XXIX INTERNATIONAL SYMPOSIUM ON

MODERN TECHNOLOGIES, EDUCATION AND PROFESSIONAL PRACTICE

IN GEODESY AND RELATED FIELDS

TECHNICAL PROGRAM

&

ABSTRACT BOOK

05 – 06 NOVEMBER 2019

ISTANBUL - TURKEY

The electronic version of this booklet can be found at
http://www.gravity.itu.edu.tr/symp2019/

Foreword

Dear Colleagues,

XXIX International Symposium on "Modern Technologies, Education and Professional Practice in Geodesy and Related Fields" is organized as ITU-USLMB joint symposium in İstanbul, Turkey and it is held by Istanbul Technical University (ITU), Geomatics Engineering Department on November 5-6, 2019.

The annual symposium has been successfully organized by Union of Surveyors and Land Managers of Bulgaria (USLMB) since 1990's in Sofia city of Bulgaria. This is the first time that this symposium is organized as a joint symposium in a different country. This year, the two days meeting program with 67 presentations by contribution of the authors from 10 different countries, including Bulgaria, Russia, Iran, China, Poland, United States, Italy, Maldives, Brunei and Turkey, aims to constitute a scientific, multidisciplinary sharing and interaction platform for our colleagues where they will have knowledge and experience change on the recent advances and their reflections in Geodesy and related fields. With contribution of the professionals from the academia, industry and representatives from the public authorities with promising young scientists, a fruitful and improving meeting organization is aimed at ITU. In this view, as being symposium organizing committee, we attached great importance to the active participation of young researchers in the symposium and scheduled two special sessions with the presentations on highly interesting topics from the young colleagues.

During the last decades, geodesy in general have experienced a notable swing in both their recognition and contribution to the end-products, used by scientists, engineers and the public. The mission coverage of geodesy has been significantly enlarged and this was mainly due to the enormous advances of new technologies and changes of human requirements in the new millennium. In the developing world, multidisciplinary projects and productions are at the forefront and the discipline of geodesy has to maintain its special and key position in these team-works. In this manner, it is very important to come together, to discuss common problems, to exchange ideas on developing solutions with scientific methods and technologies as well as to discuss the way of improvement the quality of human resources in the sectors. Active international cooperation is critical and bilateral effort should be made to strengthen the position of the geodesy discipline and to ensure that it takes the place it deserves in the wide range of multidisciplinary applications of spatial data.

From this point of view, it is hoped that this meeting provides a communication atmosphere among the colleagues from the participating countries and enables an initialization for further relations and fruitful collaborations among the colleagues in the future.

We feel special honor to welcome you at the XXIX International Symposium on "Modern Technologies, Education and Professional Practice in Geodesy and Related Fields" in the year that we are celebrating the 70th year of Geodetic Education in Turkey, and the 50th year of that at Istanbul Technical University.

Yours Sincerely,

İstanbul
November 2019

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Overview

Time	November 5, 2019	Time	November 6, 2019
08:45-09:15 **09:15-10:00**	**REGISTRATION** Opening and Welcome	**08:45-09:00**	**Registration**
10:00-11:00	SESSION – I: **GEODESY & RELATED FIELDS** **Chairs:** *Prof.Dr. Rahmi N. Çelik* *Dr. Ivan Kaltchev*	**09:00-10:40**	SESSION – VI: **REMOTE SENSING & APPLICATIONS** **Chairs:** *Assoc.Prof. Dr. Füsun Balık Şanlı* *Assoc.Prof.Dr. Mila Atanasova*
11:00-11:20	**COFFEE BREAK**	**10:40-11:00**	**COFFEE BREAK**
11:20-13:00	SESSION – II: **GEODESY & RELATED FIELDS** **Chairs:** *Assoc.Prof.Dr. Emine Tanır Kayıkçı* *Assoc.Prof.Dr. Mohammad Ali Sharifi*	**11:00-12:10**	SESSION – VII: **PHOTOGRAMMETRY & NEW TECHNOLOGIES** **Chairs:** *Prof.Dr. Dursun Zafer Şeker* *Prof.Dr. Kazimierz Becek*
		12:10-13:00	**TECHNICAL TOUR:** **ITU CSCRS** (Center for Satellite Communications and Remote Sensing**)**
13:00-14:00	**LUNCH**	**13:00-14:00**	**LUNCH**
14:00-15:30	SESSION – III: **GEODESY & SPECIAL TOPICS IN SURVEYING** **Chairs:** *Prof.Dr. Uğur D. Şanlı* *Prof.Dr. Keranka Vassileva*	**14:00-15:10**	SESSION – VIII: **GEODETIC EDUCATION & QUALITY ASSESSMENT** **Chairs :** *Prof.Dr. Hande Demirel* *Prof.Dr. Boyko Ranguelov*
15:30-15:50	**COFFEE BREAK**	**15:10-15:30**	**COFFEE BREAK**
15:50-17:10	SESSION – IV: **GEODESY & EARTH GRAVITY FIELD** **Chairs :** *Assoc.Prof.Dr. Ramazan Alpay Abbak* *Assoc.Prof. Dr. Lyubka Pashova*	**15:30-16:00**	SESSION – IX: **LAND USE & LAND INFORMATION SYSTEMS** **Chairs:** *Prof.Dr. Reha Metin Alkan* *Assoc.Prof.Dr. Christina M. Cherneva*
17:10-17:20	**SHORT COFFEE BREAK**	**16:00-16:20**	**COFFEE BREAK**
17:20-18:00	SESSION – V: **SPECIAL SESSION FOR YOUNG RESEARCHERS-I** **Chairs :** *Assist.Prof.Dr. Metin Nohutcu* *Assist.Prof.Dr. Davis Dinkov*	**16:20-17:00**	SESSION – X: **SPECIAL SESSION FOR YOUNG RESEARCHERS-II** **Chairs :** *Assoc.Prof.Dr. Bihter Erol* *Assoc.Prof.Dr. Asparuh Kamburov*
18:00-19:00	**ICEBREAKER**	**17:00-17:15**	**CLOSING & REMARKS**

10:40-11:20	**POSTER SESSION**	***10:40-11:20***	**POSTER SESSION**

Technical Program

	TIME	November 5, 2019
	08:45 – 09:15	REGISTRATION
	09:15 – 10:00	Opening & Welcome
10:00 – 11:00 || SESSION – I GEODESY & RELATED FIELDS *Session Chairs : Prof. Dr. Rahmi Nurhan Çelik & Dr. Ivan Kaltchev*		
S1.O1	**10:00 – 10:20**	Are Crowdsourcing, Open Data and Emerging Technologies Promising New Future in Geodesy? ***(Keynote Speech)*** *Rahmi Nurhan Çelik* (TR)
S1.O2	**10:20 – 10:30**	Archaeoseismology of the North Black Sea - Bulgaria-Russia Expeditions *Boyko Ranguelov* (BG), *Orlin Dimitrov* (BG), *Andrey Korzhenkov* (RU), *Evgeny Rogozhin* (RU), *Alexandr Ovsyuchenko* (RU)
S1.O3	**10:30 – 10:40**	Ocean Tide Loading Displacements Observed by Very Long Baseline Interferometry During IVS CONT14 Campaign *Kamil Teke* (TR)
S1.O4	**10:40 – 10:50**	The State of the Art About Drought Monitoring Observed by the New Satellite-based Techniques *Gonca Okay Ahi* (TR)
S1.O5	**10:50 - 11:00**	Assessment of Single Point Approaches for Datum Definition in Classical Monitoring Networks *Mohammad Ali Sharifi* (IR), *Saeed Farzaneh* (IR), *Zahra Banimostafavi* (IR)
11:00-11:20 Coffee Break		
11:20 – 12:50 || SESSION – II GEODESY & RELATED FIELDS *Session Chairs: Assoc. Prof. Dr. Emine Tanır Kayıkçı & Assoc.Prof. Dr. Mohammad Ali Sharifi*		
S2.O6	**11:20 – 11:40**	Analysis of GNSS-derived Water Vapour during Extreme Weather Events in Black Sea Region ***(Invited Presentation)*** *Emine Tanır Kayıkçı* (TR), *Mualla Yalcinkaya* (TR), *Selma Zengin Kazanci* (TR), *Mesut Demircan* (TR), *Seldanur Çelik* (TR)
S2.O7	**11:40 – 12:00**	Atmospheric Correction of Satellite Altimetry Observations using Complementary Geodetic Data **(*Keynote Speech*)** *Mohammad A. Sharifi* (IR), *Saeed Farzaneh* (IR), *Masoud Dehvari* (IR)
S2.O8	**12:00 – 12:10**	High-rate GNSS precise point positioning (PPP) *Reha Metin Alkan* (TR), *Veli İlçi* (TR), *İ. Murat Ozulu* (TR), *Serdar Erol* (TR)
S2.O9	**12:10 – 12:20**	Monitoring the Water Vapor, Snow/Ice and Sea Level Changes in the Antarctica with GNSS Meteorology and GNSS Reflectometry Techniques ***(Invited Presentation)*** *M. Oğuz Selbesoglu* (TR), *H. Hakan Yavasoglu* (TR), *M. Fahri Karabulut* (TR), *V. Engin Gülal* (TR), *Himmet Karaman* (TR), *Mustafa E. Kamaşak* (TR)
S2.O10	**12:20 - 12:30**	Multi-GNSS Contribution to Single-Frequency Precise Point Positioning *Berkay Bahadur* (TR), *Metin Nohutcu* (TR)
S2.O11	**12:30 – 12:40**	Assessment of PPP Positioning Accuracy with Different Meteorological Data Sources *Buğçe Gökçe* (TR), *Duygu Dülger* (TR), *Berkay Bahadur* (TR), *Metin Nohutcu* (TR), *Kamil Teke* (TR)
S2.O12	**12:40 – 12:50**	Methodology Assessment on Orbit Determination of LEO Satellites in Purpose of Global Geopotential Model Validation *Rewa Alkahal* (TR), *Bihter Erol* (TR)
LUNCH 13:00 – 14:00		

14:00 – 15:30 || SESSION – III GEODESY & SPECIAL TOPICS IN SURVEYING *Session Chairs : Prof. Dr. Uğur D. Şanlı & Prof. Dr. Keranka Vassileva*		
S3.O13	**14:00 – 14:20**	New Aspects in GNSS Positioning and Velocity Estimation ***(Keynote Speech)*** *D. Uğur Şanlı* (TR)
S3.O14	**14:20 – 14:40**	Geodetic Monitoring of Displacements and Deformations for Assestment of Effect from Suspend of Exploitation of Pernik Mines ***(Invited Presentation)*** *Ivan Kaltchev* (BG), *Maria Kaltcheva* (BG)
S3.O15	**14:40 – 14:50**	Evaluating the Repeatability of RTN GNSS (CORS-GNSS) *Atınç Pırtı* (TR), *Ramazan Gürsel Hoşbaş* (TR)
S3.O16	**14:50 – 15:00**	Natural Hazards, Geophysical Fields and Ecology Problems on the Bulgarian Black Sea Coast *Boyko Ranguelov* (BG), *Evgeny Rogozhin* (RU), *Orlin Dimitrov* (BG), *Andrey Korzenkov* (RU), *Alexandr Ovsychenko* (RU)
S3.O17	**15:00 – 15:10**	Usability of the New GNSS-based Positioning Technologies *Veli İlçi* (TR)
S3.O18	**15:10 – 15:20**	3D Transformation Parameter Estimation for Automatic Point Cloud Registration *Ramazan Alper Kuçak* (TR), *Serdar Erol* (TR)
S3.O19	**15:20 – 15:30**	Accuracy Assessment of Satellite Positioning Techniques on Unmanned Aerial Vehicle (UAV) Photogrammetry *Ersin Turan* (TR), *Serdar Erol* (TR), *Ramazan Alper Kuçak* (TR), *Bihter Erol* (TR)
15:30-15:50 Coffee Break		
15:50 – 17:10 || SESSION – IV GEODESY & EARTH GRAVITY FIELD *Session Chairs : Assoc. Prof. Dr. Ramazan Alpay Abbak & Assoc. Prof. Dr. Lyubka Pashova*		
S4.O20	**15:50 – 16:10**	Recent Developments on Gravimetric Geoid Determination ***(Invited Presentation)*** *Ramazan Alpay Abbak* (TR)
S4.O21	**16:10 – 16:20**	Refinement and Construction of Louisiana Local Gravity Grid for Precise Geoid Determination *Ahmed Abdalla* (USA), *Clifford Mugnier* (USA), *Bihter Erol* (TR), *J. Anthony Cavell* (USA)
S4.O22	**16:20 – 16:30**	Estimation of Sea Level Trend in the Black Sea from Satellite and in-situ Data *Nevin Betul Avsar* (TR), *Senol Hakan Kutoglu* (TR), *Shuanggen Jin* (CN)
S4.O23	**16:30 – 16:40**	A Spectral Filtering Approach to Assess the Trend of Recent Mass Decrease over Lake Urmia Using GRACE's Mascon Solution *Alireza Sobouti* (IR), *Mohammad Ali Sharifi* (IR)
S4.O24	**16:40 – 16:50**	Physical Height Changes Estimated by GRACE Data: A Case Study over Greenland *Emel Zeray Öztürk* (TR), *Ramazan Alpay Abbak* (TR)
S4.O25	**16:50 – 17:00**	Impact of Tides Constituents on Determining of Sea Level Trends in the Southwestern Coast of Turkey *Muharrem Hilmi Erkoç* (TR), *Uğur Doğan* (TR)
S4.O26	**17:00 – 17:10**	Analyzing the Interpolation Techniques by Computing the Height Transformation Surfaces Using GPS/Leveling Data *Onur Karaca* (TR), *Bihter Erol* (TR)
17:10-17:20 Short Coffee Break		

