shown a growing economic relevance and protected areas offer unique opportunities for visitor experiences. In fact, since protected areas generally restrict most primary sector activities, tourism is one of the few suitable tools for local development (and for financing protected areas management). Situated at the crossroad between technology and tourism, "smart tourism" arises as an innovative and integrated approach to a new tourism paradigm. Underlying the concept of "smart tourism" from an humanware approach five dimensions need to be considered: (i) value creation; (ii) smart technologies; (iii) sharing economy; (iv) smart and sustainable destinations; and, (v) tourism experience. For nature-based tourism destinations (as it is the case for the Azores), the concept of "sustainable destination" mostly relies on the environmental quality and ecological preservation of conservation areas, which requires the development and application of robust and cost-effective site planning, management and monitoring approaches. In the Archipalego of the Azores, the main threat for nature conservation is land use/land cover change, mostly driven by urban and tourism development, spread of invasive alien species, natural hazards, and also intensification of agricultural activity and livestock grazing [1] [2] [3] [4]. This communication presents a Remote Sensing-based methodological and operational framework (using Sentinel-2 and Landsat-8 free and open access satellite multispectral data) based on the Google Earth Engine (GEE) platform for monitoring land cover/land use changes in the Azores Islands Natural Park, using the S. Miguel Island Natural Park (the most visited Island Natural Park located in the most populated and large island of the Azores Archipelago) as case-study area.

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USING SOCIAL MEDIA TO MINE AND ANALYSE PUBLIC SENTIMENT DURING A DISASTER: A CASE STUDY OF THE 2018 SHOUGUANG CITY FLOOD IN CHINA

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Abstract

Social media has been applied to all natural disaster risk-reduction phases, including pre-warning, response, and recovery. However, using it to accurately acquire and reveal public sentiment during a disaster still presents a significant challenge. To explore public sentiment in depth during a disaster, this study analysed Sina-Weibo (Weibo) texts in terms of space, time, and content related to the 2018 Shouguang flood, which caused casualties and economic losses, arousing widespread public concern in China. The temporal changes within six-hour intervals and spatial distribution on sub-district and city levels of flood-related Weibo were analysed. Based on the Latent Dirichlet Allocation (LDA) model and Random Forest (RF) algorithm, a topic extraction and classification model was built to hierarchically identify flood-relevant topics and public sentiment responses in Weibo texts. The flood-related Weibo were generalised into six topics: 'Weather warning', 'Traffic conditions', 'Rescue information', 'Public sentiment', 'Disaster information', and 'Other'. A secondary classification was implemented to divide the topic of 'public sentiment' into nine more detailed sentiments, concerning 'The disaster situation', 'Questioning the government and media', 'Seeking help', 'Praying for the victims', 'Feeling sad about the disaster', 'Making donations', 'Thankful for the rescue', 'Worrying about vegetable prices', and 'Other'. The majority of the topics in the Shouguang flood-related Weibo were 'public sentiment', among which 'questioning the government and media' was the most commonly expressed. The trend of the variation in Weibo text numbers for different topics and sentiments over time corresponded to the different development stages of the flood. On a sub-district level, the spatial distribution of flood-relevant Weibo was mainly concentrated in the south-central and eastern parts of Shouguang, near the river and the downtown area, which have high population densities. At the city level, the Weibo texts were mainly distributed in Beijing and cities in the Shandong Province, centring in Weifang City. The results indicated that the classification model developed in this study was accurate and viable for processing social media texts during a disaster. The findings can help researchers, public servants, and officials better understand the public sentiments towards disaster events, accelerate disaster responses, and support post-disaster management.

WATER DATA STANDARDS BY THE HYDROLOGY DOMAIN WORKING GROUP OF WMO AND OGC – FROM DEVELOPMENT TO IMPLEMENTATION AND ADOPTION

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Abstract

WaterML 2.0 [1] is a series of information models and encodings for the representation of water features and observations data, developed for the exchange of such datasets across information systems. WaterML 2.0 consists of four parts dealing with different types of hydrological data: Part 1 (Timeseries) defines an encoding for timeseries observations enabling exchange of data such as water level or discharge; Part 2 (Ratings, Gaugings and Sections) deals with rating conversions (stage to discharge etc), gauging observations and river cross-sections which are part of most surface water monitoring programs; Part 3 (Surface Hydrology Features) is a conceptual model describing surface water hydrologic features such as rivers, lakes, catchments and drainage networks; and Part 4 (GroundWater Markup Language 2 [GWML2]) supports the description of key hydrogeological entities such as aquifers and water wells, as well as related measurements and groundwater flows.

From 2009-2018, these water data standards were developed by the Hydrology Domain Working Group of WMO and OGC [2]. The working group develops technical solutions and standards for exchanging data describing the state and location of water resources, both above and below the ground surface. The HDWG includes representatives of member organisations of the OGC drawn from government agencies, industry, universities, and non-government organisations largely from Europe, North America, and Australasia.

Implementation and adoption of WaterML 2.0 standards is a critical next step. National Meteorological and Hydrological Services (NMHSs) in many countries have already implemented WaterML 2.0 within their national water information systems. In May 2017, the WMO Executive Council formally adopted WaterML2: Parts 1 and 2 as official standards for use by NMHSs and within the WMO Hydrological Observing System (WHOS). Adoption of GWML2 by WMO is expected in the near future.

WHOS is a portal for accessing existing online hydrological data, drawing from the water information systems of countries around the world. WHOS is being developed in two phases. The first phase already completed is a map interface on the WMO website that links to those NMHSs that make their real-time and/or historical stage and discharge data freely and openly available online [3]. The second phase is a much more comprehensive undertaking aimed at developing a complete services-oriented framework linking hydrologic data providers and users through an information system that enables data registration, data discovery, and data access. Work on phase 2 of WHOS is currently being undertaken by WMO.

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SESSION:
Earth Observations Data Cubes (EODC)

ANALYSIS READY SENTINEL DATA FOR FINNISH SPATIAL DATA PLATFORM

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Abstract

The Finnish Meteorological Institute is hosting analysis ready Sentinel 1, 2 and 3 data at the National Satellite Data Center. As part of the Finnish Spatial Data platform Sentinel data and derivative information has been produced into the common Finnish grid EPSG:3067. Sentinel 1 ground range detected data has been preprocessed and combined to a mosaic with a tuned sen1mosaic (Thanks to Sam Bowers) setup. In addition to 11 day mosaics three times a month since 2017 also the single preprocessed scenes are available to enable investigation of single measurements and time series. For Sentinel 2 the Finnish Environment Institute has produced on the Finnish Calvalus-cluster NDVI, NDBI, NDMI, NDSI and NDTI mosaics for each month and 15th to 15th day months. Sentinel 3 data are the SYNERGY combined data sets since their production at ESA. To provide a data cube capability all data is available on a public S3 http-service in addition to GeoServer OGC interfaces. Sentinel 1 and 2 data are available as cloud optimized GEoTiffs. With the help of SpatioTemporal Asset Catalogues describing and pointing to each file, the data can be queried and combined from http range requests. Web Feature Service 3.0 is also available to retrieve subsets from these assets. This data pool hopes to inspire similar efforts particularly in Arctic regions as similar assets available from other Arctic territory would enable an integrated Arctic data system.

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BIG EARTH DATACUBE SERVICES: CONCEPTS, STANDARDS, TOOLS

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Abstract

Datacubes form an enabling paradigm for serving massive spatio-temporal Earth data in an analysis-ready way by combining individual files into single, homogenized objects for easy access, extraction, analysis, and fusion - "one cube says more than a million images". In common terms, goal is to allow users to "ask any question, any time, on any size" thereby enabling them to "build their own product on the go".

In terms of standards, geo datacubes are part of the coverage concept, a unifying paradigm for spatio-temporal sensor, image (timeseries), simulation, and statistics data. The OGC coverage data and service standards suite offers a stable, implemented, and proven baseline for flexible, harmonized services - 2.5 PB Web Coverage Service (WCS) services are known, coverage analytics queries have been parallelized across 1, 000+ Amazon cloud nodes. A large, increasing number of open-source and proprietary tools support the coverage standards suite.

In this talk we present the concept of datacubes, the standards that play a role, based on the OGC datacube reference implementation, rasdaman, and further tools.

BIGDATACUBE: INTRODUCING PUBLIC/PRIVATE DATACUBE PARTNERSHIPS

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Abstract

The BigDataCube project [1] is advancing the innovative datacube paradigm, i.e., analysis-ready spatio-temporal raster data to commercial Earth Observation (EO) service federations. To this end, the European Datacube Engine (in database lingo: "Array Database System"), rasdaman, has been installed on the public German Copernicus hub, CODE-DE, as well as in the commercial cloud environment of cloudeo AG to offer datacube analytics services and to federate both, thereby demonstrating an integrated public/private service. Further data centers have joined meantime.

Started in January 2018 with a runtime of 18 months, BigDataCube has complemented the batch-oriented Hadoop service already available on CODE-DE with interactive datacube capabilities offering "any query, any time, on any size", strictly based on open geo standards and federated with other data centers. On this platform novel, specialized services can be established by third parties in a fast, flexible, and scalable manner. A special seamlessly integrated security mechanism allows access control down to the level of single pixels.

To this end, several features crucial for commercial services had to be added, such as access control (in particular in face of the automated distributed processing), quota, billing, as well as tuning to the specific cloud configuration of CODE-DE. The result shows federation of rasdaman installations on CODE-DE, cloudeo, and CreoDias; several international data centers have expressed their interest in joinin. Based on the technology platform, best practices for mixed federations are being established in preparation of extending the results of BigDataCube into a common European Datacube Federation on which individual value-adding services can rapidly be established by third parties.

BigDataCube is supported by the German Ministry for Economic Affairs and Energy.

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BUILDING A LARGE-SCALE EARTH OBSERVATIONS DATA CUBE: LESSONS LEARNED FROM THE AFRICA REGIONAL DATA CUBE (ARDC) ON AMAZON WEB SERVICES (AWS)

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Abstract

The Africa Regional Data Cube (ARDC) is a cloud-hosted system based on Open Data Cube (ODC) that harnesses the latest Earth observation and satellite technology to help Kenya, Senegal, Sierra Leone, Ghana, and Tanzania address food security as well as issues relating to agriculture, deforestation, and water access. The system was set-up, configured, and deployed by the Committee on Earth Observation Satellites (CEOS) System Engineering Office (SEO) in partnership with the Group on Earth Observations (GEO), Amazon Web Services (AWS), Strathmore University in Kenya, Office of the Deputy President - Kenya, and the Global Partnership for Sustainable Development Data (GPSDD). Earth observation data and satellite imagery assist researchers studying food security to help end hunger in Africa. The ARDC can also play a critical role in supporting refugees, internally displaced peoples, and people living in fragile or conflict-affected states.

ARDC is one of the foundational building blocks for the upcoming multi-million-dollar Digital Earth Africa (DEAfrica) initiative. DEAfrica will improve the understanding of Africa's changing landscape, providing much-needed insights, knowledge and analysis for more informed, strategic and inclusive decision-making across the continent. Building on the ARDC and the Digital Earth Australia program developed by Geoscience Australia, DEAfrica will use the ODC technology to translate more than 35 years of Earth observation satellite imagery into information and insights on the changing African landscape and coastline. DEAfrica will use the same ODC technology that underpins Digital Earth Australia and the ARDC. This project will revolutionize land planning, agriculture, security, emergency response, climate change adaptation and mitigation, mining, environment analysis, and research.

This paper presents a summary and cost analysis of our experience using Amazon Web Services (AWS) to host large volumes of multiple datasets, web-based User Interface (UI), Jupyter notebooks, and other web services for a novel mobile application. In order to provide adaptability, flexibility, scalability, and robustness, we leverage widely-adopted and well-supported technologies and the AWS Cloud platform. ARDC has empowered users by providing features that assist with streamlining data preparation, data processing, data visualization, and a wide usage of Analysis Ready Data (ARD) products in order to achieve a wide variety of Earth imaging objectives.

DATA HYPERCUBES IN ORBIT

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Abstract

The small satellite market is expected to grow towards a global value of 7 billion USD by 2022. This estimated boost is led by an increasing demand for analytical payload data processing in orbit, necessary to perform intelligent decisions and improve mission autonomy.

In November 2018, the Hyperscout project [1] successfully demonstrated the great accomplishment of having the first small satellite in orbit performing onboard image processing on data from a miniaturized hyperspectral imager. Following this success, S&T is now investing in in-orbit creation of projected hypercubes from raw data, and performance of intelligent image interpretations, such as cloud masking and land cover classification, using machine learning techniques.

Having an onboard data handling system for real-time data processing enables onboard satellite data product generation, drastic data volume reduction before downlink, in-orbit advanced analyses algorithms, across-orbit mission configuration, autonomous instrument calibration and a reactive mission planning based on intelligent derivation of information.

Within the FONDA project, the possibilities of intelligent onboard payload data processing for imaging satellites are further explored, aiming to perform end-user data analysis in orbit. This would widen the applicability of the microsatellite platform, including areas such as early warning and rapid response systems. Via FONDA, S [&]T is also investigating the use of onboard deep learning-based image processing. The goal is to perform the learning, which requires large amounts of training data and computational resources, on ground, and to only run inference on board. The project has the support of two pilot users: SSTL and Honeywell.

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1. HyperScout: Onboard Processing of Hyperspectral Imaging Data on a Nanosatellite; Small Satellites, System & Services Symposium

DCS4COP AND EODATABEE: A NOVEL EO DATA INTERACTION CAPABILITY

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Abstract

The Data Cube Service for Copernicus project (DCS4COP, EU_H2020) addresses the challenges of handling the big volumes of Copernicus data, integrating data streams from different sources and generating high-quality information. The project sets out to demonstrate and establish a novel service for the value-adding Earth Observation industry: the EODataBee service.

The DCS4COP objectives are

To provide a novel service to intermediate business users.

To exploit the scientific excellence of precursor projects.

To develop and stablish a DataCube environment for Copernicus data.

To exploit European EO infrastructure.

To prepare a comprehensive service portfolio.

To integrate the services into user's workflows.

To consolidate the commercial cooperation framework.

To establish the self-sustained business.

DCS4COP wants to demonstrate, first, the value of EO data for the market segment of coastal and inland water services, capitalising on the vast experience of the DCS4COP team in water quality, which ensures the high quality of the environmental information service. The project will also evaluate other thematic areas for the long-term plan and business expansion of the service, like atmosphere, land or emergency.

EODataBee service model

EODataBee will be a commercial service with a portfolio comprising a great variety of environmental information layers, easy-to-integrate user interfaces and applications, tailored trainings and consultancy services. This will be offered as a Platform as a Service (PaaS) or Software as a Service (SaaS) to intermediate business users acting on the market of environmental information products and services.

EODatabee will offer individual solutions tailored to customer requirements, allowing users to detail the specific thematic, geographical and temporal requirements while offering great flexibility with respect to the technical infrastructure and user-defined processing. The service will cover a large part of the EO value chain and will seamlessly integrate environmental data from other sources.

It will enable user (1) who already provide services to end users to add additional spatial information layers to their portfolio and to optimise their production process in terms of efficiency and costs; and (2) who are not yet on the market to enter this market at a very low entry level and with high-quality services right from the start.

EODataBee is a novel capability to ease the integration, preparation and processing of numerous data sources for EO downstream applications.

EOXCLOUDLESS - EXPLOITATION READY SATELLITE IMAGERY, SOURCE DATA FOR VIEWING AND ANALYSIS

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Abstract

The EOxCloudless product family [1] provides off-the-shelf or custom tailored mosaics free of clouds as Data Cubes. In its simplest form the mosaics are provided as numerous GeoTIFFs in a pyramid structure following the WMTS tilematrixset definition (see [2] for details). Off-the-shelf mosaics contain 4 bands (8- or 16-bits) but custom mosaics may include any number of bands as well as potentially a metadata band allowing tracing back to individual input satellite images on a per-pixel basis. The cloud removal algorithms, optimized for viewing or analysis, are easily adjustable to input data from multiple satellite platforms/sensors and to run on any conventional cloud provider and perform additional custom functions via a python interface.

The provided GeoTIFFs can be loaded in a simple HTTP server or a more complex server software like the Open Data Cube. The Open Source library geotiff.js [3] for example allows exploration and analysis of GeoTIFFs directly in the browser like shown in the COG-Explorer [4] demonstration.

Sentinel-2 cloudless [5] is the global visualization product of EOxCloudess. It is a yearly series of global sunny homogeneous 10m satellite maps. It combines trillions of pixels collected during differing weather conditions over a whole year and merges them into a mosaic, almost free from atmospheric impacts. The mosaics are freely provided via Web Map Tile Service (WMTS) as well as Web Map Service (WMS) under a Creative Commons license (2016 CC-BY; newer CC-BY-NC-SA).

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IN A NUTSHELL: THE MIRACULOUS WORLD OF COVERAGES

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Abstract

The concept of coverages as a unifying paradigm for spatio-temporal sensor, image (timeseries), simulation, and statistics data is recognized as a corner stone for interoperable services in INSPIRE and beyond. The OGC coverage data and service standards offers a stable, implemented, and proven baseline for flexible, harmonized services - 2.5 PB Web Coverage Service (WCS) services are known, coverage analytics queries have been parallelized across 1, 000+ Amazon cloud nodes. Many open-source and proprietary tools support the coverage standards suite.

However, due to the dynamic nature of the field - standards evolve due to technical insights gained, new tools start promoting their individual visions - it has become less than trivial recently to understand terms, trends, standards, and how they relate, differ, or agree.

In this talk, we give a condensed overview of the coverage landscape. We focus not on technical depth, but on relating different concepts and standards published recently. Goal is to enable the audience to correlate OGC, ISO, and other work and be aware of recent harmonization efforts. The presentation is based on our many years of work on coverage standardization in OGC, ISO, and INSPIRE and as editor of the larger part of these standards

INTRODUCING THE DATA CUBE FACILITY SERVICE – TOWARDS A TURNKEY SOLUTION TO EARTH OBSERVATION DATA USE CASES

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Abstract

The amount of available data from Earth Observation has been growing exponentially in recent years, shifting the challenge from lacking data availability towards the determination of an efficient exploitation strategy for huge data set. The classic approach of downloading data and processing at user infrastructure is thus more and more replaced by data local solutions on powerful cloud infrastructures. The required expertise to fully reap the benefits from today's opportunities in EO includes aspects of thematic processing, data science, sensors, cloud infrastructure, and value-adding – and easily overwhelms many potential users, particularly non EO experts.

The Data Cube Facility Service (DCFS) is a commercial activity initially funded by ESA that aims at reducing the required expertise for users of different backgrounds as much as possible and enabling them to effectively work with the included environmental information at minimum cost and effort by offering not only the data but also the required infrastructure and tools to efficiently access, analyse, and process them. To this end, DCFS will offer a wide range of EO data from different sensors including the global and full archive of Sentinel-1 GRD, Sentinel-2 (L1C and L2A), Sentinel-3 OLCI and SLSTR, Sentinel-5P, Landsat-8, Envisat MERIS, MODIS, the European archive of Landsat-5, 7, 8 and commercial data from PlanetScope, as raw sensor data or higher level thematic data, in data cubes, i.e. in regular N-dimensional arrays.

The service will offer seamless access to entire archives of sensor data through standard interfaces or in standard file formats. The service allows processing from raw sensor data to thematic data, and DCFS data cubes will establish a common grid by re-projection and resampling and allow for instant access through all dimensions including time and variable dimensions. DCFS will hence offer Analysis Ready Data (ARD) for a wide range of applications that can be tailored by users according to their specific needs. The service will guide the user through the decision process with respect to technical aspects like the infrastructure set-up and the trade-off between on-the-fly processing and pre-processing of entire data cubes. Users may develop their own processing work flows on data cubes via common APIs including OGC interfaces to generate value-added downstream products.

The DCFS offer is complemented by sophisticated user and access rights management and a market place that allows users to share their value-added products with others or even commercialize them. DCFS will commence its operations in the first half of 2020 and has the ambition to attract potential users with state-of-the art technological solutions at industry-leading prices.

NEXT GENERATION DATACUBE SERVICE BASED ON CLOUD-NATIVE ARCHITECTURE

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Abstract

In the past, infrastructure limitations mandated that if one wants to do efficient analysis on EO data, one needs to pre-process it to the common structure – create so called "DataCube". This pre-processing usually involves re-gridding, re-projection and some more advanced steps such as atmospheric correction, orthorectification, etc. This step is costly, both from processing as well as storage perspective as it commonly required replication of data. One can leverage parallel processing in a way to eliminate additional storage, but overall costs remain. These limitations commonly result in reduced data coverage, either spatial (e.g. country instead of world) or temporal (only one year). Another disadvantage of this approach is inflexibility – whenever an improvement in the process is implemented, one has to re-process complete archive.

Nowadays, with cloud infrastructure rampant and cloud-optimized data formats appearing, the term "DataCube" is losing relevance. Or rather, it is shifting one layer down – to individual scenes. Cloud-optimized GeoTiff (COG) has all necessary elements of the data cube – internal tiling, overview layers, location data in the header, etc. Sentinel-2 native JP2000 contains a pyramid (based on wavelet transform) as well, and NetCDF/HDF format also. Match this fact with recent "standards" to process data to L2A on ground segment level (e.g. ESA) and having data available on the cloud (DIAS, AWS, GCP, etc.) and what one data analysts needs is a "data driver" rather than "DataCube". Due to different formats of the data, meta-data and other specifics, it is inconvenient for a random user to access it in an efficient manner. The task of the "DataCube operator" is therefore to adapt their data access engine to various data sources rather than to pre-process these data sources to match their processing engine.

A technical solution demonstrating above described approach is Sentinel Hub, which is around for a bit longer than two years now, more or less as long as Sentinel-2 is operational. It is used by hundreds of applications and tens of thousands of end-users, processing more than two million requests per day. Average response time is 0.7 seconds, which is more than fast enough for vast majority of users. In this time Sentinel Hub executes all the typical DataCube steps - find relevant scenes addressing user's request, read necessary data, re-project and re-grid to specified parameters, create a composite or statistical analysis, etc. Data access interfaces are compliant with commonly used OGC standards (WMS, WCS, WMTS, etc.) so that it is easy for users to integrate these in their existing environments.

We will present how Sentinel Hub is handling federation approach, running on various platforms in parallel (AWS, Mundi, CreoDIAS, ONDA), long time-series analysis, how annual cloudless mosaic can be created ad-hoc and how it is possible to engage data fusion to combine various data sources, e.g. performing on-the-fly orthorectification of Sentinel-1 GRD data.

Special focus will be put on lessons learned, providing guidance on good and not as good examples of existing data structure, most commonly used functionality by end-users, limitations of existing standards and how to work around them as well as some thoughts on possible business models and how one benefits best with open-source approach.

OGC GEOSPATIAL DATA CUBE COMMUNITY PRACTICE

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Abstract

Data cubes for geospatial information provide the means to integrate observations and other types of geospatial data for use in multiple applications through simplified access and efficient analytics. The OGC Community Practice defines requirements that a Data Cube implementation needs to meet to be compliant with the practice. The requirements are groups into a core set to be satisfied by all Geospatial Data Cubes and other sets for extensions beyond the core.This Community Practice documents aspects of operational systems that are agreed by the OGC members to be requirements for Geospatial Data Cubes. It draws from the operational systems as listed in the references section including:

- OpenDataCube (Previously Australian Geoscience Data Cube)
- EarthServer-2 project
- Rasdaman
- EOX Sentinel-2 cloudless
- Advanced geospatial Data Management platform (ADAM)
- Sentinel Hub
- ESA EO Data Cube Facility

With this paper and other activities, OGC is contributing to the advancement of Geospatial Data Cubes and their interoperability. A recent US NGAC Task Team made this recommendation.

OPEN DATA CUBE (ODC) BENCHMARKING: APPROACHES, CHALLENGES, AND EXPERIENCE

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Abstract

The Open Data Cube (ODC) is an open source solution for accessing, managing, and analyzing large quantities of Geographic Information System (GIS) data - namely Earth observation (EO) data. It presents a common analytical framework composed of a series of data structures and tools which facilitate the organization and analysis of large gridded data collections. ODC was developed for the analysis of temporally-rich earth observation data, however the flexibility of the platform also allows other gridded data collections to be included and analyzed. Such data may include elevation models, geophysical grids, interpolated surfaces and model outputs. A key characteristic of ODC is that every unique observation is kept, which contrasts with many other methods used to handle large gridded data collections. ODC has seen a rapidly growing user community recently. This community is faced with the challenge of adopting best practice in the Earth Observation (EO) data analysis processes. To identify best practice, it is necessary to measure the performance of data storage and retrieval methods. We seek to accomplish this through setting up a performance benchmarking framework to span various data storage and retrieval methods. This paper describes the three such cases that we use: (1) identifying dimensions of performance; (2) defining generic analysis processes and subprocesses; and (3) defining performance indicators for each process and sub-process along each dimension of measurement. The well-known Committee on Earth Observation Satellites (CEOS) Data Cubes and Africa Regional Data Cube (ARDC) were used to apply the performance benchmarking methodology. The paper outlines the set-up and functioning of the framework. Finally, the comparison matrix necessary to study such a methodology is described. The paper outlines a feasible approach for setting up a performance benchmarking framework either on a regional, national or continental level.

REALTIME PLANETARY-SCALE DATACUBE FUSION

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Abstract

The datacube model has rapidly gained acceptance as a cornerstone for analysis-ready data, and also the corresponding service model which is more powerful, but easier to use than existing API-based interfaces. Mature and widely adopted datacube standards show the way how datacube functionality can be presented to clients, be they human or m2m connections. Specifically, the OGC Coverage Implementation Schema (CIS) data model and the Web Coverage Service (WCS) service model suite define a framework adopted by the main open-source as well as proprietary tools, including MapServer, GeoServer, GDAL, QGIS, ArcGIS, and python/OWSlib.

While the basic, most widely used functionality includes access, possibly extraction, and reformatting of a data sub(set) for download, processing and in particular data fusion represent complex, resource-intensive challenges. In the WCS suite this is addressed through a concept of modularity where WCS Core (which is mandatory for any WCS to implement) offers the GetCoverage request to accomplish “give me part of this spatio-temporal coverage, in my favourite format” and (optionally implementable) extensions add further functionality facets, up to the spatio-temporal datacube analytics language, Web Coverage Processing Service (WCPS) 5.

For example, computing the NVDI over Europe, on the 1st of July 2018, using Sentinel data stored in a datacube with the same name, and returning the result as a NetCDF file, can be achieved with the following WCPS query:

```
for $c in (Sentinel)
return encode(

(($c.nir – $c.red) / ($c.nir + $c.red))

[ Lat(35:70),
 Long(10:40),
 time(“2018-07-01”)
 ],

“image/tiff”
)
```

As WCPS allows combination of datasets (“joins” in database terminology) the question arises: what if datacubes to be combined reside on different computers (cloud scenario), or even in different data centers (federation scenario)? A suboptimal implementation obviously could cause massively degraded performance.

In this contribution we present federation methods implemented in the rasdaman datacube engine which is accepted technology leader, standards driver, and reference implementation for datacubes.

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THE IMPLEMENTATION OF OGC VISION OF DATA CUBES IN EARTHCUBE CYBERWAY

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Abstract

In the computer science term, a data cube is referred to a multi-dimensional array of values, such as time series of image data, which is massively larger than hosting computer's main memory. In the Earth observation domain, the data cube concept has been extended to refer to a system that manages multi-dimensional array of Earth observation data and provide system users access and analytic capability to the data. In the past several years, there have been multiple data cube implementations for time-series remote sensing images. For example, Geoscience Australia developed a data cube system for Earth observation data that tiles time-series satellite images into small tiles, arranges them with temporal-priority access in the data storage, and provide visualization and analysis to the data [1]. In order to provide guidelines on future data cube implementation and facilitate the interoperability of data and functionalities among the data cub systems, the Open Geospatial Consortium developed a draft white paper, entitled "Geospatial Data Cube Community Practice" [2]. The white paper describes the OGC vision of data cubes that handle geospatial data, the geospatial data cubes. It lists a set of core and optional requirements on information model, data preparation, data analytics, and interoperability for implementing a geospatial data cube. Although currently it is a draft, the document is expected to become an official OGC guideline soon. On the other hand, EarthCube is a community-driven NSF Geoscience Program for building cyberinfrastructure to support geoscience research [3]. EarthCube program has funded a set of components and system integration projects to develop the cyberinfrastructure. One of the system integration projects is CyberWay, which integrates the capabilities and systems of multiple existing EarthCube building blocks to support Earth science research, particularly, the Earth system modeling. Satellite remote sensing data is one of major data sources in CyberWay to support Earth system modeling. The capabilities described in the OGC document are what modeling community needs. Therefore, CyberWay has been implemented with data cube capabilities described in the draft OGC document. This presentation describes the general concept on data cubes, the OGC vision and requirements of geospatial data cubes, approaches to implement the vision of OGC geospatial data cubes in CyberWay to support Earth system modeling, the experience and lessens-learned from the implementation, and suggestion for improvement on both the white paper and the implementation.

