

РЕЗЮМЕТА

на научните трудове

на доц. д-р Лъчезар Христов Филчев

представени за участие в конкурс за заемане на академичната длъжност „Професор”, обявен в Държавен вестник (ДВ) бр. 62/27.07.2021 г. (стр. 93, № 632) от Института за космически изследвания и технологии - БАН (ИКИТ-БАН) в област на висше образование „4. Природни науки, математика и информатика”; професионално направление „4.4. Науки за Земята”; научна специалност „Дистанционни изследвания на Земята и планетите” за нуждите на секция „Дистанционни изследвания и ГИС” при ИКИТ-БАН.

София

2021

**A1. Дисертационен труд за присъждане на образователна и научна степен
"доктор" Автореферат**

БЪЛГАРСКА АКАДЕМИЯ НА НАУКИТЕ
ИНСТИТУТ ЗА КОСМИЧЕСКИ И СЛЪНЧЕВОЗЕМНИ ИЗСЛЕДВАНИЯ
Секция „Дистанционни изследвания и ГИС“

гл. ас. Лъчезар Христов Филчев

МОДЕЛ ЗА РАЗПОЗНАВАНЕ НА СТРЕСОВИ СИТУАЦИИ В ИГЛОЛИСТНИ
ЛАНДШАФТИ С ИЗПОЛЗВАНЕ НА МНОГОКАНАЛНИ И СПЕКТРОМЕТРИЧНИ
СПЪТНИКОВИ ДАННИ

АВТОРЕФЕРАТ

на

дисертация за присъждане на образователна и научна степен
“ДОКТОР”

София
2011 г.

ANNOTATION

The significance of Earth Observation and Remote Sensing (RS) for monitoring of forest health and stress in particular is emphasized in numerous documents, directives, laws and initiatives of international organizations, such as the European Union (EU), the United Nations (UN) Food and Agriculture Organization (FAO), and various national strategies and laws. The study objectives of the present Ph.D. thesis are the coniferous landscapes in the Teyna River Basin. The study subject is the abiotic stress of coniferous landscapes caused by uranium mining. The aim of the study is to develop a model for recognition and assessment of abiotic stress of coniferous landscapes caused by uranium mining, using ground-based biogeochemical, biophysical and field spectrometry data, and multispectral and hyperspectral very high resolution (VHR) satellite data. The methods employed in the study are geoinformation methods, statistical and geostatistical methods, cartography methods, geochemical and landscape ecology methods. The Ph.D. Thesis is 163 pages and consists of four Chapters, Conclusions, Contributions, and three Appendices totalling to 13 pages and comprising 9 Tables. The Thesis includes 45 Figures, 19 Tables, and 42 Equations in the main body text. The References include a total of 285 items, of which 101 are in Cyrillic, and 184 are in Latin. The results have been published in 9 papers and presented at 6 national or international scientific events. The main results and contributions of the study are:

- 1) An assessment of the use of the existing transfer functions, geometrical and reflection models in RS for detection and assessment of abiotic stress has been made. The results prove that the hybrid models and joint use of reflectance, geometric-optical and atmospheric transmittance models provide for reliable assessment of the biogeochemical properties of coniferous landscapes, and respectively, of abiotic stress;
- 2) A dose-response relationship model has been developed and approbated for the study area of the *Teyna* River Basin – the *Iskra* uranium-ore section, for two periods: 1993-1996 and 2011, using ground-based biogeochemical, biophysical, and multi- and hyperspectral satellite data. The model employs several complimentary models for establishing the dose-response relationships, such as: 1) Digital Landscape Model (DLM); 2) Geostatistical models of pigment, Leaf Area Index (LAI), heavy metals, metalloids and radionuclides, and total technogenic pollution coefficient - Z_c distributions; 3) Model of pigment content derived by broadband and narrowband VI from multispectral and hyperspectral data, and red-edge position; 4) Geodatabase model;
- 3) By testing different geostatistical interpolators for clustered point samplings of geochemical and biophysical data, it has been found out that the optimal interpolator is the Inverse Multiquadratic Function from the set of Radial Basis Functions (RBF);
- 4) Based on the reclassified values of the coefficient of total technogenic pollution – Z_c , the classes of polluted and abiotically stressed coniferous landscapes in the *Teyna* River Basin have been determined;
- 5) It has been found out that multispectral data can be used to detect abiotic stress in coniferous landscapes caused by uranium mining;
- 6) An abiotic exstress in coniferous landscapes has been found out, based on the blue shift and red edge position, depth and asymmetry. The exstress manifestation is in the higher chlorophyll and carotene content in the needles of coniferous landscapes. This is also supported by field spectrometry and hyperspectral satellite reflectance data from EO-1/Hyperion;
- 7) It has been found out that the VIs TCARI and MCARI, as well as the first principal component (PC1) of the VIs: TCARI, MCARI, PRI and MTVI 2, can be used to detect and assess abiotic stress in coniferous landscapes caused by uranium mining.

В.4. Хабилитационен труд - научни публикации (не по-малко от 10) в издания, които са реферирани и индексирани в световноизвестни бази данни с научна информация

Bulgarian Academy of Sciences. Space Research and Technology Institute.
Aerospace Research in Bulgaria. 29, 2017, Sofia

B4_1

**REVIEW OF SPECTRAL VEGETATION INDICES AND METHODS
FOR ESTIMATION OF CROP BIOPHYSICAL VARIABLES**

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Abstract

In present article a brief overview is presented on spectral vegetation indices and methods for estimation of crop main biophysical variables and their proxies. The main VIs used in estimation of nitrogen and chlorophyll, biomass, LAI and fAPAR, fCover, and photosynthesis are summarized.