17:20 – 18:00 || SESSION – V SPECIAL SESSION FOR YOUNG RESEARCHERS *Session Chairs : Assist. Prof. Dr. Metin Nohutcu & Assist. Prof. Dr. Davis Dinkov*		
S5.O27	**17:20 – 17:30**	Use of Transferable Development Rights (TDR) Method on the Preservation of Historic Buildings in Turkey *Yunus Konbul* (TR), *Mustafa Yanalak* (TR)
S5.O28	**17:30 – 17:40**	Georeferencing in 3D point Clouds with L1 Norm (least absolute value) Method *Ülkü Kırıcı Yıldırım* (TR), *Yasemin Şişman* (TR)
S5.O29	**17:40 – 17:50**	Smart City Applications *Hilal Türk* (TR), *Reha Metin Alkan* (TR)
S5.O30	**17:50 – 18:00**	A Performance Analysis of Low-Cost Single and Dual frequency GNSS receivers Using N-RTK *Nedret Bozkurt* (TR), *M. Halis Saka* (TR)
18:00 – 19:00 ICEBREAKING		

	TIME	November 6, 2019
09:00 – 10:40 || SESSION – VI REMOTE SENSING & APPLICATIONS *Session Chairs : Assoc. Prof. Dr. Füsun Balık Şanlı & Assoc. Prof. Dr. Mila Atanasova*		
S6.O31	**09:00 – 09:20**	Regularized Greedy Forests for Polarimetric Sar Image Classification ***(Invited Presentation)*** *Mustafa Üstüner* (TR), *Füsun Balık Şanlı* (TR)
S6.O32	**09:20 – 09:40**	Making Sense of a PsInSAR Sentinel-1A/B map of a Long-term Explored Oil and Gas Deposits: Case Study of Seria, Brunei Darussalam Field ***(Invited Presentation)*** *Kazimierz Becek* (PL), *Saygın Abdikan* (TR), *Çağlar Bayık* (TR), *Gabriel Yong* (BN)
S6.O33	**09:40 – 09:50**	Detection of Ground Motions in Coastal Area *Hristo Nikolov* (BG), *Mila Atanasova* (BG)
S6.O34	**09:50 – 10:00**	Geospatial Technologies Applied for Morphometric Analysis of Debris Flows Basins in the Eastern Rhodopes, Bulgaria *Asparuh Kamburov* (BG), *Valentina Nikolova* (BG), *Radostina Rizova* (BG)
S6.O35	**10:00 – 10:10**	Burned Large Forest Area Mapping Based on Google Earth Engine *Adalet Dervisoglu* (TR), *Nur Yagmur* (TR), *Aylin Tuzcu* (TR), *Nebiye Musaoglu* (TR)
S6.O36	**10:10 - 10:20**	On the Use of Genetic Algorithm in Component Substitution-based Pansharpening *Volkan Yılmaz* (TR)
S6.O37	**10:20 - 10:30**	Performances of Landsat 8 and Sentinel-2 Data in Mapping Open Mining Areas; İstanbul Case Study *Hazal Ciğerci* (TR), *Filiz Bektaş Balçık* (TR)
S6.O38	**10:30 - 10:40**	Improving the Classification Accuracy of Hyperspectral Images: an Analysis of Feature Selection Approaches *Akhtar Jamil* (TR), *Bülent Bayram* (TR), *Erdal Alimovski* (TR)
10:40-11:00 Coffee Break		
11:00 – 12:10 || SESSION – VII PHOTOGRAMMETRY & NEW TECHNOLOGIES *Session Chairs : Prof. Dr. Dursun Zafer Şeker & Prof. Dr. Kazimierz Becek*		
S7.O39	**11:00 – 11:10**	A Low-cost UAV-PPK Method – Accuracy and Application *Davis Dinkov* (BG)
S7.O40	**11:10 – 11:20**	Assessment of Satellite Derived Bathymetry Data Usage in the Hydrographic Survey Planning Phase *Koray Açar* (TR), *Dursun Zafer Şeker* (TR)
S7.O41	**11:20 – 11:30**	Visualization of Geospatial Point Clouds Through Virtual Reality System *Deyan Sosserov* (BG), *Tanya Slavova* (BG)
S7.O42	**11:30 – 11:40**	Direct Geo-referencing of UAV Images for Orthophoto Generation based on RTK GNSS Positioning *Burak Akpınar* (TR), *M. Oğuz Selbesoğlu* (TR), *Nedim Onur Aykut* (TR), *Onur Can Bayrak* (TR), *Bülent Bayram* (TR)
S7.O43	**11:40 – 11:50**	Documentation of Archeological Sites with UAVs: A Case Study of Nikopolis ad Nestum in SW Bulgaria *Grigor Nikolov* (BG), *Lyubka Pashova* (BG)
S7.O44	**11:50 – 12:00**	Comparison of Different Deep Learning based Face Recognition Systems *M. Taha Aydın* (TR), *Metehan Doğan* (TR), *O. Can Bayrak* (TR), *Bülent Bayram* (TR)
S7.O45	**12:00 – 12:10**	Research Activities in ITU Research and Application Center for Satellite Communications and Remote Sensing (CSCRS) ***(Invited Presentation)*** *Elif Sertel* (TR)

TECHNICAL TOUR || 12:10 – 13:00 **ITU Research and Application Center for Satellite Communications and Remote Sensing (CSCRS)**		
LUNCH 13:00 – 14:00		
14:00 – 15:10 || SESSION – VIII GEODETIC EDUCATION & QUALITY ASSESSMENT *Session Chairs : Prof. Dr. Hande Demirel & Prof. Dr. Boyko Ranguelov*		
S8.O46	**14:00 – 14:20**	50 years in Geomatics Engineering Education at ITU ***(Keynote Speech)*** *Himmet Karaman* (TR), *Mustafa Yanalak* (TR)
S8.O47	**14:20 – 14:40**	Accreditation in Geomatics Engineering: Lessons Learned ***(Invited Presentation)*** *Hande Demirel* (TR)
S8.O48	**14:40 – 14:50**	Project CABARET – WP7 Educational Development and Deliverables *Boyko Ranguelov* (BG), *Fathimath Shadiya* (MV), *Fathimath Nistharan* (MV), *Mariyam Humra* (MV), *Mariyam Eeman* (MV), *Mohamed Haikal Ibrahim* (MV)
S8.O49	**14:50 – 15:00**	Review and Analysis of Best Practices for Creating Geoportals *Kostadin Nikolov* (BG)
S8.O50	**15:00 – 15:10**	VR Technologies in Geospatial Education *Tanya Slavova* (BG), *Deyan Sosserov* (BG)
15:10-15:30 Coffee Break		
15:30 – 16:10 || SESSION – IX LAND USE & LAND INFORMATION SYSTEMS *Session Chairs : Prof. Dr. Reha Metin Alkan & Assoc. Prof. Dr. Christina Mikrenska-Cherneva*		
S9.O51	**15:30 – 15:40**	Energy performance certificate for buildings: an opportunity to establish building energy information system integrated with cadastral system in Turkey *Mehmet İşiler* (TR), *Büşra Kartal* (TR), *Mustafa Yanalak* (TR)
S9.O52	**15:40 – 15:50**	GIS Application for Water Company Needs *Christina Mickrenska-Cherneva* (BG), *Radoslav Mladenov* (BG)
S9.O53	**15:50 – 16:00**	Land Use / Land Cover Change with Corine Data: Case of Turkey *Selin Tekin* (TR), *Arzu Erener* (TR)
16:00-16:20 Coffee Break		
16:20 – 17:00 || SESSION – X SPECIAL SESSION FOR YOUNG RESEARCHERS *Session Chairs : Assoc. Prof. Dr. Bihter Erol & Assoc. Prof. Dr. Asparuh Kamburov*		
S10.O54	**16:20 – 16:30**	Analysis of GNSS satellite visibility according to the max(GDOP) criteria for the region of Turkey *Sinan Birinci* (TR), *Furkan Soğukkuyu* (TR), *M. Halis Saka* (TR)
S10.O55	**16:30 – 16:40**	Analyses on High Resolution Global Digital Terrain Model Qualities and Their use in Gravity Reductions *Aslınur Bahçekapılı* (TR), *Bihter Erol* (TR)
S10.O56	**16:40 – 16:50**	Assesments On Temporal Variations of Earth Gravity Field with GRACE Observations Using Different Computation Services *Bilal Mutlu* (TR), *Muhammed Raşit Çevikalp* (TR), *Bihter Erol* (TR)
S10.O57	**16:50 – 17:00**	Precise Orbit Determination (POD) of LEO Satellite Missions *İlker Üstüner* (TR), *Serdar Erol* (TR)

POSTER SESSION – November 5-6, 2019 *Posters will be available on boards in the poster hall during the symposium.*		
SP.P01	**10:40 – 11:20**	Creation And Use of Digital Territory Models *Dimitar Tonkov* (BG)
SP.P02	**10:40 – 11:20**	Ecological Monitoring with Multispectral Images *Yoana Tsarovka* (BG)
SP.P03	**10:40 – 11:20**	Evaluation of Covariance Determination Procedure Using GOCE gradient data and Least Squares Collocation *Hadi Heydarizadeh Shali* (IR), *Sabah Ramouz* (IR), *Abdolreza Safari* (IR), *Ricardo Barzaghi* (IT)
SP.P04	**10:40 – 11:20**	BalkanMed Real-time Severe Weather Service: Progress and Prospects in Bulgaria *G.Guerova* (BG), *T.Dimitrova* (BG), *M.Slavchev* (BG), *K.Stoev* (BG), *S. Georgiev* (BG), *Keranka Vassileva* (BG)
Closing & Remarks		

Technical Program as PDF

ABSTRACTS

Archaeoseismology of the North Black Sea - Bulgaria-Russia Expeditions

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Abstract

Significant number of expeditions to the Bulgarian and Russian coastal areas has been performed during the last years in the frame of the bilateral scientific cooperation (common projects, unified methodologies, integrated complex geological and geophysical investigations, etc.). The main aim of these expeditions was to reveal the relationships between the seismic effects on the archaeological objects, discovered and excavated, and the influence of the strong earthquakes occurred in ancient and historical times in depth, when they exist or not and to present the areas where such dependencies are adequate. Such approach is newly performed and is targeted to the increased completeness to the earthquakes catalogues, data about secondary effects (such like tsunamis, landslides, turbidities, etc.). The only source of similar information up to now was the written documents by different chroniclers. The massive measurements in situ, visual documentation, comparative studies, timing and destructions, damages or other effects to the ancient structures can help drastically to fulfill the missing data into the earthquakes catalogue time series. The combination between archeological findings and artifacts, surface and deeper active faults, geophysical characteristics of the local and regional seismic sources are these fundamentals which help the discovery and deeper archaeoseismology investigations and understanding. The results obtained are targeted to the new seismic zoning procedures, which do not consider up to now this significant source of information.

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Keywords: *Archaeoseismology, New data; Complex investigations* ***S1.O2***

Ocean Tide Loading Displacements Observed by Very Long Baseline Interferometry During IVS-CONT14 Campaign

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Abstract

Ocean tide loading (OTL) displacements can be predicted by convolution software, e.g. SPOTL (Agnew 1996), which convolve the elastic load Green's function over the gridded values of global ocean tide models such as FES2014 (Carrère et al. 2016) for the whole oceans. Besides, ocean tide loading (OTL) displacements can be observed with space geodetic techniques. In this study, the amplitudes and Greenwich phase lags for each coordinate component, i.e., radial, west, and south of the principal semi-diurnal (M2, S2, N2, K2) and -diurnal tides (K1, O1, P1, Q1) of OTL displacements were estimated at the very long baseline interferometry (VLBI) sites of the 15 days long continuous VLBI campaign, CONT14, carried out by the International VLBI Service for Geodesy and Astrometry (IVS). In the estimation of the amplitudes and Greenwich phase lags of the tidal constituents, hourly VLBI station coordinate time series were used as observations derived through analyzing 1 hour VLBI sessions of the CONT14 campaign. In the analysis of hourly sessions of the CONT14 campaign, to derive accurate hourly station coordinates, troposphere delays estimated from daily sessions were reduced from the observations a priori to the analysis. The estimated amplitudes and Greenwich phase lags of the principal constituents of OTL displacements were compared with the predictions of the state-of-the-art ocean tide models, among others, FES2012 (Lyard et al. 2006, Carrère et al. 2012), FES2014 (Carrère et al. 2016) and TPXO8 (Egbert and Erofeeva 2002, Egbert et al. 2010). Both the amplitudes and the phases between VLBI estimates and those predictions of ocean tide models agree well for the semidiurnal principal lunar tide, M2 (the largest tide in amplitude) at all the VLBI sites and in most of the coordinate components. As expected, the remaining tides cannot be resolved. Because the 15 days long hourly station coordinate time series does not satisfy the minimum period of Rayleigh criterion (Foreman 1977) to distinguish between neighboring frequencies. The RMS misfits of the M2 tide of OTL displacements in all coordinate components between VLBI and ocean tide models over coastal sites are found about two times larger than those of inland sites. This result indicates the insufficiency of ocean tide models gridded input data and convolution scheme over coastal regions.