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THE SWISS DATA CUBE : EARTH OBSERVATIONS FOR MONITORING SWITZERLAND'S ENVIRONMENT IN SPACE AND TIME

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Abstract

The key to sustainable development is achieving a balance between the exploitation of natural resources for socioeconomic development, and maintaining ecosystem services that are critical to human's wellbeing and livelihoods. Some of these environmental issues can be monitored using remotely-sensed Earth Observations (EO) data that are increasingly available from freely and openly accessible repositories. However, the full information potential of EO data has not been yet realized. They remain still underutilized mainly because of their complexity, increasing volume, and the lack of efficient processing capabilities.

The Swiss Data Cube (SDC) is a new paradigm revolutionizing the way users can interact with EO data. It lowers the barrier caused by Big Data challenges (e.g., Volume, Velocity, Variety) and provides access to large spatiotemporal data in an analysis ready format. It significantly reduces the time and scientific knowledge required to access and prepare EO data having consistent and spatially aligned calibrated surface reflectance observations.

Switzerland is the second country in the world, after Australia, to have a national-scale Data Cube. Currently, the SDC holds 34 years of Landsat 5, 7, 8 (1984-2018) and 3 years of Sentinel-2 (2015-2018) Analysis Ready Data (ARD) over Switzerland. Sentinel-1 data will be added at the beginning of 2019.

We will present how the SDC is used to monitor environmental changes across the country and can enable more effective responses to problems of national and regional significance. The SDC can provide the long baseline required to determine trends, define present, and inform future.

TIME SERIES EXPLORATION TOOLS FOR EARTH OBSERVATION HERITAGE MISSIONS AND BEYOND

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Abstract

With the launch of new generation satellite missions the need to access historical Earth Observation (EO) data series has strongly increased, particularly for long-term science and environmental monitoring applications. This trend is driving users to request time-series of data spanning 20 years and more, likely to increase even more in the future, in particular regarding the growing interest on global change monitoring and policy makers decisions on the observed changes particularly in the climate system (atmosphere, ocean, cryosphere, carbon and other biogeochemical cycles, sea levels).

The content of EO data archives is extending from a few years to decades and therefore, their value as a scientific time-series is continuously increasing. The advances in satellite sensor characteristics (spatial resolution, temporal frequency, spectral sensors) as well as in all related technical aspects (data and metadata format, storage, infrastructures) underline the strong need to preserve the EO space data without time constraints and to keep them accessible and exploitable, as they constitute a humankind asset. Dedicated activities are carried out at ESA in the frame of the Heritage Data Programme, for the generation of long time series of coherent data through curation of heritage missions in alignment and continuity with current and future missions.

As part of the European Space Agency activities, multi-mission ground systems are operated to acquire, process, archive and distribute data from ESA Missions, including the Heritage Missions, as well as the Third-Party Missions under specific agreements with international partners (e.g. NASA, JAXA) and commercial data owners. ESA EO data dissemination services have been designed, according to internationally recognized standards and best practices (e.g. CEOS, OGC) to provide reliable services to support both interactive access (e.g. web client to explore data catalogues) and automated access (e.g. via API and machine-to-machine interfaces for automated access to the data).

To ensure, enhance and facilitate discovery and access of ESA space heritage data (and associated information holdings) by a broader community of users, the Heritage Data Programme supports pilot initiatives to assess innovative tools and services. The ESA PDGS Data Cube has demonstrated the effectiveness of the new paradigm aiming at pulling out the full potential of EO data providing pixel-based access to large spatio-temporal data stored in the ESA dissemination services and enabling on-the-fly analysis-ready form. Systematic and regular provision of Analysis Ready Data (ARD) significantly reduces the burden on EO data users.

This paper describes the ESA PDGS Data Cube platform and relevant functionalities implemented to facilitate exploration and delivery of Heritage Mission (HM), Earth Explorer (EE) and Third-Party Mission (TPM) data in its native context of a virtual globe via any standard Internet browser.

USING DATA CUBES AND JUPYTER NOTEBOOKS IN DOCKER CONTAINERS TO TEACH BIG EARTH DATA

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Abstract

The Copernicus Master in Digital Earth is a two-year, full-time, integrated Erasmus Mundus Joint Master Degree offered by the Universities of Salzburg, Bretagne Sud, and Olomouc with the goal to provide up-to-date and high-level education for Master students (https://cde.sbg.ac.at/). Preparing students for increased requirements in the operational Earth observation (EO) domain and teaching them big Earth data in this context plays an important role in future education, but also challenges traditional ways of teaching.

Here, we endeavour to employ free and if possible, open source technology to create a secure and scalable environment, in which students can acquire theoretical knowledge, but are also allowed to perform hands-on tasks in EO data cubes. The requirements for such a classroom setting can be summarised as follows:

- every student has their own environment (instance) where they can work during the whole semester
- each instance provides exactly the same initial setting for every student
- the instances are secure from a technical point of view, but allow students to explore and perform a variety of analysis possibilities on their own
- the number of instances is scalable to any number of students, assuming available hardware capabilities are available
- no manual cost for setting up any number of instances
- no interference between the individual instances
- data, output and code, developed and generated by students, are persistent during the whole semester, but are automatically wiped once the class is completed
- easy maintenance of teaching material

The solution and technology stack we employ is based on Docker containers, where each container runs its own instance of an Open Data Cube (ODC) in conjunction with a Jupyter notebook. Therefore, a Docker container is started for each student where the data is persistently stored outside of the Docker container. Once the Docker container is running, a script populates the ODC with pre-defined satellite data (here: Sentinel-2), pulls the most up-to-date teaching materials (e.g. multiple Jupyter notebooks) from a dedicated GitHub repository and starts the Jupyter notebook server. Each Docker container is accessible from a different port and protected by a password.

Several Jupyter notebooks provide theoretical background knowledge and code to the students. They are organised as tutorials for the following topics and more under development:

- Tutorial 1: What is a data cube?
- Tutorial 2: Retrieving data from data cubes
- Tutorial 3: Time series analysis
- Tutorial 4: Creating RGB images and maps
- Tutorial 5-n: Problem oriented sample use cases from different application domains

This setup is able to meet the previously listed requirements and provides a state-of-the-art teaching environment in the area of data cubes. The concept allows maintenance and further development without requiring changes to the Docker set-up due to the separation of Docker set-up, data, and tutorials. The newest version of the Jupyter notebooks (i.e. tutorials) is always pulled from GitHub upon launch, including any recent changes made by educators. Our solution allows students to play around with their own data cube in a safe environment that can be rebuilt to the original state any time.

SESSION:
Hyperspectral Remote Sensing

AHSI: THE HYPERSPECTRAL IMAGER ON CHINESE GF-5 SATELLITE

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Abstract

Hyperspectral imaging technology provides high spectral resolution information of the objects on the earth. Hyperion [1] and CHRIS [2] have been the main sources of space-borne hyperspectral data in the past few decades. However, the quality and quantity of the data cannot totally meet the challenging requirements of various applications. We design and develop a visible and short-wave infrared hyperspectral imager, i.e. the Advanced Hyperspectral Imager (AHSI), which is one of the six payloads on Chinese GF-5 satellite launched on May 9th, 2018. AHSI is the first space-borne hyperspectral sensor that utilizes both the convex grating spectrophotometry and an improved three-concentric-mirror (Offner) configuration. It has a spectral range of 400-2500 nm, with the spectral resolutions of 5 nm in VNIR (visible /near-infrared), and 10 nm in SWIR (short-wave infrared), respectively. The swath width is 60 km, and spatial resolution is 30 m. This study introduces the design and imaging principle as well as the technical breakthroughs, prelaunch performance of AHSI. Results show that AHSI has competitive performance comparing to other spaceborne hyperspectral imagers to be launched in the next few years, such as EnMAP of Germany [3], HISUI of Japan [4], and PRISMA of Italy [5]. The AHSI has outstanding capability of detecting and identifying different ground objects and will benefits many realistic applications in environment monitoring, land resources exploration, disaster monitoring, precision agriculture, forestry survey, urban planning, and so on.

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APPLICATION OF CHINESE NEW GENERATION HYPERSPECTRAL SATELLITE IN MONITORING OF INLAND WATER QUALITY

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Abstract

China successfully launched the GF5 satellite on May 9, 2018. It is equipped with six earth-observing payloads, including an Advanced Hyperspectral Imager (AHSI). AHSI can acquire 330 spectral bands in the spectral range from visible to short-wave infrared (400 ~ 2500nm), with spectral resolution of 5 nm in visible and near-infrared bands, and 10 nm in short-wave infrared bands. Such many hyperspectral visible and near-infrared bands are quite useful in retrieving of water quality parameters in optically complex inland waters, and the short-wave infrared bands are also important for atmospheric correction of highly turbid inland waters. Besides, AHSI can acquire images with 60 km width and 30 m spatial resolution, so it has great potential in inland water monitoring. We used a scene of GF5-AHSI image covering Taihu Lake to test the potential of GF5-AHSI in inland water quality monitoring. Firstly, we evaluated the signal-to-noise ratio (SNR) of each band, and found that the SNRs are more than 300, 100, and 60 in visible, near infrared, and short infrared bands (at 1250, 1650nm), respectively. These SNRs meet the basic needs of inland water quality parameter inversion and atmospheric correction. Then, we extracted the distribution of aquatic plants and cyanobacteria blooms. Finally, we used the non-aquatic plants and non-cyanobacteria blooms area to retrieve chlorophyll-a and suspended particulate matter. The preliminary results show that GF5-AHSI can be well applied to monitor inland water quality.

ESTIMATION OF WINTER WHEAT LEAF AREA INDEX AT DIFFERENT GROWTH STAGES USING OPTIMIZED RED-EDGE HYPERSPECTRAL VEGETATION INDICES

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Abstract

Leaf area index (LAI), as one of the most important indicators in vegetation growth monitoring, has been used widely in crop growth monitoring and yield estimation. The characteristics of crop varied with phenological changes and consequently resulted in LAI variation. Previous studies focused on LAI retrieval for whole growth stages, this study inversed LAI at five main growth stages using widely-accepted vegetation indices and optimized red-edge hyperspectral vegetation indices. The main objectives of this study are:1) to distinguish the most relative red edge wavelengths in estimating LAI for distinct growth stages; 2) to find the suitable index for growth stages. The results show that LAI retrieval at various growth stages have distinct results. The best fitted indices vary at different growth stages. Most vegetation indices show best performance in milky stage because leaves rise to maximum in this stage which benefits to inverse LAI. Red-edge based indices have better relationships with LAI. Indices using 740nm are capable to inverse LAI during stem elongation, anthesis and milk development stages. Indices with 705 nm showed better results in jointing and ripening stages. The results indicate that:1) specific indices for distinct stages leads to better results than using single index for all stages; 2) indices with red-edge are capable to inverse LAI and optimal wavelength varied for distinct growth stages. The rational assumptions and reasons are discussed and analyzed in this paper from the perspective of characteristics of winter wheat at different growth stages and the mechanisms of vegetation indices. The conclusion drawn from this paper provided a new thought in LAI retrieval and crop growth dynamic monitoring.

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EVALUATION AND VALIDATION OF GF-5/AHSI FOR MINERAL MAPPING

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Abstract

Mapping surface mineralogy using hyperspectral imaging (HSI) provides an opportunity to improve initial steps of mineral exploration. The spectral range covering from 0.4 to 2.5 μm provides abundant information about many important Earth-surface minerals. Chinese Gaofen-5 (GF-5) Advanced Hyperspectral Imager (AHSI) sensor, launched on 9 May 2018, gives us an opportunity to evaluate short-wave-infrared (SWIR) spaceborne hyperspectral capabilities for mineral mapping besides EO-1 Hyperion sensor of NASA, USA. AHSI covers the 0.4 to 2.5 μm spectral range with 330 spectral bands at approximately 4 nm spectral resolution in VNIR spectral range and 8 nm spectral resolution in SWIR spectral range, and has 30m spatial resolution over a 60 km-wide swath. This study evaluates the mineral mapping performance of the GF-5 AHSI data using spectral matching and unmixing methods, and comparing its performance with the EO-1 Hyperion. The mean mineral mapping accuracy with GF-5 AHSI data is greatly improved especially for the minerals which absorption position is near to 2.4μm such as calcite. The results illustrate that the GF-5 AHSI has better capacity for mineral mapping than EO-1 Hyperion.

GF-5 HYPERSPECTRAL IMAGE ENHANCEMENT USING SPARSE TENSOR ROBUST PRINCIPAL COMPONENT ANALYSIS FOR FINE CLASSIFICATION OF COASTAL WETLANDS IN YELLOW RIVER ESTUARY, CHINA

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Abstract

On May 9th, 2018, China successfully Launched Gaofen (GF)-5 satellite, which takes an advanced hyperspectral sensor that collects fine spectral data of ground objects using 330 bands from 400 nm to 2450 nm and 30 m spatial resolutions. The GF-5 hyperspectral images would greatly benefit fine surveying and monitoring works of natural resources in China, e.g., coastal wetlands. Unfortunately, the data quality of hyperspectral imagery is still restricted by the hardware technique of imaging spectrometer on the satellite, although the GF-5 hyperspectral imaging techniques have been greatly optimized and improved by many specific schemes. Some big noise or outliers inevitably exist in the image scene, which degrades the application performance of GF-5 hyperspectral images. Therefore, we utilize sparse tensor robust principal component analysis (STRPCA) to eliminate the big noise or outliers from the images and enhance the data quality of GF-5 hyperspectral data. The STRPCA considers the data cube feature of hyperspectral imagery, and assumes the big noises or outliers are few in the image while the clean hyperspectral data with main information is low-rank. The method decomposes the 3-order HSI tensor into a low-rank tensor and a sparse tensor, where the sparse tensor takes gross errors and noise of spectral signals. Moreover, we implement the GF-5 hyperspectral data of coastal wetlands in Yellow River Estuary, China to design experiments to verify the performance of STRPCA. The classification maps between enhanced image with STRPCA and original GF-5 data, together with results from other state-of-the-art methods are compared in the experiments. Experiments results show that the STRPCA could successfully remove big noise and outliers in the GF-5 image and greatly promote the classification accuracy of hyperspectral data. Moreover, the STRPCA outperforms other state-of-the-art methods in the image enhancement of GF-5 hyperspectral data.

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GF5-BASED WATER QUALITY MONITORING OF CHINA EAST DONGTING LAKE

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Abstract

The Gaofen-5 (GF5), a Chinese civilian remote sensing satellite carrying six high-spectral-resolution Earth-observing instruments, was launched at Taiyuan Satellite Launch Center on June 9th , 2018. The GF5 was designed to detect different kinds of environments, including inland waters. In this study, we used GF5-AHSI (Advanced Hyperspectral Imager) products to monitor the water quality of East Dongting Lake in winter and by the way tested the ability of GF-5 to estimate inland waters quality. By using atmospheric correction, radiometric correction and MNDWI, the Level-L1 products of GF-5-AHSI is preprocessed to obtain the water surface spectral reflectance which was ideal enough for retrieving water quality parameters. Through analyzing the obtained spectral reflectance, we calibrated our empirical models for retrieving the water quality parameters including chlorophyll a (Chl-a) concentration, total suspended matter (TSM) concentration, transparency (Secchi disk depth: SDD) and eutrophication levels. As a result, the Chl-a was up to 39.8 ug/L, the TSM was up to 53.6 mg/L, the SDD was up to 0.65m and the lake almost arrived at moderate eutrophication. We compared the four derived parameters with some previous research of East Dongting Lake and the comparison showed that they were consistent. In addition, the spatial distribution maps of the water quality parameters created by ArcGis indicated that the distribution rules of the four parameters were different between southern East Dongting Lake and northern East Dongting Lake, respectively. Chl-a concentration, TSM concentration, and SDD in the southern lake varied with the distance from the shore to the center while the spatial variation of the three parameters in the northern lake were not obvious. Moreover, the northern TSM concentration was higher than the southern one while the northern Chl-a concentration and SDD were lower than the southern ones. This study preliminarily confirmed the potential of GF5-AHSI images in retrieving water quality parameters and could provide some useful information for the local environmental protection departments and Dongting Lake researchers.

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HIGHLIGHTS ON THE HYPERSPECTRAL PRISMA MISSION: PLANNED AND ONGOING SCIENTIFIC ACTIVITIES

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Abstract

On March 2019 the PRecursore IperSpettrale della Missione Applicativa - PRISMA will be launched with the Vega vector on a sun-synchronous orbit at 620km. The PRISMA mission was fully developed by the Italian Space Agency (ASI). The mission combines two payloads: a hyperspectral and a panchromatic camera [1].

An overview of the PRISMA mission characteristics through the first images and the planned three years Cal/Val activities will be presented.

The PRISMA hyperspectral payload is a pushbroom scanner covering the full range (VNIR-SWIR) from 400 to 2500nm with 239 spectral bands at a spatial resolution of 30 m with a swath of 30 km, while the panchromatic camera provides 5m pixel images co-registered with hyperspectral imagery. PRISMA is a prism spectrometer and it is characterized by a variable bandwidth across the nominal spectral range, nevertheless the band width is less than 12nm (i.e. between 7.3 and 11.04nm). The PRISMA coverage is global with a 29 days (orbit repeat period), while the revisit time on a specific area of interest is of 7 days thanks to the off-nadir angle of about 18°.

After the end of the commission phase (scheduled for June 2019), it is foreseen a structured three years CAL/VAL activity, which will be performed on scattered instrumented sites in Italy. The test sites have been selected according to the peculiar thematic areas of interest [2] for the mission (e.g., topsoil characteristics, vegetation biophysical parameter retrieval, snow and coastal waters), moreover international test site are still under definition. The Cal/Val activities includes: airborne surveys with VNIR-SWIR scanner eventually coupled with thermal LWIR multispectral data, field activities contemporary to the PRISMA acquisitions. CAL/VAL activities will be planned in synergy with ESA (i.e. Fluorescence Explorer –FLEX and the CHIME hyperspectral missions) and the actual ASI missions' development (hyperspectral mission SHALOM).

Moreover, the PRISMA acquisition plan will be presented to strengthen the ongoing collaborations between the Authors and the RADI Chinese colleagues in the framework of the active international collaborations programs. The opportunity to foster a synergy between the Italian PRISMA and the Chinese Gaofen-5 missions, in order to increase the possibility to have more consistent hyperspectral time series suitable to monitor environmental processes such as the plant phenology.

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LEAF AREA INDEX INVERSION BY CONSIDERING THE ANISOTROPIC FEATURES OF DIFFERENT WHEAT VARIETIES

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Abstract

Wheat geometry structure induces variations in spatial distribution of the canopy and problems in the inversion process of biophysical and biochemical variables. As a function of wavelength, illumination-viewing geometries and canopy structure, canopy bidirectional reflectance can characterize canopy anisotropy feature theoretically [1]. In order to demonstrate the above theory this study explored Bidirectional Reflectance Distribution Function (BRDF) features of erective variety Jing411 and loose variety Zhongyou9507 by analyzing bidirectional NDVI、inversed BRDF model parameters and six BRDF shape indictors in red band(680nm)and NIR band(800nm) based on the semi-empirical BRDF kernel driven model. The results showed the NDVI of both erective and loose variety show explicit anisotropy and the bidirectional reflectance of two varieties behaves differently in two bands which are mainly ascribed to spatial distribution of wheat canopy, wavelengths, and illumination-viewing geometries and observing noise. Finally it is concluded wheat canopy in red band exhibits stronger surface scattering that is geometric effect and in NIR band shows stronger volumetric scattering that is volumetric effect. In terms of wheat variety, geometric weight、ANIF and ANIX of erective variety are greater than that of loose variety in red band, and AFXR is less than which indicates a stronger geometric effect for erective wheat. In NIR band, volumetric weight and AFX of loose variety are greater than that of erective variety, indicating a stronger volumetric effect for loose wheat. Therefore multi-angle observations are feasible and applicable enough to characterize wheat canopy anisotropic features [2].

Directional observations, taking the form of BRDF shape indicators, were employed to detect canopy BRDF features for erective variety Jing411 and horizontal variety Zhongyou 9507. It is concluded that: i) wheat canopy in red band shows prominent geometric effect with a hotspot in backward scattering direction, resulting in the strong anisotropy of NDVI; ii) the erective wheat presents stronger geometric effect in red band than loose wheat, and loose variety displays higher volumetric effect in NIR band than the erective variety. This information is considerably helpful to estimate the canopy biophysical and biochemical variables with multi-spectral and multi-angle remote sensing data.

Because of the experiment condition limitation, the satellite remote sensing data was absent. Further research on large scale combined airborne remote sensing and ground observation is needed to validate the above conclusion.

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OPTIMAL HYPERSPECTRAL VEGETATION INDICES FOR WINTER WHEAT FUSARIUM HEAD BLIGHT DETECTION IN CANOPY SCALE

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Abstract

Rapid and non-destructive detection of winter wheat Fusarium head blight is important for disease control. Hyperspectral remote sensing has shown potential for the detection of wheat disease, and many hyperspectral features have been developed to detect disease, such as derivative spectral features, continuous removal transformed spectral features and hyperspectral vegetation indices (VIs). This study aims to analyze the spectral reflectance of the wheat canopy in the range of 350–1000 nm and to find the optimal hyperspectral features for Fusarium head blight detection at Zadoks stage 65 (anthesis stage) and Zadoks stage 75 (milk stage). Reflectance within the range of 434—681nm were found sensitive to Fusarium head blight in Zadoks stage 65, while 724—1000nm sensitive in Zadoks stage 75. Hyperspectral VIs with these sensitive wavebands were examined and compared for the detection of Fusarium head blight using partial least square regression (PLSR). The results showed that, the optimal hyperspectral VI for Fusarium head blight detection was Structure Intensive Pigment Index (SIPI) in Zadoks stage 65, with R2 as 0.53, and Triangular vegetation index (TVI) in Zadoks stage 75 with R2 as 0.64. The reason of SIPI's good performance for Fusarium head blight detection in Zadoks stage 65 was that SIPI could extract the pigment changing features, which were sensitive to disease infection at this stage. While TVI's good performance in Zadoks stage 75 was due to the chlorophyll destruction and wheat ear tissue shortage caused by the infection of Fusarium head blight, which led to an increase of red reflectance and a decrease of NIR reflectance. Our results demonstrated that hyperspectral VI was a quick and effective way for Fusarium head blight detection at canopy scale.

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THE PAVIA TEST SITE: A COMPARISON OF AIRBORNE AND SATELLITE DATA SETS

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Abstract

This paper describes the first results of hyperspectral processing and change detection analysis on the well-known Pavia hyperspectral test site between the airborne data acquired by DAIS and ROSIS sensors in 2002 [1] and the spaceborne GaoFen-5 sensor in 2018.

1. The analysis of the recently acqured satellite dat at 30 m spatial resolution is based on a preliminary chain that includes:
2. the definition of the material that are present on the ground according to a revised legend with respect to the one available for the 2002 airborne DAIS data, rwocniling the university area wut the city centre one;
3. the selection of suitable endmembers by means of a combined analysis of the data and the spectra for the selected material as available from (on-line) respositories of urban materials;
4. the extraction of abundance maps using suitable linear [2] and non-linear [3] unmixing approaches;
5. a comparison of the results for validation purposes with respect to abundace maps at 30 m spatial resolution obtained by the classification of VHR data of the test area (the city of Pavia and its immediate surroundings).

Once the analtsis of the satellite data is completed, a suitable multi-resolution change detection chain will be considered, in order to understand what has changed in the test area between the two acquisitions. That will require the extraction of abundance maps of the same materials mentioned in point 2 above from DAIS data, the resampling of these abundance data to 30 m and the comparison of the results, by means of change vector analysis.

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THE RESEARCH ON LANDCOVER CHANGE IN BEIJING-TIANJIN-HEBEI REGION IN CHINA OVER THE PAST 25 YEARS

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Abstract

LUCC is key research issue in global change in many international projects. It is the result of multiple driving factors interaction, in which the mechanism and process are complex. Since the 21st century, the landcover in China has changed greatly, especially in Beijing-Tianjin-Hebei region, Yangtze River Delta other and the Pearl River Delta with rapid economic development. Beijing-Tianjin-Hebei region is an important economic growth pole, and the coordinate development between Beijing, Tianjin and Hebei is a key national strategy in China. Therefore, it is of great significance to carry out the study on land cover change in Beijing-Tianjin-Hebei region.

Based on the 30m HJ-1A/B and Landsat TM images, object-oriented classification method is used to extract landcover information of Beijing-Hebei-Tianjin over the past 25 (1990-2015). Accuracy validation is carried out through hundreds of field samples. Then, the land cover change in Beijing, Tianjin and Hebei in the past 25 years was studied. Over the past 25 years, great land cover changes have taken place in Beijing-Hebei-Tianjin region with the rapid economic growth. Construction land and transportation land increased rapidly, cropland decrease continuously. The growth rate is great in Beijing and Tianjin than in Hebei. Construction land and transportation land in Beijing increased rapidly, which is the main type of landcover change, but the growth rate has slowed down in the past five years. The terrestrial area increased because of continuous reclamation. The mining, transportation land in In Hebei province increased rapidly.

SESSION:
Life Science & OMICS and Digital Earth

ENVIROMENTAL MICROBIOMICS AND BIG DATA

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Abstract

Metagenomics is revolutionizing our idea of ourselves and of our genomes.

Life at the interface of the microbial and superorganismal world is the focus of a number of studies highlighting how understanding of the boundaries of healthy living requires a deep insight into how microbes interact with our metabolism and immune system. Nutrition and the environment emerge as a crucial regulator of this equilibrium and exerts major modulating roles.

Here we will discuss the computational challenges in exploring and integrating big data at the interface between environmental pollution, nutrition, microbiome and immunity for self-sustainability of health.

We describe how this massive interdisciplinary endeavour requires handling and interconnecting large amounts of data from different sources.

In this talk we will describe in detail the following points related to computational and environmental metagenomics challenges:

1. The state of the art and interoperability of the bioinformatics platforms, pipelines and databases used for metagenomics, metabolomics, and of the requirements for nutritional phenotype data analysis and for the integration of metagenomics data with the human nutritional, environmental, and immune phenotype.
2. Evaluate existing tools regarding interoperability for the analysis of datasets from different origin, including but not limited to those generated within the Microbiomics networks, integrating measurements from different technologies on the same samples, as well as Galaxy pipelines, cloud computing and federation of datasets for datamining of complex datasets.
3. Discuss the most relevant reference experiments, focusing on meta analysis of microbiome and exposome datasets, assessing the effect of urbanization on the microbiome, comparing rural and urban populations. We will discuss the results of testing existing pipelines to a custom designed test case proof of concept dataset, on nutritional phenotype integrated with a total description of the foods, including both their nutrients, the environmental variables and microbiome composition.

Finally we will critically assess how achievements in the field of computational metagenomics will foster the industrial application of big data in healthy ageing, nutrition and immunology, for self-sustainability of health and for the development of novel functional foods and healthy lifestyles.

METABOLOMICS: BIG DATA FIRST NEED TO BE GOOD DATA

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Abstract

The analysis of big collection of data is changing the approach to biology and medicine by allowing researchers to extract information and knowledge from rapidly growing electronic databases of clinical and bioanalytical data. The availability of these large collections is the basis for the new paradigm of predictive medicine. This approach relies on multivariate statistical techniques and machine learning tools. However, especially for metabolomics, the size of the generated datasets is not per se a virtue. Samples collected in different places, stored in different biobanks following different operating procedures generate data that are not directly comparable. The big challenge here is not to produce many data, but to produce data that are correctly standardized to make coherent and comparable sets useful for statistical analysis. This is particularly true in the perspective of the large multicentric studies that are necessary to demonstrate to regulatory agency the usefulness of metabolomics in the clinical routine.

THE VALUE OF AND IMPEDIMENTS TO OPEN DATA SHARING OF MICROBIAL WHOLE GENOME SEQUENCES (WGS):

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Abstract

As Next Generation DNA Sequencing (NGS) spreads globally fast, there is an obvious potential to develop a global microbial WGS database to aggregate, share, mine and use microbiological genomic data.

In the not so distant future such data collections will be used as diagnostic tools. In the end, all microbial species, strains, clones will be in the database, enabling any laboratory to upload its sequence and seek the correct answer, meaning species, type (clone) and antimicrobial resistance. If/when all microbiological labs start using this system, it will also enable real-time global surveillance of all relevant communicable diseases (human, animal, plant)

It is important to note that such databases will provide the basis for a platform for WGS investigations of all microorganisms, human and animal pathogens, environmental microorganisms, microorganisms used in food production (probiotics, industrial strains etc.)

This system would promote equity in access and use of NGS worldwide, including in developing countries, but it should be noted that a number of obstacles to open data sharing of WGS data exists.

A global system is suggested in the global initiative: the Global Microbial Identifier (www.globalmicrobialidentifier.org) an initiative presently involving > 250 researchers from > 50 countries, managed by a Steering Committee chaired from Nanyang Technological University.

This presentation will go through a number of the benefits from and obstacles to such a system with a specific focus on the transnational (global) sharing of microbial DNA data.

SESSION:
Multi-source satellite data for agronomical operational products

A GENERALIZED CLASSIFICATION APPROACH FOR PERMANENT AND ROW CROPS.