Comparison of Global and Continental Land Cover Products for Selected Study Areas in South Central and Eastern European Region

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Abstract: Land cover is one of the key terrestrial variables used for monitoring and as input for modelling in support of achieving the United Nations Strategic Development Goals. Global and Continental Land Cover Products (GCLCs) aim to provide the required harmonized information background across areas; thus, they are not being limited by national or other administrative nomenclature boundaries and their production approaches. Moreover, their increased spatial

resolution, and consequently their local relevance, is of high importance for users at a local scale. During the last decade, several GCLCs were developed, including the Global Historical Land-Cover Change Land-Use Conversions (GLC), the Globeland-30 (GLOB), Corine-2012 (CLC) and GMES/Copernicus Initial Operation High Resolution Layers (GIOS). Accuracy assessment is of high importance for product credibility towards incorporation into decision chains and implementation procedures, especially at local scales. The present study builds on the collaboration of scientists participating in the Global Observations of Forest Cover—Global Observations of Land Cover Dynamics (GOF-C-GOLD), South Central and Eastern European Regional Information Network (SCERIN). The main objective is to quantitatively evaluate the accuracy of commonly used GCLCs at selected representative study areas in the SCERIN geographic area, which is characterized by extreme diversity of landscapes and environmental conditions, heavily affected by anthropogenic impacts with similar major socio-economic drivers. The employed validation strategy for evaluating and comparing the different products is detailed, representative results for the selected areas from nine SCERIN countries are presented, the specific regional differences are identified and their underlying causes are discussed. In general, the four GCLCs products achieved relatively high overall accuracy rates: 74–98% for GLC (mean: 93.8%), 79–92% for GLOB (mean: 90.6%), 74–91% for CLC (mean: 89%) and 72–98% for GIOS (mean: 91.6%), for all selected areas. In most cases, the CLC product has the lower scores, while the GLC has the highest, closely followed by GIOS and GLOB. The study revealed overall high credibility and validity of the GCLCs products at local scale, a result, which shows expected benefit even for local/regional applications. Identified class dependent specificities in different landscape types can guide the local users for their reasonable usage in local studies. Valuable information is generated for advancing the goals of the international GOF-C-GOLD program and aligns well with the agenda of the NASA Land-Cover/Land-Use Change Program to improve the quality and consistency of space-derived higher-level products.

Keywords: land cover; earth observation; validation; weighted accuracy; confidence levels; inter-comparison; SCERIN

PRELIMINARY ANALYSIS OF COPERNICUS DATA FOR NATURAL HAZARDS MONITORING OF THE BULGARIAN BLACK SEA COASTAL ZONE

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Abstract

The Bulgarian coastal zone is exposed to wide variety of natural hazards, where their complex impact may cause negative social and economic consequences and environmental changes. To improve the understanding of such dangerous and destructive processes, a new knowledge and techniques are required. Satellite imagery is critical to deliver a clear picture on the extent of devastation after any disaster that is happening on Bulgarian territory. In recent years, with becoming operational, Copernicus data and products become as well freely available to the scientific community and end users. To address the national needs and priorities, set out in the National Strategy for Disaster Risk Reduction 2017–2030, this paper provides a systematic analysis of the Copernicus data for the purposes of compiling different cartographic products and maps for monitoring of equatorial and adjacent terrestrial ecosystems. A comparative review of optical and radar satellite images comprising the data archive since the beginning of 90th and data from Copernicus initiative till now covering the western Black Sea area is presented. The data analysis will contribute to develop wide-range monitoring of the potential endangered areas, detection of slow surface movements and delineation of destructive natural hazard events. We complimented the analysis with tracking time changes of the coastal area for the last three decades for the test risk region of northern Bulgarian coast. This region is undergone on the recent vertical crustal movements, active landslide processes, and coastal abrasion; it is one of the regions in Bulgaria with a high seismic risk. The importance of Sentinel data for monitoring in Bulgaria is discussed, taking into account that the Bulgarian National program for disasters preparedness and risk mitigation is harmonized with the EU policy of natural hazard risk mitigation.

Keywords: Copernicus Program, natural hazard, optical satellite data, radar satellite data, Black Sea region

INTRODUCTION

Natural hazards monitoring is one of the important activities included in the disaster risk reduction (DRR) strategies on different management level. The national policy of Bulgaria in this field is regulated by a number of normative documents, which determine the roles of involved stakeholders and their responsibilities, regulate the terms and conditions for the functioning of the National System for early warning and alert, and the establishing of scientific monitoring networks.

Estimation of biophysical and biochemical variables of winter wheat through Sentinel-2 vegetation indices

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Abstract

Dimitrov, P., Kamenova, I., Roumenina, E., Filchev, L., Ilieva, I., Jelev, G., Gikov, A., Banov, M., Krasteva, V., Kolchakov, V., Kercheva, M., Dimitrov, E., & Miteva, N. (2019) Estimation of biophysical and biochemical variables of winter wheat through Sentinel-2 vegetation indices. *Bulgarian Journal of Agricultural Science*, 25(5), 819–832

Traditionally, the growth and physiological status of winter wheat (*Triticum aestivum* L.) is monitored in the field by measuring different biophysical and biochemical variables such as Above Ground Biomass (AGB), Nitrogen content (N), N uptake, Leaf Area Index (LAI), Fraction of vegetation Cover (fCover), Canopy Chlorophyll Content (CCC), and fraction of Absorbed Photosynthetically Active Radiation (fAPAR). The objective of this study was to investigate the possibility of estimating these crop variables through statistical regression modelling and spectral vegetation indices derived by the Sentinel-2 satellites. Field data were collected over two growing seasons, 2016/2017 and 2017/2018, in test fields around Knezha, northern Bulgaria. A combination of spectral data from Sentinel-2 images and field spectroscopy obtained through the first growing season was used for model calibration and cross-validation. The models were further validated with Sentinel-2 image data from the second growing season. The accuracy of the models varied widely across crop variables. According to the cross-validation, the relative RMSE was below 25% for fAPAR, fCover, and fresh AGB, with particularly good result for fAPAR (13%). For N content and dry AGB the error was between 25% and 30%. The accuracy was low for CCC, LAI, and N uptake (error between 30% and 43%). The models' performance was worse when they were applied to the data from the second growing season, resulting in relative RMSE which were 3-8% higher in the general case. The cross-validation results suggested that the variety-specific models are more accurate than the generally calibrated models for most crop variables. The accuracy obtained in this study for the prediction of fAPAR, fCover and AGBf through VIs is promising. Future studies and incorporation of new field data will be needed to better account for variety, season, and site variations in the modelled relationships and to improve their generalisation potential.