Keywords: *VLBI; troposphere zenith delays; CONT14 hourly sessions; ocean tide loading displacements*

S1.O3

The State of the Art about Drought Monitoring in Turkey Observed by the New Satellite-based Techniques

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Abstract

Drought is a long-lasting shortage in water supply in the atmosphere, surface and groundwater expressing itself with (i) less than average precipitation (meteorological drought), (ii) followed by a damage in crop production or in the ecology, if below-average precipitation period is extended (agricultural drought) and also with (iii) significant fall of water reserves such as in aquifers, lakes (hydrological drought). Thus, drought monitoring is crucial for the economy and water resources management for a country, however, it cannot be achieved properly in national scale with the traditional observation methods. In this study, the data provided by the new satellite techniques among others; Center for Space Research (CSR)'s Level 3, Release 5 (RL05) data observed by GRACE satellite (Gravity Recovery and Climate Experiment), TRMM (Tropical Rainfall Measuring Mission) precipitation data, GLDAS (Global Land Data Assimilation System) data, a terrestrial modeling system incorporating satellite and ground-based observations and finally drought indices (ENSO: El Niño–Southern Oscillation, NOA: North Atlantic Oscillation, SCPDSI: self-calibrating Palmer Drought Severity) have been used to study the state of the art about drought in Turkey covering the period from April 2002 to January 2016. The results of this study reveal the dominant periods, notable information about the spatial distribution, spatial and temporal change rate and several prominent reasons of the drought events observed in Turkey. Besides, according to the results of this study, La Nina effect seems to affect the precipitation amount in Turkey which results in a meteorological drought. The spatial distribution of the drought is primarily affected by the precipitation history but also by uncontrolled human usage of water resources, especially in Central Anatolia. Finally, it is suggested from this study that the GRACE-observed time series have the sensitivity of revealing the aforementioned three types of drought occurred in Turkey. Besides, the signals of the agricultural and hydrological drought are found out more dominant than others.

Keywords: *terrestrial water storage (TWS); GRACE; drought; Turkey* ***S1.O4***

Assessment of Single Point approaches for Datum Definition in Classical Monitoring Networks

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Abstract

The behaviors of engineering structures such as dams, power plants and towers have a great importance nowadays and are usually performed in three different methods: classical, satellite and precise instrumental methods. By installing means of sensors, tensile, shear and deflection inside the structure during construction and analysis of information obtained from these sensors continuously, during construction and after operation of the structure for stability control. These tools allow the internal analysis of structures. Displacement analysis is divided into two categories: robust and non-robust. These methods are based on the results of two epochs which were be measured in two different epochs of time. IWST and L1 norm minimization are categorized in the robust methods, which calculate the matrix of displacement between them by minimizing the second and first norm. Non-robust methods are also use statistical tests to determine unstable points in geodetic networks, the most prominent of which, is Global Congruency Test (GCT). There are various ways to discover unstable points in the geodetic networks. Robust and GCT are classical and Simultaneous Analysis of Two Epochs (SATE) is a new method to achieve this purpose. These methods are based on single point analysis to detect unstable points. The purpose of this paper is, to select the optimal method between them, by using distance simulated data. After determining the success rate of each method and choosing the optimal method between them, using it, the unstable points in the real network of certain dam, dam of Jamishan, will be discovered.

Keywords: *Stability Analysis of geodetic networks, Single point methods, GCT, Stable Method, SATE Method*

S1.O5

Analysis of GNSS-derived Water Vapour during Extreme Weather Events in Black Sea Region

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Abstract

In Turkey, severe weather events have increased severely since beginning of years 2000s. According to hazard management data of last 20 years, Black Sea Region has been affected by hydrological origin severe weather events. Moreover, according to climate change scenarios (until 2100) for future, it has been foreseen that East Black Sea Region will be one of the region where severe weather events especially heavily rain and flood will increase related to climate change. This situation states a necessity of reliable weather monitoring and prediction system. The capacity of prediction and monitoring of severe weather events formation depends on accurate water vapor information. Radio waves transmitted from Global Navigation Satellite System (GNSS) satellites experience tropospheric errors through the neutral atmosphere before reached to receivers. With the setting of the regional GNSS networks, monitoring the variations in Precititable water vapor (PWV) by using Zenith Tropospheric Delay (ZTD) estimated at GNSS stations and meteorological data has become the focus in the field of GNSS meteorology. The focus of this work is to monitor the changes in atmospheric water vapor during extreme weather events in Black Sea Region by PWV estimates from GNSS data analysis, radiosonde data and ERA-Interim data.

In order to determine atmospheric water vapor distribution by GNSS meteorology; networks established in Samsun and Trabzon were used. Samsun and Trabzon networks has been designed with 4 new constructed GNSS reference stations SAME (10. Regional Service/Turkish State of Meteorological Service, Samsun), SOMU (Ondokuz Mayis University, Samsun), MACK (Macka Vocational School, Karadeniz Technical University, Trabzon) and TRAB (Department of Geomatics Engineering/Karadeniz Technical University, Trabzon) within the TUBITAK research project 116Y186 and 15 CORS-TR stations (Continuously Operating Network Stations in Turkey). Zenith total delays (ZTD) from GNSS data are analyzed during a test period covered a passing of a strong weather over these stations in the years 2017-2019. For the validation of GNSS-derived water vapor estimation, radiosonde data from adjacent radiosonde station in Samsun (13070) and ERA-Interim data were used for Samsun network. For Trabzon network, only ERA-Interim data were used for validation.

Keywords: *Extreme Weather; GNSS Meteorology; Radiosonde; ERA-Interim; Water Vapor* ***S2.O6***

Atmospheric Correction of Satellite Altimetry Observations using Complementary Geodetic data

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Abstract

Access to fresh water resources are going to be a critical issue to many people on the world. On the other hand, sea level rise of the oceans and open seas due to the global warming is another challenging issue to the coastal zone population. Therefore, monitoring the inland fresh water bodies and inshore sea level height changes is of key important to hydrologists and marine scientists. Besides the in situ measurements of ground-based sensors, observing the water level changes both in the inland bodies and the oceans supplies valuable information. Atmospheric and radiometric corrections are required to get correct and precise records on the measured surface heights. It is more crucial wherever troposphere is highly changing either spatially or temporally. Both the inland bodies' and inshore water's observations are subject to the significant effect of troposphere and particular attention is required. Water vapor as a constituent of troposphere affects the propagated signals from the altimetry satellite. Correct distance from the satellite to the water surface is obtained if this effect or the so called wet tropospheric delay is considered. Generally, wet tropospheric delay correction is made by the satellite onboard radiometer sensor measurements. It can measure the water vapor and estimate the wet tropospheric delay value by observing the amount of temperature brightness. The algorithm that derives wet tropospheric delay from temperature brightness observations is based on the amount of returning radiation from the surface. Consequently, a uniformly reflected signals i.e., backscattered signals from the oceans could leads to an accurate value. Estimation of wet tropospheric delay from temperature brightness observations will be unstable wherever radiometer footprint includes land i.e., the coastal areas or lakes. Hence, reliable estimate of wet tropospheric delay value is impossible through the radiometric observations. For these observation points, numerical weather forecasting models is used for correcting wet tropospheric delay effect of altimeter observations. Accuracy of model-based estimated correction is highly dependent on the assimilated data into the numerical models in the study area. More data is included more accurate estimate is expected. Alternatively, GNSS tomography can be employed for wet delay estimation especially in the coastal and inland water where the radiometer sensor is not capable of measuring temperature brightness and expensive ground-based radiometers are absent.

cont.

In this study, at first accuracy of the tomographic model has been compared to a numerical weather model. Then, estimated wet tropospheric delay by tomography approach has been applied to enhance the altimetry observation profiles. It should be noted that tomography problems are usually ill-posed. Generally, to solve this kind of ill-posed problem, mathematical constraints or initial value of unknowns is considered to make it well-posed. Mathematically, functional expression of the unknown parameters and obtaining the value of the expression using data on the observation points helps to get more stable problem. In this way, the number of unknowns decreases and therefore the problem becomes well-posed. In this study, a functional based model was used to solve the tomography problem, and the value of wet refractivity indices were estimated in the coastal network of GNSS stations. In this functional based model, experimental orthogonal functions and spherical cap harmonics were used to represent the vertical and horizontal distribution of wet refractivity indices in the network and eventually the three-dimensional model was obtained. Moreover, using spline bases functions, a four-dimensional model of wet refractivity indices has been formed. By comparing the wet refractivity indices with the data of radiosonde station in the network and considering the data of the ERA5 numerical model, it could be concluded that the tomographic method has a lower RMSE value rather than numerical model. Therefore, it is possible to obtain more accurate wet tropospheric delay from GNSS tomography with an appropriate functional model. The area covered by the CTRN network in California is considered as test area because of high density GNSS stations and also accessibility of a radiosonde station to control the accuracy of tomographic results. Processing times are also being considered when the altimeter satellite observation passes through the network.

Keywords: *Spherical Cap Harmonics, Empirical Orthogonal functions, Base Spline Functions, Radiometer, Saral Satellite*

S2.O7

High-rate GNSS Precise Point Positioning (PPP)

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Abstract

The aim of this paper is to investigate the effect of different sampling rates on GNSS precise point positioning (PPP) results. In order to investigate 'how does the observation rate affect the PPP positioning accuracy', a number of GNSS measurements were conducted. The data sets were collected on a Geodetic Point (GP) with accurately known coordinates on 29 August 2018. The experiment was carried out Trimble R10 multi-frequency multi-constellation GNSS receiver, and the data were collected at 1, 2, 5, 10, and 20 Hz data sampling intervals in five different consecutive static sessions. Each collected raw data were converted into the standard RINEX files and sent to the one of the most widely used Canadian Spatial Reference System-Precise Point Positioning (CSRS-PPP) online GNSS processing service by choosing kinematic processing option. The CSRS-PPP is a free online service that operated by Natural Resources Canada (NRCan). The PPP-derived coordinates retrieved from CSRS-PPP service were then compared to the known coordinates of the GP. The overall results indicate that the high-rate GNSS-PPP provides cm to dm accurate positioning by only using a GNSS receiver data along with the precise satellite orbit and clock products. The accuracy obtained from our study indicates that the PPP can be used in surveying and mapping applications including cadastral surveying, mining surveying, agriculture surveying, detailed topographic plans, general detailed site plans, GIS applications, as well as measuring large earthquake displacements and the dynamic behavior of the civil engineering structures. As it stands, PPP technique has become a powerful tool for accurate positioning very easily, conveniently while reducing the surveying costs.

Keywords: *GNSS; PPP; High-rate PPP; GNSS Sampling Rate; Online GNSS Processing* ***S2.O8***

Monitoring The Water Vapor, Snow/Ice and Sea Level Changes in The Antarctica with GNSS Meteorology and GNSS Reflectometry Techniques.

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Abstract

Advanced remote sensing tools based on space geodetic techniques are widely used for various purposes, such as monitoring sea level, snow depth and, in particular, sounding water vapor which is the most abundant and important greenhouse gas in the Earth's atmosphere. Over the past decade, GNSS Meteorology technique have become an effective tool for obtaining tropospheric parameters of the atmosphere. Moreover, GNSS reflectometer technique has been used in the last few years for obtaining important physical parameters such as snow depth and water level change with high temporal resolution and high accuracy. The main purpose of the study is monitoring the Horseshoe Island region's tropospheric water vapor variations, snow depth and ice thickness changes by means of GNSS Meteorology and GNSS Reflectometry techniques. For this purpose, determination of tidal effect and monitoring of snow / ice heights on Horseshoe Island will be carried out with observations of ultrasonic level sensors, meteorological stations and GNSS stations specially designed for the subject. In this respect, the Troposphere and Sea Level Reflectometer Observation Station and the Troposphere and Snow / Ice level Reflectometer Observation Station have been developed in accordance with the challenging weather conditions of Antarctica region with the cooperation of Yildiz Technical University and Istanbul Technical University. These comprehensive observation stations are based on space-based geodetic systems and are designed to produce output by combining high accuracy sound wave positioning data and meteorological station data. In addition, the parameters obtained from these stations will provide important information to support other scientific studies such as bathymetric mapping, geological and geophysical studies, real-time positioning, navigation and tectonics. We believe that the observations of these stations will contribute to the monitoring of global climate change and will support the scientific studies of our country in Antarctica. This study is funded by the Scientific and Technological Research Council of Turkey (TUBITAK Project No: 118Y322).