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Abstract

Vegetation indices (VI) derived from satellite images are well correlated with the parameters that define crops status and for nearly four decades the Normalized Difference Vegetation Index (NDVI) remained one of the most consistently and widely measured vegetation indices across a wide variety of spaceborne sensors, providing plurality of information and historical archives. NDVI data at high temporal frequency have been widely used to track seasonal phenology of green-up and senescence over a large variety of ecosystems from space using NOAA's Advanced Very-High Resolution Radiometer (AVHRR) [1] and NASA's Moderate Resolution Imaging Spectrometer (MODIS) [2]. Earth Observation (EO) data are recognized of strategic relevance in monitoring crop fields, providing the necessary information to food security and early warning systems.

However, vegetation indices and/or spectral data by themselves are often not up to the challenge of crop species discrimination. The revisit frequency of Landsat 8, which is relatively low (16 days), presents challenges for agricultural applications that rely on high frequency sampling during critical phases of the crop growth cycle. Recent studies have fused higher spatial resolution map products derived from Landsat with higher frequency MODIS or AVHRR data [3]. However, high resolution map products derived from Landsat data such as the Cropland Data Layer (CDL) [4], which is produced by the United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS), are generally only produced at regional scales and are therefore not available for much of the world. Further, medium/low resolution maps are not worldwide applicable due to the different extent of the cropland characterizing each country and finally the accuracy of such maps is not the same across the world [5].

The use of phenology from multi-temporal images plays an important role in crop classification [6]. The identification of crop classes benefits from phenological information by employing phenological transitions of relevance to interpret multitemporal data and by deriving phenological metrics and building classification rules based on crop calendar and crop conditions [7]. Rules based on phenological metrics are more robust than statistical methods, which are more dependent on specific datasets and are therefore harder to generalize.

Phenological stages can be directly used to separate crops with distinct crop calendars; on the other hand, when phenological stages are available, it is possible to derive crop spectral properties at certain phenological stages.

However, the phenology variables alone may not be sufficient to discriminate permanent crop (orchards), due to they reduced variation of the spectral indices along the year. Then, the paper is devoted to present a generalized procedure capable to classify both permanent (olive groves and other) and row crops.

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A PHENOLOGY-BASED CLASSIFICATION USING SENTINEL-2 TIME-SERIES DATA IN A SEMI-ARID IRRIGATED REGION.

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Abstract

As world population growth and climate change are undeniable in recent decades, the pressure on our planet's limited natural resources is increased dramatically. Agricultural production is one of the major components which exert this pressure. In this context, the monitoring of agriculture on a local and regional level has become more and more important for sustainable management of crop distribution and production.

In semi-arid areas, an operational crop mapping and yield predictions system are needed to supply valuable information about the management of agro-resources and environment to farmers, policymakers and other decision-makers. In this light, remote sensing can provide to agriculture is data related to crop types identification and area estimation. In this paper, the potential of phenological metrics data, derived from the time series of Sentinel-2A Normalized Difference Vegetation Index (NDVI) was evaluated using Random Forest (RF) classification [1] to identify and map various crop classes over an irrigated perimeter. The smoothed NDVI time series obtained by the TIMESAT software [2] was used to extract profiles and phenological metrics, which constitute potential explanatory variables for cropland classification. The method of classification applied involves the use of a RF classifier. The results demonstrated the capability of high spatial resolution (10 m) satellite imagery to capture the phenological stages of different cropping systems over the study area. Furthermore, the implemented cropland mapping framework yielded an overall accuracy of 93.43% and a kappa index of 90%. These preliminarily results are encouraging and confirm the potential of utilizing phenological metrics derived from Sentinel-2 NDVI time series to systematically identify and map crop types in semi-arid irrigated region.

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ASSESSMENT OF MODIS PHENOLOGICAL METRICS PERFORMANCE TO IDENTIFY THE BEHAVIOR OF AGRICULTURAL SYSTEMS

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Abstract

Studying vegetation phenology at large spatial scale offer better understanding of the behaviors and the global distribution of agricultural areas. The use of remote sensing data is an essential key to follow-up the phenological vegetation changes. The purpose of this study is to define a phenology-based methods for assessing the importance of phenological metrics in mapping and monitoring agricultural area in a semi-arid context in Morocco using support vector machine classification [1]. The Normalized Difference Vegetation Index (NDVI) time series [2], extracted from MODIS (Moderate Resolution Imaging Spectroradiometer) MOD13Q1 product, were used to derive phenological metrics between 2010 and 2016 using TIMESAT software [3]. Then, SVM classification method was performed based on phenological metrics to classify the main agricultural zones over the study area for each agricultural season. The results demonstrated the ability of phenological metrics to identify the main agricultural systems, which are: 1) irrigated annual crop (irrigated perimeters and the small and medium hydraulic), 2) irrigated perennial crop, 3) rainfed areas and 4) fallow. In addition, the classification results can constitute relevant means of control and spatio-temporal monitoring of illegal pumping zones and monitoring changes over agricultural systems. Overall, the results are relevant for the development of measures to prevent environmental, agricultural and socio-economic issues emerging from spatio-temporal changes in plant distribution.

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BUILDING CAPACITY FOR LOCAL FOOD RESILIENCE: A CASE STUDY IN QUEENSLAND, AUSTRALIA

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Abstract

With increasingly severe and frequent weather events, Australia's fresh produce supply chain is becoming more susceptible to delays and disruption, impacting local communities' ability to meet their own needs during and immediately following disasters such as flooding and fire (Australian Government, 2010; Reis and Ferreira, 2015). Australian authorities acknowledge the vital importance of communities in leading their own initiatives in disaster response and recovery, ensuring such activities are coordinated and led efficiently by their employment of effective communication (COAG, 2011; IGEM, 2018). Utilising smart, geospatially informed technology is central to this imperative (Ai et al., 2016; Sterlacchini et al., 2018).

The authors present on their ongoing project to empower community in food-related disaster resilience, through accessing geospatial knowledge (Reis, 2019). The long-term aim is to produce a geospatially-informed online interface with: a) timely input from members in the local food procurement and distribution network; b) clear visualisation of demand and supply in real-time for members of the public; and c) provision for local leaders to make decisions that can facilitate community-led activities.

The authors present on findings from the first stage of investigation, consulting with industry and community, including learnings from the application of an online platform "Basecamp". Conducted in conjunction with our industry partner, the Office of the Inspector-General Emergency Management (IGEM), this stage revealed the strong desire to establish a shared vision and purpose among the participants, regarding their preferred communication during and immediately following disasters. The results highlight the clear need to pre-empt design of software or other mechanisms with establishing and nurturing communities of practice (for example, Denison and Williamson, 2013; Dodd, 2017). This has immediate implications for budgeting and planning future community empowerment initiatives, wherein the resultant tools can make a difference – in this case in local food resilience.

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CHANGING CROPPING PATTERNS OF CORN AND SOYBEAN IN USA

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Abstract

Corn and soybeans are the most important grain crop for human food, livestock feed and bio-product support [1] . The United States contributes 46% of the global corn and 33% of the global soybeans [2]. Cropping variation in corn and soybean would greatly disturb global food security. Understanding how the cultivated pattern of corn and soybean changes and their relationships is of great reference value for forecast and assessment of global food industry and futures trading. The primary objective is to identify the spatial pattern of corn and soybean and their rotation characteristics over time in the contiguous United States. The paper provides an accessible framework to quantify the temporal change in spatial cropping patterns of corn and soybean by cropping intensity and gravity center of cropping areas based on county scale in the contiguous United States for the years 2008-2017. CropScape provides National Crop Date Layer (CDL) for each year since 2008 and some areas early in 1997, which is an open web-service with 30m pixel resolution released by the USDA National Agricultural Statistical Service (NASS) [3]. The resulting patterns highlight the distinct patterns of corn and soybean cropping variability change as well as their crop rotation. A further explore is try to find the drivers of which crop to plant in projecting the future changes.

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CLUSTERING OF MULTISPECTRAL SATELLITE TIME SERIES FOR CONSTANT PATTERN RETRIEVAL AT THE FIELD LEVEL

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Abstract

The detection of constant spatial behaviors inside agricultural fields, which are stable through time, can be a challenging task for optimizing farming practices by providing to farmer information on possible uniform vigour zones to support agro-management.

The main objective of this study consists in the evaluation of the standard K-means clustering algorithm applied to Landsat multispectral satellite time series for detecting temporally stable patterns in different crop fields in Italy, related to within-fields crop vigour spatial distribution. This procedure has been developed in the framework of the ERMES (an Earth obseRvation Model based ricE information Service) project, which is a FP7 Project co-funded by the European Commission with the objective of developing a prototype of downstream service dedicated to the rice sector to support authorities and farmers (grant agreement n◦ 606983).

In order to automatically detect within fields constant patterns, a three steps methodology was developed in IDL (programming language) code. The first time series processing step of the procedure, for each field of the test areas, determines the retrieval of three intermediate outputs: i) “Soil Fields” where to derive the bare soil constant optical pattern relatable to topsoil properties and composition; ii) “Vegetation Fields” where to derive the biomass constant pattern; iii) “Excluded Fields” as composed by a mixture of bare soil and crops, including crop residues. The second step of the procedure consists on applying on these layers specific spectral indexes to derive a new synthetic data set describing soil and crop characteristic pattern to be further clusterized. On this synthetic data set, to improve the comparison of spatial patterns occurring on a given parcel of images acquired on different dates/years, the Z-score spatial normalization was applied to each field. In the last step, a clustering procedure was applied.

Results obtained on the Maccarese farm in Central Italy show a good accuracy for the biomass constant patterns with respect to winter wheat field data (yield maps) collected on some test fields.

The procedure was successfully applied both for topsoil and biomass clustering on rice fields in different test sites (Greece, Spain and Iran).

The present study illustrates the potential of the proposed standard clustering methodology in mapping constant patterns for applications in the area of precision farming management.

The availability in the near future of new satellite time-series datasets with increased spatial (e.g., Venµs), temporal (Sentinel 2) and spectral resolutions (e.g., hyperspectral satellite sensors PRISMA, GF-5, EnMAP, ECOSTRESS and Sentinel 10) will certainly require further experiments on the proposed procedure and clustering methods to assess their detection accuracy, so to provide a more robust tool to the farmers. The availability of hyperspectral time series will also allow to increase the retrieving of both topsoil and crop biophysical properties so to have a functional clustering which better addresses the agronomical practices.

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CROP DISEASES AND PESTS MONITORING AND FORECASTING SYSTEM

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Abstract

In light of the incompetence of traditional field investigation of projecting the information of one site to the whole region that can hardly meet the demand of applying remote sensing (RS) for large-scale and fast monitoring on crop diseases and pests, the relevant forecasting and RS monitoring research have been conducted, clarifying the spectral response sensitive band and signature of different crop diseases, pests. The models have been developed for hyperspectral/multispectral RS monitoring on the major diseases and pests of wheat, rice, maize, cotton and other crops at the leaves, canopy scale. It has also established the crop diseases, pests RS monitoring and predicting model in comprehensive consideration of crop growth, temperature, humidity, and other environmental factors. It has systematically proposed the pre-disaster alarming, disaster monitoring and post-disaster loss assessment methods for crop diseases, pests management. It has taken the lead to set up the national scale crop diseases, pests monitoring and prediction system, with regular publication of relevant thematic maps and scientific reports of the nation and key regions.

Establishing a crop diseases and pests RS monitoring and alarming technical system. It has clarified the spectral response sensitive band and signature of different crop diseases, pest insects. The models have been developed for hyperspectral/multispectral RS monitoring on the major diseases and pests of wheat, rice, maize, cotton and other crops at the leaves, canopy scale. It has also established the crop diseases, pest RS monitoring and predicting model in comprehensive consideration of crop growth, temperature, humidity, and other environmental factors. It has systematically proposed the pre-disaster alarming, disaster monitoring and post-disaster loss assessment methods for crop disease& pest management.

Developing the RS monitoring and forecasting system for crop diseases and pests. Through the integration of the diseases and pests monitoring, forecasting and other technologies and the combination of the RS, GIS and network technology, it has developed a WebGIS-based RS monitoring and forecasting system for crop diseases, pests, which is capable of 24-7 on-line operation, computation and product generation. On top of that, this system enables the regular publication of relevant monitoring and forecasting, thematic maps and scientific reports of the scale of the nation, key regions and counties.

Launching the application and demonstration of RS monitoring on crop diseases and pests. Leveraging the RS monitoring and forecasting on crop diseases, pests, it has generated and issued the relevant report and thematic products related to wheat, maize, rice and other major crops in different scales of the nation and in main granary bases. Its research findings have been adopted by various organizations and platforms, including General Office of the State Council of the People's Republic of China, 《Plant Diseases and Pests Intelligence》 of NATESC of Ministry of Agriculture, and Cropwatch, the second RS fast reporter on the food production situation of the world.

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DEVELOPMENT OF A TOOL FOR AUTOMATIC BARE SOIL DETECTION FROM MULTITEMPORAL SATELLITE OPTICAL IMAGERY FOR DIGITAL SOIL MAPPING APPLICATIONS

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Abstract

Understanding the variability of soil attributes allows to improve the farm production efficiency, accompanied by a reduction in environmental impacts and effective usage of resources. Several studies confirmed the potential of optical remote sensing data for quantifying soil attributes, such as clay content, soil organic carbon and texture classes [1].

A challenging issue in spatial-temporal soil surveying by remote sensing data is the limited availability of cloud-free images or affected by cloud/shadow. Further, imagery with high temporal resolution is extremely important for observing terrestrial surfaces [2].

This study will investigate the use of multispectral (Landsat 8 OLI & Sentinel-2 MSI) satellite imagery at the regional/local scale, for the automated detection of agricultural bare soil occurrence, exploiting bands covering the spectral range from visible to shortwave infrared.

The study objective is to provide bare soil time series that could be subsequently exploited in digital soil mapping (DSM) approaches based on multispectral or, also in view of the next future missions (PRISMA, EnMAP, CHIME) hyperspectral remote sensing data.

The research investigates the feasibility of developing an open source tool able to generate bare soil time series suitable to apply DSM techniques to retrieve topsoil spectral characteristics, e.g. for variable-rate nutrient applications. The use of multi- or hyperspectral remote sensing data into soil monitoring and digital mapping can provide a large-scale survey, comprehensive and effective sites' monitoring and assess topsoil variables characteristics.

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EFFICIENT CORN CULTIVATION AREA IDENTIFICATION WITH MULTITEMPORAL SYNTHETIC APERTURE RADAR AND OPTICAL IMAGES IN THE GOOGLE EARTH ENGINE CLOUD PLATFORM

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Abstract

The distribution of corn cultivation areas is crucial to ensuring food security, eradicating hunger, adjusting crop structures and managing water resources. The use of coarse spatial resolution images as original data at scales of hundreds of metres, such as Moderate Resolution Imaging Spectroradiometer (MODIS) and Advanced Very High-Resolution Radiometer (AVHRR), is predominant in previous studies. However, the emergence of high-resolution images, such as Sentinel-1 and Sentinel-2, enables the identification of corn at the field scale, and these images can be applied on a large scale with the support of cloud computing technology. This study represents an important attempt to map corn at a 10 m resolution at the province scale. Hebei Province is the major production area of corn in China and faces serious groundwater overexploitation due to irrigation. Corn was mapped using multitemporal Synthetic Aperture Radar (SAR) and optical images in the Google Earth Engine (GEE) cloud platform. A total of 1712 scenes of Sentinel-2 and 206 scenes of Sentinel-1 data acquired from June to October 2017 were processed to composite image metrics as input to a random forest (RF) classifier. A monthly and metric composite of multitemporal image was adopted for the time series analysis. Percentile and mean value of series were typically statistics, and have been applied successfully to identify tree cover [1, 2] and paddy rice [3]. The percentile and mean value can be calculated regardless the length of series or the lack of some data. So, we choose the percentile and interval mean value as representative feature of series. For Sentinel-2, two groups of metrics were calculated for six reflectance and three VI bands [1, 2, 4]: 1) percentile composites: 10%, 25%, 50%, 75%, and 95% percentiles were produced in the GEE platform. 2) The mean value in the 10-25%, 10-90%, 10-100%, 25-50%, 25-75%, 50-75%, 75-90%, 90-100%, and 0-100% intervals were calculated for six spectral and three vegetation indices to determine the value between two selected percentiles for each pixel across all images. For Sentinel-1, two groups of metrics for the VV and VH bands were created to represent the series of images: 1) For the monthly composites, the median value of the June, July, August, September, and October data was measured to obtain phenology information. 2) For the percentile composites, 10%, 25%, 50%, 75%, and 95% percentiles were calculated for SAR images as for optical images. To avoid speckle noise in the classification results, the pixel-based classification result was integrated with the object segmentation boundary completed in eCognition software with the assistance of the ESP [5] tool to generate an object-based corn map according to crop intensity. The results indicated that the approach using multitemporal SAR and optical images in the GEE cloud platform is reliable and efficient for corn mapping. The corn map has a high F1-Score of 90.08% and overall accuracy of 89.89% according to the test dataset, which was not involved in model training. Based on cloud computing, the GEE platform efficiently processed and composited thousands of imagery scenes. The metric compositing, training and application of the RF classifier to output the corn map takes only ~10 hours at the province scale. This GEE efficiency shown in corn mapping on a large scale is consistent with that of cloud computing-based classifications of landcover and crop type and will represent a new paradigm in the future [4].The results of the corn map are expected to provide detailed information for optimizing crop structure and water management, which is a critical issue in this region.

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EVALUATION OF MODIS VEGETATION INDEX DATA FOR CROP CLASSIFICATION OF NEPAL WITH MULTI-DIMENSIONAL DATA FORMAT (MDD) STRUCTURE AND ANALYSIS TOOL

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Abstract

Monitoring crop cycle and crop based land use/land cover (LULC) using time series Moderate Resolution Imaging Spectroradiometer (MODIS) vegetation index (VI) datasets is very popular and common in the present world. Time series MODIS vegetation index (VI) data hold the effective results for the large-area cropping mapping. The main objective of this current study was to examine the time series MODIS normalized different vegetation index (NDVI) and enhanced vegetation Index (EVI) datasets for crop profile and crop based land use land cover (LULC) classification in the country. In this study NDVI and EVI were calculated using surface reflectance MODIS (MOD09A1 8 days 500 meters) data from 2001 to 2018 for crop area monitoring of entire Nepal based on multi-dimensional dataset (MDD) structure using multi-dimensional analysis of remote sensing (MARS) software for crop based . MDD is a multi-dimensional data format that can integrate the temporal, spatial and spectral features of remote sensing data and can calculate the various indexes quickly and precisely. The multi-temporal NDVI and EVI data pursued similar seasonal responses with correlated profiles around the growing phase and both are important for global to local level vegetation change studies. Here, NDVI, EVI results were compared and analyses. The results concluded that both EVI and NDVI perform effective and perceptively. Crop cycle and crop area distributions were characterized by comparing annual products for 2001 to 2018. The results demonstrated true and effective information for crop cycle and crop based LULC classification using MODIS data of Nepal.

FOOD SECURITY TEP - SUPPORTING SUSTAINABLE INTENSIFICATION OF FOOD PRODUCTION FROM SPACE

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Abstract

The Food Security Thematic Exploitation Platform (TEP) is the youngest out of seven TEPs supported by ESA and is developed in an agile mode in close coordination with its users. It provides a platform for the extraction of information from EO data for services in the food security sector mainly in Europe & Africa. Thereby it targets to foster smart, data-intensive agricultural and aquacultural applications in the scientific, private and public domain [1]. The platform is currently in its second phase of development.

The Food Security TEP builds on a large and heterogeneous user community, spanning from agriculture to aquaculture, from small-scale farmers to agricultural industry, from public science to app developers to the finance and insurance sectors, from local and national administration to international agencies. Its technical infrastructure is a web based Platform-as-a-Service, developed by CGI Italy, which leverages the most advanced cloud computing technologies. This platform provides easy access to all Copernicus data and a wealth of additional data sources and facilitates implementation of specific services, by adding new processing algorithms and allowing their execution, monitoring and maintenance. The main point of access to the platform is the Open Expert Interface providing the main functionalities of the platform and access to a variety of tools and data sets. Moreover, Food Security TEP allows data visualization on mobile devices and the provision of customized products and services to selected users. Service pilots demonstrate the platform's ability to support agriculture and aquaculture with tailored EO-based information services.

Several service pilot applications in Africa were developed by the Food Security TEP project partners together with African users. Project partner VITO NV, Belgium, cooperates with the UN World Food Program to improve crop insurance for farmers in Kenya. Their pilot application is successfully providing EO-based crop productivity estimates as input to index-based insurance provided by WFP's R4 Rural Resilience Initiative. Similarly, EO service provider VISTA GmbH, Germany cooperates with the local company FarmDrive, with the aim of improving access to credits for smallholder farmers in Kenya. The resulting pilot service shows that continuous monitoring of agricultural fields at the regional scale allows objective assessment of crop development to better manage the company's portfolio risk and hence support the sustainability of their mobile loan services to local farmers. The capability of EO-data to support African farmers' management decisions is shown in another pilot for irrigation management in Zambia, also led by VISTA. It shows that EO information can help to reduce the amount of irrigation water needed while maintaining stable or even improved yields. Finally, a pilot application is being developed by Hatfield Consultants, Canada in conjunction with UN FAO and local partners in Tanzania and focuses on mapping coastal aquaculture sites for a national inventory as well assessing site suitability for seaweed production in Zanzibar. Both aquaculture applications were successfully developed by integrating Coastal TEP SAFI services [2] instead of replicating existing information.

These use cases implemented in developing countries show that using a dedicated cloud-based platform for Earth Observation applications leads to an easier cooperation between international project partners and increases the available information for agricultural and aquacultural management in the target countries. In general, exchange of information in the cloud allows easier exploitation of data while securing data ownership for all partners. The Food Security TEP PaaS provides access to big data computing capabilities, which shall not be built locally, allowing even remote areas with relatively poor infrastructure to reap the benefits of globally available data sets and tools like satellite imagery.

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MULTI-SOURCE EO DATA FOR SUPPORTING AGRICULTURE MANAGEMENT IN AFRICA

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Abstract

AfriCultuReS is a 4 years project funded by EC in the framework of the H2020 initiative. The project aims at providing decision makers on food security in Africa with the information and tools required to enrich and improve multi-level decision making. AfriCultuReS will design, implement and demonstrate a holistic Food Security Spatial Decision Support System (FS-SDSS) that will integrate EO data, in situ and crowdsensed information, crop models, weather forecasts, climate seasonal predictions and climate projections and socio-economic parameters to support science backed decision making on food security.

The project will involve all key players of AfriGEOSS, GEOGLAM, SIGMA, ARTEMIS, African Drought Observatory and other initiatives as well as local partners and stakeholders representing the diversity of African agricultural systems, in an effort to push forward the services provided by current monitoring and early warning systems, with innovative fusion of data from multiple sources (EO, in-situ monitoring networks, citizen-based crowdsourcing) in a vertical manner. Environmental and weather conditions, climate change, regional Information, Land Use and Management, Rainfall, Temperatures, Ground Cover, Modelled Plant Growth, Production Variables, Production Statistics, Economic Information will be made available for both crops and livestock.

Tackling food security requires a holistic approach based in the collaborative integration of complementary earth and atmosphere sciences to pave the way forward to accurately map and forecast food production. Joint exploitation of time series of past and present climate information and EO data coupled, through predictive analytics, with crop models, allow better understanding about the earth surface dynamics affecting food production, hence decision makers can be provided with accurate information to analyse key questions related to food production:

- is that area dedicated to and appropriate for food production? How long is that area been used for food production?
- This season, when is the right time for planting and for what crop? When was planted? which crop was planted?, when was the crop harvested?
- Which is the potential yield in that area? What is the physiological status of the culture? How does it differ from the normal behaviour? How much does it differ?
- Has the crop been affected by an adverse phenomenon? How severely?
- What is the likelihood of occurrence of the phenomenon in a given area? How severe can the effects be?

In particular, the project will put emphasis upon the concept of multi-source data integration in support of decision making and risk assessment about food production, by integrating information produced ‘ad-hoc’ by the project with those provided by other European and International initiatives (data services federation).

The AfriCultuReS services have been divided in 7 categories each one comprising a series of products. The present list of services and encompassing products is based on a series of initiatives taken by project’s team to collect users requirements. The services are named as following: climate, crop, drought, land, livestock, water, weather.

These 7 services include 57 products. For some of the products, when considered useful, a low [< 1 km], medium [> 1 km] and high [<= 30 m] spatial resolution version will be provided for supporting continental, regional and local applications.

Most of the low and medium spatial resolution products are taken from other projects (e.g. Copernicus Global Land Services) and modified according to the AfriCultuReS needs.

The paper aims at presenting preliminary results of validation activity of the EO satellite images based products/services developed by the project by exploiting the ground data collected by the project African partners.

SIM: SMART IRRIGATION FROM SOIL MOISTURE FORECAST USING SATELLITE AND HYDRO–METEOROLOGICAL MODELLING

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Abstract

The conflicting use of water is becoming more and more evident, also in regions that are traditionally rich in water. With the world's population projected to increase to 8.5 billion by 2030, the simultaneous growth in income will imply a substantial increase in demand for both water and food (expected to increase by 70% by 2050). Climate change impacts will further stress the water availability enhancing also its conflictual use. The agricultural sector, the biggest and least efficient water user, accounts for around 24% of total water use in Europe, peaking at 80% in the southern regions, is likely to face important challenges in order to sustain food production and parsimonious use of water [1].

The paper shows the development of a system for operative irrigation water management able to monitor and forecast the crop water need reducing the irrigation losses and increasing the water use efficiency. The system couples together satellite and ground data, with pixel wise hydrological soil water balance model using recent scientifically outcomes on soil moisture retrieval from satellite data and hydrological modelling. Discussion on the methodological approach based on the satellite land surface temperature LST, ground evapotranspiration measures, and pixel wise hydrological modelling [2] is provided proving the reliability of the forecasting system and its benefits.

The activity is part of the European Chinese collaborative project (SIM, Smart Irrigation Modelling, www.sim.polimi.it) which has as main objective the parsimonious use of agricultural water through an operational web tool to reduce the use of water, fertilizer and energy keeping a constant crop yield. The system provides in real-time the present and forecasted irrigation water requirements at high spatial and temporal resolutions with forecast horizons from few up to thirty days, according to different agronomic practices supporting different level of water users from irrigation consortia to single farmers [3, 4].

The system is applied in different experimental sites which are located in Italy, the Netherlands, China and Spain, which are characterized by different climatic conditions, water availability, crop types and irrigation schemes. This also thanks to the collaboration of several stakeholders as the Italian ANBI, Capitanata and Chiese irrigation consortia and Dutch Aa and Maas water authority

The results are shown for two case studies in Italy and in China The Italian ones is the Sud Fortore District of the Capitanata Irrigation consortium which covers an area of about 50'000 hectares with flat topography, hot summer and warm winter, mainly irrigated with pressurized aqueduct. The district is an intensive cultivation area, mainly devoted to wheat, tomatoes and fresh vegetables cultivation The Chinese one is in the Hehie Daman district covering an area of 20000 ha with fixed time flooding irrigation.

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SPATIO-TEMPORAL PATTERNS OF CROP RESIDUES OPEN BURNING IN NORTHEAST CHINA BASED ON MODIS FIRE AND LANDCOVER PRODUCTS

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Abstract

Farmers use fire as a tool for shifting agricultural and removal of excess crop residue from fields [1]. Northeast China is an important commodity grain base for the country. There is much corn and rice residue in field. Therefore, crop residue open burning in the field before sowing and after harvesting is a common farming practice in the study area. Previous studies have found that crop residue open burning can be an important local and regional contributor of particulate (such as PM2.5) and trace gas (such as CO, NOx, and SO2) emissions that affect both air quality and public health [2, 3]. Recently, crop residues open burning has been paid more attentions by government and public. The aim of the present study is to better understand the spatio-temporal patterns of crop residue open burning in Northeast China for the years 2003 through 2016 using remote sensing datasets. For this analysis, MODIS fire (MOD14A1 and MYD14A1) and landcover (MCD12Q1) products were used to derive daily crop residue open burning spots from 2003 to 2016. Time Scan Statistics method [4] was used to examine the temporal cluster of crop residue open burning for each year. Meanwhile, Moran's I and Getis-Ord Gi* [5] was used to examine the global and local spatial cluster of crop residue open burning at county scale. Totally, the results revealed an increasing trend of crop residue open burning during 2003 and 2016. The amount of crop residue burning spots from 2014 to 2016 are much more than that from 2003 to 2013. For monthly variations, detected crop residue open burning spots in April and October show the largest number in Northeast China. There are 54.87% and 36.56% of crop residue open burning spots in spring and autumn, respectively. The cluster periods of crop residue open burning were from 6 to 90 days for various years with an average 38 days. From spatial perspective, crop residue open burning was occurrence in Songnen, Sanjiang, and Liaohe Plain. Moran's I of crop residue burning spots in Northeast China changed significantly, that were 0.11 and 0.43 from 2003 to 2016. This result indicate that crop residue open burning shows a strongly spatial autocorrelation. Three peaks of Moran's I appeared respectively in 2003, 2011 and 2015. At local scale, there are three significantly hot spot regions (46 counties) and significantly two cool spot regions (40 counties) in Northeast China. Our study provides more details and deeper for understanding of crop residue open burning in Northeast China than the previously available national scale studies.