Keywords: biomass; canopy chlorophyll; leaf area; nitrogen content; satellite imagery



Article

Sub-Pixel Crop Type Classification Using PROBA-V 100 m NDVI Time Series and Reference Data from Sentinel-2 Classifications

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Abstract: This paper presents the results of a sub-pixel classification of crop types in Bulgaria from PROBA-V 100 m normalized difference vegetation index (NDVI) time series. Two sub-pixel classification methods, artificial neural network (ANN) and support vector regression (SVR) were used where the output was a set of area fraction images (AFIs) at 100 m resolution with pixels containing estimated area fractions of each class. High-resolution maps of two test sites derived from Sentinel-2 classifications were used to obtain training data for the sub-pixel classifications. The estimated area fractions have a good correspondence with the true area fractions when aggregated to regions of 10 × 10 km², especially when the SVR method was used. For the five dominant classes in the test sites the R² obtained after the aggregation was 86% (winter cereals), 81% (sunflower), 92% (broad-leaved forest), 89% (maize), and 67% (grasslands) when the SVR method was used.

Keywords: crop mapping; Sentinel-2; sub-pixel classification; area fraction images

CROP TYPE MAPPING USING MULTI-DATE IMAGERY FROM THE SENTINEL-2 SATELLITES

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(Submitted by Corresponding Member P. Velinov on April 19, 2019)

Abstract

This paper presents the results of a crop type mapping exercise conducted in two study areas in Bulgaria and based on data from the Sentinel-2 (S2) satellites. A multi-date maximum likelihood classification approach was used in which nine spectral bands from three cloud-free images, well distributed across the growing season, were used. Validation was performed using field data collected as part of the study and data from the Integrated Administration and Control System (IACS) dataset. Depending on the validation dataset and the study area, an overall accuracy of 74–95% was achieved after the crop type maps were post-processed by mode filtering. Further increase in accuracy may be obtained if parcel boundaries, as defined in the IACS dataset, are used to aggregate the per-pixel classification to a parcel level.

Key words: remote sensing, Sentinel-2, satellite imagery, crop mapping, maximum likelihood classification

Web based EMF monitoring in urban environment

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ABSTRACT

The development of mobile communications in the past decade imposed a real risk to human health. The ever growing technology needs and developments in the telecommunication technology are one of the environmental issues of the urban environments. One solution to accommodate the technology developments is to optimize the mobile communications network which is a topic of investigation of many scientific and technology teams. In order to optimize the network it is necessary to make regular measurements and assess the risk on human health and optimize the mobile network on the basis of software defined radio /SDR/. In European Union /EU/ and in Bulgaria are present regulations for the control of electromagnetic field /EMF/ emissions. Investigation of the EMF pollution on the territory of Sofia municipality is performed within the domain from 100 MHz to 7 GHz using standard measurement equipment, and portable field spectrometer based on SDR. The characteristics of the three spectrometers provide for a more in depth analysis of the EMF sources. The field measurements are continuous during day and nighttime. The data is stored in a personal geodatabase format (ESRI Inc., Academic license) and MySQL and stored on the FTP server of Technical University /TU/ of Sofia IT infrastructure. The data is visualized on a web-portal developed by TU team. In conclusion is analyzed the opportunities for urban developments in view of urban planning for the development of the city of Sofia in compliance with national and EU environmental legislation.

Keywords: EMF monitoring, urban environment, database, EU environmental legislation, Software defined radio

B4_7

1129

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Qualitative evaluation and within-field mapping of winter wheat crop condition using multispectral remote sensing data

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Abstract

Roumenina, E., JeleV, G., Dimitrov, P., Filchev, L., Kamenova, I., Gikov, A., Banov, M., Krasteva, V., Kercheva, M. & Kolchakov, V. (2020). Qualitative evaluation and within-field mapping of winter wheat crop condition using multispectral remote sensing data. *Bulg. J. Agric. Sci.*, 26 (6), 1129–1142

This study presents a method for evaluation and mapping of winter wheat crop condition using a set of crop variables, e.g. leaf area index (LAI), fraction of absorbed photosynthetically active radiation (fAPAR), fraction of vegetation cover (fCover), fresh above ground biomass (AGBf), and Nitrogen uptake derived from multispectral imagery. First, the crop condition is assessed with respect to each variable using a qualitative, three-grade scale. In a second step, these individual assessments are combined to produce assessment map of the crop's general condition, discriminating between three possible conditions – Good, Fair, or Poor. The method was tested on winter wheat fields in Bulgaria in two agricultural years – 2016/2017 at phenological growth stage (FGS) Z31 to Z34 and 2017/2018 at FGS Z30. The results presented were based on Sentinel-2 satellite imagery (at 20 m spatial resolution) and imagery from Specialized Unmanned Aerial Vehicle (SUAV) sense FlyeBee Ag, equipped with Parrot Sequoia camera (resampled to 10 m spatial resolution). The remotely sensed crop condition was validated against independent ground-based assessments in a number of elementary sampling units (ESUs). The proposed approach proved to be effective and the crop condition was accurately determined in 87% – 94% of the ESUs depending on the FGS/agricultural year and the imagery type. We observed only minor differences in the areas of the three crop conditions when mapped with Sentinel-2 and Parrot Sequoia data.

Keywords: winter wheat; crop condition; assessment map; Sentinel-2; Parrot Sequoia camera

B4_8

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A REVIEW OF EARTH OBSERVATION RESOURCES FOR SECONDARY SCHOOL EDUCATION – PART 1

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Keywords: Secondary School, Science Education, Earth Observation Education, STEM,
EO, MOODLE.

Abstract

This article provides an overview of worldwide web and e-Learning resources for Earth Observation (EO) education for secondary schools. The main EO education initiatives supported by international, EU and national organizations. The article elaborates on future prospects of EO education in the education system its relevance for the society and its connection with STEM subjects.

B4_9

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CROP TYPE MAPPING IN BULGARIA USING SENTINEL-1/2 DATA

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Keywords: Crop Type Mapping, Sentinel, Google Earth Engine, Random Forest

Abstract

Advanced possibilities have emerged in the recent years for semi-automatic crop type mapping at national level due to the availability of Sentinel-1 and -2 satellite data. In this study, 14 crop type classes were mapped over Bulgaria using three bi-monthly composite image mosaics for 2019 generated in the Google Earth Engine (GEE) cloud computing platform. The overall accuracy when both Sentinel-1 and -2 mosaics were used was 78%, while the accuracy was slightly less when only Sentinel-2 data was used (75%). The accuracy was highest for “Cereals”, “Maize”, “Sunflower”, “Winter rapeseed”, and “Rice” - over 80% for both user’s and producer’s. However, the accuracy for classes such as “Vegetables”, “Technical crops”, “Forage crops”, “Fallow”, etc. was low. These classes represent categories suitable for the agricultural practice and statistics but are too general and difficult to distinguish using satellite data. It was found also that accuracy tend to be higher for larger parcels. Using composites with higher frequency and adapting the legend classes to include only crops which are similar in phenology and morphology are suggested as possible ways forward.