Keywords: *GNSS Meteorology; GNSS reflectometry; troposphere; antarctica; water vapor* ***S2.O9***

Multi-GNSS Contribution to Single-Frequency Precise Point Positioning

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Abstract

Over the past decade, Precise Point Positioning (PPP) has been a highly popular topic within the Global Navigation Satellite System (GNSS) community because of its unprecedented benefits such as operational simplicity, cost-effectiveness, elimination of base station requirements, etc. The traditional PPP approach employs the dual-frequency ionosphere-free combination of code and phase measurements. However, the number of dual-frequency GNSS receivers which are mostly used in geodetic applications requiring high positioning accuracy is quite limited. On the other hand, single-frequency GNSS receivers still dominate the GNSS market due to their considerably low costs. Therefore, single-frequency PPP (SF-PPP) has been increasingly taking attention in GNSS-related researches. Nevertheless, the positioning accuracy obtained from SF-PPP is mainly dependent on the number of available satellites. In recent years, the emergence of new navigation systems, e.g. Galileo and BeiDou, together with the completion of the GLONASS constellation provides important opportunities to enhance the positioning performance of SF-PPP. In this context, the main objective of this study is to evaluate the contribution of multi-GNSS integration that includes GPS, GLONASS, Galileo and BeiDou satellites to the SF-PPP performance. For this purpose, the SF-PPP model used in the study, which is based on the single-frequency ionosphere-free combination of code and phase measurements (GRAPHIC) is presented firstly. The related model also comprises the approach utilized to combine multi-constellation data. The study also includes an experimental test in which daily observation datasets collected at five IGS stations during the 1-week period of August 25–31, 2019 were processed under two different modes; GPS-only and multi-GNSS SF-PPP. Then, the solutions of two PPP modes were statistically analyzed in terms of positioning accuracy and convergence time. The results indicate that the integration of four constellations improves the positioning performance of SF-PPP considerably in comparison with the GPS-only mode.

Keywords: *Multi-GNSS; PPP; Single-frequency, GRAPHIC* ***S2.O10***

Assessment of PPP Positioning Accuracy with Different Meteorological Data Sources

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Abstract

Precise Point Positioning (PPP) is the Global Navigation Satellite System (GNSS) technique which enables centimeter- or millimeter-level positioning accuracy globally with a single receiver through precise orbit and clock products acquired from a global network. The tropospheric delay on GNSS signals is one of the main error sources in PPP. Traditionally, the modeling of tropospheric delay is separated into hydrostatic (dry) and wet parts. While the hydrostatic component of the tropospheric delay can be modeled efficiently, it is rough to model the wet component because of the irregularities in water vapor variation. In the standard PPP approach, the Saastamoinen model is typically used to correct the hydrostatic delay depending on the meteorological data, whereas the wet delay is estimated as a random-walk process together with the other unknown parameters. The meteorological parameters required for determining the hydrostatic delay can be obtained from empirical models such as Global Pressure Temperature (GPT) and its successor versions (GPT2, GPT3) on a global scale. Alternatively, the real meteorological measurements collected at the related site can be used for modeling the hydrostatic component of tropospheric delay. Although the in situ meteorological measurements are generally more reliable as they are collected at the site, the number of GNSS stations including the related sensors is restricted. In this context, the main objective of this study is to evaluate the influence of different meteorological sources on the positioning performance of PPP. For this purpose, the meteorological data of 10 International GNSS Service (IGS) stations for four different periods throughout the year have been obtained from GPT2, GPT3 models and real surface measurements. Using these different meteorological data sources, PPP solutions have been performed separately and the results have been analyzed in terms of positioning accuracy and precision. The results show that the PPP solutions which utilize the meteorological data from GPT2 and GPT3 provide comparable positioning performance, while the use of the real meteorological data considerably improves the positioning accuracy, especially for the vertical component.

Keywords: *GNSS; PPP; Tropospheric delay; GPT2; GPT3; Meteorological Data* ***S2.O11***

Methodology Assessment on Orbit Determination of LEO Satellites in Purpose of Global Geopotential Model Validation

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Abstract

The determination of Earth's gravity field, vertical datum and height unification, geophysical and geodynamical phenomena have become reliant on the Global Geopotential Models. These models are generally derived by satellite-only, terrestrial, or combined data. An assessment of these global geopotential models is essential to determine their accuracy to be used in various applications. Therefore, models derived specific parameters may be assessed by the comparison with other conventionally derived parameters. However, precise orbit determination for the validation of global geopotential models has been approved in theory. The accuracy of Earth's gravity field depends potentially on the orbit of the satellite's mission. Conversely, the determination of satellites orbits is affected by the accuracy of the gravitational forces, and merely on the gravity field models that represent the effect of Earth's gravity. Particularly, the harmonic expansion of the models are employed in measuring gravitational perturbations in the dynamic orbits determination procedure. In this study, the validation of Earth's gravity field models by precise orbit determination is discussed. Additionally, the effects of perturbation potential on the orbital elements are analyzed by modeling the orbital motion of **Gravity Field and Steady-State Ocean Circulation Explorer (GOCE)** satellite mission by the short arc approach. Which is, in this case, half of one revolution of the satellite – 45 minutes. Applying numerical integration methods, a single-step Runge Kutta method, and a multi-step Adams and Bashforth method to estimate the orbit. The Precise Science Orbit of GOCE is taken as a reference orbit solution to compare the results. The RMS-fit value between the two orbital models is used as an assessment tool between global geopotential models employed separately in deriving the predicted orbit.

Keywords: *Global Geopotential Models; Earth's Gravity Field; Orbit determination; Low Earth Orbit satellites; GOCE mission*

S2.O12

New aspects in GNSS Positioning and Velocity Estimation

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Abstract

GNSS positioning today can most often be maintained using two survey methods: continuous and campaign measurements. Continuous measurements are costly and the desired ground coverage cannot always be guaranteed. In addition, it is not always feasible to set up permanent stations in various natural hazard environments such as landslide beds. Hence, campaign GNSS measurements are still favorable among researchers. Up to date, scientists have put tremendous effort to reveal the time series characteristics of both "continuous" and "campaign" GNSS. In this study, new aspects in positioning and velocity estimation from GNSS campaign measurements will be discussed. For instance, campaign measurements repeated every year with 8-10 h sessions do not produce equivalent results with campaign measurements repeated every year with 24 h sessions in terms of position and site velocity estimation. Hence, observation session duration needs to be extended to 24 h when using PPP or using relative positioning (RP) over long baseline lengths. The research today shows that campaign measurements repeated once every 4 months produce site velocities almost as accurate as site velocities produced from continuous GNSS. In the accuracy modelling of the vertical component, differing from the other modelling efforts, one needs to take into account the effect of the annual seasonal motion. The presentation focuses on the above highlighted issues with examples from the International GNSS Service (IGS) network using IGS data and products.

Keywords: *GNSS*; *positioning*; velocity; *accuracy; PPP* ***S3.O13***

Geodetic Monitoring of Displacements and Deformations for Assessment of Effect from Suspend of Exploitation of Pernik Mines

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Abstract

The Pernik Coal Basin is the oldest in Bulgaria - its operation starts on 17.08.1891. Depth of bedding of coal beds is small (10-130m). In the last years, after the mining operations were stopped on 2000, emergency situations occurred on the territory of the town of Pernik, which are directly related to the mining activity carried out in the Pernik basin. Risky and emergency situations potentially affect all types of engineering facilities on the terrain of the city of Pernik (buildings, streets, roads, railways, bridges, stadiums, other facilities) as well as elements of the underground engineering infrastructure (water mains, sewerage, cable routes, etc.). The main goal of the project is to carry out studies and analyzes and to propose design solutions for the development of the geodetic network for surveying of the movements and deformations of the land surface and the mining mass with objects in order to organize specialized monitoring as a preventive measure for the purpose of conservation of objects and facilities from the harmful influence of the mining works and the consequences of stopping their operation in region of Pernik Mining. The territory covered by the project is about 213ha in the center of City of Pernik, Bulgaria. Different methods and instruments were applied for performing of precise geodetic measurements for deformation monitoring for last 9 years. Some results and conclusions are presented in the report based on collected 4D data base.

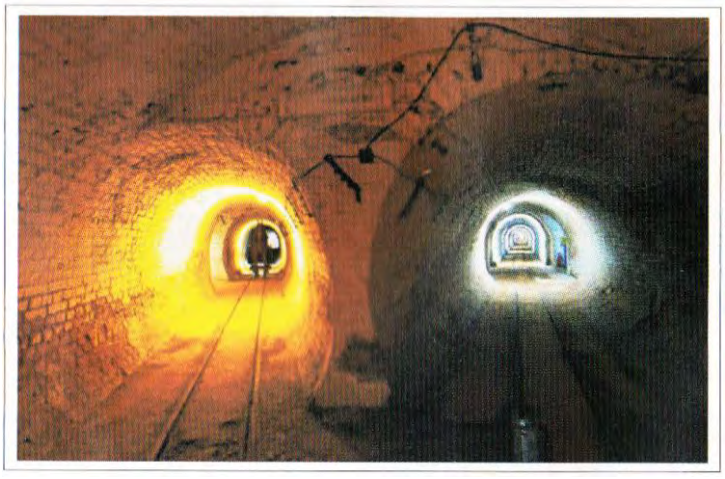

Figure : *Pernik Coal Basin, Bulgaria*

Keywords: *Deformations and movements monitoring; Precise geodetic measurements - methods and Instruments*

S3.O14

Evaluating the Repeatability of RTN GNSS (CORS-GNSS)

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Abstract

Real Time Network GNSS (RTN GNSS) measurements like other survey measurements are not devoid of errors. The purpose of this study is to show that RTN results can seriously be degraded by obstructions such as trees, buildings. This paper shows the investigations of the positioning error sources, studying their effects, and searching for methods to decrease, or possibly eliminate these errors in order to achieve better positioning accuracies in RTN GNSS. As stated above, one of the major problems is the signal attenuation which occurs when GNSS signals are attenuated by shades of trees or leaves. Another problem associated with RTN positioning is the multipath which tends to degrade the accuracy in the building areas. On the other hand, this study investigates the achievable accuracy and repeatability of the RTN under different satellite configurations by using VRS and FKP methods. Accuracy of spatial data is reported according to the National Standard for Spatial Data Accuracy of United States (NSSDA).

Keywords: *GNSS (RTN-GNSS); FKP; VRS* ***S3.O15***

Natural Hazards, Geophysical Fields and Ecology Problems on the Bulgarian Black Sea Coast

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Abstract

An integrated approach to the new and interpreted geophysical data, natural hazards expressions and local natural resources is applied to reveal the relationships, dependencies and possible interactions between the potential geophysical fields, DEM and bathymetry, natural hazards developed in the regional geodynamic context and the natural resources explored and exploited since historical times up to the present days. The main aim of this study is to reveal the relationships in depth, when they exist or not and to present the areas where such dependencies are not adequate. Such approach is newly performed and is targeted to the scientists, decision makers and local and regional authorities to inform them about possible sustainable deployment of the natural resources and their effective exploitation in case if a strong multihazards natural phenomena affect the study area and the possible effects to the environment. The side effect of this research is the deeper view to the possibilities of the recent geophysics to help the extended knowledge and mitigation measures in case if the strong disaster occurred and environmental pollution generated and registered. The results obtained suggested that no frequent matching is observed, but when exists, it could be useful. All other cases need further, local and more complex research to discover the useful relationships.

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Keywords: *Natural hazards; geophysical fields; environmental problems* ***S3.O16***

Usability of the New GNSS-based Positioning Technologies

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Abstract

This study aims to determine the positioning accuracy and the usability of the two of the state-of-the-art positioning technologies; Trimble CenterPoint RTX and CSRS-PPP. For this aim, we conducted GNSS observations at the seven different test points with 20 km intervals that were located from the Corum province to the Kirikkale province. The observation data were collected using a Trimble R10 dual-frequency GNSS receiver. The coordinates of the test points were obtained from CenterPoint RTX in real-time and CSRSS-PPP services 20 days after the observation time. These coordinates are compared with the reference coordinates obtained from differential solution using GrafNET post-processing software. The maximum errors in latitude, longitude, and position components are cm-level, while the maximum errors in height components are 2-dm level for both of the technologies. The average results show that both of the services provide cm-level accuracy for all of the components. The results also show that the obtained accuracies will meet the current requirements of the many positioning applications, and therefore the usage of these new technologies will increase soon due to the advantage of them compare to the classical positioning techniques. The main limitation of the CenterPoint RTX service is the initialization time to obtain these levels of accuracies. The main limitation of the CSRS-PPP service is not to provide a real-time solution.

Keywords: *Precise Point Positioning; CSRS-PPP; CenterPoint RTX* ***S3.O17***

3D Transformation Parameter Estimation for Automatic Point Cloud Registration

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Abstract

Working with highly accurate data to create a model from point clouds is a very important issue for geodetic and 3D modeling studies. If the data of the model surface in the current point cloud is missing or is not sufficient for accuracy, it would be a more accurate approach to integrate the reference data into a more accurate point cloud. The aim of this study is to combine point clouds in the production of more accurate models and to make a contribution to improve the detail and accuracy of 3D modeling. It is also intended to determine how much the accuracy of different point clouds combined by 3D transformation estimation methods can be improved. For these reasons, Automatic Keypoint matching algorithms were used for initial registration and accuracy investigation. Besides, the ICP (Iterative Closest Point) algorithm for combining 3D-point clouds and 3D Similarity Transformation for transformation parameter estimation was used. In the proposed algorithm, after the data was filtered and segmented according to optimum curvatures, the corresponding keypoints were determined according to angle and distance. Then, the transformation parameters were automatically calculated for coarse registration with Gauss Markov and Gauss Helmert adjustment models and ICP was applied for fine registration**.** Therefore, these methods will be possible by comparing the previously used methods to reveal the missing and superior aspects of the algorithm.