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SESSION:
Multi-technique and multi-platform approaches for digital heritage

A MULTIDISCIPLINARY APPROACH TO ARCHAEOLOGICAL RESEARCH IN SANT'ARSENIO (SALERNO, ITALY): NEW METHODOLOGIES AND CONSOLIDATED PRACTICES FOR THE KNOWLEDGE OF CULTURAL HERITAGE.

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Abstract

This paper is part of a wider project for the identification, research, protection and protection of archaeological evidence within the village of Sant'Arsenio (SA), through the use of new technologies applied to archaeological research.

In particular, the activity combines typical Remote Sensing tools (satellite data and UAVs), with a particular preference for open source software and open access databases (QGis, Sentinel 1 and Sentinel 2 data of the Copernicus Programme, ESA SNAP, etc.), and of archaeological research practices (study of ancient and modern bibliographic sources, field survey, topography analysis, identification of extraction points of building material and courses and water sources, etc.) [1, 2].

Sant'Arsenio is a small town in the western part of Vallo di Diano, a large plain surrounded by mountains, between 450 and 480 m above sea level, located on the border between Campania and Basilicata. The formation of the Vallo di Diano dates back to the Pleistocene. Around 200, 000 years ago it was a large swamp, reclaimed during the historical period (Roman period) by canalization and drainage works to promote settlement and agricultural exploitation in the area. In medieval times the occupation of the Vallo is abundant, with the birth of new inhabited centers, monasteries and fortified sites.

The historical / archaeological documentation for the plain of the Vallo is more or less conspicuous, while the municipality of Sant'Arsenio is little known in the modern bibliography and, only recently, has been involved in systematic investigations.

The common opinion is that the town has its origins in the Middle Ages and that the "importance" of the center in the economy of the territory remains marginal until the passage to the Abbey of Cava de'Tirreni (12th century).

Information about the archaeological potential of the Sant'Arsenio appears to be relatively scarce compared to those available for the surrounding municipalities (Polla, Atena Lucana, Teggiano, Sala Consilina).

This lack is due to the absence of systematic studies and the lack of planning of archaeological research activities in the municipal pomerium.

The most ancient evidences identified in the place are those found during the S.t.A.r.S. (Sant'Arsenio Survey) and V.A.L.L.O. (Valorizzazione Archeologica di un Lago non Lago Onnicomprensivo) projects, directed by Prof. A. Guidi (Università di Roma 3), by Prof. A. Cazzella (Università di Roma La Sapienza), coordinated in the field by dr. F. Nomi (Unviersità di Roma 3) in the years 2012, 2013 and 2014.

The work of the archaeologists of Rome has allowed, over the years, to deepen the knowledge about the occupational dynamics, with materials and remains of settlements from the Eneolithic to the VIII-VI century. B.C.

This paper presents the data collected between the end of 2018 and the beginning of 2019 from the research activity of the IMAA-CNR (Istituto di Metodologie per l'Analisi Ambientale del Consiglio Nazionale delle Ricerche), as part of an agreement in force between the institute and the Municipality of Sant'Arsenio.

In particular, the satellite data (Sentinel) [3] and the acquisitions UAVs [4], in the visible and in the multispectral, assisted by archaeological research, show some anomalies in the area. A W / NW probably referable to prehistoric and medieval settlements (loc. Serra la Compra and Monte Carmelo). To the north, a large area that could be the site of a VI century necropolis. B.C. and of a Roman settlement. While, to E you notice signs of ancient canalizations and buried structures, along the medieval border of the Municipality of Sant'Arsenio, in the place where there were probably some mills, mentioned in the sources, of which today there is still a trace in the toponymy (Via Fosso del Mulino).

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A STUDY OF TEMPORAL AND SPATIAL PATTERN DYNAMICS ON THE ANCIENT TRADE SITES AND HISTORICAL ROUTES ALONG THE MARITIME SILK ROAD (INITIAL SEGMENT) BASED ON SPATIAL INFORMATION TECHNOLOGY

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Abstract

The "Maritime Silk Road" was an ocean trade channel through which ancient people used ocean currents and monsoon climate and increasingly mature navigation technology to communicate between different plates. Combined with historical documents, field data, and the multi-source remote sensing image of the site, the Maritime Silk Road (initial segment) trade site database was established, and the spatial distribution characteristics of the trade sites in different historical periods of the Maritime Silk Road (initial segment) were analyzed in this study. Based on the distribution maps of trade sites and site environmental data in different historical periods, the trade route of the Maritime Silk Road (initial segment) is drawn by using GIS spatial analysis method, on the basis of historical ancient books and regional system surveys in different historical periods. By using the historical data of nature and humanities with the trade route data of Maritime Silk Road in different periods, the spatial evolution track and change mechanism of the historical trade route of the Maritime Silk Road (initial segment) were comprehensively analyzed. Thematic maps of the maritime trade routes in different historical periods and the thematic maps of the trade-time changes of the trade routes were obtained. The natural and human factors that impact the temporal and spatial patterns of the trade route of the Maritime Silk Road (initial segment) in different periods were qualitatively analyzed, which provided a basis for the protection and sustainable use of the Maritime Silk Road. Taking the advantage of geographic information system technology to the spatial management and analysis of data to establish the spatial database of cultural sites on the Maritime Silk Road. Influence area of cultural heritage is obtained by using the methods of spatial analysis such as buffer analysis and three-dimensional analysis, then discussing the spatial and temporal distribution characteristics of the cultural sites. The integration of geographic information data to users provides a visual informational management platform for the study of the maritime Silk Road.

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A WEB BASED LIGHTWEIGHT FULLY AUTOMATIC CULTURAL HERITAGE 3D MODELLING AND VISUALIZATION SYSTEM

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Abstract

Most of the cultural heritage in the world are suffering danger of damaging and erosion for various aspects such as human activities and nature environment changing, though few of them were well protected. 3D digitization is an important way to record precious cultural relics data for various applications including protection, exhibition and education, etc. Photogrammetric image matching and laser scanning are two common utilized and effective of high precision 3d model reconstruction solutions for cultural heritage protection. Laser scanning is able to generate high accuracy point cloud with using laser scanner which is relatively expensive for most cultural protection agency. Photogrammetric solution is relatively cheaper but difficult to study. Both of the methods require high performance computer. Meanwhile, the efficiency of digitization is another important factor for cultural heritage documentation. There are only sixty thousand people working on cultural heritage and museum in China, but they need to manage 108 millions of movable cultural relics in museum and 0.76 millions of immovable cultural sites. Lack of protecting forces and professional workers is a serious problem for each museum in the world.

Three-dimension model reconstruction is a difficult task with a series processing steps which require technologies and skills from multiple subjects, especially information technologies, such as computer science and survey. However, most of the practitioner of cultural heritage have background knowledge of archeology, history and museology, rather than information technologies. The procedure of image collection, data processing and model editing operation is too complex for them to handle for most of them, as well as visualization of consequently generated textured 3d model. On the other hand, it requires relatively high performance computer to processing photogrammetry algorithm including image matching, triangulation and texture optimization.

In this paper, we presented a lightweight web based fully automatic 3d model reconstruction system specially for cultural heritage named Get3D using photogrammetry technologies, which is able to greatly simplify the procedure of cultural heritage documentation. People only need to upload images to website which satisfying photogrammetry overlapping collected using camera or mobile phone without need to give any camera parameters, the backstage cloud computing system generate high quality 3d textured model automatically. The output 3d reconstruction results are stored in the cloud platform and optimized according to PC and mobile applications. User can visualize or download the model by browser from mobile phone or computer. The backstage system is a distribute computation system which is able to adjust the computation resources according to simultaneous task number. We split the procedures of 3d model reconstruction into sub-tasks, including tie-point extraction, tie-point matching, dense matching, point cloud optimization, triangulation, texture mapping and color optimization, etc. For the sub-tasks have strong dependent relation, a delicate designed job scheduling system is needed to arrange the sub-tasks. Beyond the distribute computation system, we also embed deep learning algorithm specially trained for cultural heritage into our system to improve quality and robustness of 3d model reconstruction.

Now, the system is opened freely to users. More than ten thousand of high quality 3d textured models are created using this system which proved effectiveness of the framework and algorithms presented in this paper.

ADVANCED MULTI-TECHNIQUE AND MULTI-PLATFORM SPACE TECHNOLOGIES FACILITATE THE DEVELOPMENT OF "DIGITAL HERITAGE"

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Abstract

Nowadays, with the rapid development of Earth observation and information science, the integrated use of multi-technique and multi-platform approaches [1] tends to hasten an innovative research division, so-called "Digital Heritage" that will be indeed beneficial for the sustainable conservation of heritage (irreplaceable wealth for the universe) as well as for the discipline development of "Digital Earth" Science.

Archaeological discovery and heritage site monitoring are two prominent tasks (actually they are sequentially interconnected) in the sustainable development of cultural heritage sites. First, to prevent illegal or improper utilization, space archaeology provides a new paradigm in archaeological prospection, in particular for desolate and large-scale regions where field investigations are inaccessible or labour consuming. Second, as a direct monitoring approach, the ground-airborne-space monitoring solution assesses conditions of heritage sites by using quantitative pre-cursors extracted to derive a scientific decision-making. In this study, several multi-platform advanced space technologies, including SAR, LiDAR and geophysics, in archaeological prospection and heritage conservation were firstly introduced, highlighting the significance of the methodology adoption. Second, pilot case studies [2-3], including SAR and LiDAR for archaeology, geoarchaeology, UAV and InSAR for the landscape-to-monument scale change detection and preventive monitoring, were presented to pinpoint the performance and potential of multi-technique and multi-platform approaches in the detection, monitoring and assessment of cultural heritage sites. Finally, to benefit the relevant community, representative research directions of "Digital Heritage" were proposed from the technology innovation and promotion.

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APPLICATION AND EXPLORATION OF MULTI-DIGITAL TECHNOLOGY IN HERITAGE IMPACT ASSESSMENT OF GREAT WALL RELATED CONSTRUCTION PROJECTS

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Abstract

The applicant led the team to undertake heritage conservation planning, landscape conservation and construction projects in cultural relic preservation area, implemented cultural heritage impact assessment(HIA) and technical services, main cases including new Beijing Zhangjiakou intercity railway Badaling Great Wall section heritage impact assessment, new projects for 2022 Winter Olympics near Great Wall Heritage assessment.

In heritage impact assessment practice cases, according to ICOMOS Guidance on Heritage Impact Assessment for Cultural World Heritage Properties, for different types of construction projects, it respectively adopted visible region simulation analysis of geographic information system (GIS), analysis of low altitude aerial photography, 3D modeling analysis, VR multi-platform approaches, landscape effect comparison analysis before and after implementation and other assessment methods, which achieved good research, consultation and evaluation results.

Supported by new technologies, used heritage impact assessment as a tool for evaluating impacts from new project affecting the cultural heritage of Greatwall, it Provides guidance and framework for working methods, so that will not change or affect the Great Wall OUV and the cultural heritage landscape.

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APPLYING MULTI-CLASSIFICATION TECHNIQUES USING SATELLITE IMAGERY TO DETECT AND EVALUATE THE LAND-USE/LAND-COVER CHANGES AND ITS EFFECTS ON THE HERITAGE SITE OF NAQSH-E JAHAN SQUARE AT ISFAHAN, IRAN

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Abstract

Naqsh-e Jahan Square in Isfahan which constructed during 17th century, beside its historical important, is one of UNESCO World Heritage Sites (registered as a World Heritage Site in 1979 at UNESCO's conference in Egypt). Also, this great building is surrounded by numbers of heritage sites (i.e. Abbasi Great Mosqu, Sheikh Lotfollah Mosque and Ali Qapu palace). There is no doubt that, the urban sprawling presents a global phenomenon in the developing countries; e.g. Iran. Urban expansion is one of the key factors in changing land cover/use which caused major risk around the heritage sites in Isfahan. Preservation of cultural heritage sites are a pressing issue especially for territories subjected to a long period of human action that could adversely influence environment and heritage properties. Recently, using remote sensing from optical/multi-spectral sensors is processed in widely to detect and identify the digital heritage. Satellite images can give multi-information about the archaeological areas and monitor the risk which cause their degradation. This study deals with the spatial characterization over time of the urban sprawl close to and around Naqsh-e Jahan Square in Isfahan. Analyses and quantification of the spatial dimension of the urban expansion has been extracted using multi-classification techniques by Envi, ArcMap, and Snap software. On the other hand, the study involves the collection of multi-temporal and multi-sensor satellite data; Landsat MSS 1975, ETM+ 1999 and Sentinel2 2018. The quantification and mapping of urban sprawl enabled us not only to quantify and spatially characterize urban sprawl but also to create a model to mitigate the impact and provide some operational recommendations to protect the archaeological site. As a whole, outputs from our investigations clearly highlight that the current availability free of charge of long term satellite time series provides an excellent low cost tool for several applications including risk monitoring around the heritage sites.

CAPTURING CROP MARKS IN APULIA REGION BASED ON THE ENHANCEMENT OF MULTISPECTRAL SATELLITE IMAGES

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Abstract

Space technologies have been used in the past for the detection of still un-excavated and buried archaeological remains [1–2]. The improvements of space technology and specifically sensors used for earth osbervation can provide a large number of datasets with high spatial resolution covering also the visible and the near-infrared part of the spectrum. The exposure of buried features can be detected from space based on various satellite image processing techniques which aim to inedtify crop marks [3–5]. Crop marks are usually formed in regions where vegetation overlays near-surface archaeological remains. Since archaeological remains tend to retain different percentages of soil moisture in contrast to the rest of the cultivated area, spectral differences, especially in the Near Infrared (NIR) part of the spectrum, can be recorded from satellite sensors. Depending on the type of the buried archaeological features, crop vigour may be enhanced or reduced [6].

In the area of Apulia region in Southern Italy, a large number of crop marks is found. These marks traces belong to a long human habitation of the area since the Neolithic age [7-9]. In specific in the area of the Tavoliere territory, which covers approximately 3000 km2, the specific soil and geomorphological charactertics, the type of vegetation as well as the agricultural practices have created special conditions for the appearance of crop marks.

In this study, high spatial resolution satellite datasets from the GeoEye and QuickBird sensors are processed so as to map such crop marks of the area. Both sensors have the ability to capture the near infrared part of the spectrum which is important for the image enchacement of the specific marks. Severall vegetation indices have been employed in the area such as the Normalized Difference Vegetation Index and Soil Adjusted Vegetation Index, while in addition the linear equations and ratios among the three components (vegetation/crop, vegetation/soil, and crop/soil) were implemented. Other enchcement techniques such as the Principal Component Analysis and HSV transformation were also evaluated. The final results were cross-compared with each other in terms of improvements of the interpretation for the detection of crop marks. The final outcomes showcase that space technology can support archaeo-landscape studies providing evdence of archaeological features.

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CULTURAL HERITAGE MAPPING ON MALAY SULTANATE KINGDOM USING MOBILE LASER SCANNER IN ALOR SETAR, KEDAH.

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Abstract

Mobile laser scanning and mobile mapping are frequently used to capture high quality 3D models of cultural heritage sites, historical building and urban heritage areas. Processing of point cloud data collected with Mobile laser scanner system efficiently and with methods fit to a particular task is great importance to harvest the benefit of technology. This paper attempt to mapping the heritage building data captured for the former Malay sultanate Kingdom at Alor Setar, Kedah which exist since 1700s. The mobile laser scanner of TOPCON IP-S3HD1 3D has being used for the data collection for the further purpose in extracting the urban components that forming Malay kingdom consist of streets, open space and building. Finding show that the point cloud processing with the georeferenced and texture information has a great potential to be used for the urban component analysis at the later stage of constructing 3D model of that Malay Kingdom. As it demonstrated, the achievable accuracy levels, thus makes the system practical for many applications in cultural heritage mapping.

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DEFORMATION MONITORING ON SHANHAIGUAN GREAT WALL USING AN ADVANCED SMALL-BASELINE SAR INTERFEROMETRY APPROACH DEDICATED TO SENTINEL-1 DATA IN MOUNTAINOUS AREAS

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Abstract

Shanhaiguan Great Wall was built in the Ming Dynasty of ancient China, located south of Yan Mountian and north of Bohai Sea. It is 26 kilometers long, and has been severed as a crucial guard to the narrow passage between Northeast and Central East China since ancient times. In this study, for the conservation and sustainable development of Shanhaiguan Great Wall, we use multi-temporal SAR interferometry (MT-InSAR) techniques to monitor abnormal deformation over this heritage site and its surrouding areas. We proposed an advanced small basedline SAR interferometry (SB-InSAR) approach to retrieve ground movement information based on 31 Sentinel-1 single look slant range complex (SSC) SAR data from October 2016 to March 2018 [1]. Generic Atmospheric correction online service for InSAR (GACOS) data are involved for the troposphere atmospheric phase correction by virtue of integrating the weather model data from European Centre for Medium-Range Weather Forecasts (ECMWF), GPS data with high temporal resolution and Digital Elevation Model (DEM) data with high precision level. Combining the retrieved deformation results and on-site investigation, we analyze the drive forces and mechanism of abnormal deformation over the high-risk areas. Especially, since the major part of Shanhaiguan Great Wall is located among settlement regions, the influences of anthropic activities on the sustainable development of the heritage site are identified and highlighted. This study provides scientific support to the future protection of Shanhaiguan Great Wall. What's more, it can be used as a pioneer for the monitoring and sustainable development of large-scale linear cultural heritage sites.

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DETECTING SEISMIC DAMAGE SCARS IN MONUMENTS THROUGH A JOINED USE OF HISTORICAL SOURCES AND INFRARED THERMOGRAPHY

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Abstract

It is well known that monument restoration and conservation plans require to analyze the history of the building so as to understand how it was conceived and realized, the changes made by human actions or imposed by natural extreme events (e.g. earthquakes, floods, landslides) over the centuries, in what way and why it was used in the past. Strategies aimed to reply these questions rely on the integrated use of historical investigations and non-destructive diagnostic techniques, such as the infrared thermography, considered widely as a tool for cultural heritage analysis

The work aims to provide a methodological approach to detect damage scars and rebuilding interventions carried out on monuments hit by earthquakes. The methodology takes advantage of joint and cross-correlated use of historical-technical primary sources and infrared thermography surveys. In order to test the methodology, we consider here some monuments located in towns of the Basilicata Region (Southern Italy) and hit by the 23 July 1930 Irpinia (Mw=6.7) and 23 November 1980 Irpinia-Basilicata (Mw=6.8) earthquakes. The proposed approach can be useful in view of planning restoration/conservation interventions on monuments.

IDENTIFYING THE ORIGINAL PHARAONIC LAND BOUNDARY AROUND THE HISTORICAL TELLS USING REMOTE SENSING INDICES AND CHANGE DETECTION METHOD ACCORDING TO MULTI-SENSORS AT KAFR EL-SHAIKH GOVERNORATE, EGYPT

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Abstract

The archaeological area of Kafr El-Shaikh governorate has a history extends from the 5th millennium BC to the late antique period. The Kingdom of Ancient Buto (near the study area), has been ruled the Lower (North) of Egypt before the union between North and the South since about 5000 years. Recently, this Kingdom has been divided to many of the little Tells. Strabo (geography historian), has been referred that Buto originally consisted of two great cities, Pe and Dep (63 BC/23AD). The general idea for archaeologists about what Strabo has been said; that Buto is the recent small Tell beside Desouk city. Remote sensing data can be an efficient tool in such cases. The aim of this study is to declare some of the original boundary of the ancient kingdom at Kafr El-Shaikh governorate. In this study, the optical data of Corona, Landsat and Seniel-2 have been used. ArcGIS, Envi, and Snap software are used here in the processing of the satellite image data. As whole, the ancient site of the kingdom at Kafr El-Shaikh governorate is detected using change detection techniques between 1968 and 2018. In the same context, remote sensing indices have been used to detect the differences in the reflected values of the vegetation land between 1968 and 2018. According to the extracted results from the data, the essential site is started from the north (near the coast of the Mediterranean Sea) in a big space which extent from the north to the south of Kafr El Sheikh Governorate. In the time of Roman Empire in Egypt and as a result of the climate changes, this Tell has been divided to some of the small tells which spread around the ancient Delta branches. In more details, as result of the rapidly land-use land-cover changes in Delta Egypt, the Tells are become smaller than the period of the Roman Empire in Egypt.

INSAR TOOL FOR THE PREVENTIVE MONITORING AND SUSTAINABLE DEVELOPMENT OF THE HISTORICAL CENTER OF ATHENS AND A FIELD CHECK DEVELOPMENT.

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Abstract

Historical sites located in urban or rural areas are susceptible to displacement of Earth's surface, which could lead to dislocation of structures. Protection and conservation of our cultural assets for future generations in the face of various natural or anthropogenic hazards is a major concern nowadays. Understanding the deformation process is essential for interpreting the archaeological finds and the site formation and of course to protect them from the related hazards. During the last years, spaceborne Synthetic Aperture Radar (SAR) interferometry has proven to be a powerful remote sensing, non-invasive, tool for detecting and measuring ground deformation and studying the deformation's impact on man-made structures. By using large stacks of SAR images acquired over the same area, long deformation time series can be analyzed using multitemporal differential SAR interferometry techniques.

This study aims to demonstrate that Persistent Scatterers Interferometry (PSI) technique to monitor potential ground deformation affecting monuments of great importance historical center of Athens.

The Cultural Centre of Athens has suffered damages from a number of earthquakes (historical and modern) and gradual changes on its landscape due to on-going geomorphological and geological processes. The principal archaeological monuments of the Cultural Centre of Athens in this study include the Hadrian Arch, Herodes Atticus Odeon and the Temple of Olympian Zeus (Olympion) and the Panathinaic Stadium, which is built entirely of marble and hosted the first modern Olympics in 1896.

For this purpose a dataset of 20 TerraSAR-X Stripmap scenes, descending with HH polarization, spanning the period 5/3/2012 - 30/08/2016 was used. The multitemporal SAR interferometry technique used, was based on the dataset of scenes mentioned above, concerns a two-step Tomography-based Persistent Scatterers Interferometry (Tomo-PSInSAR) approach [1]. In the past research studies on the area at regional scale showed that Athens downtown is relatively stable with local signs of subsidence of low rates. The present study focus on monument scale interferometric processing. Tomo-PSInSAR outperforms PSInSAR in the detection of PS points by jointly analyzing SAR amplitude and phase information, which is also essential for structural instability monitoring, taking advantage of the increased observation samples in vertical by jointly extraction of single PSs and double PSs (on overlaid pixels). Interferograms were generated using the star-graph approach based on the reference imagery selected. Orbit parameters (disseminated with SAR data) and SRTM DEM data were applied for the removal of flat-Earth and topographic phase, resulting in differential interferograms. In order to enhance the spatial density of PS measurements as well as to minimize the displacement errors from thermal expansion/contraction, the extended Tomo-PSInSAR model with a two-tier network was introduced for height and motion estimation (linear rates and thermal amplitudes) as well as for retrieving deformation time series of PS points. In order to facilitate scatterers recognition and field validation the data were extracted and categorized through geospatial analysis. Then, these layers converted into a kml layer that were overlaid onto a Google Maps/Earth base-map. All users were able to access the kml layer integrated on the base-map of their choice, through their personal google account at any given moment on the field work.

Results show that (i) due to high resolution of stripmap scenes multiple scatterers are detected over monuments and thus be able to assess differential deformation (ii) not high-rate subsidence is measured (iii) transfer of results to devices (smartphones, tablets or pads) in synergy with GPS, each scatterer's deformation rate can be controlled and done where rehabilitation operation is required.

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INTEGRATED 3D-BASED TECHNOLOGIES FOR A CRITICAL READING OF MOUNT SANNACE'S ARCHAEOLOGICAL EVIDENCES

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Abstract

Works related to the recovery and enhancement of Mount Sannace's Archaeological Park in the municipality of Gioia del Colle (Bari) began in 2016 through a resolution of The Puglia Region. The latter act, promoted by the Regional Secretary of the Ministry of Culture and Cultural Activities for Puglia that also exposed the involvement of the Archaeological Council and the Puglia's Museums net, is structured into four different areas which are: - Archaeological and conservative's interventions, - conservation and restoration interventions, - botanical interventions and – communication and benefit improvement interventions. Regarding the latter specific intervention, digital media have been created with a strong communicative and technological connotation in order to connect cultural contents in a concise and attractive form. As we know, museum communication through an extremely articulated system of languages and communication techniques uses methods and processes shaped around different purposes, contents and different stakeholders. The museum, intended as a mere container for the sole purpose of preserving objects, has long since given space to productions and cultural promotions activities that have finally allowed the entry of new forms of communication. These methods, based on dynamic narration and multimodal information, aim to implement an effective dialogue with the anthropological, economic, social and cultural context, activating a set of multiple activities aimed at transmitting in a more simple way complex and constantly evolving messages. Regarding Mount Sannace, the simple linear and didactic communication modality gives way to informative, persuasive and educational communication. The visit to the park is accompanied by non-traditional exhibition logics with the main purpose of renewing interest in the archaeological area and consequently inviting new visitor flows. The attractiveness of 3D-based content and the persuasiveness of information constitute a fundamental basis for an equally important result: a better understanding of the connected cultural informations. The perceptive and cognitive processes are experiencing a radical change given by the freedom of using multimedia, new technologies and a swift towards iconic information rather than written word: from analytical, structured, sequential and referential, the practices are becoming more generic, global, simultaneous and holistic. It follows a greater awareness of the inherent values of archaeological structures besides an improved and synthetic ability to understand historical transformations as well. In this regard, the virtual reconstruction of ancient contexts is given by the technological basis of these objectives. The reconstructive work is achieved by the combined studies of different survey systems that, alongside the classical ones, include remote sensing, photogrammetric survey, three-dimensional analysis of architectural structures and their contextualisation in their historical reference period. In particular, the archaeological documentation has been reviewed in the light of a re-reading of the information related to the integrated survey and the various possibilities offered by the 3D environment. The result of all this shows a new and more careful reconstruction of the appearance of the inhabited area, highlighting the various historical phases. Furthermore, it unfolds a storytelling that moves its paces around the great temples, the contextualized pottery and the new features of the Hellenistic houses.

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LOCATION-BASED IMMERSIVE EXPERIENCES AND DIGITAL HERITAGE

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Abstract

Digital technologies have had a transformational impact on modern society with unprecedented social and economic changes taking place within a generation. The so-called millennials generation were born into a world which, in many respects, is completely different to the one their parents and grand-parents were born into. As a consequence, local heritage and traditions may be less relevant to the millennials than they were to their parents and grand-parents.

This oral presentation looks at some of the various platforms and technologies that can be used for location-based digital heritage applications and the ensuing potential benefits to society and education.

LONG-TERM SOFTWARE PRESERVATION: A PRACTICAL CASE

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Abstract

One of the first and most important steps of any adequate long-term digital preservation strategy is the elaboration of an exhaustive inventory of items to be preserved. Indeed, preparing such an inventory is a best practice to be applied by archive owners. The European Space Agency (ESA), through its Heritage Data Programme (LTDP+), continuously applies this and other such best practices in the management of its Earth Observation (EO) data holdings.

In the implementation of its long-term data preservation strategy, ESA – in coordination with other institutional space data archive owners – has concluded that inventories created for this purpose cannot be limited to the raw data that is downlinked from satellites and derived Level-0, Level-1, Level-2 products and auxiliary data. In fact, inventories need to encompass associated information items such as documents, videos and software, just to name a few. The broad consensus in the digital preservation community is that preserving these items in addition to the actual data is fundamental for an effective outcome as it allows target users to understand and use the data several years after it was originally acquired and stored.

Whilst a lot of effort and resources have been dedicated in the last decades to researching, developing and putting in practice formats and techniques for the preservation of data (e.g. self-contained formats like SAFE, HDF or netCDF) and documentation (e.g. FITS, PDF/A), substantially less attention has been paid to the topic of software preservation. This has led to typical situations where data and documentation exist and have been properly preserved but the software used to read and process them has not and therefore costly activities, such as manual porting or complete rewrite from scratch, are necessary for appropriate usage. However, solutions and techniques for software preservation exist that can contribute to more effective overall preservation efforts. One of them is virtualization.

This paper describes work performed at ESRIN, the Italian establishment of ESA, that allowed the preservation of software developed in 2005-2007, for hardware that is now obsolete and unavailable for purchase, so that it is executable today in the absence of the original hardware. The solution uses currently available virtualization technology and the preserved software consists of a virtual appliance that can be dynamically deployed and run on it. As the paper highlights, such an approach can be technology and platform-independent through the reliance on open standards such as the Open Virtualization Format (OVF). Besides the practical purpose of the activity (to preserve the executable outcome of a ESA project), this work serves as a proof of concept for a general software preservation strategy that could be applied by archive owners systematically (e.g. to virtualize a complete Ground Segment for its long-term preservation).