B4_10

Г.7. Научни публикации в издания, които са реферирани и индексирани в световноизвестни бази данни с научна информация

Bulgarian Academy of Sciences. Space Research and Technology Institute.
Aerospace Research in Bulgaria. 27, 2015, Sofia

LAND-USE/LAND-COVER CHANGE OF BISTRISHKO BRANISHTE BIOSPHERE RESERVE USING SENTINEL-2 SIMULATED DATA

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Abstract

The aim of this study is the evaluation of changes in land-use/land-cover on the territory of Bistrishko Branishte biosphere reserve (UNESCO, MAB), Vitosha; with the use of simulated Sentinel-2 data. For this purpose the CHRIS/PROBA image acquired on 22 June 2012, and on 28 September 2012 are geometrically and atmospheric corrected and co-registered. The topographic normalization is applied to the second image due to shadows cast on the slopes of the Valley of the river Bistrica. In order to simulate the Sentinel-2 bands, the spectral channels of the CHRIS/PROBA are spectrally resampled to spectral width of the Sentinel-2 bands. The spatial resampling of the Sentinel-2 bands is done using a Landsat 7 ETM + panchromatic band (15 m). On the classification of land-use/land-cover an accuracy assessment and cross-validation is made by using ground-based data. The results show that between 60 ha and 72 ha of coniferous plants were devastated by a forest fire in 2012. the results obtained demonstrate the ability of the Sentinel-2 mission to detect sudden changes in land-use/land-cover caused by forest fires.

Г7_1

Bulgarian Academy of Sciences. Space Research and Technology Institute.
Aerospace Research in Bulgaria. 28, 2016, Sofia

A COMPARATIVE ANALYSIS BETWEEN MODIS LST LEVEL-3 PRODUCT AND IN-SITU TEMPERATURE DATA FOR ESTIMATION OF URBAN HEAT ISLAND OF SOFIA

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Abstract

In present study we use global eight-day MODIS Land Surface Temperature (LST) and Emissivity Level-3 satellite products (MOD11A2 and MYD11A2) with in-situ data from automatic weather stations (AWS) to analyze usability and reliability of satellite derived LST data for Urban Heat Island estimation for the city of Sofia, Bulgaria. In order to achieve the study aim the terrestrial measurements from eight AWS were compared to the extracted pixel values from the MODIS LST Level-3 products. The so formed time-series were averaged to align with MODIS LST Level-3 products and gap-filled using the established relationship between the satellite and terrestrial data. A very strong positive relationship ($R^2=0.97$ at 95% confidence interval) was found for the eight ground AWS which readings were analyzed on a diurnal and seasonal basis for the year of 2013. It is suggested that the pronounced diurnal and seasonal variations in the trends and correlation between satellite and in situ temperature data were primarily related to the different land-use/land-cover type of the mixed pixel of MODIS.

Г7_2

Bulgarian Academy of Sciences. Space Research and Technology Institute.
Aerospace Research in Bulgaria. 29, 2017, Sofia

Г7_3

ASSESSMENT OF THE LAND SURFACE TEMPERATURE DYNAMICS IN THE CITY OF SOFIA USING LANDSAT SATELLITE DATA

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Abstract

The article presents the first attempt to analyse the urban heat island of the city of Sofia using satellite data. For this purpose the thermal data from Landsat ETM+ and TIRS sensors have been used. A statistical analysis of the results was carried out as well as an analysis of the changes in the surface temperature for the selected time interval – 2000–2015. The impact of the type of land cover was analyzed. For this purpose, a visual land-cover classification has been drawn up, whereby the surveyed territory is divided into 16 classes. A detailed analysis of the data over the entire survey period shows a gradual rise in the city's temperature due to the change in the urban environment. One of the conclusions of the study is that thermal images over time can be successfully used to detect changes in the land cover by temporal analysis.

Bulgarian Academy of Sciences. Space Research and Technology Institute.
Aerospace Research in Bulgaria. 33, 2021, Sofia

Г7_4

A REVIEW OF EARTH OBSERVATION RESOURCES FOR SECONDARY SCHOOL EDUCATION – PART II

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Keywords: Secondary school, science education, Earth Observation education, STEM,
EO, e-Learning.

Abstract

This article is a continuation of an overview of the contemporary resources for Earth Observation (EO) education for secondary schools. The themes covered by the sequel are the main EO education initiatives supported by international, EU and national organizations, outreach activities, citizen scientists' projects and free and open source software (FOSS) EO tools. The article elaborates on future prospects of EO resources developments in the education system its relevance for the society and its connection with STEM subjects.

Г.8. Научна публикация в нерелативирани списания с научно рецензиране или в редактирани колективни томове

Г8_1

S E S 2 0 1 4
Tenth Anniversary Scientific Conference with International Participation
SPACE, ECOLOGY, SAFETY
12 – 14 November 2014, Sofia, Bulgaria

**ДОБРИ ПРАКТИКИ В БЪЛГАРИЯ ЗА ПРИЛОЖЕНИЕ
НА СПЪТНИКОВИ ДАННИ В ЗЕМЕДЕЛИЕТО И ЛАНДШАФТНО-
ЕКОЛОГИЧНИЯ МОНИТОРИНГ**

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Петър Димитров, Александър Гиков, Евгения Руменина, Стефан Стаменов**

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Ключови думи: спътникови данни, земеделие, екологичния мониторинг

Резюме: Работата е посветена на някои от основните изследвания в областта на приложението на аерокосмически данни в земеделието и ландшафтно-екологичния мониторинг на територията на България, проведени от членовете на Секция „Дистанционни изследвания и ГИС“ към Институт за космически изследвания и технологии – БАН.

**BEST PRACTICES IN SATELLITE DATA APPLICATIONS FOR AGRICULTURE
AND LANDSCAPE-ECOLOGICAL MONITORING IN BULGARIA**

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Keywords: satellite data, agriculture, environmental monitoring

Abstract: The work is dedicated to some of the basic research in the application of aerospace data in agriculture and landscape-ecological monitoring on the territory of Bulgaria, carried out by members of the Section "Remote Sensing and GIS" at the Space Research and Technologies Institute - BAS.