Keywords: *ICP, Point Cloud, Registration, Transformation* ***S3.O18***

Accuracy Assessment of Satellite Positioning Techniques on Unmanned Aerial Vehicle (UAV) Photogrammetry

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Abstract

By the end of the 20th century, Unmanned Aerial Vehicles (UAV) were started to widely used on daily life in consequence of decreased production cost and increased options. UAV essentially is remotely controlled or autonomous aircraft that performs particular tasks and can carry payload without pilot onboard. Capability of carrying camera onboard enables to make use of it in photogrammetric technique. Main problem of photogrammetry is defining unknown parameters of collinearity equations (interior and exterior orientation parameters) these effectuate mathematical model. Photogrammetric cameras interior parameters are generally known. Yet, in classical airborne photogrammetry, exterior orientation parameters are computed by Ground Control Points (GCP), which are signaled and measured on the surface, via air triangulation. By the development of sensor systems, integration of Global Navigation Satellite System (GNSS) and Inertial Measurement Unit (IMU) with UAV brings up new approaches in photogrammetry. Obtaining instantaneous coordinates and rotation parameters can be utilized for orientation of images. Depending on GNSS measurement technique, accuracy of system can be increased with less ground points. Although classical GNSS measurement has low accuracy, Real Time Kinematic (RTK) and Post Process Kinematic (PPK) relative approaches enhance point accuracy up to cm through GNSS methods. Within this scope; it is intended to analyze point accuracy and assess dependability of survey for geodetic and cartographic applications by using RTK, PPK (Post Process Kinematic) and GCP outputs. By performing different approaches, it is aimed to eliminate dependency of GCP's on the photogrammetric mapping. With this object in mind, 18 ground points were set in ITU-Ayazağa Campus as GCP and test points and positioned by static GNSS measurement. Images which taken by DJI Phantom 4 RTK, are evaluated to produce orthophoto map. Outputs of each technique are compared between each other.

Keywords: *Accuracy; RTK; PPK; GCP; GNSS; Photogrammetry; UAV* ***S3.O19***

Recent Developments on Gravimetric Geoid Determination

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Abstract

Geoid, which is a levelling surface of Earth's gravity field, is used for a reference surface for heights and depths. Thus it has essential important role in engineering structures that need physical heights such as orthometric and normal systems referenced to the geoid and quasi-geoid, respectively. Nowadays due to developments in approximations recently, the geoid can be precisely computed by combining terrestrial gravity data, digital elevation model (DEM) and global geopotential model (GGM). The Least Square Modification of Stokes' Formula (aka the KTH method and its additive corrections in geodetic literature) is one of methods that produce the precise gravimetric geoid. This method was successfully utilized in some parts of the world such as Baltic Countries, France, Greece, Scandinavia, and Turkey etc.

In this study, recent developments by the KTH approximation are explained then, the method was implemented in Konya Closed Basin (Central Turkey) by using LSMSSOFT developed by the author. For this purpose, two different DEMs (SRTM and ASTER) and various GGMs were tried to obtain the precise geoid model. The effect of new approximations on the accuracy of gravimetric geoid was numerically discussed in this study. Consequently, how we can obtain an optimum geoid model is explained by comparing GNSS-levelling control points in the absolute and relative sense.

Keywords: *Accuracy assessment, Gravimetric geoid model, Konya Closed Basin, KTH method, LSMSSOFT*

S4.O20

Refinement and Construction of Louisiana Local Gravity Grid for Precise Geoid Determination

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Abstract

In this study, the terrestrial and marine gravity data sets undergo refinement and validation for the sake of precise geoid determination in Louisiana. The erroneous gravity data represent the main source of errors that can easily propagate into the geoid if not refined and eliminated. The purpose of this study is to ensure the integrity of the reliability of these data sets and merge them safely in the final gravity grid. This will highly reduce gross-error propagation into the geoid due to the inconsistency in the multipurpose collection of the gravity data. The NGS (National Geodetic Survey) goal aims for a 2 cm geoid over all the states based on the GRAV-D project for airborne gravity measurements. The recent NGS report reveals accuracy probability of ~25 cm for the geoid heights over Louisiana. For refinement of the terrestrial and marine gravity data we first cross-validate each dataset individually to assess their quality. We use bilinear interpolation method to predict the gravity values during the cross validation based on leave-one-out procedure within the specified search radius around the test point. The standard deviation is used as cut-off for outlier detection, it is set at ±10 mGal for the terrestrial gravity and ±5 mGal for the marine data after elimination of the crossovers. After that, we carry out another comparison to validate two combined global geopotential models (EGM2008 and XGM2016) to use the best-fit one in filling the gaps due to lack of gravity measurements. EGM2008 has a slight best-fit agreement compared to GM2016, therefore, it will be used in to restore and construct the gravity data. The construction of the gravity grid is carried by means of remove-restore procedure using EGM2008 and terrain correction. A grid of a 1x1 arc-min resolution is constructed based on the spatial distribution of the sparse gravity data over Louisiana using search radius technique to count the number of points within the search radius. Different radius values are investigated in order to find the optimal choice of the sparse data to appropriately determine the interpolation and filling areas in the final grid. Numerical comparisons and analysis of the newly constructed grid of Louisiana are addressed and illustrated.

Keywords: *gravity data*; *geoid*; *gross-error*; *NGS; EGM2008;* remove-restore; *terrain correction; outliers*

S4.O21

Estimation of Sea Level Trend in the Black Sea from Satellite and in-situ Data

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Abstract

Sea level is a dynamical parameter related to climate change. Recently global sea level rise is accelerating during the 21st century in response to ocean thermal expansion and glaciers/ice sheet melting, and sea level change has a strong regional pattern. In this study, a comprehensive analysis of sea level change in the Black Sea is performed using satellite and in-situ data. Sea level observations from satellite altimetry and tide-gauge stations were used to estimate the trend of the Black Sea level and its periodicity. The present-day sea level changes in the Black Sea were investigated using multi-mission gridded satellite altimetry data covering nearly 24.5 years from January 1993 to May 2017. The mean rate of sea level rise has been detected as 2.5 ± 0.5 mm/year over the entire Black Sea. If considering the dominant cycles, until December 2014, the Black Sea level has risen at a rate of about 3.2 ± 0.6 mm/year. The maximum rate (~ 5 mm/year) was observed in the part which is between of 38°–40° northern latitudes and 41°–42° eastern longitudes of the Black Sea. Besides, coastal sea level changes were analyzed from 13 tide-gauge stations along the Black Sea coast. However, most tide-gauge data are not up to date and tide-gauges' spatial distribution is poor along the Black Sea coast. Nevertheless, using the available data relative sea level change were assessed, and generally seen a rise (except for the Bourgas station). The results also showed that there were significant vertical ground movements at some tide-gauge locations. For the nearly co-located Global Positioning System (GPS) and tide-gauge stations (at Trabzon, Sinop and Sile locations), after determining vertical motion from the GPS measurements, correlation coefficient between the trends obtained from altimetry and tide-gauges were greatly improved from 0.37 to 0.99. Furthermore, over the period of 2002–2017, the rate of seawater mass change in the Black Sea from the Gravity Recovery and Climate Experiment (GRACE) mascon solutions was 2.3 ± 1.0 mm/year. The sum of mass-induced and steric-induced (temperature + salinity) changes showed similar fluctuations with the total sea level changes obtained from altimetry.

Keywords: *Black Sea; Sea level change; Satellite altimetry; Tide-gauge; GRACE* ***S4.O22***

A spectral filtering approach to assess the trend of recent mass decrease over Lake Urmia using GRACE's Mascon solution

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Abstract

GRACE's Mascon solution provides surface mass change in the term of Equivalent Water Height (EWH) with a spatial sampling of one arc-degree cell. Mascon solution solves for monthly gravity field variations, so the time series of a Mascon over a certain region, especially basin areas, is an invaluable resource for tracking the large-scale mass change over a certain period of time. In this study we analyze variations of EWH over the Lake Urmia region using the Mascon's time series spanning the interval from January 2003 to July 2016. Due to the seasonal meteorologically related variation and the recent desiccation of Lake Urmia, it is expected that the annual variation and the secular trend to be the strongest spectrums of the Mascon's signal. However, to study the nature of these variations, especially the secular one, we need to distinguish the signature of the different frequency components, in particular the inter-annual variations. Therefore, we design a Finite Element Response (FIR) filter as a spectral filtering approach to separate different frequency components from the original signal in order to gain a better insight into the behavior of secular trend of mass decrease in the area. The outcome of study suggests a non-linear secular trend which is an evident deceleration (1.5 cm/yr^{-2}) in the rate of the decrease in EWH over the Lake Urmia region during last years.

Keywords: *GRACE's Mascon; FIR filtering; Urmia Lake; non-linear trend; Equivalent Water Height*

S4.O23

Physical Height Changes Estimated by GRACE Data: A Case Study over Greenland

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Abstract

Studies in recent years show that there are large mass variations in the Polar Regions of the Earth. Mass variations especially caused by global climate change necessitate modeling the redistribution of mass, investigation of its effect to the physical surface (e.g. vertical and horizontal displacements) of the Earth and evaluations of the future variations. The Gravity Recovery and Climate Experiment (GRACE) satellite mission, launched in 2002, contributed to the knowledge of temporal variations of geoid/quasigeoid heights induced by mass loading. With the implementation of the GRACE-Follow On (GRACE-FO) project, which is the continuation of the GRACE twin satellites that completed their mission in 2017, an important step was taken for the continuity of tracking Earth's mass movement across the planet. The main aim of this study is to estimate the physical height changes over Greenland where mass variations are intense. The effect of the mass redistribution to the physical height changes was investigated by means of the monthly release 6 GRACE based Global Geopotential Models (GGMs) developed by the CSR (Center of Space Research, the University of Texas at Austin) center as well as Preliminary Reference Earth Model (PREM). The evaluated physical height changes were analyzed using two different methods: the seasonal decomposition method and the Principal Component Analysis/Empirical Orthogonal Function (PCA/EOF) method. The main findings demonstrate that mass redistribution on a large scale over Greenland affects the physical height changes significantly. Vertical displacements vary from region to region but they increase more in particular in South Greenland, during the years 2004-2010 considerably.

Keywords: *geoid/quasigeoid heights; GRACE; Greenland; physical height changes; vertical displacements*

S4.O24

Impact of Tides Constituents on Determining of Sea Level Trends in the Southwestern Coast of Turkey

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Abstract

Human populations more than others in coastal areas in the world thanks to economic or other benefits. So, the scientists are carried out more and more studies such as sea level rise, tidal analysis, sea populations and etc. in coastal areas. In this study, we are aimed to investigate main tidal parameters effects on sea level trends in the Southwestern coasts of Turkey. For this purpose, relative sea level trends and tidal parameters have been estimated over period 1998-2018 by main tidal frequencies using least squares harmonic estimation method from 6 tide gauge stations distributed in the southwestern coast of Turkey operated by TUDES (Turkish National Sea Level Monitoring System). Satellite altimetry data also have been used for the determination of absolute sea level. The data have been obtained by AVISO data archive in period of 1993-2015.

The tidal model belonging to each year between 2004 and 2018 have been analyzed carefully to compare model of different years and methods. In addition, main tidal parameters M_2, S_2, K_1, O_1 and standard deviation of tidal parameters have been calculated for each year. Sea level trend and tidal constituents have been calculated and compared with two methods both tide gauge station and satellite altimetry. For each year, tidal model has been created and compared previously studies and global model such as FES2004.

Keywords: *Tide; Sea Level; Tide Gauge; Satellite Altimetry; Time Series* ***S4.O25***

Analyzing the Interpolation Techniques by Computing the Height Transformation Surfaces Using GPS/Leveling Data

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Abstract

The orthometric heights, which also play important role in many fields such as engineering surveying, flood management, coastal research, navigation, management of water sources, and risk analysis for earthquakes, etc., can be obtained by using the connection between geoid undulation and ellipsoidal height. Within the scope of this study, local geoid models are determined by using different interpolation techniques in order to obtain geoid height information with high accuracy that directly affects the precision of transformed orthometric height through GNSS. Although there is no regional geoid model within 2-3 cm accuracy in Turkey yet, local GPS/Leveling surfaces "local geoid models" are computed in limited areas using sufficiently dense GPS/Leveling benchmarks. In the content of research, the cross validation results belonging to the 12 interpolation techniques are investigated in order to test the consistence of computed grid values within themselves. In the light of obtained results, it can be stated that linear interpolation results for all of the gridding methods except minimum curvature, polynomial regression (simple planar surface, bilinear saddle) and moving average reveal the best performance with a standard deviation of 5.5 cm and 6.0 cm. The performances of the determined grids are examined at the reference benchmarks and test benchmarks, respectively by employing linear, nearest neighbor, cubic and spline interpolation methods. As a linear interpolation result of these testing processes of grids, biharmonic spline interpolation method draws the attention as the most accurate method, whose standard deviation is 1.2 cm at the reference benchmarks and 3.2 cm at test benchmarks. This results show that generated geoid model data can be used in all kind of engineering projects that require height information within cm accuracy. In the evaluation of nearest neighbor interpolation at test points, the grid data that is obtained through natural neighbor method gives the most accurate result while moving average method gives the worst result. When considering cubic interpolation results, this can be said that triangulation with linear interpolation gives the best result; on the contrary, moving average gives the worst result. In the evaluation of spline interpolation results at test points, point Kriging (linear drift) and point Kriging (quadratic drift) give the best results. On the other hand, moving average has the worst standard deviation value. This results show that generated geoid model data can be used in all kind of engineering projects that require height information within cm accuracy.