MULTI-TEMPORAL SAR AND OPTICAL CHANGE DETECTION WITH COSMO-SKYMED AND COPERNICUS SENTINELS FOR DIGITAL RECORDING OF CULTURAL HERITAGE AT RISK

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Abstract

It is nowadays common to monitor cultural heritage through Earth Observation data, whenever anthropogenic or natural processes are threatening their conservation and making sites inaccessible. However, only recently heritage practitioners have started combining techniques and data, instead of relying only on a preferred source of information – which mostly consists in very high-resolution (VHR) optical images against a still limited use of satellite Synthetic Aperture Radar (SAR). In the context of the current discussion about Copernicus services for cultural heritage integrating imagery from the Sentinels with those from contributing missions such as the Italian Space Agency (ASI)'s X-band SAR constellation COSMO-SkyMed, we explore benefits and limitations of a multi-technique and multi-platform approach of change detection for heritage conservation. We prove the concept in selected heritage sites across the globe, with regard to: (i) illegal excavations (namely, looting), (ii) anthropogenic disturbance, and (iii) urban sprawl. In Apamea, Syria, bespoke COSMO-SkyMed Spotlight VHR SAR acquisitions at 1-m spatial resolution allowed us to observe changing patterns of looting, to complement time series analysis of tens of cloud-free Sentinel-2 optical images at high temporal resolution. Vice versa, in Nasca, Peru, a systematic COSMO-SkyMed StripMap time series at 3-m resolution allowed precise identification of the extent of damage caused by a truck that incidentally crossed over three linear geoglyphs in early 2018, that Sentinel-2 could barely capture at 10-m . Instead, in Cyrenaica, Libya, Sentinel-2 proved effective to screen wider regions and undertake comparative condition assessment of sites impacted by unregulated urbanization across the landscape.

QUICK AND LOW-COST HIGH RESOLUTION REMOTE SENSING USING UAV AND AIRCRAFT TO ADDRESS INITIAL STAGE OF DISASTER RESPONSE

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Abstract

Recently, the demanded cases of UAVs (Unmanned Aerial Vehicles) have dramatically increased to collect information at the initial stage of disaster. In particular, the practicability of low-altitude aerial photography is increasing along with spreading of SfM/MVS (Structure from Motion/Multi-View Stereo) photogrammetry technique, which arrows us to generate three-dimensional model, point cloud, DSM (Digital Surface Model), and ortho-projection image from multiple pictures [1].

Although UAV can collect high resolution images, its area is limited because of the battery capacity. We have been promoting experiment of high resolution aerial photography using Nagoya city helicopter with commercial reflex digital camera in collaboration with disaster prevention department and fire department of Nagoya city to develop a method to collect information at the initial stage of disaster.

We performed the experiment to compare UAV and aircraft using following instruments.

We use DJI Phantom 4 Pro for UAV. The image sensor of the camera is 20M pixel and 1 inch CMOS type. The focal length of the lens is 24mm (35mm full-frame format equivalent). Max flight speed of Phantom 4 Pro is 72km/h and max flight time is 30 minutes. The battery capacity is 5870mAh and voltage is 15.2V. For the flight planning and automated flight, we use Map Pilot for DJI.

We use Nikon D810 reflex digital camera on the helicopter. The image sensor of the camera is 36.35M pixel and 35mm full-frame CMOS type. Mounted lens is AF-S Nikkor 28mm f/1.8G. The Nogoya city helicopter is Eurocopter AS365N3. Max flight speed is 324 km/h and max flight time is 3 hours and half. Fuel capacity is 1, 158 litter. For the flight planning, we use Mission Planner. During helicopter flight, we show the planned route and present position of the helicopter to pilot using GPS and GIS software.

For SfM/MVS processing, we use Agisoft PhotoScan software.

In an example of the UAV flight, flight time is about 10 minutes, mission time is about 8 minutes, flight altitude from the ground is about 100m, cruising velocity is 5m/sec, and we get 103 images with 80 percent overlap. As a product of SfM/MVS procedure, we get 15.2 hectare coverage area with 2.55 cm/px ground resolution.

In an example of the helicopter flight, flight time is about 1 hour, mission time is about 30 minutes, flight altitude from the ground is about 800m, cruising velocity is 25m/sec, and we get 1466 images with 2 seconds interval shutter. As a product of SfM/MVS procedure, we get 4960 hectare coverage area with 14.5 cm/px ground resolution.

On the other hand, we have been promoting photo-map integration tool that is not depending on SfM/MVS technique.

Recently, UAVs are introduced to lots of Japanese local governments for their disaster response. People gradually recognize that UAVs are quite useful for information collection in the early stage of disaster [2]. However, there is no established method of sharing/utilizing information obtained by UAVs. Although detailed three-dimensional modelling and ortho mapping using SfM/MVS technique are very powerful, there are some problems that should be solved for use in emergency cases: techniques of image processing, time consumption of image processing, and constraints for taking aerial photos.

To approach this situation, we have newly developed the UAV aerial photo sharing web system "UAV oblique photo browser" as a light weight and simple system that is actually useful in the initial stage of disaster [3].

The advantages of oblique photo and the browser comparing with vertical photo or ortho photo are as follows: (1) It is easier to distinguish partial damage of buildings. (2) It is possible to shoot objects and place even when it is difficult to shoot from directly above such as a fire case. Also, the reliance on the skill of UAV operation is low. The operator is able to collect disaster information in the similar way to ordinary use. (3) It is possible to visualize on geographic information system (GIS) quickly and easily. Since high-level processing

such as SfM does not exist in the process, time and special skill are not required for processing. When UAV photos are uploaded to the server, they will be immediately visualized on WebGIS.

In the UAV oblique photo browser, an arrow pointing to camera direction is displayed on the map at the UAV photo taking position. By selecting a location on the webGIS, photographs with its position in the imaging range is filtered using the estimation algorithms of image footprint on a map. By selecting a photo that you are focusing attention, its shooting range is visualized on webGIS and the photo can be magnified and displayed. It is also possible to download photos to local drive.

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THE METHOD OF RAPID ACQUISITION OF FACADE IMAGE AND INTELLIGENT RETRIEVAL OF DECORATION CATEGORY OF CHINESE TRADITIONAL DWELLINGS: TAKING THE RESIDENTIAL ENTRANCE OF LIUKENG VILLAGE AS AN EXAMPLE

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Abstract

In the upsurge of Chinese rural construction, relevant scholars or designers need the automatic classification and intelligent retrieval tools of investigation photos to classify the features of rural dwellings' facade, construct the "style map" of the whole village and region, select the cases of similar styles in the region, and study the fusion and transition among different styles. The image recognition technology which based on the machine learning algorithm has developed rapidly and showed considerable accuracy in biometric and other fields [1], but its application in the analysis of traditional rural architectural styles is still immature, it is a difficult problem to automatically comb and retrieve massive investigation photos and intelligently refine features [2]. The case study on image acquisition and type analysis of residential entrance in Liukeng village (Jiangxi province, China) can break through the bottleneck of image acquisition, and build the whole operation chain from image acquisition to style quantization, which can significantly improve the accuracy and feasibility of classification. Therefore, an open and shared network can be established to achieve the cross-region retrieval and comparison of traditional rural architectural decorative styles and features, which has broad application prospects.

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THE OPEN SOURCE FRAMEWORK OF 4TH GENERATION DIGITAL WORLD HERITAGE SITES: WIKIHERITAGE

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Abstract

Digital World Heritage sites are the services and applications of intellectual assets with specific cultural and scientific values for the history of human beings in the digital publishing era and are an indispensable part of digital Earth. The first generation of Digital World Heritage sites involves the display of digital information using the QR code. The second generation of Digital World Heritage sites emphasizes the integration of digital information management system. The third generation of Digital World Heritage sites uses cloud-based real-time computing technology to enhance digital information (supporting synchronized virtual reality, real-world holographic imagery, etc.), and has been implemented in Paintings Gallery of the Musee du Louvre (2016, France), and the Vatican Museums (2017, Italy), and Hong Kong Science Museum (2018, China).

Here we propose that the fourth generation of Digital World Heritage sites should provide a visitor-and-developer-friendly framework to make the information (type of building, architectural or technological ensemble or landscape which illustrates significant stages in human history, etc.) of all world heritage sites accessible online to all who are interested, while maintaining the features of real-time virtual reality through digital Earth computing technology. WikiHeritage is a Wikipedia-based framework for the fourth generation Digital World Heritage sites, using Docker Compose Technology to construct a fully open, global-based, interactive platform. The United Nations Educational, Scientific and Cultural Organization (UNESCO) has collected and published abundant data of World Heritage Sites, based upon which modern digital display/utilization scheme and management solutions will be implemented. It is important to vision that the fourth generation of Digital World Heritage sites will not be using any single media form, but instead will use multiple technologies to provide stimulating expansion of the real world and opportunities to better present the diversity and flexibility of human society, history, and our relationship with planet Earth. An example of the fourth generation of Digital World Heritage sites has been proposed for the Qingdao Urban Planning Exhibition Center.

It is clear that the fourth generation of Digital World Heritage sites will depend on enthusiastic leadership and active involvements of many young professionals with expertise in diverse fields linking with Digital Earth. The key word in the development of WikiHeritage is "open source". With the rapid development of technology, the arrival of the era of citizen science (the general public is more and more engaged with technology), and the recent advances of scientifi understanding of the Earth system, all are welcome to join and co-lead a global collective effort to realize the fourth generation Digital World Heritage sites in multi-technique and multi-platform approaches for digital heritage.

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THE OPEN SOURCE TOOLS OF DIGITAL THE WORLD HERITAGE SITES: WIKIHERITAGE

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Abstract

Digital the World Heritage sites are the services and applications of intellectual assets with specific cultural and scientific values for the history of human beings in the digital publishing era and are an indispensable part of digital Earth. The first generation of Digital the World Heritage sites involves the display of digital information using the QR code. The second generation of Digital the World Heritage sites emphasizes the integration of digital information management system. The third generation of Digital the World Heritage sites uses cloud-based real-time computing technology to enhance digital information, currently has been implemented in Paintings Gallery of the Vatican Museums, Italy, and Musee du Louvre, France, and Hong Kong Science Museum, China.

Here we propose that the fourth generation of Digital the World Heritage sites should provide solutions which is easy for every one click deployments of complex frameworks and best in class docker support complete online with simulation for real-time synchronized virtual reality, augmentation of real-world, and holographic imagery through digital Earth computing technology. The fourth generation Digital the World Heritage sites could be based on the well-established Wikipedia platform (WikiHeritage has been established), use Docker Compose Technology to construct a fully open, global-based, interactive platform. The United Nations Educational, Scientific and Cultural Organization (UNESCO) has collected and published abundant data of World Heritage Sites, based upon which modern digital display/utilization scheme and management solutions will be implemented. It is important to vision that the fourth generation of Digital the World Heritage sites will not be using any single media form, but instead will use technologies (such as virtual reality, holographic images, real-time interactions with professionals and other stakeholders) to provide stimulating expansion of the real world and opportunities to better present the diversity and flexibility of human society, history, and our relationship with planet Earth. Our science team has been to determine the fourth generation of Digital the World Heritage sites example in Qingdao Urban Planning Exhibition Center.

It is clear that the fourth generation of Digital World Heritage sites will depend on enthusiastic leadership and active involvements of many young professionals with expertise in diverse fields linking with Digital Earth. After developments in technology continue, the era of “big data” has arrived, the general public is more and more engaged with technology through citizen science and crowd-sourcing, and the same time the open source tools behind the world's best startups advances which have been made in our scientific understanding of the Earth system.

We welcome all professionals to join and co-lead a global collective effort to realize the fourth Generation Digital the World Heritage sites in Multi-technique and multi-platform approaches for digital heritage.

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SESSION:
Role of Geoscience and Remote Sensing in a transformed Society

ALTERATION MINERAL DETECTION IN ANTARCTIC ENVIRONMENTS USING LANDSAT-8 AND ASTER SATELLITE REMOTE SENSING DATA

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Abstract

Multispectral remote sensing satellite imagery has high capability to provide detailed mineralogical information for geological mapping in inaccessible regions such in Antarctic environments (Clark et al., 1990). In this study, the applications of Landsat-8 and the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) data were investigated to extract mineralogical information in inaccessible domains. The north-eastern Graham Land, Antarctic Peninsula (AP), Antarctica was selected as case study in this research. A two-stage approach was applied to distinguish pixel and sub-pixel targets in the satellite images. In the first stage, Continuum Removal (CR) spectral mapping tool and Independent Components Analysis (ICA) were applied to Landsat-8 and ASTER spectral bands to map poorly exposed lithologies at regional scale. The second step was established based on target detection algorithms such as Constrained Energy Minimization (CEM), Orthogonal Subspace Projection (OSP) and Adaptive Coherence Estimator (ACE) to ASTER shortwave infrared bands for detecting spectral features attributed to alteration mineral assemblages at district scale. The results of this investigation demonstrated the applicability of Landsat-8 and ASTER spectral data for lithological and alteration mineral mapping in poorly exposed lithologies and inaccessible regions, particularly using the image processing algorithms that are capable to detect anomaly pixels and sub-pixel targets in the remotely sensed images. In conclusion, a simple and robust satellite-based remote sensing approach for geological mapping in inaccessible and poorly exposed regions was established, which is comprehensively applicable for lithological and alteration mineral mapping in the Antarctic environments and hydrothermal ore minerals prospecting in other inaccessible regions around the world.

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BIG DATA FROM SPACE FOR PRECISION AGRICULTURE APPLICATIONS

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Abstract

This paper presents an approach to agricultural area monitoring and to enable precision agriculture at large scale based on the analysis of big data consisting in Satellite Image Time Series (SITS) acquired by ESA Sentinel-2 (S2) satellite constellation. The approach has been developed in the framework of the ESA SEOM - Scientific Exploitation of Operational Missions - S2-4Sci Land and Water project. Two macro challenges are considered: i) automatic update of thematic maps; and ii) unsupervised multi-temporal fine characterization of land plots devoted to agricultural activities.

Applications of remote sensing in agriculture benefit from the prior knowledge about which areas are dedicated to agricultural activities. However, landcover maps are seldom updated and ground reference data seldom available at large scale. To compensate for these limitations, existing thematic products are employed as an information source for extracting weak labeled training samples. Thematic information is then updated both in time and space, and effectively upscaled to the desired spatial resolution (in this case the one of S2) by means of the weak labeled training samples and multitemporal remote sensing images. Agriculture-related classis from the thematic maps are then ingested by a module for multi-temporal fine characterization of agricultural fields. The module is flexible and adaptive. It effectively handles massive data quantities from long SITS of remote sensing images to identify single crop fields and perform phenological parameter extraction at parcel level with a fine characterization in space and time. These parameters are used to build crop parameter maps and informative layers to be employed from the conductors or administrations for precision agriculture management initiatives.

COMBINED REMOTE SENSING SATELLITE DATA FOR MAPPING ALTERATION ZONES RELATED TO ZN-PB SULFIDE MINERALIZATION

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Abstract

The Franklinian Basin of North Greenland has a unique potential for exploration of world-class zinc deposits (Kolb et al., 2016). In this investigation, the application of a combined satellite-based remote sensing approach using Landsat-8, Phased Array L-band Synthetic Aperture Radar (PALSAR) and Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) data was investigated for zinc exploration in the trough sequences and carbonate shelf-platform of the Franklinian Basin. Robust image processing algorithms were implemented for detecting spatial distribution of pixels/sub-pixels related to key alteration mineral assemblages and structural features that may represent potential undiscovered Zn-Pb deposits. Fusion of Directed Principal Component Analysis (DPCA) and Independent Component Analysis (ICA) was applied to some selected Landsat-8 mineral indices for mapping gossan, clay-rich zones and dolomitization. Major lineaments, intersections, curvilinear structures and sedimentary formations were mapped and highlighted by application of Feature-oriented Principal Components Selection (FPCS) technique to cross-polarized backscatter ratio images of PALSAR data. Mixture Tuned Matched Filtering (MTMF) algorithm was applied to ASTER VNIR/SWIR spectral bands for subpixel detection and classification of alteration minerals such as hematite, goethite, jarosite, alunite, gypsum, chalcedony (hydrous-silica), kaolinite, muscovite, chlorite, epidote, calcite and dolomite in the prospective targets. Using the remote sensing approach several high potential zones characterized by distinct assemblages of alteration minerals and geological structural trends were identified that may represent potential undiscovered Zn-Pb deposits in the trough sequences and carbonate shelf-platform of the Franklinian Basin. This investigation establishes a straightforward/cost-effective satellite-based remote sensing approach for reconnaissance stages of mineral exploration in hardly accessible parts of the High Arctic environments.

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COMPARISON OF CLASSIFICATION ACCURACIES FOR PLANET AND WORLDVIEW-3 SATELLITE IMAGES TO PRODUCE LAND USE / COVER MAPS

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Abstract

The purpose of this study is to compare classification performances of Planetscope and Worldview-3 satellite images and to determine how classification accuracy might be improved in conjunction with additional spectral bands and higher spatial resolution of Worldview-3 satellite image. In addition, it is explored whether Planetscope image is adequate or not for producing an accurate thematic map. The study area covers approximately 15634 ha area, including 7 land cover classes, that are water, vegetation, agricultural area, reeds, soil, barren land and rural area. As known, satellite images having low or medium resolution, might be inadequate to extract such a detailed information, hence, high resolution satellite images are required. In this study, Planetscope and Worldview-3 were used as the satellite data. Planetscope satellite image, which has high spatial and temporal resolution, has 4 spectral bands with 3.0 m spatial resolution. Planetscope satellite image belongs to Planet constellation, which has approximately 120 doves, with the aim of monitoring entire Earth daily without any gap. The reason of choice of Planetscope satellite image is its ability to provide cloudless images. The reason of choice Worldview-3 image is its high spatial and spectral resolutions, that are 2.0 m spatial resolution and 8 spectral bands, respectively. The four of spectral bands are additional bands, including coastal, yellow, red edge, and NIR2. For classification, Random forest and Nearest neighbor methods were considered as object based classification methods in order to produce land use / cover thematic maps. Firstly, segmentation process was applied to satellite images. To train the aforementioned classifiers, training samples were directly collected from the field with GPS and field spectroradiometer. It should be noted that Worldview- 3 image cannot be acquired on the field survey day due to the cloudy weather conditions. Thus, it was acquired two weeks later than the field survey day. However, Planetscope image can be acquired on field survey despite of cloudy weather conditions. To evaluate the classification results, precision, recall and F1 score metrics were used as criteria. The thematic land use / cover maps, including all the classes, were produced, accordingly, and the results obtained on the test dataset showed that both satellite images are adequate for discriminating these seven classes and classification accuracy of Worldview-3 satellite image is higher than those of Planetscope satellite image.

DEVELOPING STANDARDS FOR EARTH OBSERVATION DATA PRODUCTS

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Abstract

The increasing demand for Earth Observation (EO) data to support environmental monitoring, to anticipate and respond to natural disasters, to inform decision making and to assist citizens in their daily activities poses a requirement for EO data to be accessible, user-friendly, and easy to merge when coming from different data sources. This presents an opportunity for industry, professional associations, and national standards bodies to work together to define standards that will help improve the generation, distribution and utilization of EO data. The IEEE Geoscience and Remote Sensing Society (GRSS) has created the GRSS Standards for Earth Observations Technical Committee (GSEO TC) to bring diverse stakeholders together to develop and promote standards that will help advance the usability and uptake of remote sensing products to address user needs. The GSEO TC, which consists of experts from remote sensing companies, research institutions and national standards institutes, has sponsored Projects that are working on standards for the characterization and calibration of hyperspectral (250 nm to 2500 nm) imaging devices (P4001), metadata content and data encoding standards for Synthetic Aperture Radar (P4002) and GNSS Reflectometry (P4003) products, and procedures and terminology related to the calibration of passive microwave radiometers (P4004). An additional study group is investigating the potential for standardizing how radio frequency interference (RFI) encountered by satellite systems is reported. Work is being done in an open and transparent manner while leveraging scientific research and practical experience to codify the optimum technological procedures and specifications for the application of new technologies.

DIGITAL APPROACH TO FOREST COVER MAPPING: A CASE STUDY OF FOREST-TUNDRA IN NEAR-YENISEI SIBERIA

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Abstract

Remote sensing data (RSD) are widely used for vegetation mapping in combination with analysis of topographic and climatic factors, which have an effect on vegetation spatial patterns. Mapping is an effective method to monitor vegetation cover changes, it is especially important for large remote areas of Siberia.

The objective of this study is to develop an approach to vegetation cover mapping based on RSD, digital elevation model (DEM), forest inventory data, and ground data using GIS-technology.

We developed an algorithm of semi-automated creation of vegetation cover maps, which includes four main steps.

1) Inventorization and classification of current vegetation cover using principles of Kolesnikov's dynamic classification. According to these principles, vegetation cover were classified based on similarity of vegetation growth conditions [1]. This classification is being a basis for developing of the map legend.

2) An automated classification of potential vegetation growth conditions (VGC) based on the analysis of DEM, climatic, orographic, soil, and hydrological factors [2]. Development of a map of potential VGC with help of Knowledge Engineer Module [3]. The decision tree inputs are the raster layers of the spatial distribution of morphometric and climatic parameters. A layer of potential VGC types is a basis of vegetation cover mapping.

3) Automated classification of Landsat-8-OLI images by the method of maximum likelihood to identify land cover classes based on spectral characteristics. Interpretation of the obtained classes as vegetation types and their complexes with help of field data.

4). Development of the map of vegetation cover based on Decision Tree Classification with help of Knowledge Engineering Module [3]. The inputs of the expert classification are the layer of satellite imagery recognition and raster layers of potential VGC map.

According this algorithm, we developed the thematic maps of the test area in the north of near-Yenisei Siberia.

The test area (68º20' - 68º30' N, 88º30' - 89º00' E) is partly in the forest-tundra and partly in northern taiga subzones. The area contains various vegetation types, which are combined to make tundra, forest-tundra, taiga forest, and bog complexes. Forests occupy not more than 15-20% of the area.

A map of potential VGC was developed based the analysis of DEM and DEM-based topological profiles. The map shows hierarchical units of growth conditions classification - 7 geomorphological complexes of growth conditions (GMC) and 21 types of vegetation growth conditions (VGC). VGC types were identified for each GMC based on slope angle and elevation above sea level. A layer of potential VGC types was created to serve as a basis of vegetation cover mapping

We obtained a total of 43 land cover classes from classifying RSD and they were interpreted as a following: 17 classes of forests and woodlands, 10 classes of forest-bog complexes, 8 classes of tundra, 4 classes of bogs, 1 class of tundra-forest complexes, and 3 classes of stone runs. The initial classes were distributed using a layer of VGC types with help of the expert Decision Tree Classification. As a result, the vegetation types and their complexes obtained totaled 16 and described in a legend.

The accuracy of the vegetation cover map obtained was estimated through Kappa analysis [4]. An overall Kappa coefficient is 0.79.

With this approach, quantitative characteristics of environmental factors were used to identify the sites with relatively similar VGC. This allowed us to identify land cover units, relatively homogeneous by climatic, orographic, edaphic, and biotic parameters.

The combined use of automated methods and expert interpretations of the classes obtained allowed us to map the vegetation cover characteristics (VGC types, forest types, forest-tundra, forest-bog complexes) directly unrecognizable in space images, but very important for thematic mapping.

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DIGITAL EARTH AND MAIN CONANDRUM OF CARTOGRAPHY

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Abstract

Concept of Digital Earth makes possible scale-less and projection-less processing and visualizing of geospatial data and, therefore, could be regarded as an “impossible thing” for classical cartography. Digital Earth unveils the internal, unrecoverable limitations of the cartographic method caused by its basic principles – data generalization and using of cartographic projection.

It has already been shown that achievement of scale-independency and projection-independency was the result of the use of images (more correctly, remote sensing data) instead of classical vector cartographic signs as a carrier for the geospatial context [1].

Vector data of different topology (points, polylines, polygons, 3D-objects) is the ultimate carrier for the representation of geospatial features on maps. Also, vector data used for generation of scalar data – for example, calculating of areas of countries, lengths of coastlines, as well as secondary scalar data (densities of parameters, relative values, etc.). From the point of view of classical cartography, there are two possible carriers for the representation of correct geospatial information: 1) vector data, and 2) scalar data. Combination of vector and scalar geospatial data is a backbone of the map-based decision-making.

However, vector data are not an attribute of geospatial objects themselves and do not characterize them, but rather their replicas, given to a certain map projection and a certain scale only. Vector borders of same geospatial features in different scales will be different inevitably, therefore their scalar characteristics will be different as well, and in some cases, these values will not converge to any reasonable limit. This paradox, well-known as a “coastline paradox”, is caused by fractal nature of geospatial features, and was explained more than half century ago [2]. In addition, this effect is amplified by temporal dependence and variability of geographical parameters – for example, periodic displacement of the “fuzzy” coastline due to tidal and other influences. Thus, using of geospatial data in a form of signs – both vector and scalar – leads to inconsistency, wrong decision making, isolation of tiers of hierarchically organized decision making and governing systems, makes impossible free transitions of geospatial data from scale to scale, and, consequently, ultimately undermines sustainable development. It means that signs (both in vector and scalar forms) are a methodically incorrect representation of geospatial features, since they are characterized only scale-dependent and projection-dependent replicas of geospatial features, not features by themselves. In other words, cartographic signs are not able to support critically important topological relationships – an inter-scale topology.

The irreconcilable contradiction between the inevitability of the use of cartographic signs in cartography and their fundamental methodological incorrectness can be described as the main conundrum of cartography.

Instead, Digital Earth clearly demonstrates ability to provide inter-scale topology of geospatial data because of using of images instead of cartographic signs as a carrier for meaning. This contradiction could be resolvable with the help of images.

More interestingly, what this geospatial conundrum exactly repeats the paradox of "quadrature of the circle" in geometry that was resolved more than two thousand years ago. That paradox was resolved by the means of developing of fundamentally new type of data - irrational numbers. It is now necessary to recognize the fundamental impossibility of using cartographic signs as carriers of geospatial information. Geospatial conundrum could be resolved in the Digital Earth paradigm by using of images as a ‘sign-less’ transport for the geospatial context.

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ELECTRICITY DEMAND MONITORING IN JAPAN BY USING TIME-SERIES DMSP STABLE LIGHTS IMAGES AND ITS APPLICATION TO LONG-TERM DAMAGE ASSESSMENT OF NATURAL DISASTERS

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Abstract

This paper demonstrates the potential of the Defense Meteorological Satellite Program/Operational Linescan System (DMSP/OLS) stable light imagery for electricity consumption (EC) estimation in Japan and long-term damage assessment of natural disasters in term of yearly EC fluctuation, taking the Japan Earthquake & Tsunami of 2011 as a case study. The DMSP stable light imagery has been widely recognized as a useful tool for estimation of economic variables such as GDP, EC, population [1]. However, while DMSP stable light data is proved successful for single-year estimation of the economic variables, the use of this data is still limited in the time-series domain. This is due to several well-known problems with the DMSP including lack of on-board calibration [1], geometric error [2], sensor saturation [1]. Researchers have spent much efforts on methods for intercalibration and saturation correction of DMSP stable light data [1], however surprisingly much less efforts on geometric correction method which should be the first in the preprocessing chain and is currently needed [3] [4]. In regard to long-term relation between economic variables (EC, GDP, Population) and DMSP nighttime lights, it has been categorized into GDP-centric countries (nighttime lights positively correlates with GDP but not population) and Population-centric countries (nighttime lights positively correlates with population but not GDP). These kind of analysis for Japan are lacking. Furthermore, in term of disaster management, the 2011 Great Earthquake & Tsunami in Japan had severe instant and long-term damages, and DMSP data is potential for long-term damage assessment for the region. To conclude, in this study we have: (1) developed a new geometric correction method for DMSP stable light images which resulted in better correlations between DMSP stable light images of the same year as compared to those of original images and most recent shift-based geometric correction method [2]; (2) developed an EC estimation method from corrected DMSP data which is then used to derive electricity demand maps for Japan from 1992-2013, a correlation value R-squared of 0.92 is achieved between census EC and total DMSP sum of lights (SOL) for the period of 1992-2013; (3) performed analysis of correlations between DMSP night light data and GDP and population in Japan, it is found that Japan is a population-centric country with R-squared values of 0.9 (SOL vs total population) and 0.17 (SOL and GDP). However, a deeper analysis reveals that while the total GDP has poor correlation with SOL, there are GDP components which have positive correlations with SOL including government consumption (0.71), domestic consumption of semidurable goods (0.76) and services (0.77) and several others; (4) a long-term damage assessment of the Japan Earthquake & Tsunami of 2011 by using the EC maps in (2) was conducted. It is found that an area of 286.208 km-squared has sufferred from the disasters. It caused the EC of the area drop significantly in 2011 (-42%) and to its lowest level in 2012 (-78%) before starting its recover in 2013. In conclusion, this study showed potentials of nighttime lights data for (1) electricity demand estimation in large scale which could then be used to provide demand-side information for power-grid system modelling, and (2) quick and low-cost damage assessment of disaster.