Г8_2

FOURTEENTH INTERNATIONAL CONFERENCE ON MARINE SCIENCES AND TECHNOLOGIES



**SATWEBMARE PRODUCTS AND SERVICES IN SUPPORT OF THE
SUSTAINABLE MANAGEMENT OF THE BULGARIAN COASTAL ZONE**

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Abstract. The coastal zones have important ecological, social, and economic impact on the human life and are undergoing the severe anthropogenic degradation that is happening against the backdrop of environmental alterations due to climate change. To address the challenges of present and future environmental changes in coastal areas, this article aims to represent a prototype of Web-based integrated system SatWebMare designed to provide through geo-portal innovative products and services for integrated coastal zone management of the Bulgarian coastal zone, inline with the nowadays concepts of Big Data. The SatWebMare prototype system will combine geo-database sets from different sources, which will be used for improving a spatial and temporal accuracy of modeling the air-land-sea interaction processes and their forecast. An overview of the system architecture consisting of three main modules will be presented. The SatWebMare geo-portal aims to provide an access to products and services with added-value information for ministries, agencies, local authorities, and other stakeholders in support of the integrated coastal zone management.

Keywords: Earth Observation, Bulgarian coastal zone, Geportal, Open Source, Big Data

BigSkyEarth conference: AstroGeoInformatics, Tenerife, Spain, December 17-19, 2018

Challenges and Solutions for Utilizing Earth Observations in the "Big Data" era

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Abstract

The ever-growing need of data preservation and their systematic analysis contributing to sustainable development of the society spurred in the past decade, numerous Big Data projects and initiatives are focusing on the Earth Observation (EO). The number of Big Data EO applications has grown extremely worldwide almost simultaneously with other scientific and technological areas of the human knowledge due to the revolutionary technological progress in the space and information technology sciences. The substantial contribution to this development are the space programs of the renowned space agencies, such as NASA, ESA, Roskosmos, JAXA, DLR, INPE, ISRO, CNES etc. A snap-shot of the current Big Data sets from available satellite missions covering the Bulgarian territory is also presented. This short overview of the geoscience Big Data collection with a focus on EO will emphasize to the multiple Vs of EO in order to provide a snapshot on the current state-of-the-art in EO data preservation and manipulation. Main modern approaches for compressing, clustering and modelling EO in the geoinformation science for Big Data analysis, interpretation and visualization for a variety of applications are outlined. Special attention is paid to the contemporary EO data modelling and visualization systems.

Keywords: Geo-sensor networks, Earth Observations, Big Data, Data bases, EO Analytics

<p style="text-align: center;">International Soil Congress 2019</p> <p style="text-align: right;">17-19 June 2019 Ankara, Turkey</p> <p style="text-align: center;">Complex Assessment of Winter Wheat Growing Conditions in Northwestern Bulgaria</p> <p style="text-align: center;">Viktor KOLCHAKOV¹, Milena KERCHEVA², Martin BANOV³, Veneta KRASTEVA⁴, Eugenia ROUMENINA⁵, Petar DIMITROV⁶, Georgi JELEV⁷, Lachezar FILCHEV⁸, Emil DIMITROV⁹, Alexander GIKOV¹⁰</p> <p>Abstract</p> <p>The objective of the study is to make a complex assessment of the winter wheat (<i>Triticum aestivum</i> L.) status in case of two commonly used varieties in Bulgaria - „Annapurna” and „Enola”, grown on Chernozems in Northwestern Bulgaria. Thirty elementary sampling units (ESUs) have been located on the field units’ territory for performing the observations on phenological stages, presence of weeds, crop disease and pests and for collecting of soil and plant samples for laboratory analyzes. The following indicators were used to evaluate the growing conditions of the crop during the phenophases: sum of precipitation; land evaluation; soil nutrient supply; soil moisture supply; number of emerged plants per area; height of plants; weight of the aboveground dry biomass; number of stems per area; number of productive tillers per area; Nitrogen uptake by plants; presence of weeds; crop damage caused by diseases and pests. A three-stage ranking of the crop conditions was defined: 3 - high, 2 - average and 1 - low. The complex evaluation of the development of the crop throughout the growing season is presented as an arithmetic mean of the indicators estimates for each phenological phase. The complex assessment for the studied field Units ranges from average to high according to the conditions and the state of the crop during the whole growing season.</p> <p>Keywords: winter wheat, growing conditions, ranking, Chernozems</p>	<p>Г8_4</p>
<p style="text-align: center;">DISSEMINATION OF KNOWLEDGE ON EARTH OBSERVATION FROM SPACE AMONG STUDENTS</p> <p style="text-align: center;">Garo Mardirossian, Lachezar Filchev</p> <p><i>Abstract:</i> One of the most powerful and effective applications of space science and technology is in earth observation from space. Despite its great importance, which will inevitably grow in the future, the theme of these space technologies is absent from traditional school education. This motivates the importance of spreading space knowledge among learners, in particular for studying Earth from space. The article briefly examines the perennial activities of scientists from the Space Research and Technology Institute at the Bulgarian Academy of Sciences for the dissemination of knowledge on the study of Earth from space among learners. Specific examples outline the main guidelines in this activity – publishing books and brochures, realization of targeted projects, seminars and lectures, organization of exhibitions, publication of scientifically popular articles in school newspapers, etc.</p> <p><i>Key words:</i> space science and technology, earth observation from space, activities, dissemination of knowledge, learners</p>	<p>Г8_5</p>

SATWEBMARE INTERACTIVE WEB-MAPPING SYSTEM IN SUPPORT OF THE SUSTAINABLE MANAGEMENT OF THE BULGARIAN COASTAL ZONE

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РЕЗЮМЕ

В статията е представен преглед на разработван прототип на интерактивна уеб картографска система SatWebMare за българската крайбрежна зона. Интерактивната система е проектирана да предоставя чрез геопортал иновативни продукти и услуги за интегрирано управление на крайбрежната зона. Уеб картографската система комбинира геоданни от различни източници като сателитни изображения, карти, векторни слоеве и други набори от данни. Накратко е разгледано съдържанието на SatWebMare геопортала. Чрез системния уеб интерфейс ще бъде осигурен достъп до приложения и продукти с подобрена пространствена и времева разделителна способност за три области на интерес – морски вълнови климат, природни опасности и геомагнетизъм за българското крайбрежие. Уеб картографската система се разработва с използване на свободен софтуер с отворен код, OGS стандарти и в съответствие с препоръките на Европейската директива INSPIRE. След пълното разработване на прототипната система, тя ще позволи да се осигури достъп до продукти и услуги с добавена стойност, които са полезни за министерства, агенции, местни власти и други заинтересовани страни в подкрепа на вземането на решения.