Keywords: *Local geoid; height transformation; surface interpolation* ***S4.O26***

Use of Transferable Development Rights (TDR) Method on the Preservation of Historic Buildings in Turkey

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Abstract

Historic buildings are one of the few objects that can connect a country to its past, build national pride, and also provide urban aesthetics and bring touristic income. Therefore, it is important to preserve them. Today, the practice of preservation of historic landmarks in Turkey is considered to be a successful one with its strong legislation and well-functioning preservation boards. However, in this study, we will look at the situation from the perspective of building owners. When a building is decided to be preserved, put aside its demolition, even minor changes require the approval of preservation boards. This might be a great method for the sake of preservation, however from the owners' perspective, it is problematic to impose restrictions on "development rights" of people without the compensation of any kind (e.g. expropriation). For example, when a two-storey historic building is preserved in a neighborhood where development plan (zoning) allows five-storey buildings, because of the preservation decision, the owner of the historic building is prevented from his/her "right to build", which is causing an enormous amount of loss of "development gain" for the owner. On the other hand, this is a fact that public finances of countries cannot afford to expropriate every preserved real estate in whole country. At this point, Transferable Development Rights (TDR) (in Turkish, İmar Hakkı Transferi) can be a good method in Turkey as well, which has been used in many other countries for quite a long time. TDR simply means that the owner of a preserved real estate is allowed to transfer his/her development right to somewhere else. They can use their development right either by physically building it on another land parcel, or sell their right to someone else. By this way, the cost of preservation is financed by the real estate market or the community, not by the State. In other words, the economic loss (because of the restriction) of the owner is compensated without the State spending any money. In fact, TDR method already has clauses in the Turkish legislation, however it has never been used. This study tries to shed light on the TDR method to be used on historic buildings in Turkey by analyzing how it can be implemented, what the barriers are, and finally its advantages and disadvantages.

Keywords: *Transferable development rights; historic buildings; preservation; development right; development gain*

S5.O27

Georeferencing in 3D point clouds with L1 norm (least absolute value) method

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Abstract

A point cloud is a three-dimensional structure that consists of a large number of points at a certain distance to each other in a digital environment. The point cloud should best symbolize the surface being received. Georeferencing (transformation) should be performed to make the obtained point cloud useable. While performing georeferencing, the control points to be selected should cover the entire project. In a coordinate transformation, some different coordinate transformation methods might be choosing according to shape of computation surface, aim of transformation and amount of the points with known coordinates in both coordinate systems. In applications corrected (adjusted) measurements can be determined with more than necessary measurements. Due to more measurements than necessary, the inconsistency between measurements results in no single meaningful solution. Therefore, only meaningful solution can be obtained by abide to different aim functions. One of these methods is L1 norm (Least Absolute Value Method- LAV) which solution aims to In L1 norm (LAV) method, the solution is made by trial and error or the problem is converted to linear programming While, the advantage of this method is that it has little or no effect on the big error. The disadvantages of this method are difficulties of solving and accepts the same number of unknown measurement as correct.

In this application L1 norm method was used on the georeferencing with Bursa-wolf model. 3D point cloud was used as a data. Common points were selected from the data set to cover the working area homogeneously. Georeferencing was done using these common points. The calculated transformation parameters were tested on other points and the correction values were calculated. Results were reviewed.

Keywords: *point cloud; L1 norm; georeferencing* ***S5.O28***

Smart City Applications

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Abstract

The number of people living in cities is increasing rapidly in the world whose population is rapidly increasing day by day. It is estimated that 80 percent of whole population will live in the cities. Obviously, this tendency has a huge effect on all the cities. In the cities where the people migrate from, it is aimed to protect the qualified work force and to provide the life welfare for preventing the people from moving to another city.

On the other hand, it is a necessary to provide a high-quality service to all the people including the immigrants with the limited sources in despite of the increase in the population. Due to the rapidly increase in the population in cities, they will most probably suffer from lack of several types of services about energy, infrastructure, transportation, health, nutrition, etc. in the future. Even today, most of these deficiencies unfortunately start to present as a result of the decrease in the sources. To come up with this vital problem, planning of smart cities must be paid attention. The smart city projects involve sustainable, habitable and digital city concept. Also, they purpose to remedy cities' deficiencies about these concepts. For this reason, sustainable, efficient and applicable smart systems should be built in especially metropoles by considering security and health. To achieve this, 'Smart City' concept is suggested. In medium and big scaled cities, ten-year, twenty-year and thirty-year smart city plans are made. According to the premier global market intelligence firm (IDC), it is estimated that the expenses about 'smart city' planning, which was 81 billion dollars in 2018, will be around 158 billion dollars in 2022.

The smart city wheel, created by Dr. Boyd Cohen, is accepted worldwide since it is followable and inspirational for new projects. As the European Union (EU) described that smart city, at the center of the wheel, consists of smart mobility, smart people, smart economy, smart environment, smart government and smart living. The Smart Cities Council (SCC) announced that increased quality of life means higher quality life living conditions for the inhabitants of the city. Smart cities provide efficient usage of work force, natural and financial resources.

Non-integrated applications, visionless authorities, financial insufficiencies, people excluded from the process, technological information and lack of experience are obstacles to developments in the 'smart city' concept. In addition, cooperation between the institutions is so important in applications of the 'smart city' concept. The 'smart city' concept, a multi-discipline approach, consist of not only technological components and international firms, but also the people.

cont. ***S5.O29***

The ‘smart city’ concept, which cannot be restricted in anyway, also involves the urban management and the city-dwellers. Mobile applications become prominent as most frequently used method in the smart city projects. In addition, internet of things and social media are also frequently used in the projects.

On the other hand, big data methods are generally used by metropolitan municipalities. Nowadays, there is a problem about the big data due to the data collected from things via the sensors. In addition to data processing, providing security is also necessary during the smart city projects. This study consists of definition and components of the ‘smart city’ concept, the potential difficulties of smart city projects and the benefits of smart cities with examples from the worldwide.

Keywords: *Smart city; iot; big data* ***S5.O29***

A Performance Analysis of Low-Cost Single and Dual frequency GNSS receivers Using N-RTK

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Abstract

Today, low-cost and high-performance GNSS devices can be successfully used in many fields including, autonomous vehicles, unmanned aerial vehicles (UAVs), railways, maritime, agriculture, GIS, communication, energy, natural events, sports and meteorological studies. In real time positioning, the **R**adio **T**echnical **C**ommission for **M**aritime **S**ervices (**RTCM**) data structure including base station correction information can be transmitted to the receiver by The **N**etworked **T**ransport of **R**TCM via **I**nternet **P**rotocol (**NTRIP**) data transmission protocols. Thus, it can provide more flexible solutions for precise measurements compared with the standard **R**eal-**T**ime **K**inematic (**RTK**) positioning technique can be achieved.

GNSS receiver manufacturers offer low cost products with acceptable accuracy for real-time analysis. In this study, a base station (NTRIP-Caster) was established using open-source software of U-Center and RTKLib to test the Ublox C94-m8p single-frequency GNSS receiver. RTCM correction data transmitted from this single frequency base station was transmitted over the internet to single-frequency C94m8p and dual-frequency ZED-F9P receivers (NTRIP-Client) and real-time network solutions, at the same time RINEX data were recorded at 1-second intervals. In order to compare the accuracy of low-cost devices with post-processing (PPK) data, RINEX data were collected and then the estimated solutions were analyzed using the dual-frequency receiver with RTKLIB software.

Results revealed that real-time solutions obtained with U-Center software for low-cost single-frequency receivers are in float solution, whilst the results of PPK solution obtained with RTKLIB software are mostly in fixed solution. It was also observed that for low-cost dual-frequency receivers using real-time solutions obtained with U-Center software are fixed in the surveying trajectory except for the worst visibility condition. This solution results are varying from RTKLib software solution are in centimeter level.

Keywords: *Low cost; GNSS; NTRIP; RTCM; PPK* **S5.O30**

Regularized Greedy Forests for Polarimetric SAR Image Classification

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Abstract

SAR images are usually preferred for agricultural classification since SAR signals are sensitive to the crop structure and dielectric properties. In particular, PolSAR images provide more beneficial information for crops as they record the complete characteristics of the scattering in each polarization for the targets. The aim of this paper is to evaluate the potential of Regularized Greedy Forest (RGF) for crop classification from multi-temporal PolSAR data as well as to compare the performance of RGF with Random Forests (RF) and Support Vector Machines (SVM). For the classification of five crops (maize, potato, wheat, sunflower, and alfalfa) in the test site, polarimetric features of Cloude–Pottier decomposition were used as the input data. The Cloude-Pottier decomposition (also known as H/A/α decomposition) is an eigenvector-based decomposition of coherency matrix. The performance of RGF was compared with RF and SVM in terms of overall accuracy, kappa coefficients and computational cost. . K-fold (K=5) cross validation was used to assess the classification accuracies. Experimental results demonstrated that RGF can achieve higher accuracy (0.787 (+/- 0.035)) than RF (0.766 (+/- 0.037)) and SVM (0.738 (+/- 0.039)) for the classification of crop types. In terms of computational cost, RGF is faster than SVM and RF for the training process. Our results suggest that new generation ensemble learning algorithms such as RGF could provide many benefits in terms of accuracy and computational cost for the analysis of remote sensing data.

Keywords: *PolSAR; Regularized Greedy Forest; Polarimetric Decomposition; Agriculture; Classification*

S6.O31

Making Sense of a PsInSAR Sentinel-1A/B map of a Long-term Explored Oil and Gas Deposits: Case Study of Seria, Brunei Darussalam Field

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Abstract

The Persistent Scatterer Synthetic Aperture Radar Interferometry (PsInSAR) is a method for recording of displacement of "opportunity" object on the earth's surface as a function of time, using data captured during a repeat-pass SAR-enabled satellites. A contemporary interest in the PsInSAR technique are due to at least two facts, i.e., freely available SAR data and a high accuracy of displacement determination of objects. Applications of the PsInSAR method are mostly concentrated on identifying of displacement of the terrain surface caused by both anthropogenic and natural processes. In this contribution we discus some observations we made while studying a PsInSAR map produced from a time series of the Sentinel-1A/B images taken over the active oil and gas exploration field located in Seria – Kuala Belait area, Brunei Darussalam. In addition to the PsInSAR map, we had on hand the aerial Light Detection and Ranging (LiDAR) data recorded in 2009 and 2018, and high resolution orthophoto over selected sites within the area of interests (AOI). These datasets are complement with an in depth local knowledge of a qualified geologist (one of the authors of this study), who has been living in the AOI. In our study we propose a geotechnical or geomorphological interpretation of the apparent subsidence or lift of sections of AOI. We also analyse of the time series of a few PS located within the subsidence or lift areas of AOI. The main conclusions of the study, include a correlation between the LiDAR elevations and PS displacements, confirmation that the PsInSAR method can be used to quantify the large scale terrain deformation of terrain cased geotechnical processes initiated by disturbances of the subsurface and surface of the earth in oil and gas exploration areas.

Keywords: *PsInSAR; LiDAR; Brunei Darussalam; Oil & Gas; Geotechnics; Geomorphology* ***S6.O32***

Detection of Ground Motions in Coastal Area

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Abstract

Landslide processes are considered to be the major part of the natural hazards occurring on the northern part of the Bulgarian sea side. Their monitoring can be done by direct measurements in dedicated GNSS networks, which is the most accurate method. The objective of this study is to provide solid grounds for monitoring of the landslide processes using innovative methods by combining GNSS and SAR data. This goal will be to achieved by implementation the following two sub-objectives: first, establishment a verified methodology for extracting high-quality information from SAR images aimed at continuous monitoring of landslide areas integrating interferometric images (IFI) and in-situ GNSS data and second, based of freely accessible data provided by ESA and national sources to create a working prototype of an information system for monitoring and preventing the effects of earth crust movements (landslides, falls, etc.). One of the scientific tasks to be solved includes the development of methodological approaches to compare the results of the combined processing of interferometric images from SAR, in-situ measurements by permanent GNSS stations from the national NIGGG network in the area of study and geodetic measurements of a newly built test network a specific area on the Northern Black Sea coast of Bulgaria subject to landslide processes. After the primary processing of the data from three sources, their reconciliation which will form a geodatabase for subsequent spatial analysis envisaged in GIS environment. It is foreseen that the end-product of this processing to be accessible through a dedicated website, which will raise awareness among stakeholders about the ongoing risky geodynamic processes taking place in the area. This will increase the readiness of national and local authorities, as well as society as a whole, improve prevention and address the consequences of natural disasters, in particular by the occurrence of landslides.

Keywords: *ground motion, GNSS, InSAR, landslide monitoring* ***S6.O33***

Geospatial technologies applied for morphometric analysis of debris flows basins in the Eastern Rhodopes, Bulgaria

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Abstract

Debris flows occur in deep erosion landforms and are considered as movement of earth masses usually triggered by intensive rainfall and snowmelt. They often occur suddenly and could affect infrastructure as well as to influence human activity and life. This determines the growing need to deepen the research of these natural phenomena and to hold debris flow monitoring in the areas with high susceptibility to these events. Besides the intensive rainfall and snowmelt there are several other factors - prerequisites to debris flows: morphometric characteristics, rocks composition, active tectonics and deforestation.