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EXTRACTION OF GLACIERS LAKE SURFACE THROUGH DIFFERENT INDICES USING REMOTE SENSING IMAGERY FOR PAKISTAN

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Abstract

Extracting the glaciers lake surfaces with remote sensing imagery has been important in glaciered regions. Glaciers lakes are still threats to infrastructure, livelihood and local community. One of the most difficult task is to distinguish the glaciers, glaciers lakes and dry from dry land. Remote sensing imagery is most widely used for water resources in remote area and monotonious regions. Several techniques were used to extract the glaciers lake surface using Landsat imagery. In this study, the glaciers lakes were extracted by different indices. Automatic glaciers lake mapping, normalized different water index and modify normalized water difference index with on screen digitization (1, 2). The Landsat 8 datasets are used to extract the glaciers lakes surface for 2018 in Hunza River Basin, Pakistn. The numbers of glacial lakes in Hunza were found 110 in 2001, which increased in 2005 upto 141. During the 2001, the one major lakes were found to be glaciers lakes outburst flood history. Similarly, it was found the noticeable increased in glaciers lakes from 2001 to 2005. During the 2013, the glaciers lakes expansion found to be decreased but increased the lakes. Recently, glaciers lakes are increased as compared to 2001. The number of major lakes in 2018 found similar trends as 2001, 2005, 2013. The expansion major Glaciers lakes outburst flood lake in 2018 increased as compared to 2005 based on the empirical approach. Therefore, AWEI and MNDWI result were found to more significant for this region.

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GLACIER AND GLACIAL LAKE CHANGES IN THE MT. XIXIABANGMA AREA USING MULTITEMPORAL LANDSAT IMAGES SINCE 1988

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Abstract

Glaciers in the Himalayan region have experienced severe thinning and retreat under warming in recent decades, which increases risk of glacial lake outburst floods (GLOFs). Himalaya is labeled as one of the most GLOFs-vulnerable region in the world. To improve our ability of risk assessment and mitigation countermeasures, changes of glaciers, glacial lakes and their relationship should be acknowledged. In this study, we used Landsat TM/ETM+/OLI images to survey glacier changes and glacial lake development since 1988 in the Mt. Xixiabangma region. Our results displayed that glaciers have generally experienced retreat, and the number of glacial lakes has greatly increased with some in quick expansion. Ice-contacted lakes have greatly expanded. More attention should be paid to these lakes in continuous expansion due to their high risk of potential outburst. Compared with precipitation variation, temperature rise plays a more important role in glacier and glacial lake changes.

HISTORICAL LAND COVER CHANGES AND EMERGING GLOBAL LAND COVER PATTERNS UNTIL 2050: THE CASE OF ESA-CCI-LC DATASETS

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Abstract

Global land cover maps have been the main source of monitoring global landscapes for diverse applications e.g., food production, urbanization, deforestation, air/soil/water pollution, and climate change. Several attempts have been made to generate global land cover maps driven from remote sensing data and in-situ data e.g., IGBP-DISCover, GlobeCover 2009, FAO, GLC2000, MODIS, GlobeLand30 [1]. Understanding the trend of global land cover changes as well as the direction of future changes is of outmost importance to a broad spectrum of stakeholders, and essential for addressing the sustainable development goals worldwide. European Space Agency has recently released a new dataset called CCI-LC at 300 m spatial resolution and 24-year continuous temporal coverage within 1992-2015. The main objective of this study is to quantify the global land changes within this timeframe and also to predict the future land change by 2050. This is a timely objective since more than ever scientists and environmentalist need to know how our planet will look like in future. Our findings reveal substantial land changes of different kind e.g., deforestation, urbanization, desertification, forestry, water and ice shrinkage across different continents. Our predictive modeling for year 2030 and 2050 messages dramatic changes among different land cover types. Our discussions and conclusions can guide policy-makers, environmental planners, ecosystem services analysts, and climate change researchers to gain finer insights about our resources. Future research direction draws attention for investigating the underlying causes and consequences on our ecosystems and human population.

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IEEE GRSS INITIATIVES TO SHARE, UNDERSTAND AND ANALYZE EO DATA

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Abstract

The role of Earth observation data in the context of Digital Earth is very relevant, and it is strongly correlated with the possibility to share, understand and analyze these data in an agreed and somehow "standardized" manner. To this aim, the IEEE Geoscience and Remote Sensing Society ha undertaken many initiatives, aimed at building an agreed framework for sharing data sets, but also results of data analyses.

The first initiative is the GRSS Data and Algorithms Standard Evaluation (DASE) platform, which has been designed in order to host the very successful annual Data Fusion Contest organized by the Image Analysis and Data Fusion Technical Committee. The platform provides a set of community data sets and algorithm evaluation standards for use by the Earth observation community to support research, development, and testing of algorithms for remote sensing data products. The website is aimed at remote sensing scientists, students, and professionals, who wish to evaluate the performances of their image analysis methods on freely available data against undisclosed test samples. Currently, automated online evaluation of classification results from sample hyperspectral datasets is supported. The system is envisioned to grow to encompass more remote sensing modalities and types of processing results.

The second initiative is the new GRSS Standards in Earth Observation (GSEO) Technical Committee. The GSEO mission is to advance the usability and uptake of remote sensing products by convening experts from academia, industry and government to create and promote standards and best practices. Working groups identify where standardization can improve the generation, distribution and utilization of interoperable data products from remote sensing systems and then work with existing Standards Development Organizations such as IEEE, OGC and ISO to publish standards that will be widely adopted.

Additionally, GRSS provides a Code Library. The Remote Sensing Code Library (RSCL), is an IEEE GRSS initiative aimed at establishing a large family of remote sensing computer codes-- contributed by members of the remote sensing community and their host institutions—that can be shared by other members of the community, not only to verify and extend published results, but also to reduce the duplication of time and effort invested in the development of these codes. RSCL invites researchers to submit their codes, which will then be reviewed by an Editorial team to insure relevance and quality. Accepted codes become citable in the literature, just like journal publications; when an individual uses a code from the RSCL to generate results and then includes them in a journal or symposium publication, that user is expected to cite the code and its authors.

IMPROVING INFORMATION EXTRACTION IN EO BIG DATA BY IMAGE SELECTION BASED ON CAPACITY INVESTIGATION

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Abstract

Recently, there has been a surge of interest in Earth observation (EO) Big data systems in Earth science and environmental engineering. In fact, given the possibility of digging deep into the description of environmental characteristics provided by the diversification of the information to be processed, it is expected to obtain detailed information extraction on the environmental phenomena, leading to a thorough quantification of the Earth surface components and elements. However, processing more data and records does not always result in a better characterization of the environmental properties. Indeed, it is true that in an actual estimation scenario it is not possible to guarantee that the estimation model is correctly specified due to measurement or estimation imperfections. This effect is even more evident in a multimodal analysis set-up, as the differences in time, space, spectral, and radiometry resolutions might affect the correct alignment, labeling and reference of the records to be processed.

Naturally, this leads to the investigation of multimodal remote sensing ability to extract accurate and reliable information from a set of heterogeneous records [1, 2]. This study is instrumental to understand the limits of multimodal remote sensing analysis, as well as to quantify the actual benefits that such an analysis can provide to the characterization of phenomena occurring on Earth surface. In fact, the capacity of multimodal remote sensing information extraction varies depending on the assumptions that are made on the feature statistics and the knowledge of the sample distribution [3]. In order to obtain the best information extraction performance from multiple images, it is expected that the multimodal estimation procedure would ideally weight the inputs coming from the multiple image processing, so to make best use of the relevant information collected by the different scenes. This results in an adaptive scheme that would achieve optimality in information extraction, but that might be too complex to implement if not perfect knowledge of feature distributions and pixel noise statistics is available [4].

By means of an information theory-based approach [5], it is possible to compute the actual bounds for maximum information extraction that a given EO Big data system can achieve in terms of reliability and accuracy. Such an analysis is instrumental in order to obtain during preprocessing an estimate of the best performance of information extraction any EO analysis can achieve. Thus, assessing maximum reliability and capacity of the considered multi-image framework would lead to a thorough understanding of the best subset of data that should be used to achieve the maximum information extraction. Hence, it would be possible to understand what images are actually providing information on the considered scene, so the best use of the remote sensing data pool can be made for the given analysis. In this work, we design an automatic architecture for image selection that is able to extract the subset of images from EO Big datasets that would allow to achieve the best information extraction performance. Experimental results obtained over real datasets display the practical benefits provided by the proposed approach.

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LOOKING FORWARD, THE DIGITAL FUTURE IS UPON US: EARTH OBSERVATION AS A PIVOTAL ELEMENT FOR NEXT GEN EDUCATION AND EMPLOYMENT

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Abstract

Humans are inextricably tied to the earth where sustainability is imperative to the survival of our species. With a projected population growth to 11 billion by the end of this century, Digital Earth platforms and technologies, particularly earth observation using remote sensing at all spatial and temporal scales, will play an important role in meeting the needs of society, whether related to energy, forecasting and recovery from natural disasters, impacts from climate change, or ensuring that resources of the natural environment remain viable for future generations [1]. Given this pivotal role of Digital Earth technologies, we should be concerned about the production of an educated workforce who are skilled up to meet the challenges that lie ahead.

The shape of the future workforce is currently the subject of intense scrutiny as we cross a threshold into quite a different industrial revolution, one that will create new types of employment opportunities, reduce or eliminate some current jobs [2], and demand the ability of the workforce to adapt as rapidly as the technology itself [3, 4]. An innovative mind and skill set is required for future workers [5, 6], particularly as the entire concept of 'work' is projected to change dramatically [6] spawning a "new work mindset" comprised of new job clusters [5] which embrace spatial technologies. Earth observation is paramount to science-based approaches to sustainability and solutions to mounting environmental problems. Remote sensing is at the cutting edge of, e.g. weather crisis events, temporal oil spill detection, crop prediction and spatially-explicit ethnographic inputs using Big Data [7, 8]. Earth observation is now embraced by all disciplines in some way, presenting a paradigm shift in how we view the world.

Ultimately the challenge is to recruit students into the spatial sciences to embrace the digital Earth. By aligning education with industry needs, altering curriculum to produce desired knowledge and skills, we can form passionate leaders who find ways to make things happen. This paper will present future earth observation job opportunities and showcase innovative curriculum transformed to produce graduates who will have the ability to infer from remote observations of the environment, solve problems which require spatial and temporal interpretation, understand uncertainty and the need for multiple lines of evidence to arrive at a conclusion.

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MONITORING OF THE ACTIVE LAYER THICKNESS OVER THE QINGHAI-TIBETAIN PLATEAU PERMAFROST REGION

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Abstract

Permafrost is one of the largest elements of the terrestrial cryosphere and is extremely sensitive to climate change. Changes of permafrost not only affect regional and global water circulation, carbon deposit and climate warming, but also influence ground ecological, geophysical, and biogeochemical processes in cold regions. The permafrost region of the Qinghai-Tibet Plateau is the highest and largest permafrost area in the middle and low latitudes of the world. The Qinghai–Tibet railway, from Xining to Lhasa, is 1956 kilometers long, including a length of 550 kilometers over the permafrost region. The region along Qinghai-Tibet Railway is selected as our study region. In order to monitor the active layer over the study region, the surface deformation pattern can be analyzed by the C-band SAR data of the Sentinel-1 satellite and the L-band SAR data of the ALOS satellite, with the help of PS-InSAR and D-InSAR. The well-received Stefan model is applied to simulate the active layer depth based on the land surface temperatures (LSTs) data acquired from the Moderate Resolution Imaging Spectroradiometer (MODIS) and soil thermal parameters. Surface deformation and ground temperature data from the borehole monitoring along the railway were used to validate the results. The estimation results from the InSAR deformation observation and Stefan model are in good agreement with the in-situ measurement.

OBIA APPROACH AS SUPPORT TO VEGETATION CHANGE TRACKER ALGORITHM FOR QUANTIFYING VEGETATION CHANGES IN A MEDITERRANEAN COASTAL ECOSYSTEM

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Abstract

Mediterranean coastal dunes constitute an irreplaceable ecosystem for mankind, since they guarantee human well - being and environmental survival, protecting coastline from storms, nutrient cycling and recreation. Moreover, over the last few years, they have assumed increasingly relevant socioeconomic importance thanks to their capacity to address social needs emerged after the end of the II World War, such as, for instance, the exponential growth of population, new life styles and wide economic interests. Therefore, their landscape has been gradually moulded by a strong anthropic pressure prompting a series of phenomena of soil degradation, i.e. erosion, contamination, salination and fragmentation of ecosystems.Consequently, coastal dunes are recognized as highly endangered ecosystems and the European Commission is trying to sensitize the Member States to detect proper coastal management and planning approaches.To contribute to such a purpose, a deep knowledge of land cover changes and, consequently, of vegetation modification trends is required. Therefore, this research is intended to analyse and quantitatively reconstruct the history of vegetation changes in the experimental area of Santa Margherita di Savoia, in Puglia Region (Southern Italy), by combining the Object BasedImage Analysis (OBIA), for classifying a dense Landsat time series stack, and vegetation change tracker (VCT) algorithm.

The experiment was conducted in the biggest salt flat of Italy, which covers a straight spit of land of 20 x 5 km2. Its soil is predominately clay, characterized by a highly imperviousness. For these reasons, it has represented a natural habitat for the proliferation of water vegetation and for both migratory and resident birds. Therefore, it has been recognized as a natural reserve created in 1977.

A dense time series Landsat data over forty – years period, with a cloud cover less than 10 %, was acquired and, subsequently, radiometrically and geometrically corrected using PCI Geomatica software. The pre-processed images were separately segmented applying two steps procedures: the former was used to identify general land cover classes, while the latter was aimed to refine it. Subsequently, they were processed through the application of a decision tree classification in eCognitionDeveloper 9 (TRIMBLE Germany Gmbh)environment. The class rules were interactively set, visually interpreting threshold values based on training data and pre-existing maps.The OBIA approach was preferred to the pixel-oriented method because of its ability to increase the classification accuracy since it exploits both spectral and spatial information. Classification accuracy was assessed at object level through an error confusion matrix.

The vegetation monitoring was carried outdeveloping a proper vegetation change tracker (VCT) algorithm, based on the analysis of spectral temporal information. Indeed, to meet this purpose, a time-series trajectory was defined and analysed in order to produce vegetation change maps.

Detailed classification maps of coastal vegetated areas were generated by processing of each image. Therefore, area of interest was split in three categories: open sand dunes, sparse coastal vegetation and dense coastal vegetation. Subsequently, the obtained classified maps were compared in order toquantitatively reconstruct the trend ofvegetation changes. Maps comparison showed a reduction of vegetation amount.

Research results arepromising, although they could be drastically improved using high resolution satellite images, able to map in detail the landform of the study area.

RESEARCH AND DEVELOPMENT OF SPATIALLY MEASUREABLE 3D GEOGRAPHIC INFORMATION MANAGEMENT PLATFORM FOR PEARL RIVER ESTUARY

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Abstract

In recent years, as maritime management gradually become information technology oriented, needs for complex GIS information services grows at a fast pace. Our research builds on the foundation of traditional GIS fields, and applies latest intergrated multidimensional geo-survey and information management technologies to develop a spatially measureable GIS management and decision-making support system. With the use of 3D Modeling and Virtual Reality applications, our research aims to achive more standardized, automatic and percision focused maritime management of shipping, safety, risk control, decision making, etc. We then use Pearl River Estuary as our case study to demonstrate the efficiency and benefits of such system.

SIMULATION OF THE COVERAGE OF THE COMPLETE EARTH FROM MULTIPLE SATELLITES IN GEOSTATIONARY AND POLAR ORBITS

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Abstract

This project aims to investigate the viability of a satellite constellation that can provide full Earth imagery of all portions of the dayside and nightside simultaneously with an update period as short as 5 minutes. We apply orbital simulation software based on well-defined characteristics of existing geostationary Earth observation satellites (e.g. GOES, Meteosat, Himawari) in order to determine the latitude at which pixel resolution growth becomes too high to represent a GSD of 1km. Polar viewing orbits, primarily Molniya and Tundra, are considered to target these uncovered regions and determine how best to achieve full Earth coverage over the period of a year. The results of these simulation studies will determine their total coverage, FoV, and number of satellites required, and hence the optimum configuration for the constellation. The images provided by the system aim to be representative of what could be observed by the human eye, for this reason viability of a 4K RGB Bayer colour filter sensor is assessed along with the required optical system. Furthermore, dynamic range will be investigated to determine whether it is feasible to cover the 12 orders of magnitude in radiance (from first approximation) of spanning the terminator to radiometrically resolve both the sunlit Earth (200W/cm2/sr) and the faintest airglow/night-time light features (0.2nW/cm2/sr). The culmination of orbital simulations and definition of sensor characteristics will provide the information to produce renderings, using 500m resolution RGB data, to represent what would be seen from the chosen configuration including night-time light, aurora and cloud overlays.

SPATIOTEMPORAL VARIATIONS AND REGIONAL DIFFERENCES OF EXTREME CLIMATE EVENTS IN THE COASTAL AREA OF CHINA

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Abstract

Within the context of climate change, extreme climate events have occurred frequently. Extreme climate events have more significant and stronger impact than average state on social-economic development and ecological environment evolution [1-3]. The coastal area of China (CAC) is a region with high ecological vulnerability and is extremely sensitive to global climate change. Extreme climate events such as typhoon, storm surge, heavy rain, heat waves and drought occur frequently in the coastal area of China, resulting in grave consequences in term of sea level rise, sea water intrusion, urban waterlogging, reduction of agricultural and sideline production and so on, affect the regional socio-economic sustainable development directly, which poses a huge challenge and a serious threat to the ecological and environment protection and people's living conditions [4-9].

Based on daily temperature and precipitation dataset of 156 weather station records from 1961 to 2014 in the CAC, 27 extreme temperature and extreme precipitation indices were calculated, and then the extreme climate events' characteristics on terms of change trend and its persistence, periodicity, abruptness and spatial pattern were investigated comprehensively and thoroughly using a set of mathematical and statistical methods including trend analysis, Morlet analysis, Mann-Kendall test, accumulative anomaly analysis and Pettitt test.

Results showed that an upward trend in warm extremes and a downward trend in cold extremes as well as diurnal temperature range. The decadal trend rates of the night extremes were obviously higher than those of the day extremes in the CAC. Generally, a decrease was observed in the multi-year averages of the frost days, ice days and diurnal temperature range, and an increase was observed in the mutil-year averages of the summer days, tropical nights, minimum value of daily maximum temperature, minimum value of daily minimum temperature and growing season length from north to south. However, a little variation was observed in the multi-year averages of the cool days, cool nights, warm days, warm nights, maximum value of daily maximum temperature, maximum value of daily minimum temperature, cold spell duration index and warm spell duration index between the sub-regions and the entire coastal area of China. The primary period of extreme temperature indices varied from 2 to 8 years in the sub-regions of the CAC, and no significant decadal period was detected. The mutation time of extreme temperature indices occurred mainly in the 1980s and the 1990s in all sub-regions. Additionally, the cold extremes and minimum values of daily maximum (minimum) temperature mutated earlier than those of the warm extremes and maximum values of daily maximum (minimum) temperature. After mutation, the extreme warm events and extreme value events tended to occur frequently, whereas the occurrence of extreme cold events decreased gradually.

And as respect to extreme precipitation events, it showed that there was a generally insignificant upward and downward tendency of extreme precipitation events in the southern and northern coastal area, respectively. Persistent of tendency suggested that trends of extreme precipitation events in Huabei, Huanghuai, Jiangnan and Huanan coastal areas would continue but trends in Dongbei and Jianghuai coastal areas would mostly present contrary to the past in the future. Multi-year averages of all extreme precipitation indices except consecutive dry days varied largely in the CAC, generally highest in Huanan coastal area and lowest in Huabei coastal area. The primary period of extreme precipitation indices varied from 2- to 7-year in the sub-regions. The abrupt change of extreme precipitation indices occurred mainly in the 1990s and the 1970s in the CAC.

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SUITABILITY ASSESSMENT AND VALIDATION OF SNOW LEOPARD HABITAT BASED ON MULTI-SOURCE DATA FUSION TAKING THREE-RIVER-SOURCE NATIONAL PARK FOR EXAMPLE

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Abstract

Snow leopard, as a typical cat with the highest elevation distribution in the world, is the top species in the mountain food chain of plateau. Known as the "King of Snow Mountain", it has been listed in the national first-level list of protected animals and the international red pape. snow leopards are only distributed in 12 countries such as China, Mongolia, Russia, Pakistan and India [1]. China is the world's largest snow leopard distribution and the largest number of countries [2]. In China Three-river-source national park is the most mainly concentrate region for snow leopard. In recent years, successive habitats have been divided into fragmented surface. Snow leopards face enormous threats to their survival, but continuous monitoring is not easy [3]. A lot of research work about snow leopard has been carried out [4-12].

In this paper, multi-source data fusion technology [13] was proposed to assess the suitability of snow leopard habitat from the perspective of geography. The suitability of multi-factor habitat was evaluated including terrain conditions, ecological landscape and human activity factors. The variables affecting the habitat suitability distribution of snow leopard include the three categories. The first one is the variables related to topographic conditions, such as elevation, slope, aspect, landform type, smoothness coefficient. The second one is the variables related to ecological landscape, such as vegetation type, fragmentation, habitat quality index. The third one is the variables related to human activities, such as distance from road, distance from open-pit excavation site, functional distinction. Then Habitat suitability evaluation model based on multi-factor fusion has been constructed.

Then, suitability grade assessment of snow leopard habitat is based on the numerical results of the suitability evaluation of snow leopard habitat, and its quantitative value is graded qualitatively. In order to evaluate the suitable classification results of snow leopard habitat more comprehensively, in this paper three evaluation models: classification accuracy evaluation model, classification overall accuracy evaluation model and information quantity evaluation model have been considered synthetically. And three evaluation indexes, weighted total deviation classification accuracy, classification interval and information quantity, are selected as evaluation indexes to determine whether the suitable classification of snow leopard habitat is reasonable or not. According to the optimal segmentation method of ordered clustering, the suitability of snow leopard potential habitat is divided into five grades. The higher the grade, the better the suitability, the lower the grade, the worse the suitability. Potential habitat maps of snow leopards in Three-river-source National Park has been drawn.

Finally, the historical records of snow leopard trace points distribution are introduced to verify the accuracy of the model. The accuracy of the model is verified by calculating the overlap ratio between the actual snow leopard distribution area and the suitability evaluation area. Based on the data of 7 known snow leopard trace sample points, the matching coefficient between the evaluation value and the known observation value was calculated, and then the results of habitat suitability evaluation of snow leopard were verified. The accuracy verification results of snow leopard habitat suitability evaluation results show that the matching coefficient is as high as 85%. It is proved that the multi-factor fusion method has a high degree of fitness and accuracy for the spatial distribution of snow leopard habitat suitability.

In the future, we will explore the evaluation method of habitat suitability of snow leopard, which combines food, species competition, abundance and other factors. In addition, the multi-angle accuracy verification will be further carried out on the basis of known sample data and more robust model method.

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SURFACE MODELLING OF NATURE AND NATURE'S CONTRIBUTION TO PEOPLE IN CHINA

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Abstract

Satellite observations can frequently supply spatially continuous information about the Earth's surface, which is impossible from ground-based investigations, but remotely sensed data by satellites are not able to directly obtain process parameters. Ground observations are able to obtain highly accurate data with high temporal resolution at observation points, but these observation points are too sparse to satisfy some application requirements. The most effective method for Earth's surface modelling entails the integration of satellite observations with ground observations. However, the full integration was ignored in most of the methods. For finding a solution for this problem, we suggest an alternative method, high accuracy surface modeling (HASM), which takes global approximate information (e.g., satellite observation data or spatial model outputs) as its driving field and local accurate information (e.g., ground observation data or spatial sampling) as its optimum control constraints. A Fundamental Theorem of Earth Surface Modelling (FTEM) has been created along with HASM development and applications. From FTEM, seven corollaries were deduced, corresponding to spatial interpolation, spatial upscaling, spatial downscaling, data fusion and model-data assimilation respectively. In this paper, we present development of HASM and FTEM as well as applications into surface modelling of nature and nature's contribution to people in China.

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THE IEEE GRSS DATA AND ALGORITHMS STANDARD EVALUATION (DASE) PLATFORM AND THE IEEE GRSS DATA FUSION CONTEST INITIATIVE

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Abstract

Ensuring homogeneity and reproducibility of performance assessment procedures is an aspect of major relevance in the development and validation of methods for the analysis and processing of remotely sensed data. In this framework, the IEEE Geoscience and Remote Sensing Society (GRSS) has recently pursued the GRSS Data and Algorithms Standard Evaluation (DASE) initiative [1]. DASE (http://dase.grss-ieee.org) is a web-platform developed by the Ticinum Aerospace company (Pavia, Italy) under the coordination of the GRSS and especially its Image Analysis and Data Fusion Technical Committee (IADF TC), to offer the remote sensing community a web-based system for benchmarking data analysis results. DASE allows for: (i) storage of remote sensing data sets, including large-sized data and annotated training and test sets; (ii) download of remotely sensed and training data; (iii) submission of processing results obtained from these data; and (iv) automatic computation of performance parameters of each submission with respect to test data. While training sets are made available alongside the corresponding remote sensing data, test sets remain undisclosed to avoid any possible bias. Numerous data sets are currently available through DASE, covering a variety of sensors, applications, and spatial resolutions. They include hyperspectral, multispectral, synthetic aperture radar, and LiDAR data, and range from extremely high-resolution optical and LiDAR data of an urban and harbor area to coarse-resolution multimodal data for global land-use mapping. DASE currently allows automatically scoring results of supervised classification and hyperspectral target detection.

Recently, it has also served the latest editions of the annual flagship initiative of the IADF TC, i.e., the IEEE GRSS Data Fusion Contest (DFC) [2, 3]. Since 2007, the DFC has been aimed at promoting progress in the fusion and analysis of multisource remote sensing data. Every year, the IADF TC releases a challenging multisource data set and proposes one or more competitions to the community. Winners are determined based on benchmarking processes and evaluations by an Award Committee.

The 2017 DFC [2] consisted in classification of land use in various urban environments. More precisely, the objective classes were Local Climate Zones (LCZ) [4], which establish a standard for urban climatologists in order to study urban heat islands and their impact on the environment. Several cities all over the world were selected to test the ability of LCZ prediction at generalizing, which is a crucial scientific challenge. The contest used open source data, namely Landsat and Sentinel-2 multispectral imagery, and ancillary data in the form of OpenStreetMap cartography. More than 800 submissions were processed by DASE.

In 2018, the DFC focused on different questions: which sensors are best suited for diverse land use applications, and how to efficiently fuse multi-sensor information? For this purpose, multispectral LiDAR data, hyperspectral data, and Very-High-Resolution (VHR) imagery were provided over central Houston (Texas, USA). For the training region only, ground-truth was also released. It corresponded to 20 urban land use and land cover classes. This time, DASE evaluated more than 1300 classification maps.

The DASE platform has demonstrated to be an effective tool for the benchmarking of remote sensing image processing results, even in large-scale applications involving hundreds of submissions. It is envisioned to grow further in the future with the inclusion of more remote sensing data modalities and of performance metrics for more typologies of processing results (e.g., change detection, 3D modeling, or physical parameter regression).

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VEGETATION PHENOLOGY CHANGE AND CLIMATE FEEDBACK: FROM EARTH OBSERVATION TO SIMULATION

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Abstract

Advanced vegetation spring phenology has been documented in the past decades by both satellite and ground based records. The spring phenology advancement is an immediate response to climate change. It also mediates climate system through a series of biophysical effects. We use the multiple remote sensing data to explore the spring phenology change and its response to climate change across regions and biomes in the past three decades. Then we use coupled Community Earth System Model to investigate feedbacks of phenology shift to the climate system. Based on the earth observation data, we found heterogeneous phonological shift. The observed spring phenological advancement in boreal and temperature forest enhances mean surface warming in Northern Hemisphere. The warming is prominent in Eurasia but negligible in North America. The temperature response to SP shift is a combined effects of radiative forcing through the change of cloud cover and snow cover change in mid- to high- latitudes, and biophysical feedbacks by changing the latent and sensible heat in the vegetated regions. Our findings suggest that cloud radiative forcing and snow albedo forcing are as important as vegetation biophysical impact on the climate system when they are modulated by vegetation change in the spring transition season.

SESSION:
Science as a Service bringing together data and tools

A DOCKER-BASED HPC ARCHITECTURE FOR REMOTE SENSING IMAGERY PROCESSING

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Abstract

Introduction

Explosion of earth observation data has led to tremendous computing requirements in remote sensing imagery processing. High performance computing(HPC) has been proven as an effective means to tackle this issue due to its powerful computing capability. But it's not easy to deploy a HPC due to its complexity and HPC uses dedicated hardware resource, therefore can't be shared by other applications. Docker is a popular technology which can simplify deployment of software as well as improve system resource utilization by containerization. In this paper, we propose an architecture which employs docker technology to build a HPC for sensing imagery processing. This approach greatly lowers the barriers of building HPC as well as improves system resource utilization.