Ключови думи: проект SatWebMare, уеб картографиране, наблюдение на Земята, интегрирано управление на бреговата зона, Черно море, Българско крайбрежие

ABSTRACT

The article aims to represent a general overview of the prototype web-mapping interactive system SatWebMare for the Bulgarian coastal zone. The interactive system is designed to provide through geo-portal innovative products and services for integrated coastal zone management. The web-mapping system combines geo-databases from different sources such as satellite imagery, maps, vector layers and other

datasets. The content of the SatWebMare Geo-Portal is briefly outlined. The web-interface system will provide access to applications and products with an improved spatial and temporal resolution for three areas of interest - sea waves, natural hazards and geomagnetism in the Area of Interest (AOI). The web-mapping system is developing based on the free and open-source software, OGS standards and following the EU INSPIRE Directive recommendations. Once the prototype system is fully developed, it will enable to provide access to value-added products and services that are useful to ministries, agencies, local authorities and other stakeholders in support of the decision making.

Keywords: SatWebMare project, Web-mapping, Earth observation, integrated coastal zone management, the Black Sea, Bulgarian coastal zone

ВЪЗМОЖНОСТИ ЗА ПРОГНОЗИРАНЕ НА ДОБИВА ОТ БИОЛОГИЧНА ПШЕНИЦА С ИЗПОЛЗВАНЕ НА АЕРОКОСМИЧЕСКИ МЕТОДИ

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Ключови думи: дистанционни изследвания, биологично земеделие, модели за прогнозиране на добива от пшеница

Резюме: С изменението на климата все по-чести стават неблагоприятните природни явления, като наводнение и суша, които от своя страна са основна заплаха за добивите от пшеница. Почти всички региони на планетата са уязвими от подобни климатични събития. Дистанционните методи могат да помогнат на земеделските производители давайки им актуална информация за състоянието на посевите и прогноза на добивите от пшеница, като по този начин минимизират риска от климатичните промени.

POSSIBILITIES FOR FORECASTING THE YIELD OF ORGANIC WHEAT USING AEROSPACE METHODS

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Keywords: remote sensing, organic farming, models for forecasting wheat yield

Abstract: With climate change, adverse natural phenomena, such as floods and droughts, are becoming more common, which in turn are a major threat to wheat yields. Almost all regions of the planet are vulnerable to such climatic events. Remote sensing methods can help farmers by giving them up-to-date information on the condition and yield forecasting of wheat crops, thus minimizing the risk of climate change.

МОДЕЛИ НА ГЕОСИСТЕМИ И АБИОТИЧЕН СТРЕС В ДИСТАНЦИОННИТЕ ИЗСЛЕДВАНИЯ

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Ключови думи: *абиотичен стрес, моделиране, геосистеми*

Резюме: *В областта на съвременните дистанционни изследвания се полагат усилия по моделиране на предавателните свойства на атмосферата, както и на отражателните свойства на обектите от земната и акваториалната повърхност. С помощта на тези модели е възможно решаването на права и обратна задача, т.е. генериране на спектрален коефициент на отражение (СКО) във видимата и близката инфрачервена област на спектъра от химични съставки, като пигменти - хлорофил, каротин, водно съдържание, азотно съдържание, и др. и обратно, получаване на химични съставки от СКО и биофизични и биометрични параметри на излолистната растителна покривка, като листен индекс, височина на дърветата, обиколка на дървостойте, проективно покритие и др.*

MODELS OF GEOSYSTEMS AND ABIOTIC STRESS IN REMOTE SENSING

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Keywords: *abiotic stress, modelling, geosystems*

Abstract: *In the field of modern remote sensing, efforts are made to model the transmission properties of the atmosphere, as well as the reflective properties of objects from the land and water surface. With the help of these models, it is possible to solve a straight and reverse task, i.e. generating a spectral response in the visible and near-infrared area of the spectrum of chemical ingredients, such as pigments - chlorophyll, carotene, water content, nitrogen content, etc. conversely, obtaining chemical ingredients from spectra and biophysical and biometric parameters of coniferous plant cover, such as leaf index, tree height, tree circumference, canopy forest cover, etc.*

МОДЕЛИРАНЕ НА ТЕХНОГЕННОТО ЗАМЪРСЯВАНЕ НА ВОДОСБОРА НА РЕКА ТАЙНА

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Ключови думи: тежки метали, металоиди, техногенно замърсяване, коефициент на техногенна концентрация

Резюме: На основата на полетата на стойностите на съдържанията на тежките метали, металоидите, естествените и изкуствени радионуклиди са съставени модели на полетата на стойностите на коефициента на техногенна концентрация в почвите в басейна на р. Тайна - K_c използвайки получените стойности за местния почвеногеохимичен фон за 1993 (1996) г. и 2011 г. Така получените полета са използвани за изчисляване на сумарния коефициент - Z_c чиито стойности за тежките метали в почвите за 1993 (1996) г. варират от 3.13 до 129.24, а за 2011 г. от 8.29 до 32.18. Тествани са различни интерполяционни модели на стойностите и оценка на грешката с оглед използването на най-удачния модел.

MODELING OF THE TECHNOGENICAL CONTAMINATION OF THE TAINA RIVER CATCHMENT

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Keywords: heavy metals, metalloids, technogenic contamination, technogenic concentration factor

Abstract: On the basis of the values of the contents of heavy metals, metalloids, natural and artificial radionuclides, models of the fields of the values of the technogenic concentration factor in soils in the basin of the Taina River - K_c using the obtained values for the local soil-based chemical background for 1993 (1996) and 2011. Using the interpolated fields is calculated the total pollution coefficient – Z_c which values for the heavy metals in the soils for 1993 (1996) vary between 3.13 and 129.24 and for 2011 from 8.29 to 32.18. Various interpolation models of values and error assessment have been tested with a view to using the most appropriate model.