In the current research morphometric features of debris flows basins are considered and analysed taking into account their role in hydrological processes, particularly in the distribution of the surface runoff and the water quantity of the streams /rivers and potential sediment supply. The study area is located in Eastern Rhodopes (Bulgaria) where intensive rainfall, combined with the intensive weathering, the soils and the rare vegetation determine the occurrence of debris flows The following morphometric parameters are calculated: basin area, length and shape, basin relief, relief ratio, Melton index, slope, topographic wetness index, streams density. The three main parts of the debris flows basins - initiation area, erosion channel and accumulation area are determined.

The research is elaborated in GIS environment on the base of digital elevation model and field investigations. Terrestrial laser scanning of the low part of the basins and debris flows fan is done and detailed terrain models are developed for the purpose of morphometric analyses. The georeferenced 3D model is obtained using field GNSS ground control points measured in RTK mode. The results of morphometric analysis allow to determine indicators for debris flows susceptibility assessment and could be used for calculation of the volume of debris flows deposits and assessment of the intensity of erosion. They are of importance for choosing debris flow monitoring locations as well as for designing and implementing mitigation measures. The acquisition of new data by terrestrial LiDAR will allow to evaluate the dynamic of the processes.

Acknowledgements: *National Science Program "Environmental Protection and Reduction of Risks of Adverse Events and Natural Disasters",* approved by the Resolution of the Council of Ministers № 577/17.08.2018 and supported by the Ministry of Education and Science (MES) of Bulgaria (Agreement № D01-230/06.12.2018)

Keywords: *debris flow; morphometry; terrestrial LiDAR; GIS; modelling* **S6.O34**

Burned Large Forest Area Mapping Based on Google Earth Engine

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Abstract

Approximately a few hundred million hectares of the world forest area have been affected by forest fires each year, resulting in loss of life, property and value that cannot be redeemed in a short time. Forest fires cause a great threat to the flora and fauna while substantially disturbing the biodiversity and the ecology. As a result of the inventory study conducted in 2015, Turkey's forest area was determined as 22.3 million hectares covered 28.6% of the country. From 2014 to 2018; 3117 ha, 3,219 ha, 9156 ha, 11993 ha, 5644 ha of forests were lost, respectively in Turkey. Meteorological conditions play an important role in the occurrence of forest fires; since forest fires, either natural or caused by human factor, can only take place when some optimal meteorological conditions are synchronized. High atmospheric temperatures and dryness offer favorable circumstances for a fire to start naturally. In Turkey 60% of the total forest area are considered as the first and second-degree fire sensitive areas. Looking at the forest fires taking place between the years 2014-2018, it is resulted that 20% of burning forest area is located within the Antalya and around. In this study, Antalya and its surroundings which are the first degree fire sensitive area selected as the pilot site. Forest fires occurring over a 5-year period were evaluated and the relationship between the surface temperatures and relative humidity of the large forest fires (LFFs) that damaged more than 500 hectares of land was investigated from Landsat and Sentinel satellite data. Random forest classification method and three different indices as Difference Normalized Difference Vegetation Index (dNDVI), Difference Normalized Burned Ratio (dNBR) and Normalized Difference Vegetation Index - Thermal (NDVIT) were used to extract burned areas from satellite imageries. Google Earth Engine platform was used for the analysis and results were compared with data taken from General Directorate of Forestry.

Keywords: *Large Forest Fire; GEE; Random Forest; Spectral Indices* ***S6.O35***

On the Use of Genetic Algorithm in Component Substitution-based Pansharpening

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Abstract

Pansharpening aims to transfer the spatial details of a high resolution panchromatic (PAN) image into a lower resolution multispectral (MS) image, producing an image of superior spatial and spectral quality. Various pansharpening methods have been reported so far. Of these, the component substitution (CS)-based pansharpening methods are among the most widely used ones, owing to their advantages of being fast and easy to implement. The biggest advantage of the CS-based pansharpening methods is that they are very good in enhancing the spatial resolution. However, they tend to distort the colors of the input MS image. This is due to the fact that there is not a standard color preservation procedure when producing the intensity component used by the CS-based methods. This, of course, motivates the analysts to develop more advanced approaches to produce more efficient intensity components. This study utilized the genetic algorithm (GA) within a CS-based pansharpening framework (GA-CS) to produce the optimum intensity component to eliminate the CS-based methods' disadvantage of distorting the color characteristics. The GA-CS framework estimated the optimum band weights using the GA. The GA-CS framework was conducted in two test sites, which were acquired by the WorldView-2 and IKONOS satellites. The performance of the GA-CS method was qualitatively and quantitatively compared against those of widely-used CS-based methods Gram-Schmidt (GS), Brovey, Modified Intensity-Hue-Saturation (MIHS), Principal Component Analysis (PCA) and Ehlers. Qualitative and quantitative evaluation results showed that the GA-CS framework produced images of superior color quality, compared to the other methods used. It was also concluded that the metaheuristic algorithms may be used as an efficient means of optimizing pansharpening results.

Keywords: *pansharpening; genetic algorithm; image fusion; metaheuristic algorithms; component substitution*

S6.O36

Performances of Landsat 8 and Sentinel-2 Data in Mapping Open Mining Areas; İstanbul Case Study

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Abstract

Determining and monitoring the open mining areas and its surrounding environment has an important role for natural resource management. Many efforts have been made to map open mining areas and its surrounding environment using different remotely sensed data in the last two decades. Therefore, to produce accurate thematic maps of heterogeneous areas are really difficult because of similar spectral characteristics of different objects on the earth surface. In this study, remotely sensed data that have different spatial and spectral resolutions were explored to evaluate their performances in quantifying open mining areas and its surrounding land use and land cover types in the field. The free-availability of Landsat-8 and Sentinel-2 data provides the good opportunity to produce medium spatial resolution land products. Different classification methods together with Tasseled Cap Transformation (Brightness, Greenness and Wetness) and Normalized Difference Bareness Index (NDBal) used to explore the performance of Landsat 8 and Sentinel-2 data that acquired at 25th March 2019 and 26th March 2019, respectively. For the study, a test site which is surrounded by forest and farmland was selected in the northern Black Sea coastal part of mega city İstanbul. Field collected data and google earth data were used for the performance evaluation. The accuracy of classification results was evaluated in a comparative manner using error matrix. Overall accuracy and Kappa statistics were calculated to explore the performance of Landsat 8 and Sentinel-2 data with selected methods in the selected region.

Keywords: *Open Mining Area; Landsat 8; Sentinel-2; TCT; NDBal* ***S6.O37***

Improving the classification accuracy of hyperspectral images: An analysis of feature selection approaches

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Abstract

The recent years have witnessed development of advanced airborne and spaceborne hyperspectral imaging systems which are capable of acquiring images with high spectral and spatial resolutions. These data are valuable source of information which can be used to derive useful information such as land cover classes. The presence of hundreds of bands in the acquired images provides fine details which can help identify even small objects. Although, the hyperspectral data provides detailed information about objects of interest, yet in the presence of the high dimensionality of data, we may run the risk of overfitting our model. Such models may show optimal performance on the training data however, they usually fail to generalize well for the unseen data and ultimately show very poor performance on the test data. This problem can be addressed by applying feature selection approach whose goal is to select the most relevant features out of the all available features. In this paper, we focus on dimensionality reduction techniques for classification of hyperspectral images. We particularly compare the performance of principal component analysis (PCA) and independent component analysis (ICA) methods for feature selection. The subset of selected features are then used to classify the input images into different land cover classes. We tested our method on publicly available data set of Pavia city, Italy. The data was acquired by the reflective optics spectrographic imaging system (ROSIS)-03 airborne system. The ROSIS-03 sensor consists of 115 channels with a spatial resolution of 1.3 m. The data set consists of nine different classes, including trees, asphalt, bitumen, gravel, metal sheet, shadow, bricks, meadow, and soil. The results indicated that both feature selection methods were effective for the classification of the hyperspectral data into nine different land cover classes.

Keywords: *land cover classification; hyperspectral data classification; principal component analysis; independent component analysis*

S6.O38

A Low Cost UAV-PPK Method - Accuracy and Application

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Abstract

In recent years, the unmanned aerial vehicle systems (UAVs) have demonstrated significant potentialities with potential for applications in many fields. Mapping of inaccessible and dangerous territories through field study methods is a challenging task. Remote sensing techniques may provide an alternative solution to such tasks. Usually single GNSS receivers of consumer UAVs cannot deliver submetric positioning accuracy. Therefore, it is necessary to use Ground Control Points (GCPs), measured with precise GNSS systems for accurate geodetic positioning. The purpose of this study is to evaluate the accuracy and application of a PPK (Post Processed Kinematic method) solution used for accurate georeferencing of UAV images by post processing measurements from Global Navigation Satellite Systems (GNSS). For comparison of the PPK solution with methods using ground control points (GCP), a comparative analysis of the result of the study on the same test area by the two methods was carried out. Additional factors that can affect the accuracy of the final digital data (cloud points, digital surface models – DSM and orthophoto images) are also analyzed. Experiments with different camera models which are used, number of GCPs used, and different image resolution (different UAV altitude) were made.

For the purposes of this study a UAS Phantom 4 Pro was used. Its weight is approximately 1.4 kg and its diagonal size is 35 cm. The maximum flight duration is 28 min. Phantom 4 Pro comes with a 20 MP CMOS (Complementary Metal-Oxide Semiconductor) sensor with 1 inch (25.4 mm) size. The DJI camera uses a mechanical shutter that eliminates at maximum level the distortion that occurs at high flying speed. To experiment with the PPK method, a low-cost Emlid Reach M + single frequency GNSS receiver and a specially designed kit (SNAP-PPK) were used for installation of the receiver to the UAV.

Keywords: *UAV; Structure from Motion; low-cost system; Photogrammetry; PPK Method* ***S7.O39***

Assessment of Satellite Derived Bathymetry Data Usage in the Hydrographic Survey Planning Phase

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Abstract

Bathymetric data, needed to determine sea floor topography is obtained by the ship based SONAR as sound source method and aircraft based LIDAR as light source method. These active hydrographic survey methods present high resolution and accuracy but they are expensive and need relatively long survey time because they require survey hardware and field work. Satellite Derived Bathymetry, obtained in shallower waters than 30 meter by processing high resolution multi-band satellite images, increases its potential as a fast and economical remote sensing hydrographic data collection method, although it does not replace traditional survey methods at present. In this study, the determination of the Satellite Derived Bathymetry methods to be applied and evaluation with the relevant stakeholders is discussed. It will be useful to concentrate the survey line planning on shallows, shipwrecks or dangerous areas by using the Satellite Derived Bathymetry data for exploration purposes before the depth measurement studies to be carried out by the survey ships. The study is performed on the east coast of Saros Gulf with the 167 square kilometers sea area and the depths vary between 0-102 meters. Multi-band satellite image data obtained from the Landsat 8 satellite is processed with Geographical Weighted Regression method by i.image.bathymetry module in an open source GIS software. Calculated water depths compared with the updated navigation chart depths and the shallower areas marked and noted as areas to survey primarily. The results did not achieve the accuracy standards of the International Hydrographic Organization Standards for Hydrographic Surveys (S-44). It is considered to be helpful that the Satellite Derived Bathymetry data can be used for reconnaissance but not for chart production.

Keywords: *Hydrography; Bathymetry; Satellite Derived Bathymetry; Remote Sensing* ***S7.O40***

Visualization of Geospatial Point Clouds Through Virtual Reality System

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Abstract

State-of-the-art geospatial data acquisition tools and technologies, such as laser scanning and digital photogrammetry, are becoming widely used in a daily basis geodetic tasks, especially in construction and mining sites. They provide the ability to achieve high quality measurement performance and gain of large data sets for a particular object in the form of colorized point clouds. This, in turn, leads the desire to present geospatial information in a way that preserves its main qualities - high accuracy, realism and visibility. The standard visualization methods, like 2D map or even a desktop CAD software are limited on the basis of the complete sense of such a measured environment. At this point, visualization methods like virtual and augmented reality, as well as the holography, appear at the forefront to fulfill the expectation of the geospatial data received.

Virtual reality patiently waited for its moment to be accessible and useful in entering into a broad horizon of public tasks, such as those presented in the current publication - construction and mining. Its main characteristics - immersion, interaction and imagination, perfectly fit the requirements for such a difficult environment to be represented in a digital manner. It's not only with the full 3D perception, but also the possibility to interact with the site and track its lifetime circle. These capabilities are provided through the creation of a virtual environment of the measured site in a game engine, where all its properties are generated. This software technology provides the link between the acquired geospatial colorized point clouds and their visualization through a virtual reality system. This approach leads to visualization of the virtual environment even closer to reality.