Method

We propose an architecture in which docker is underlying container and based on docker, a HPC cluster is built to accelerate remote sensing imagery processing. HPC cluster consists of several roles: a workflow manger, a resource manager, a scheduler and many execution nodes. In order to simplify the deployment, docker image is pre-built. Each role is encapsulated as a docker image which contains all the necessary stuff to run the role, including program's binary code and necessary libraries, e.g. GDAL library for imagery processing and MPI library for parallel computing. But it doesn't contain any status data, so that it can completely independent and can freely deployed without any limitations. All the status data are stored in a parallel file system, shared by all the docker instances. Due to removing external dependencies, docker image can simply be run through docker command line. Docker also facilitates well-designed internal network for communication among all the HPC docker instances. By running a set of docker image instances, a HPC cluster can be constructed in several minutes. Docker instances can be dynamically added or removed if needed in seconds. Because HPC is running on docker which system resources are shared, when HPC workload becomes low, some resources can be reclaimed then allocated to other application, thus the resource utilization can be improved.

Result

By building docker images in advance, the process of deployment becomes very easy. We only need to write a configuration file then run a script, then all the work can be done in a few minutes. It's easy to add new node when needed by simply running a new docker images. When no HPC task is running, all the docker images instances can be stopped and resource can be reclaimed on-the-fly for other tasking. A 16-nodes prototype has been built and we can use script to start a HPC environment for geoprocessing in only five minutes, it only needs 15 seconds to add a new docker computing instance.

Conclusion

HPC has been proven a powerful architecture for remote sensing image processing. But special expertise is needed to build a HPC cluster, thus, HPC usually employs dedicated resource. This has led to lower resource utilization. Using docker technology to construct HPC cluster can simplify the deployment and improve resource utilization. HPC components are built into some images, and images can be running on-demand. HPC cluster can be built very quickly and scale freely. We are investigating the Kubernetes for better resource scheduling and management.

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A PARTICIPATORY PLATFORM FOR COMPREHENSIVE GEOGRAPHIC PROBLEM SOLVING

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Abstract

To solve comprehensive geo-problems, normally different geographic processes are needed to be understood at the same time. It may require multi-disciplinary knowledge and need cooperation of experts from different research fields. A participatory geo-problem solving platform is meaningful for analyzing the problem, establishing consensus, and making solutions efficiently. However, there are two main challenges to build such a platform. On the one hand, it is hard to build a universal platform for solving different kinds of geographic problems. On the other hand, there is also a difficulty in providing a collaborative working condition for geographically distributed participants. For these two challenges, this article designs functions of the participatory platform. First, the general participatory geo-problem solving processes are analyzed and divided into six parts, including preparation, analysis, modeling, simulation, validation and comparison. Then, to implement these six parts by geographically distributed participants, several related collaborative tools (e.g., communication tool, visualization tool and data preprocessing tool) are developed for the analysis, modeling and simulation of complex geographic processes. Based on the designed six parts and corresponding tools, a web participatory platform was established, with which participants can collaboratively implement the resource preparation, geo-problem analysis, modeling solution making, geographic process simulation, result validation and comparison. Two experimental cases were also conducted to verify the feasibility and capability of this platform for comprehensive geographic problem solving.

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AN OVERVIEW OF OGC GEOSCIENCE STANDARDS AND WORKING GROUPS

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Abstract

Geospatial information is a key component for decision making [1]. The increasing amount of such data leads to a need of common description, protocols in order to ensure data compatibility, and facilitate information system maintenance.

The Open GeoSpatial Consortium (OGC) is since 1994 an international forum to discuss and elaborate standards for geospatial information. Solutions proposed by the OGC are both technical (eg. web services) and thematic standards (eg. environment, smart cities, emergency response, energy utilities, and many more). Some OGC standards are even endorsed by ISO, especially TC211 and/or were designed in collaboration with other international organization (eg. World Meterogical Organization, building Smart International).

In the geoscience domain, noticeable efforts are made in order to 1) foster the community, 2) define appropriate semantics for geoscience data description and 3) test tools and technologies for the provision of standardized geoscience data.

In 2016, GeoSciML [2] and GroundWaterML2 [3] were adopted as official OGC standards. They propose coherent conceptual and logicial models to describe subsurface components (geologic unit, geologic structures, void, borehole...) and associated data (samples, tests and laboratory analysis). Both are widely used in the geoscience community and implemented for example by the geological surveys for the exchange of geologic maps and features.

In 2017, the GeoScience Domain Working Group [4] was created in order to offer a forum to discuss, organize and harmonize geoscience related data. One of its major goal is to ensure thematic/semantic coherence within the geoscience domains which include geology, hydrogeology, geomechanics, geophysics, geotechnics, mineralogy, seismology and volcanology.

In 2018, two major interoperability experiments (IE) were driven by the geoscience community: the Environmental Linked Features IE (ELFIE) [5] and the Borehole IE [6].

ELFIE was a technical oriented IE focused on the experimentations of OGC and W3C standards to expose linked data in several domains, including hydrogeology. It aimed at establishing best practices for the exposition of such data.

The Borehole IE focuses on semantics and aims at harmonizing the definition of the borehole object and its associated data. It identifies use cases (water resource, oil & gas, ground investigation, ...) in which the borehole concept is used and target the definition of a common and domain neutral approach for describing boreholes.

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COMMERCIAL CLOUD AND EO SERVICES USAGE: OPENING THE GATES TO THE RESEARCH COMMUNITY OPEN CLOUDS FOR RESEARCH ENVIRONMENTS (OCRE)

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Abstract

Cloud and Earth Observation (EO) based services offer the European Research community a wealth of powerful tools. However, for many researchers these tools are currently out of reach. It is difficult to find and select suitable services. Establishing agreements with cloud and EO service providers and ensuring legal and technical compliance requires specialist skills and takes an inordinate amount of time. Equally, service providers find it difficult to reach and meet the needs of the research community in technical, financial and legal areas.

The Open Clouds for Research Environments consortium (OCRE) will change this, by putting in place an easy adoption route. In the autumn of 2019, OCRE will run a pan-European tender and establish framework agreements with service providers who meet the requirements of the research community. 10.000 European research and education institutes will be able to directly consume these offerings via the European Open Science Cloud service catalogue, through ready-to-use agreements. They will not have to run a tender of their own. In addition, to stimulate usage, OCRE will make available 9.5 million euro in service credits (vouchers), through adoption funds from the European Commission.

The OCRE consortium consists of GÉANT (consortium coordinator), CERN, RHEA and Trust-IT with the contribution of SixSq, as technology provider, together with EARSC and Evenflow, as support to outreach activities, and receives funding from the European Commission, as part of the European Open Science Cloud.

This presentation will introduce the benefits of the Open Clouds for Research Environment for providers and for researchers. It will also address how OCRE aggregates community demand and requirements and applies these into a pan-European call-for-competition, for commercial service providers to respond to. This tender which will be launched in Q3 of 2019, will result in procurement-compliant framework agreements with suitable suppliers. In the presentation OCRE will talk about how providers can respond to this opportunity.

In addition the presentation will touch upon how researchers, affiliated/not affiliated to institutions will be able to consume the services through ready-to-use contracts, without the need to run their own tender and how OCRE will stimulate usage through an adoption fund.

DATA CURATION OF SCIENTIFIC INVESTIGATION OVER THE SOUTH CHINA SEA

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Abstract

The Scientific Investigation over the South China Sea has significant importance and urgency. It has made a lot of valuable hydrological, meteorological, ecological, chemical and geological observation and analysis data of 75 stations on 18°N, 10°N, 6°N and 113°E section over the South China Sea, by four multi-disciplinary and inter-disciplinary voyages through four different seasons from 2009 to 2012.

Under the guidance of “Simple Data Curation Lifecycle”, we establish “Co-Construction and Sharing” data working mechanism and identify roles and responsibilities, reorganize the dataset and improve the description and description information, complete the data integration, to achieve data Access, Use and Reuse.

According to the data characteristics of multi-disciplinary, multi-variables, and different structures, we used and integrated of VDBCloud, Duckling and Science Knowledge Environment(SKE), to build a comprehensive network system of data management and sharing for the Scientific Investigation over the South China Sea. The system integrate data, product, information for user to access. Data management system focus data integration and applications. Collaborative platform focus on research team communication and collaboration. Popularization platform focus on network popularization of investigation knowledge.

This paper briefly introduces the Scientific Investigation voyage work, focuses on description of the data work mechanism and reorganization results, and the network system functions. Data Curation of this project is a useful exploration of the data management and sharing life cycle. It has achieved the effective management and timely sharing of data. Hope that through our practices to promote the capacity of development, integration and utilization of marine data resources.

INTELLECTUAL INFORMATION PLATFORM BRINGING TOGETHER DIVERSE DATA AND MODELS FOR THE INTERDISCIPLINARY PROJECTS IMPLEMENTATION AND ENVIRONMENTAL MANAGEMENT

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Abstract

Comprehensive studying the environment and making decisions on its protection requires the simultaneous use of research methods from different subject areas, as well as heterogeneous data including earth remote sensing (ERS) data.

ERS data is becoming increasingly popular for monitoring of natural and natural-technological objects and systems (NNTOs) when analyzing agriculture, forestry, water bodies, etc. Further prospects of its applying are associated with shifting from relatively simple monitoring tasks to forecasting NNTOs state under anthropogenic impact and climate changes, and to decision-making support in the environmental management.

At the same time, there is a lack of applications and decision-making support services that could be adapted for a user who does not have special skills in information technologies and ERS data processing. This gap presents a significant obstacle to a wider usage of accumulated and steadily growing volumes of ERS data.

To solve these problems, information systems of a new level are required. These systems are to be aimed at the integration of ERS and other data (both spatial and non-spatial) with models of NNTO's state forecasting and proactive environmental management, in automatic mode. Moreover, the models choice and adjustment of their parameters have to be carried out automatically as well. In addition, all these processes are to be “hidden” from the end-users, who, as a rule, do not have sufficient expertise in information technologies and are willing to interact with a simple and convenient interface.

A theoretical foundation for creation of such systems is provided by methods of a new scientific direction - qualimetry of models and polymodel complexes [1]. This theoretical basis enables embodying the intellectual multi-criteria choice of models needed for making right decision and setting the models parameters without operator intervention. Along with that, contemporary information technologies provide new opportunities for distributed systems design and operation by using cloud computing, standard internet protocols, etc.

Combining the mentioned achievements and opportunities has led to creation of a software intellectual information platform with modular structure based on a service-oriented architecture.

The flexible nature of the information platform software allows the integration of a large range of models and data including ERS data.

The main components of the platform are the following: a service bus, as a “backbone” of the platform framework; software modules for environmental parameters modeling; business process execution language tools for forming components interaction scenarios; an intellectual interface for choosing necessary models and adjusting their parameters in automatic mode; program interfaces providing interconnection of diverse ERS and other data sources.

The platform enables the process and integration of data from different Earth observation satellites, such as Sentinel constellation, Russian Resurs-P satellites, and others, as well as production and provision of new information services in different modes - interactive, automated, and fully automatic one. Successful case studies have been performed for creating new services for agricultural lands monitoring, forest management and changes detection of the forests states, environmental protection, flood forecasting, etc. [2, 3].

In general, the developed platform is a universal constructor or software suite that allows producing services and downstream applications in environment protection and environmental management.

The reported study was funded by the Russian Science Foundation (project 17-11-01254).

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MAPPING FOR NATURE LOVING CITIES: A CASE STUDY OF BIOPHILIC BRISBANE

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Abstract

Biophilic Urbanism is an emerging paradigm in urban planning that recognises the essential relationship between humanity and the natural environment, and the vital importance of designing our urban spaces to support and maintain this meaningful connection. In 2014, Reeve [1] analysed an international group of cities, for the purpose of mapping how these cities achieved and maintained an effective accord between the built environment and nature. By analysing common themes and applications, Reeve formalised the urgent need for systematic thinking and the consolidation of existing research for this design perspective to be mainstreamed – pivotal research in spanning the divide between the neo-liberal standpoint regarding urban development and its component considerations, and the ecological world-view of nature as critically important to our urban populations.

The current research aimed to further bridge this gap, enabling the 'how to' narrative of Reeve's described factors, through a foundational investigation into a new space of 'remembering' our place within nature, instead of considering ourselves as separate. Within this context, the authors considered opportunities for enabling the creation of truly biophilic cities, by acknowledging the value of disparate knowledge bases, the relative difficulty in accessing meaningful data regarding urban biophilia, and the very practical need to engage those formal standards and processes that enable digital interoperability. The project sought to create a geospatial platform for assessing and communicating such indicators, examining how these layers interact and contribute to our urban spaces, and to empower grass roots and community-level research and dissemination as a vital complement to the more traditional decision-making processes that spans councillors, real-estate developers, urban-planners and designers.

In this paper, the authors discuss the findings of a targeted case study that attempted to use open data and digital geospatial analysis as process tools to: a) provide robust yet economical observations of the existing environment and population; b) create effective visualisations for multidisciplinary consultation; and c) analyse and establish areas for prioritisation. This includes a visual interpretation of data beyond conventional administrative criteria, integrating meaningful indicators of wellbeing that are associated with nature and its existence in urban spaces.

The paper acknowledges the significant progress made by Brisbane City Council in embracing goals that people can aspire to (for example zero carbon). However, it concludes there remains significant opportunity for smaller scale projects, extant in suburbia, to make a tangible collective difference. These projects need to be evaluated and acted upon in ways that respect individual ideas and consider them within the context of an evidence-based system. The case study provides evidence of the potential to create a common platform that everyone can contribute to, using already formalised and recognised standardisation of data that provides a bridge of interoperability within this digital age. It has immediate application for community groups, council administrators charged with communicating with the community, environmental groups, and citizen scientists charged with caring for ecosystems within our larger urban spaces. The findings enable these groups to engage with decision-makers for meaningful planning that embraces nature for human health and wellbeing.

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NEW WEB-BASED SERVICES FOR EARTH OBSERVATION APPLICATIONS

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Abstract

Since beginning of 2017, the NextGEOSS project implements a pragmatic pilot-driven approach to integrate progressively the complexity of the existing global Earth Observation ecosystem, leveraging previous investments, adding new cloud technologies and resources and engaging the diverse communities to address all types of Sustainable Development Goals (SDGs).

It contributes to support Group on Earth Observation's (GEO) global priorities including support to the UN 2030 Agenda for sustainable development, the Paris Agreement on climate change, and the Sendai Framework for Disaster Risk Reduction. Running until 2020, the NextGEOSS project evolves the European vision of a user driven GEOSS data exploitation for innovation and business, relying on the three main pillars:

- engaging communities of practice
- delivering technological advancements
- advocating the use of GEOSS

These 3 pillars support the creation and deployment of Earth observation based innovative research activities and commercial services.

Based on a first initial set of 10 scientific applications used as pilots and defined by the project partners to address the main challenges and include as soon as possible contributions to SDGs associated with Food Sustainability, Bio Diversity, Space and Security, Cold Regions, Air Pollutions, Disaster Risk Reduction, Territorial Planning, Energy, the project has developed and validated a set of basic services and tools, useful to any type of application needing Earth Observation data or services.

The data hub and the services have been made available to external scientific pilots as well as a structured and documented onboarding process. This process is now on good tracks to bring short term benefits to several pioneers who will help us in return to expand the concepts, services, data catalogue and tools delivered by the project.

Recently NextGEOSS has opened two new type of services to catalogue and give access to the data and services produced by other European projects.

In 2019 the project will get involved into an Architecture Implementation Pilots (AIP-10), opened world-wide, to increase discoverability, accessibility and usability of data with a strong User Centric approach for innovative GEOSS powered applications for multiple societal areas.

This presentation will introduce the process of development of the project and the multi shape deliverables: pilot applications supporting SDGs, Earth Observation tools and services made available to develop new scientific applications using Earth Observation data, and the data and services cataloguing proposals. It will then provide all needed information to become a new partner.

All initiatives with an interest in and need of Earth observations (data, processes, models, ...), all European projects wishing to advertise the data they produce, the applications and services they have developed, are welcome to contact the project via its website: https://nextgeoss.eu/join-us/

*NextGEOSS is a H2020 Research and Development Project from the European Community under grant agreement 730329.

O-PARK - A STANDARDIZED PLATFORM FOR CONTINUOUS MONITORING OF THE PANEVEGGIO PALE DI SAN MARTINO NATURE PARK

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Abstract

One of the most visible consequences of the global warming is an increase in the frequency, intensity and spatial extent of extreme weather events like the storms that hit the north-eastern Italy in November 2018. This extreme meteorological event caused the loss of 6-8 million of cubic meters over an area of more than 20.000 hectares and a significant change in the forest-related ecosystem.

The systematic, standardized and continuous monitoring of the effects of these events on the whole ecosystem in the short and medium / long term represents a major technological and scientific challenge considering the vastness of the areas involved and the reduced availability of resources. The collection of data, either by remote platform (satellites and drones) or directly on the field, and their subsequent analysis is a key-element to understand the impacts of these phenomena on the territory and to define new policies for managing natural forest resources even in the case of emergencies and disasters [1].

The Paneveggio Pale di San Martino Nature Park is located in one of the areas most affected by the storms of October - November 2018 and affected forests that cover an area of about 580 hectares. The change in forest coverage of large areas of the Nature park is presumed to drive mid-term modifications in both the mosaic of habitats of the Park and in the distribution and dynamics of the populations of alpine fauna.

Thanks to the e-Ranger project, co-financed by the Trentino Autonomous Province, a monitoring plan using both satellites remote sensing and Internet of Things technologies has been defined on some areas hit by the crashes are constantly monitored with the scope to understand the dynamics and impacts in the short and medium term on the whole forest ecosystem. The monitoring plan will be implemented using the O-PARK [2] platform which allows the real-time measure of environmental and soil parameters like local meteorological conditions, temperature, humidity, oxygen level, electrical conductivity of the ground at different depths. The O-PARK platform allows to integrate this data with data processed from multi-source satellite images, with a time frame up to 5 days and a spatial resolution up to 10 meters, elaborating georeferenced maps of parameters representative of the state of growth and health of the forests such as biomass, water stress and chlorophyll content.

The project began at the end of 2018 and it will last for at least two years. It is the first example in Italy where the monitoring of natural parks is carried out by integrating the most modern technologies in a systematic and widespread manner over wide areas. The first expected benefit is the capability to boost the understanding of the dynamic forests-environment within ecosystems that have undergone a drastic and sudden change generating technical/scientific knowledge. Moreover, the large amount of data that will be generated and managed within the O-PARK platform will consolidate a data-driven and science-oriented approach for the definition and validation of decision-making processes for the management of protected areas.

In the present article, the first results of the project are presented together with future perspectives and possible further extensions and applications.

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PPRESIL: A TOOL TO ESTIMATE SEASONALITY TREND IN UNEVEN AND SPARSE TIME SERIES

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Abstract

The stability or change in a central ecosystem function as primary productivity is key to the evaluates the status of ecosystem itself. The trend of primary productivity is recognized as one of the component of SDG 15.3.1, while the stability of primary productivity through time could answer to the request of CBC 15.1 ("Trends in ecosystem resilience") at the moment without formalized indicator.

In situ measurements of Gross Primary Productivity (GPP) require large and costly infrastructures to estimate CO2 fluxes from eddy covariance estimates of net ecosystem exchange and respiration. Satellite medium resolution data (e.g. MODIS) are typically used to obtain global estimates of green FAPAR (the main component of GPP) at 300-m resolution. This resolution is problematic especially for biodiversity management at local scales, where it is important to appreciate habitat heterogeneity, as Mountain or Mediterranean habitats. But higher spatial resolution sensors as Landsat or Sentinel 2 have lower temporal resolution and produce sparse and irregular time series due to atmospheric perturbations making more problematic analysis of trends.

We set up a fast and robust approach based on a harmonic model linearly fitted, to estimate EFA (Ecosystem Functional Attributes) sensu Alcaraz [1], that are 3 features (mean, coefficient of variation, peak's day of the year) of the GPP proxy seasonal dynamics plus the yearly anomalies that are relevant to compare resilience across the area of study.

Our harmonic model takes inspiration from HANTS procedures (for a review see [2]) but add a year intercept to capture overall year variation and use the linear model framework (p-value, percentage variance explained) given that we use atmospherically corrected data were errors are normally distributed.

We used atmospherically corrected Landsat time series at 30 m resolution. We tested the approach over a large cloudy mountain region – the Peneda-Gerês National Park (Portugal) – data with simulated cloud cover, and a highly fire disturbed small forest – Bosco Difesa Grande (Apulia, Italy).

We built an artificially cloudy data using the 400 cloud free pixel histories found in the Peneda-Gerês time series and used 100 cloud patterns found elsewhere in the scene. We compared how much the estimates of Ecosystem Functional Attributes are influenced by cloud cover using model fitted or original time series. The original time series produce biased estimates respected to equivalent statistics on unclouded time series, while fitted data produce unbiased estimate of similar variance.

The fitted data produce Ecosystem Functional Attributes that follow better the ecological expectation (i.e. higher mean value in pixel with aspect to south and higher inter-annual variation in pixel with aspect to north west) than original time series. Further using the LCCS land cover obtained with the service EODESM within the activities of Ecopotential H2020 project, it was possible to check that the most stable, (i.e. lower coefficient of variation across yearly anomalies), were the tree classes in opposition to forbs and grassland, as expected from the study of [3].

To evaluate how our approach handle repeated critical pressure that modify the stability of the time series we applied our analysis to Bosco Difesa Grande, where we showed that the approach reach to track with the year anomalies parameters the repeated cycle of fire events (recorded in Italian official registry) and recovery, while other methods, as BFAST, that require data interpolation to deal with irregular time series and are more parameter rich fail to detect multiple changes within 2-3 years over a same pixel history, as already noted by [4].

To allow a fast and effective deployment of the approach the software was ported within the VLAB framework built within the ERA-planet network. The VLAB allows to access and query software with a web interface while the software is ported within a docker system such that framework can operate from different cloud system. The output, as netCDF dataset, collect the different statistics across pixel and across the different year and could be visualized using the tool of VLAB ecoystem.

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RUS: A NEW EXPERT SERVICE FOR COPERNICUS SENTINEL DATA USERS

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Abstract

The Research and User Support (RUS) opened on 25 September, 2017 with the aim to promote the uptake of Copernicus data, and to support the scaling up of R&D activities with Copernicus data.

The service was designed in such a way the following main issues are addressed:

1- Knowledge issues: what can be done with Copernicus data?

2- Technical issues: how to prepare the data and set-up/integrate customised processing chains?,

3- Physical issues: Earth Observation (EO) data storage limitations and processing power needed to exploit the data.

Knowledge issues are tackled thanks to a dedicated training plan that offers face-to-face training sessions as well as webinars, or online materials. Training materials and activities are tailored to specific EO community needs, using Linux-based RUS virtual environments, and Free and Open-Source Software (FOSS).

Technical issues are solved providing users with an access to a dedicated help desk and a team composed of EO and IT experts, capable of addressing any request whether these come from beginners or from skilled practitioners. The help desk and the experts can be reached by chat, email, or by phone.

Physical issues are overcome with a Platform as a Service that is configured in a scalable cloud environment that offers the possibility to remotely store and process EO data. Integral part of the solution is the adaptation of FOSS to the platform.

The RUS service, which is offered at no cost to the user, is available for a large community of users from academic and public institutions, research entities to Small and Medium Enterprises (SME).

Activities eligible on the RUS Service encompass Copernicus data discovery and handling, algorithm development (R&D), and teaching. Processing chain development by SME is eligible while commercial and operational activities are excluded. RUS users can import other datasets than the Copernicus core products; however Copernicus data should remain the main data source. Access priority to the RUS Service is given to persons working for entities located in countries represented in the European Commission (EC) and participating to Copernicus program.

The RUS Service can be reached here: https://rus-copernicus.eu/. For questions about the RUS Service, please use the Contact form (https://rus-copernicus.eu/portal/contact-us/).

The RUS Service is funded by the EC, managed by the European Space Agency, and operated by Communications & Systèmes – Systèmes d’Informations (CS SI) and its partners: Serco SPA, Noveltis, Along-Track, and CS Romania.

SAFESCALE, A CLOUD AGANOSTIC SOLUTION

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Abstract

SafeScale (https://github.com/CS-SI/SafeScale) is a cloud agnostic solution that allows developers and integrators to transparently deploy cloud applications on any cloud providers to bring the famous slogan "write once run everywhere" to the cloud. SafeScale have been developed in the DevOps spirit - pushing the automation to infrastructure creation, service deployment, data management and security management tasks by providing:

- An Infrastructure as Code (IaC) layer, which allows manipulating virtual infrastructure resources - servers, networks, data storage - and to simplify the management of cloud environments by integrating natively a full-web remote desktop system, an intuitive command line management tool and software development kits for various programming languages.
- A PaC (Platform as Code) layer that allows instantiating and managing the most widely adopted and powerful application deployment systems (Kubernetes, Swarm, DC/OS, Ansile) with a few lines of code and without additional billing costs.
- A data management layer that allows distributing transparently data over several clouds with a minimum overhead to ensure a total independence from cloud providers with a highly enhanced quality of service and security warranty to the minimum cost.
- A security layer providing a complete applicative gateway for Authentication, Authorization, Accounting, Traffic Control, Routing and intrusion detection.

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SEADATANET, AN ENHANCED OCEAN DATA INFRASTRUCTURE GIVING SERVICES TO SCIENTISTS AND SOCIETY.

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Abstract

Access to reliable, harmonised, large quantity of data has become a key topic in different fields, expecially in the oceanographic sector where the cost of data sampling is very high.

SeaDataNet infrastructure started in 2006, by means of a funded European project to create a framework for data sharing and collaboration, it provides a single website access to multidisciplinary ocean and marine data as well as data products and metadata services. It involves more than 110 data centers and it makes available more than 2 million datasets acquired from research cruises and other observational activities in European marine waters and global oceans belonging to physical oceanography, chemistry, geology, geophysics, bathymetry and biology. Over the years, it has defined de-facto standards for data, metadata and vocabularies largely used collaborating with European and international experts within the framework of IOC-IODE, ICES, adapting ISO and OGC standards, and achieving INSPIRE compliance for some metadata services directory.

On the one side, the SeaDataNet infrastructure gives the opportunity to share marine and oceanographic data sets at European level in an interoperable way to researchers that don’t have their internal IT resources in terms of personnel and infrasructure. On the other side, sharing of data and collaborative research is an important challenge not only for the marine science community but also for different actors, such as shipping companies, offshore power companies, fishing industry, tourism industry, marine and coastal authorities etc. Policy makers and companies can take advantage of the marine data resources and products available for improving their knowledge of the sea.

To deliver enhanced capabilities using new technologies now emerging, in the framework of the SeaDataCloud project, funded by the European Horizon 2020 programme, the SeaDataNet infrastructure is renewing itself with new on line services, adopting Cloud technologies and High Performance Computing (HPC) technology in order to provide more robust and reliable services.

These innovations will include a software to spatially interpolate (or analyse) marine observations that will be accessible on line using remote computing power and a Virtual Research Environment for on line collaboration. In the cloud the infrastructure will offer the opportunity for new discoveries in ocean science, new way for research collaboration as well as new economic growth for private companies, regardless resource constraints.

Acknowledgement: “SeaDataCloud project has received funding from the European Union’s Horizon 2020 Research Infrastructures programme, under the grant agreement No 730960”.

SENSOR WEB EVOLUTION - WEBS OF WEBS FOR NASA SCIENCE - FOCUS ON SMALL UNINHABITED AERIAL SYSTEMS (SUAS)

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Abstract

This paper will describe the evolution of information collection, derivation and delivery mechanisms in webs of NASA sensor webs, with a focus on recent advancements in small Uninhabited Aerial Systems (sUAS).

I will discuss the movement to "Fog Computing", also known as Edge Computing. Fog Computing facilitates the distribution of common operations and networking between edge devices and cloud computing facilities, optimizing the production of actionable intelligence.

Initially, sUASs utilized onboard data collection as standard, with minimal data downloaded directly. Information products were derived in conventional computational environments, generally desk top computers, and information products made available to the Science Community in weeks or months. With the increased availability, and increasingly lower costs, of beyond line of sight (BLOS) satellite based communication, transmission rates and data volumes increased, and processing migrated to Cloud based services. Contemporary sUASs are moving some of that information product derivation to on vehicle services, and are creating a distributed Cloud/Fog environment.

I will describe the technological advances that have made this possible, including low power multi-core Central Processing Units (CPU), and, more recently, the availability of high end Graphical Processing Units (GPU) that consume only a few watts. Intelligent system software, leveraging these hardware advances, finally allows for information product generation on-board, rather than simple data collection. Additionally, intelligent flight control systems now support mutual vehicle to vehicle collaboration, allowing sUASs to create ad-hoc sensor webs on demand, as required.

Also discussed will be the lessons learned by the Authors' development of data systems for NASA's large High Altitude Long Endurance (HALE) UASs like Predator and Global Hawk, and how those lessons are being applied to sUAS development.

This paper will focus on application, rather a deep dive into the technology, and will highlight improving data management through these new technologies.

THE NORWEGIAN NATIONAL GROUND SEGMENT FOR SATELLITE DATA; EXPLOITING THE SENTINELS.