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Изследване на водна миграция на тежки метали и металоиди в повърхностотечащи и подземни води във водосбора на р. Тайна

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Резюме. През последните десетилетия антропогенното въздействие върху околната среда се увеличи значително, което доведе до сериозни екологични проблеми във всички аспекти на природните и икономическите системи, каквито са ландшафтите. Химическият състав на повърхностните и подземните води е от съществено значение за храненето на растенията и за качеството на питейната вода, като съществено допринасят за формиране на екологичното състояние и човешкото здраве. Това изследване отразява съдържанието на тежките метали (mg/l) преди вливането на река Тайна в река Искър – ХМС-Курило, гр. Нови Искър. Представя се изчисленият "коефициент на водна миграция" – K_x по отношение на съдържанието на химичните елементи в почвите в долното течение на река Тайна. Стойностите на коефициента K_x са важни за оценяване на степента на разтваряне на скалите, степента на разтворимост на отделните елементи и химични съединения, тяхната концентрация във водната среда в процеса на миграция и химичния състав на водите в ландшафта.

Ключови думи: геохимия на подземните води, тежки метали, основни скали, почви, коефициент на водна миграция

Study of water migration of heavy metals and metalloids in surface flowing and groundwater in the catchment area of the Taina River

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Abstract. In recent decades, the anthropogenic impact on the natural environment has increased, leading to serious environmental problems in all aspects of natural and economic systems, such as landscapes. The chemical composition of surface water and groundwater is essential for plant nutrition and the quality of drinking water thus shaping out environmental and human health. This study reflects the contents of heavy metals in (mg/l) before the inflow point of the *Taina* River into the *Iskar* River – HMS-Kurillo, town of Novi Iskar and before the inflow of the *Taina* in the *Iskar* River on the road to the town of *Svoje* - according to data from the Ministry of Environment and Water. It also presents the calculated "coefficient of water migration" – K_x in terms of the content of chemical elements in the soils of the lower reaches of the River *Taina*. The values of the K_x coefficient are important in terms of the degree of decomposition of the bedrocks, the degree of solubility of the individual elements and chemical compounds, their concentration in the aquatic environment in the process of migration and the chemical composition of the migratory waters in the landscape.

Keywords: groundwater geochemistry, heavy metals, bedrocks, soils, water migration coefficient



ИЗВЕСТИЯ НА БЪЛГАРСКОТО ГЕОГРАФСКО ДРУЖЕСТВО
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Възможности за приложение на дистанционните методи в биологичното отглеждане на зърнено-житни култури – Обзор

Opportunities for Remote Sensing Applications in Organic Cultivation of Cereals – a Review

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ABSTRACT

Key words:

Remote Sensing methods,
Precision farming,
Organic farming, Cereals

In recent years, a number of studies have proven that the conventional agricultural system is not sustainable, toxic to the environment, human health, and its potential to feed humanity is limited to the next 50 years. With this in mind, as well as the increasing demand for healthy and safe foods, and the increase in the proportion of people who care about how the food they consume was produced, how much it does not harm the environment and health, farmers are starting to reorient their production into organic. Over the past 40 years, remote sensing methods and technologies have increasingly been used in agriculture. They have proved extremely useful for optimizing the working processes in the sector, as well as solving many of the problems in it. With this report, we aim to draw the scientific community's attention to the possibilities provided by remote sensing methods and technologies to solve a range of problems related to organic cultivation of cereals.



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Приложение на спътниковите дистанционни изследвания за откриване на абиотичен стрес в иглолистни ландшафти

Application of Satellite Remote Sensing for Detection of Abiotic Stress in Coniferous Landscapes

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ABSTRACT

Key words:

satellite remote sensing, abiotic
stress, coniferous landscapes,
multispectral remote sensing,
imaging spectrometry,
fluorescence imaging

In the article is made an overview of the application of different satellite remote sensing methods and technologies in detection of the abiotic stress in coniferous landscapes. The review paper is discussing in short the application of different remote sensing technologies such as: satellite multispectral and infrared (thermal), imaging spectrometry and fluorescence imaging. The studied period spans from the onset of the satellite remote sensing in the 1960s until present day. In conclusion, are drawn requirements for the perspective technologies in satellite remote sensing which should address the fast and reliable detection of the manifestation of abiotic stress in coniferous landscapes.

ANALYSIS OF THE DYNAMICS OF BUILT-UP AREAS AND ARTIFICIAL IMPERVIOUS SURFACES OF THE BULGARIAN COASTAL MUNICIPALITIES USING GHSL AND GAIA DATA

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Abstract

Socio-economic development and intensive urbanisation in coastal areas in many parts of the world in recent decades have led to a rapid increase in built-up areas. These activities have negatively affected the environment and upset the balance in the vulnerable coastal ecosystems. The Global Artificial Impervious Areas (GAIA) data analysis indicates an Artificial Impervious Surfaces (AIS) increase of 1.5 times since 1990. Since the 1960s, AIS has been dynamically expanded along the Bulgarian coastal zone. The main factors contributing to increasing AIS are urbanisation, industrialisation and tourism development processes. This study aims to assess the dynamics of impervious surface Bulgarian coastal region in the period 1975-2018, the not studied in detail so far. The analysis is carried out for the Black Sea coastal municipalities using Google Earth Engine platform of the Global Man-made Impervious Surface (GMIS), GHSL (JRC-EC) and GAIA data. Some inferences about the temporal trend of growing and spreading of AIS for four-decadal changes are made. Furthermore, recommendations for national spatial planning for responsible national authorities are provided.

Keywords: Impervious surface, Built-up, GHSL, GAIA, Copernicus Program, Landsat, Bulgarian Black Sea coast

**REVIEW OF BULGARIAN SPACE-RELATED ACTIVITIES WITHIN
THE GEO INITIATIVE AND THE EU COPERNICUS PROGRAM**

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Abstract: The free and open data policy of the Group on Earth Observation (GEO) and the EU Copernicus program helps many Bulgarian scientists, start-ups, and SMEs to choose Earth Observation (EO) data as a core for their research projects, development of applied products and services. This review summarizes the organizational activities undertaken at different levels to coordinate the efforts of stakeholders for technological development and innovation in the field of space in Bulgaria, directly or indirectly related to the use of EO over the past three decades from a scientific point of view. Bulgarian participation in GEO and ESA Plan for European Cooperative State (PECS) Agreement is also discussed. A review of normative documents, international agreements, the country's participation in space-related programs, research and applied projects, organizational activities, educational initiatives, and training is carried out. The main challenges facing the scientific community in Bulgaria and its efforts to participate actively in space-related international programs, projects and initiatives are outlined. Finally, opportunities for future cooperation within the global initiatives and programs with special consideration such as GEO, EuroGEO, Galileo, Copernicus, EGNOS, and others are given.