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Abstract

In order to take advantage of the Sentinel program, the Norwegian Space Center decided to establish a national collaborative ground segment for satellite data with the purpose of simplifying data access, ensure support for operational national services and long term preservation of data. This is the NBS where MET Norway has the technical responsibility in terms of providing the infrastructure and storage capacity for data management following the FAIR (findable, accessible, interoperable, reusable) guiding principles. Serving the data through two separate platforms i.e the Data Hub Software - developed with the purpose of supporting the ESA Copernicus data access - and satellittdata.no - designed from a number of geoscientific projects like the International Polar Year, the end users have access to the data in its original format in addition to Sentinel-1 and Sentinel-2 products in NetCDF-4/CF. Using the latter format, several product variables are prepared and made available in product raster resolution. Thus, services like regridding, subsetting, visualization and aggregation are integrated utilizing OPeNDAP in combination with OGC WMS and OGC WPS. In addition, fetching data for an end user is simplified since streaming of data by means of OPeNDAP is supported in multiple programming languages. Thus, aggregation of virtual data cubes covering user determined areas is readily possible making it easy to focus scientific work on the data of interest. Due to the strong coupling between space based earth observations, in-situ observation, model data etc, disseminating data in a generic data management system utilizing NetCDF-4/CF and OPeNDAP is convenient for seamless integration of data across branches. The current CF version is not mature for handling all parts of the Sentinel data but future development looks very promising.

UNIDATA SCIENCE GATEWAY FOR ENABLING SCIENCE AS A SERVICE TO FACILITATE OPEN SCIENCE AND REPRODUCIBLE RESEARCH

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Abstract

The geoscience disciplines are either gathering or generating data in ever-increasing volumes. To ensure that the science community and society reap the greatest benefits in research and societal applications from such rich and diverse data resources, there is a growing interest in broad-scale, open data sharing to foster myriad scientific endeavors. However, open access to data is not sufficient, research outputs must be reusable and reproducible to accelerate scientific discovery and catalyze innovation.

As part of its mission, Unidata, a cyberinfrastructure facility, has in recent years been developing and deploying data infrastructure and data-proximate scientific workflows and analysis tools using cloud computing technologies for accessing, analyzing, and visualizing geoscience data.

Specifically, Unidata has developed techniques that combine robust access to well-documented datasets with easy-to-use tools, using workflow technologies. In addition to fostering the adoption of technologies like pre-configured virtual machines through Docker containers and Jupyter notebooks, other computational and analytic methods are enabled via “Software as a Service” and “Data as a Service” techniques with the deployment of the Cloud IDV, AWIPS Servers, and the THREDDS Data Server in the cloud. The collective impact of these services and tools is to enable scientists to use the Unidata Science Gateway capabilities to not only conduct their research but also share and collaborate with other researchers and advance the intertwined goals of Reproducibility of Science and Open Science, and in the process, truly enabling “Science as a Service”.

Unidata has implemented the aforementioned services on the Unidata Science Gateway ((http://science-gateway.unidata.ucar.edu), which is hosted on the Jetstream cloud, a cloud-computing facility that is funded by the U. S. National Science Foundation. The aim is to give geoscientists an ecosystem that includes data, tools, models, workflows, and workspaces for collaboration and sharing of resources.

In this presentation, we will present our work to date in developing the Unidata Science Gateway and the hosted services therein, as well as our future directions to advance data and software transparency, open science, and reproducible research. We will share our experiences in how the geoscience and information science communities are using the data, tools and services provided through the Unidata Science Gateway to advance research and education.

VIRTUAL GLOBE-BASED VISUALIZATION AND PERSONALIZATION METHOD OF MULTI-SOURCE BUILDING MODEL

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Abstract

Visualization of building models (oblique photogrammetry models, point clouds, fine models, etc.) have an increasingly important role in the construction of digital city [1, 2]. However, most of the existing building model visualization methods have limited application scenarios and limited data types supported, and lack a unified data model to schedule and visualize multi-source and multi-scale building models. To overcome these challenges, this paper proposes a virtual globe-based visualization and personalization method of multi-source building model. First, this method constructs a geographic grid model with global latitude and longitude as a spatial reference for the unified organization of multi-source building models. Then, based on the data accuracy, the mapping relationship between the multi-source building model and the geographic grid is established. Finally, a unified description rule is designed for unified scheduling and personalization of multi-source building models, users can select the data to be visualized according to geometric or semantic attributes (data type, expression precision, etc.). Experiments demonstrate that the rendering frame rate of the method is stable at 40 frames per second or more, and the interoperability of the building model is guaranteed.

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SESSION:
Space 4.0

CLEOS (CLOUD EARTH OBSERVATION SERVICES), E-GEOS CONCEPT OF SATELLITE DATA PLATFORM

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Abstract

CLEOS is the online Satellite Data Platform to access e-GEOS Geoinformation Data, Products and Services allowing an efficient and cloud-based access to COSMO-SkyMed data (COSMO-SkyMed Cloud Hub) and to the Vertical Platforms.

CLEOS is therefore the online “platform” of platforms providing the backbone of the digital transformation process of the e-GEOS portfolio, in fact, CLEOS is a secure and structured infrastructure allowing the e-GEOS Vertical and Technological Customers to exploit e-GEOS Digital Services and, more in general geoinformation data and capabilities in a modern way.

Moreover, CLEOS provides APIs allowing Premiere Partners to access the full e-GEOS data catalog, image analysis capabilities, and reports producer tools to facilitate the integration and adoption of such tools and Information products into customer-specific business processes. Customers can use CLEOS as a heavy-duty platform to generate Analysis Ready Data or Decision Ready Products.

CLEOS is an open environment that allows the onboarding of Third Party capabilities

CLEOS is fully connected to the e-GEOS Salesforce System to manage users with a secure and API based SSO process, monitor the usage of a single component by transaction schema and finally to manage the billing and delivery process supporting customers in all the step through a success funnel and support team.

As part of the CLEOS development strategy, e-GEOS has set up a partnership with MEEO, an Italian SME focused on Data Cube technology. In the framework of this partnership, an innovative approach to Data Cube Services has been launched under the brand of CUBEO which is offering scalable and affordable massive satellite EO data pre-processing and data access services and, more in general, efficient access to distributed and heterogeneous geospatial datasets.

e-GEOS is the first customer of CLEOS capabilities powering the Vertical Platforms (braint, SEonSE, AWARE, ASKme!, Agrigeo) and to build customized services to respond to the customer requirements in terms of data acquisition, processing, and delivery of geographic information based maps, reports, and indexes or to grant a simpler and immediate access to COSMO-SkyMed data.

COMMUNITY-ORIENTED SHARING PLATFORMS IN SPACE 4.0

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Abstract

Space 4.0 will bring an enormous wealth of data on our Earth that needs to be well exploited. The Copernicus fleet has put an asset in space that provides the redundancy needed for operational use of space data. Commercial operators are complementing this with high-resolution commercial data. But how to bring this wealth to the citizens? Space 4.0 is also about best use of Big Data approaches and use of the digital information economy as a powerful tool to bring information to the citizens.

Digital platforms have to excel on 3 pillars: Technology, Content and Culture. The proven skill of the space operators to master the technology, the enormous amount of data as an excellent basis to generate appealing contents, have to be combined with the culture of digital information economy to "bring space out of space". A modern platform approach has to customize its content for a specific target community, speaking the community language, showing a complete understanding of community problems and addressing its specific needs. Sharing resources, ideas and ways to solve problems is the pillar of a new cultural approach of working together and collaborating to best leverage on the new wealth of data.

The Thematic Exploitation Platforms (TEPs) are operational today for the Urban, Forestry, Coastal, Hydrology, Food Security, Polar & Geohazards communities [1]. These platforms provide scientists, commercial operators and citizens with an environment where they can share their questions, analysis, results thought their investigation, algorithms, products to find new solutions for a better and safer world [2]. Powered by highly scalable cloud technology [3], TEPs push the state of the art and provide their target communities with an innovative environment to extract the information they need as they need it and when they need it.

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HOW EARTH OBSERVATION IS FUELLING THE DIGITAL REVOLUTION

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Abstract

Earth Observation today answers some of the fundamental question on socio - political issues. Furthermore, the availability of a global EO Dataset is unprecedented in human history. The combination of the satellite imagery with increasing availability of compute resources has been fuelling the transformation of Earth Observation towards Big Data during the recent years. This drives the Digital Revolution.

This session will talk about how Big Data paradigms applied to Earth Observation data can become an accelerator towards the “Digital Earth”. It will highlight some of the challenges – specific to Earth Observation imagery - that will have to be tackled on the way towards a highly scalable and fully automated Earth Observation Big Data processing. Examples and use cases will be used to illustrate the transformation potential.

MOVING FROM RESEARCH TO BUSINESS

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Abstract

Thirty years ago, when EARSC was born, Earth Observation (EO) was driven either by scientific objectives with a very few satellites providing images or by military / national security objectives where the images were held in a black hole. Early efforts of commercialisation were not successful; lack of assurance for the continuity of service plus many unknowns meant that the civilian sector stayed focused on research and development for a further 2 decades.

Roll forward 30 years and the EO sector is becoming strongly commercial. Driven by a number of important trends, it is going through massive change:

- The rapid growth in the number of satellites sending images back down to Earth,
- The growth of big data technologies enabling the paradigm change of user-to-data instead of data-to-user
- The emerging artificial intelligence capabilities which allow these vast data volumes to be processed
- The interest of venture capital to invest in space projects
- In Europe, the EU Copernicus programme is having a strong influence on the market sector and the free and open data policy (FODP) is offering new opportunities for entrepreneurs with lowered entry barriers.

But the FODP is just one part of the picture and for new companies to thrive, further measures can and are being taken which can drive their growth. Work in the last few years has shown that new jobs and economic development is not just driven by SME's but by young SME's. Companies in their first 5 years of life and even in their first year are the source of all, net, new jobs. Policies that help them emerge and develop can yield good results.

The European Commission through the Copernicus programme has shown a lot of leadership in this respect. Various schemes have been introduced to encourage this process including the Copernicus incubator, the accelerator, the masters supported by hackathons and user uptake measures. Funding measures are encouraged with both public and private bodies involved to offer a raft of possibilities around, loans, grants and investments.

EARSC, now seeks to develop this process further and is putting in place a new scheme to help researchers turn their ideas into businesses. Understanding the value of the technology, its products and services is key; communicating this information to users, policy makers and other stakeholders is crucial. The value in the Copernicus data is high and is helping to create many new start-ups and to develop new businesses.

Through a value-chain methodology, EARSC is demonstrating how Copernicus is offering benefits to citizens and society. The presentation will describe these methods, the results they are generating and how they can feed into a new process to help turn research into business. We shall also describe some policy measures which can help accelerate and improve the uptake of Earth Observation data.

NEW WAYS OF ACCESSIBILITY - FACILITATING A NETWORK OF EUROPEAN EO RESOURCES (NOR)

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Abstract

During the last years, more and more Earth Observation (EO) data, software applications and IT services have become available from an increasing number of EO exploitation platform providers – funded by the European Commission, ESA, other public agencies or by private investment.

Selected as prime contractor for a recent tender of ESA, Cloudeo will create a portfolio of available EO resource tier and platform services and act as a facilitator to the “Network of Resources” for both providers and end users.

As a combination of exploitation and processing platforms, the Network of Resources will support the user in procuring services and outsourcing requirements while increasing integration of EO data and information for a broader use, for scientific, social and economic purposes, as well as for the generation of new commercial applications and services.

OPEN EARTH ENGINE - A VERSATILE CLOUD EO PROCESSING & ANALYTIC CAPABILITY

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Abstract

Free and open data archives and unprecedented observing capacities led to the recent paradigm shift in Earth Observation (EO). This necessitates EO data holdings to be collocated with powerful distributed compute environments. Cloud infrastructures offer many benefits to EO users e.g. elasticity and scalability of CPU and storage capacities. In Europe, the DIAS initiative has established four cloud-based environments dedicated to the storage, distribution and management of Copernicus Sentinel data. Prevailing requirements in the European EO community for EO analytics will not be fulfilled by DIAS. This is unfortunate, as EO cloud analytical solutions have had a considerable impact on the EO community. Examples include the Google Earth Engine, hosted within the companies ICT infrastructure offering intuitive coding environments and a broad range of analytic capabilities in a scalable ICT environment. Another example is the Pangeo initiative. It is seeking to align open source developments for Geospatial data analytics with tools for the orchestration and parallelisation of computational operations in a open source stack that can be deployed in scientific or commercial clouds. Despite the growing landscape of EO platforms, a gap in capabilities prevails. What is needed is a European capability that provides processing and analytical capabilities in a truly versatile manner, and that supports any commercial, scientific or public EO related analytic requirement while clearly ensuring users IPR rights and building on the concept of federated cloud assets rather than vendor lock-in.

To fill this gap, ESA is procuring the Open Earth Engine (OEE), a cloud-based EO processing and analytic capability for innovative & versatile exploitation of big EO data. The platform will feature several deployments on different cloud infrastructures. The architecture is optimised for massive parallel computations. The primary interface is a high-level, open API that can be used from a standard desktop IDE, where the API syntax can be used together with other scientific libraries. Additional interfaces exist e.g. in form of an interactive coding environment with visualization capabilities. The API provides a set of core capabilities that have been optimized for the platform architecture and distributed compute environments. These are implemented as open source code, fully transparent and can be adapted by users, if required. The core capabilities are conceptually designed to serve as building blocks to develop more complex algorithms by users. The OEE foresees two primary usage modes, (1) rapid and interactive code development and (2) a mass processing capability. Both are appropriately reflected in the service pricing. Seamless temporal-spatial access modes to different EO data holding are complemented with on-the-fly/on-demand processing to generate e.g. ARD data. The service development is closely linked to challenging use cases. A hackathon will allow the user community to evaluate the service and identify and develop new capabilities. The OEE platform seeks to establish a strong community culture. This involves mechanisms for collaborative code development, sharing of data and integration of results through web services. A remuneration will reward users, who contribute new algorithms within the platform that are used by third parties, with OEE service credits. A billing mechanisms allows users to ascertain costs for large or computationally intensive processing operations.

The service will become accessible to users in Q1/2020 while the functionality will evolve over time. In our presentation we will present the platform concept and API in more detail. We will further demonstrate how the ESA Network of Resources and Common Architecture initiatives are linked to the development of the OEE.

SESSION:
The impact of Digital Transformation on atmospheric composition monitoring for the environmental and human welfare

ACTRIS AEROSOL PROFILING DATABASE: NEW DESIGN AND NEW PRODUCTS FOR A WIDER USE OF AEROSOL LIDAR DATA

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Abstract

The aerosol remote sensing database of the ACTRIS Research Infrastructure (Aerosol, Clouds and Trace gases Research InfraStructure Network) is facing a complete redesign with the implementation of a new workflow and delivering new products to face of growing and pressing demand of aerosol vertical profiling information. The new database replies to some technical needs like quality controls and full traceability and to the growing demand of tailored products for different end user communities.

Quality control and full traceability are two fundamental aspects of data curation being a prerequisite of a modern and efficient Research Infrastructure (RI). In particular, a RI should ensure high-quality products by implementing a rigorous quality assurance program starting from raw data up to the final products. At same time, the RI products should be fully traceable in a way that it is always possible to fully characterize all computational steps, starting from the corresponding raw data to the final products. This aspect is particularly important as it plays a fundamental role in making the data FAIR compliant.

These tasks became challenging when the RI is based on inhomogeneous sensors as happens for EARLINET (European Aerosol Research Lidar NETwork), the ACTRIS aerosol remote sensing component. EARLINET is a good example showing the high level of inhomogeneity of the network sensors (lidar systems in this case). Most of the EARLINET lidar systems are home-made or highly customized. In cases like that, the implementation of a standard, centralized and quality assured scheme for the analysis of raw data is probably the most efficient solution to provide FAIR and quality assured data at RI level. The SCC (EARLINET Single Calculus Chain) is the solution adopted by the ACTRIS (Aerosol, Clouds and Trace gases Research InfraStructure Network) aerosol remote data center to ensure homogenous, traceable and quality controlled data.

On the other hand, new tailored products are highly requested for manifold applications like model assimilation and evaluation, air quality impact investigations, aviation risks management. The development of such new products is mainly based on scientific advances and has then to be implemented into the centralize processing in a standardized way when the required maturity level is reached. This is the case for example of one promising product now under investigation about the identification of intense and potentially aviation-risky occurrence of desert dust/volcanic ash cases.

AN INNOVATIVE FULL-SCALE NESTED AIR QUALITY PREDICTION MODELING AND DISPLAYING SYSTEM IN CHINA

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Abstract

An innovative full-scale (global-regional-urban cluster-city) nested air quality prediction modeling (NAQPMS and GNAQPMS) and displaying system supported by the CAS-EARTH Project has been developed with independent intellectual property rights, to display atmospheric pollutant transport and spatial-temporal distribution at all scales. The resolution of forecasting results can be rescaled from 1°×1° globally to 1 km×1 km in the city block for realistically tracking the real-time sources and processes of air pollution. Through cross-species assimilation scheme co-constrained by multiple pollutants based on the ground observations, satellite observations and retrieval of pollution sources, we built a cutting-edge assimilation system of atmospheric chemical data, which enabled the cross-domain development of PM2.5 forecasting and pre-warning in China.

The research results fully support the establishment of the national weather and heavy pollution forecasting and warning system. Self-developed models are being operating in the National Environmental Quality Forecast and Warning Center, the Regional Centers of Beijing-Tianjin-Hebei, Yangtze River Delta, and the Pearl River Delta as well as most of the provinces and cities in China. Moreover, the models have served for air quality forecasts during number of international events including the Beijing Olympics, Shanghai World Expo, Guangzhou Asian Games, Nanjing Youth Olympic Games, Beijing APEC Summit, 9.3 military parade, and G20 conference. The results have been widely used in the prevention and control of air pollution in key areas such as the Beijing-Tianjin-Hebei, Yangtze River Delta and Pearl River Delta, and have become the core technology support for many major environmental policies, technical documents and more than 40 business platforms.

CLOUD REMOTE SENSING IN ACTRIS

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Abstract

ACTRIS (Aerosol, Clouds and Trace Gases Research Infrastructure) is preparing to start the implementation phase in 2020, with the operational phase planned to start in 2025. In this presentation we give an overview of the cloud remote sensing component of ACTRIS, which is one of the six different research areas in ACTRIS. The ACTRIS cloud remote sensing network, which is already existing to a large extent, consists of around 15 sites in Europe, each containing at least a cloud radar, ceilometer and microwave radiometer.

The processing of the ACTRIS cloud remote sensing data is based on the Cloudnet algorithm which generates cloud properties at high temporal and vertical resolution. The retrieval classifies observed atmospheric scatterers, and produces geophysical products such as ice water content and liquid water content. In addition to the official ACTRIS sites, Cloudnet processing can be applied to any site that contains the minimum instrumentation. An open-source Python version of the processing software is freely available.

The Cloudnet processing system is automated, providing near-real time generation of products, together with their uncertainties. Accurate and continuous, vertically-resolved cloud data enable evaluation of the representation of clouds in numerical weather prediction and climate models; a challenge since clouds are highly variable in both time and space. Improving the model cloud schemes will lead to more accurate future climate predictions and to better weather forecasts.

ESTIMATION OF PM2.5 CONCENTRATION BASED ON CO-KRIGING AND GEOGRAPHICALLY WEIGHTED REGRESSION

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Abstract

In recent years, PM2.5 air quality has gradually entered the public eye and become an important influencing factor for the public to go out and live. In order to effectively detect the air concentration of PM2.5 and further analyze the influence of PM2.5 concentration on sensitive group, all provinces and cities began to set up air monitoring stations in stages in 2012. However, the number of monitoring stations is limited, and the distribution is uneven in the east and west, urban and rural areas, resulting in the formation of "sample cavity" area (almost no sample points). These factors greatly limit the accuracy of PM2.5 concentration estimation. In view of the strong correlation between PM2.5 and atmospheric aerosol optical thickness (AOD), the indirect estimation of PM2.5 concentration using AOD satellite remote sensing data with long observation time, wide coverage and low cost has become an important means to overcome the inadequacy of monitoring sites. It is found through experiments that the estimated error range of the coKriging interpolation method is 0 to 105 in the densely-monitored urban area. However, the estimation error of the “sample cavity” area is more than 420, and the interpolation accuracy of the area is generally not high. This paper proposes a method combining coKriging and geographically weighted regression model to compensate for the deficiency of single coKriging method. In urban areas with dense sample points, AOD remote sensing data and PM2.5 monitoring data are still used for cokriging interpolation. The geographically weighted regression model was used for interpolation in the vast rural areas where sample points were sparse. The geographically weighted regression model considers the change of the regression coefficient with the spatial position and overcomes the shortcoming of the single coKriging method in which the interpolation accuracy is not high in the “sample cavity” region. The experimental results according Guangdong Province’ s data show that the cross-variogram function of coKriging has the range of 0.29 and the sill of 210.45. The R^2 of the geographically weighted regression model is as high as 0.6189. The interpolation accuracy of the hybrid model is 15.6% higher than that of the single cokriging model.

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EXPLOITATION OF ACTRIS/CLOUDNET IN ASSESSING THE EFFECT OF THIN CLOUD CONTAMINATION ON THE RETRIEVAL OF SOLAR INDUCED FLUORESCENCE

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Abstract

Among other vegetation indicators, the photosynthetic activity of vegetation can be quantified by measuring the emitted solar induced fluorescence (SIF). Recently, the rapid development of space-borne instruments has enable the retrieval of SIF at satellite level, exploiting distinct spectral regions to achieve this goal. In the forthcoming years, the FLORIS high spectral resolution spectrometer on board the upcoming ESA's FLuorescence EXplorer (FLEX) mission will allow the quantification of the total emitted SIF in the range of 650-780 nm.

Given the spectral range where SIF is emitted, atmospheric scattering and absorption effects, if not properly quantified, could significantly disturb SIF estimations (Sabater et al., 2017). Aiming to achieve an accurate atmospheric characterization, the FLEX mission was designed to fly in tandem with the Sentinel-3B satellite having on-board the OLCI and SLSTR instruments. The application of the existing AATSR/SLSTR algorithm (Kolmonen et al., 2016) on SLSTR data can contribute to the aerosol presence characterization process. In this context, a special case that might affect the accuracy of the retrieved SIF occurs when the aerosol retrieval is contaminated by elevated thin clouds, e.g. Cirrus-type clouds. Although clouds are screened before the aerosol retrieval, scattered Cirrus-type thin clouds may survive the screening process, thus causing unwanted contribution to the retrieved aerosol properties and further to the estimated SIF.

In this work, we explore the potential use of the cloud radar and lidar data sets available at the CLOUDNET/ACTRIS repository to detect the thin cloud conditions collocated with Sentinel-3. The retrieved aerosol properties that are possibly contaminated are compared with the positively cloud-free retrievals and with the AERONET reference database to assess the impact of the undetected thin-cloud on the SIF estimations.

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IN-SERVICE AIRCRAFT FOR A GLOBAL OBSERVING SYSTEM (IAGOS) RESEARCH INFRASTRUCTURE

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Abstract

Since 1994, IAGOS (In-service Aircraft for a Global Observing System) has been equipping commercial aircraft with instruments to monitor the composition of the atmosphere on long-haul flights around the world. The aircraft measure ozone, carbon monoxide and water vapour and nitrogen oxides along with meteorological parameters and cloud particles at cruise altitude in the upper troposphere/lower stratosphere and during landing and take-off at almost 300 airports throughout the world. We describe these measurements and their importance to the monitoring of global atmospheric composition and air quality. In particular, we show examples from the Copernicus Atmosphere Monitoring Service (CAMS) where IAGOS data are used in the evaluation and improvement of forecasts of air quality over Europe.

RELATIONSHIP BETWEEN LAND USE AND WATER QUALITY – A CASE STUDY OF THE MUN RIVER BASIN IN THAILAND

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Abstract

Quantifying the relationshap between the land use and water quality is helpful to guide land use management and control water eutrophication. This study took the Mun river basin in Thailand as an example and was based on 19 water quality monitoring stations. The watershed was divided into 19 sub-basins according to the confluence process, through principal component analysis method, calculation water quality pollution score of each water quality monitoring sites; then through remote sensing and spatial calculation, to extract the information of land use and planting patterns, and respectively to calculate the distance with the river and water quality monitoring sites and other relevant information, build quality total pollution index and soil total nitrogen and total phosphorus of multivariate linear regression equation. The results showed that the dry season the regression equation of the total land use and water quality pollution by 0.329 did not include any information, increased to 0.685;The rainy season increased from 0.352 to 0.352, significantly improve the interpretability of the model.When determined in each space the contribution rate of land use on water quality monitoring section of the nutrient concentration, on the basis of comparing river under different migration path distance of land use on the average concentration of nutrient accumulation contribution rate and cumulative percentage area, determines the distance from the river of riparian zone within 1 km distance for eutrophication of key control.

THE HETEROGENEITY ANALYSIS AND HIGH-RESOLUTION SPATIOTEMPORAL PATTERNS OF FFCO2 EMISSIONS IN CHINA

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Abstract

Anthropogenic greenhouse gas emissions (with 95 percent certainty) are the dominant cause of observed warming since the mid-20th century, among which Fossil Fuel carbon dioxide (FFCO2) emissions account for more than half of the total (fossil fuel + biospheric + background) variations in the spatiotemporal dynamics of atmospheric CO2. The aim of this study was to analyze the spatial heterogeneity of exist FFCO2 emission inventories and investigate the long-term (2000-2015) national, local and cities' high-resolution spatiotemporal patterns of China's FFCO2 emissions in hotspot megacities. Spatio-temporal heterogeneity analysis and authenticity verification of all existing FFCO2 emissions inventories, including new datasets, for China are the two necessary premises. Hu line was used to outline an initial overall spatiotemporal pattern in China by combining satellite observations with bottom-up measurements, Land Cover (LC) maps, and city-level CO2 emission inventory; Local Indicators of Spatial Association (LISA) with Empirical Bayes (EB) rate, Local Indicator of Multivariate Local Geary, factor analysis and source analysis were carried out to analyze local and cities' spatiotemporal patterns, as well as clustering, instability, factors, and sources of FFCO2. Clusters (inner cities and economic development zones, areas with vegetation and water covering) significantly vary during the 15 years. We find diverse factors (22 factors were discussed) for the FFCO2 emission distribution. Urban areas play a major positive role while cropland (strong) and grassland (slight) areas negative. And the moisture (rainfed, irrigated, and post-flooding) of the cropland areas (only can be found) turns out to be an inducer. The more moisture the croplands (only effective) is, the less regulating effect of cropland upon FFCO2 emissions is, turning out a higher emission value there. Uses of raw coal in all chosen six cities are still the primary source of FFCO2 emissions, however, diverse industrial structure and energy efficiency are increasingly bringing out various FFCO2 emission structures in different cities. There will be an out-of-balance in the current spatial patterns of FFCO2 emissions in China.

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THE IMPORTANCE OF CONTINUOUS, COMPREHENSIVE OBSERVATIONS: THE POTENTIAL OF SMEAR CONCEPT

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Abstract

The atmosphere closely interacts with the biosphere, hydrosphere, cryosphere and lithosphere as well as with urban surfaces. Human and societal actions, such as emissions-control policies, urbanization, forest management and land-use change, as well as various natural feedback mechanisms involving the biosphere and atmosphere, have substantial impacts to our environment. To be able to meet challenges related to our Earth system we need proper comprehensive observational platforms to provide deep understanding of these processes.

On-going observations are typically fragmented into greenhouse gases, aerosols, air quality, trace gases, ecosystems, climate, etc., without active collaboration between different scientific communities. However, this kind of boarders or grouping do not exist in nature and all the components are interlinked. In order to produce reliable data and in-depth understanding we need integrated approach to be able to answer global grand challenges like climate change, air quality, water and food supply in a form that societies can use without difficulties. Therefore, we have developed a SMEAR (Stations for Measuring Earth surface Atmosphere relations) concept.

During the past ten years, the SMEAR II station (in Hyytiälä, Finland) has contributed to several Pan-European research infrastructure that are currently in the ESFRI Roadmap, such as ICOS (Integrated Carbon Observation System), ACTRIS (Aerosols, Clouds, and Trace gases Research Infrastructure), AnaEE (Infrastructure for Analysis and Experimentation on Ecosystems), and eLTER (Integrated European Long-term Ecosystem, critical zone and socio-ecological system Research Infrastructure). SMEAR has provided high-quality data, trans-national access, and contributed to the development of advanced technologies in many research fields. Due to its comprehensive concept, SMEAR is capable for providing data also to several global Earth Observation systems and networks, such as to WMO GAW, GEO-GEOSS, FluxNet, AERONET and SolRad-Net.

There are several benefits that have been gained by the collaboration and comprehensiveness of SMEAR concept. The most important impact of the integration and co-location is on the scientific results like quantification of feedback loops, understanding biogeochemical cycles (including water and carbon cycles) in details, understanding gas-to-particle conversion in quantified way and understanding interlinks of several processes. Results have shown that the key in very many feedback loops and in biogeochemical cycles is what happens in molecular and cluster level (size range < 1nm – 3nm).

Using SMEAR concept in global scale enables us to perform global feedback loop analysis, find out new interactions, feedbacks and processes and collect new big data for future use to answer questions, which at the present cannot even been foreseen.