Keywords: GEO, Copernicus, Academia, Industry, National space policy.

CHAPTER 6

Surveys, Catalogues, Databases/Archives, and State-of-the-Art Methods for Geoscience Data Processing

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6.1 GEOSPATIAL SURVEYING

6.1.1 Collecting Geospatial Data Through in Situ, Aerial, and Satellite Surveying

During the 2000s and 2010s, among the many modern applications of big datasets, their number in the field of Earth sciences has grown extremely worldwide thanks to the development of industrial technologies and the space programs of the leading countries in space explorations. The precise and cutting-edge data provided by geospatial technologies empowered modern society to tackle environmental and climate change issues. In the digital age, the rapid growth of processing power and global connectivity of geosensor networks allow to collect, share, and analyze the vast amount of Earth observations (EO) data from geospatial surveying.

Geospatial data are Big Data, the number of which now has grown significantly with the accumulation of satellite images of over 660 satellites performing EOs, as listed by the Union of Concerned Scientists (<https://www.ucsusa.org/>; <https://www.pixalytics.com/>). New tools and technologies are now available to deal with Big Geo Data analytics and visualization. Geospatial information is advancing in all the dimensions of Big Data. The high-resolution observations collected by satellites are growing by a few terabytes every day. The worldwide observation information will likely surpass one exabyte according to insights of the Open Geospatial Consortium (OGC) (OGC, 2017).

Advanced Big Data techniques are useful for compressing, clustering, and modeling EO data during analysis, interpretation, and visualization in a variety of applications. The data flow from satellite, airborne, and in situ remote sensing is dramatically increasing and needs to be processed thanks to the “new” Big Data tools,

including with a new combination of former classical approaches.

Geospatial information and EO, together with modern data processing and Big Data analytics, offer unprecedented opportunities to modernize national statistical systems and consequently to make a quantum leap in the capacities of countries to efficiently track all facets of sustainable development. The GEO/CEOS study suggests that EO data has a role to play concerning most of the 17 sustainable development goals (SDGs). More specifically, around 40 of the 169 targets (representing about a quarter) and around 30 of the 232 indicators (about an eighth) are supported (CEOS_EOHB, 2018; EO4SDG, 2018).

The benefits of satellite EO are already well understood across many areas of government, industry, and science as a valuable information source in support of many sectors of society. Key benefits of satellite EO data for the SDGs reporting against the indicators are (CEOS_EOHB, 2018):

- satellite EO data making the prospect of a global indicator framework for the SDGs viable;
- the potential to allow more timely statistical outputs, to reduce the frequency of surveys, to reduce respondent burden and other costs, and to provide data at a more disaggregated level for informed decision making;
- improved accuracy in reporting by ensuring that data are more spatially explicit.

Big Data are both a challenge and an opportunity. Big Data require adopting a distributed approach to parallelizing data management, i.e., data storage and processing. According to “ISO/IEC 20546:2019 Information Technology-Big Data-Overview and Vocabulary,”

Chapter 1

**LAND COVER MAPPING USING SENTINEL
AND LANDSAT DATA: POTENTIAL AND CHALLENGES
IN THE CONTEXT OF THE NATIONAL REPORTING
OF GREENHOUSE GAS EMISSIONS IN BULGARIA**

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ABSTRACT

The aim of this study is to test the possibilities for mapping land cover at national scale using semi-automatic classification of satellite data from Sentinel-1/-2 and Landsat for the period 2012-2018. Land cover classes were defined to closely correspond to land use categories used to report greenhouse gas emissions and removals from the Land use, Land-use Change and Forestry (LULUCF) sector. The overall accuracy of the land cover maps varied from 66% in 2013 to 81% in 2018 and maps produced by using Sentinel data were more accurate (79% on average) than those using Landsat (69% on average). Broad-leaved forest and Coniferous forest classes showed good accuracy (>85% for both user's and producer's accuracy in all years). For some other classes, however, such as Orchards and vineyards, and Shrublands the accuracy was insufficient. We conclude that further studies are needed to increase accuracy and make classification results consistent through all mapped land cover classes. It was also pointed out that land cover information should be combined with other sources of spatial information, such as cadastre, in order to derive the land use information needed for LULUCF reporting.

Keywords: land cover, Google Earth Engine, Random Forest, LULUCF

Assessing of Soil Erosion Risk Through Geoinformation Sciences and Remote Sensing—A Review



Γ9_3

Lachezar Filchev and Vasil Kolev

Abstract During past decades a marked manifestation of widespread erosion phenomena was studied worldwide. Global conservation community has launched campaigns at local, regional and continental level in developing countries for preservation of soil resources in order not only to stop or mitigate human impact on nature but also to improve life in rural areas introducing new approaches for soil cultivation. After the adoption of Sustainable Development Goals of UNs and launching several world initiatives such as the Land Degradation Neutrality (LDN) the world came to realize the very importance of the soil resources on which the biosphere relies for its existence. The main goal of the chapter is to review different types and structures erosion models as well as their applications. Several methods using spatial analysis capabilities of geographic information systems (GIS) are in operation for soil erosion risk assessment, such as Universal Soil Loss Equation (USLE), Revised Universal Soil Loss Equation (RUSLE) in operation worldwide and in the USA and Modèle d’Evaluation Spatiale de l’ALéa Erosion des Sols (MESALES) model. These and more models are being discussed in the present work alongside more experimental models and methods for assessing soil erosion risk such as Artificial Intelligence (AI), Machine and Deep Learning, etc. At the end of this work, a prospectus for the future development of soil erosion risk assessment is drawn.

Keywords Artificial Intelligence (AI) • Soil erosion • Assessment risk • Universal soil loss equation (USLE) • Revised universal soil loss equation (RUSLE) • RUSLE2 (revised universal soil loss equation version 2.0) • Machine learning (ML) • Geographical information systems (GIS) • Artificial neural networks (ANN) • Convolutional neural network (CNN)