Keywords: *Geospatial; Point cloud; Virtual Reality; Visualization* ***S7.O41***

Direct Geo-referencing of UAV images for Orthophoto Generation based on RTK GNSS Positioning

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Abstract

Aerial or satellite imagery technologies have conventionally been used as a data source for geographic data collection, surveillance, mapping, and 3D modelling issues. However, over the past decade, unmanned aerial vehicle (UAV) low-altitude remote sensing technologies are widely used as an effective, fast and inexpensive tool for creating accurate orthophoto maps. The accuracy and precision of orthophoto generated by Structure from Motion (SfM) photogrammetry tool based on UAV photographs depends on many parameters including camera/image quality, flight plan, SfM algorithms and geo-referencing strategy. Taking into consideration the advantages and disadvantages of using ground control points in orthophoto production, a process based on resolution, point density, accuracy, time, expertise and costs is required. On the other hand, conventional geo-referencing based on ground control points provides high accurate positioning but the geometrical accuracy critically depends on the number and spatial distribution of the ground control points. However, direct geo-referencing of the UAV images by using the high accurate positioning ability of Network RTK and Single Base RTK methods may overcome these limitations. Therefore, the automated extraction of control points by the double frequency GNSS receivers can be eliminate the need for ground control points especially for emergency mapping applications. The main purpose of the study is the investigation of the accuracy of orthophoto production without ground control points for mapping applications. In the study, Single Base RTK and Network RTK methods based on GNSS techniques were used during AUAV's flight for direct geo-referencing. 13 ground control points were placed homogeneously at the test area for the validation of the orthophoto accuracy generated by direct geo-referencing. The ground control points were measured with Network RTK method. The images were collected using a UAV and professional camera, at a flight height of 40 m above the ground. Analysis has been carried out in order to reveal the effect of the direct geo-referencing by Single Base RTK and Network RTK positioning methods on orthophoto generation in terms of accuracy and precision.

Keywords: *UAV; Orthophoto; GNSS; RTK* ***S7.O41***

Documentation of archeological sites with UAVs: A case study of Nikopolis ad Nestum in SW Bulgaria

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Abstract

With technology development in recent years, UAV (Unmanned Aerial Vehicle) surveys complemented by dense matching algorithms became an important method for the documentation and preservation of the natural and cultural heritage. The quality of derived products such as DSM, DEM, 3D model, 3d print-out, etc., and possibilities of their further use for archaeological applications are discussed in several scientific publications, mostly in the western literature. A low altitude UAV platforms allow to experiment with digital photographs and video documentation of the archeological sites, further exploration of the utility of high-resolution imagery (sub-metre to centimetre-scale), and image-based modelling to support the generation of point clouds, orthophotographs, and other derived products.

In this paper, a UAV-based 3D model of the late antique settlement Nikopolis ad Nestum, located on the territory of the village of Garmen, 7 km from Gotse Delchev in SW Bulgaria, is presented. The drone surveying is performed using DJI Mavic 2 Pro equipped with a CMOS Hasselblad 20MP 1" sensor at three altitudes to evaluate the quality of the output and their accuracy. After the flights, all photos are processed with the use of Pix4Dmapper Pro software. Dense point clouds, DEMs and orthophotomaps are generated and point cloud classifications are performed. Comparisons between three 3D models are performed and several issues regarding the aero-triangulation and dense matching results are discussed. Some recommendations regarding Level of Detail (LoD) of DSM/DEM for construction of a 3D-model of an archaeological site, especially for the presentation of small-sized details are outlined. The acquisition of UAV images of the Nikopolis ad Nestum archaeological site provides additional sources for analysis and understanding of the landscape changes; allows an assessment of the monument's status and complements the illustrations of the preserved ancient city in Bulgaria, the only one in the Rhodopes from the Roman period in the Balkans.

Keywords: *Unmanned Aerial Vehicles; Image Classification, Digital Elevation Model, Archeological Applications, Nikopolis ad Nestum* ***S7.O43***

Comparison of different deep learning based face recognition systems

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Abstract

Face recognition systems are widely used in the fields of security, criminal identification, advertising and marketing. Nowadays, with the development of deep convolutional neural networks, significant success has been achieved in face recognition systems. One of the most important steps in the face recognition systems is the determination of loss functions. Loss functions directly affect facial features embedded in the Euclidean space during training. Euclidean distance is expected to be minimum in face image of the same person unlike in the different faces. Therefore, it is critical to determine the optimal loss function. Another factor which directly affects the success of face recognition systems is face detection. Accuracy and reliability of face detection has vital importance for extracting of facial features.

In this study, the performance of FaceNet, ArcFace and RetinaFace face recognition deep learning models in different face data sets such as VGGFace2, DeepGaze Head Pose Estimation (DGHPE) and Dataset Zoo were examined using “Transfer learning” technique. The multi-task Cascaded Convolutional Networks (MTCNN) deep learning architecture was used to determine the face frame coordinates in the images. The obtained results have been analysed and optimum conditions and image set structures were investigated to obtain better results. In cases where low accuracy was obtained, the images were analysed. The images caused low accuracy were removed from the related data set.

As a result, 86% accuracy was achieved in the DGHPE dataset by integrating FaceNet and MTCNN architectures. 97% accuracy was obtained by integrating ArcFace and MTCNN for the same dataset. In addition, Dlib Correlation Tracker has been used for GPU performance optimization to accomplish real-time face recognition.

Keywords: *Deep learning, transfer learning, face recognition, face detection* ***S7.O44***

Accreditation in Geomatics Engineering: lessons learned

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Abstract

Continues improvement strategies, leaned from industry, strongly influences engineering education, where several aspects are open to debate. This study briefly reports on experiences gained through the process of quality assurance within Geomatics Engineering in Turkey that could be also useful for other potential candidate geomatics engineering programs. The quality assurance efforts of Istanbul Technical University (ITU), Geomatics Engineering begins officially in 2000, where the program is accredited by the Accreditation Board for Engineering and Technology (ABET) since 2005. The latest accreditation visit by ABET took place in 2017 and the program received full six year accreditation until 2023. According to ABET search engine for accredited programs, the Geomatics Engineering Program of ITU is the only international program that is fully accredited. These efforts and other higher engineering education policies of Tukey, influenced other Geomatics Engineering Departments of universities in Turkey, where benefits and challenges of the accreditation process are widely discussed. The background information and challenges are briefly described, where the implemented solutions and lessons learned are presented. The continuous improvement cycle deployed by the department is introduced, where implemented assessment methods are discussed. Within the Quality Loop of the Department, two cycles are defined being; fast and slow. The fast cycle, three years loop, is used for major improvements on program outcomes, where the slow cycle is for educational objectives. The duration of the slow cycle is six years. In order to measure the degree of achievement, the department has introduced two groups of assessment being direct and indirect. Direct methods are proof-based, exit interview, focus group and the selection examination for the professional posts in public organizations. The indirect methods are lecturer survey, course evaluation by students, internship surveys, alumni and employer survey. Several inputs regarding the Geomatics Engineering program are also collected during the advisory board meetings, academic board meetings and “student forum” and evaluated as direct input from the constituents. The optimization possibilities of the described strategies and further steps for continuous improvement cycle are provided, where lessons learned from all these efforts are presented.

Keywords: *quality, engineering education, standards, continuous improvement, assessment techniques*

S8.O47

Project CABARET – WP7 Educational Development and Deliverables

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Abstract

The **CABARET** (**C**apacity **B**uilding in **A**sia for **R**esilience **E**duca**T**ion) Project is funded by the European Union under the Erasmus+ program, to foster regional cooperation for more effective multi-hazard early warnings and increased disaster resilience among coastal communities. The goal of the Project is to strengthen the evidence-base in support of the implementation of the new framework. The participants constructed of a consortium of 14 European and Asian higher education institutions from nine countries - four from Europe and five from Asia. The Project covers three years period and intend many meetings among participants for data and knowledge exchange. The MGU and MNU participation are active as co-chairs of the WP7 – "Learning and teaching tools methodologies and approaches to the MHEW (Multi Hazards Early Warnings) and sustainable development of the resilience. The progress and achievements of the WP7 co-chaired by MGU and MNU are presented and the developments of MOOC's (Major Online Open Courses) are under discussion. The intended deliverables include: MOOC's, Educational Platform development, Manual for use, Implementation actions, Students and wider public presentations about MHEWS, International educational cooperation among partners, Sandpit events, Promotions, etc. The Project CABARED is going to finish soon and the newly obtained results and developments need approval by all the partners and participants for the common sake.

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Keywords: *Project CABARET; WP7; MOOCs; deliverables* ***S8.O48***

Review and Analysis of Best Practices for Creating Geoportals

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Abstract

In recent years, there has been a growing interest and activity in developing and using websites that provide access to geographic content. Access to spatial data, observations and analytical results from a variety of sources facilitates interdisciplinary and exploratory research, analysis and decision-making, and the resolution of geospatial problems. This is achieved through the development of the World Wide Web (WWW) and Geographic Information Systems (GIS). Geographic portals are a response to this need to disseminate geographic data and leverage significant GIS investments in GIS capabilities and content. Access, dissemination and share of geographic information are the core objects of any spatial data infrastructure (SDI) project. Spatial data infrastructures (SDIs) are an interoperability constituent for spatial data management at national, regional and local level.

Geoportal is "a system for accessing spatial data regardless of location, format and data types"(ESRI, 2013). The Open Geospatial Consortium (OGC) defines Geoportal as "the human interface for collecting online spatial data sources, spatial data sets and services together" (OGC, 2004). With the development of web services, the implementation of SDI has been increasingly successful in accessing and sharing data. Geoportal is an input to SDI systems. As Geoportal systems represent a bridge between data producers and users through web services, they are the visible interface through which the requirements of SDI systems are met. Geoportals act as data collectors that provide a single point of access to different sources of information. They play an important role in the form of entry points that serve to discover, visualize and retrieve data and services that make up the geospatial network.

There are different capabilities and architectures for developing and implementing geo-portals:

- Geoportal architecture - OGC implementation
- Geoportal architecture - ESRI implementation
- Geoportal architecture - Open access implementation
- Etc…

The main purpose of the elaboration is a description of the different realizations, perform a comparative analysis, note and highlight the benefits of each.

Keywords: *GIS; SDI; Geoportals* ***S8.O49***

VR Technologies in Geospatial Education

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Abstract

Virtual reality (VR) is an interactive computer-generated simulation of a real or fictional environment. This term, that is widely used nowadays, has history dating back to the 1960s. Since then different types of virtual reality have been defined. This requires to outline what exactly is meant by this term in the current paper and where its place is in comparison to the other 'realities'.

During the last decade VR, traditionally associated with video games, is gaining a contemporary increasing popularity in other divisions including education and engineering. On one hand, it is investigated the role of computer simulations and gamification in modern education, how these improve teaching results, what are the strengths and the problems. On the other hand, it is studied how this technology is currently implemented in engineering and geospatial science and workflow in particular and how this could be developed in future. The study on the available practical examples is supplemented by analysis of the measurement tools and the data appropriate for rendering a real-world simulation.

The available technical solutions on the market are reviewed in terms of building up a VR laboratory. The hardware classification, including VR visualization tools like head-mounted displays and CAVE automatic virtual environments, is defined by properties like a degree of immersion and affordability. Regarding to software, a subject of interest are game engines which main characteristics are presented in the paper. Bearing in mind the possible options for future development and extension of a system it is proposed a solution for the needs of geospatial education.

Keywords: *Virtual Reality; Geospatial; Education* ***S8.O50***

Energy Performance Certificate for Buildings: an Opportunity to Establish Building Energy Information System Integrated with Cadastral System in Turkey

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Abstract

Growing population and economic development in cities causes increasing energy consumption. This disregarded consumption has adverse impacts on environment and national economies such as; climate change and high expenditure for the energy. In this regard, energy efficiency has become important subject that is urgently required to deal. In world cities, building sector is responsible for 36% of global final energy consumption and about 40% of total CO2 emission. In the last two decades, policies on energy efficiency in residential buildings have been regulated by European Union. European Directive 2002/91/EC on the Energy Performance of Buildings (EPBD) was the main legislative regulation in order to improve the energy efficiency of European building stock. According to EPDB, The Energy Performance Certification for Buildings (EPC) became mandatory for European countries. Energy certification is a series of operations that is put forward to determine the energy saving potential, energy consumption and CO2 emission of buildings. Some of the European countries have been begun to establish their own national energy certificate database. In this context, many legislations were also made in Turkey based on the EU Directive. By the impact of energy efficiency policies, government aims to reduce energy intensity about 20 % by 2023 in reference to 2011. EPC activities started on January 1, 2011. National calculation model is used to evaluate the final energy consumption and related CO2 emission of buildings via the BEP-TR2 software. The EPC is the mandatory requirement for obtaining Building Occupancy Permit in Turkey. In addition, EPC is required during the stages of the purchasing, selling or leasing buildings. EPC is the opportunity of good and reliable data for establishing energy information system integrated with cadastral systems. Spatial planning and energy efficiency activities should be carried out together in order to achieve sustainable development. EPC information should be integrated with other data sources such as cadastre, geographical data and atmospheric data. Spatial analysis should be enabled to apply on EPC data to monitor current condition and to make effective and feasible decisions. In this study, legal context and technical procedures for energy efficiency of building in Turkey are explained and possible effects of EPC on construction sectors are examined in Turkey. In addition, technical developments for collecting and evaluating data for the energy consumption are overviewed. Lastly, a methodology for integration of EPC data into the cadastral system is suggested. This study aims to present how to integrate energy performance data of buildings into the cadastral systems.

Keywords: *energy consumption; CO2 emission; energy efficiency; energy certification of buildings, cadastre, urban planning*

S9.O51

GIS Application for Water Company Needs

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Abstract

The process of designing and implementing digital models (or GIS) for underground network infrastructure and facilities (UNF) includes a number of activities related to the analysis of source data and materials to identify objects, pre-processing the initial information, creating spatial database and development of relevant graphic (maps) and text (registers) materials.

Nowadays, every organization needs to be flexible and able to respond timely and adequately to the changes that occur in a complex and dynamic external environment. The paper proposes an approach for the design and development of a geoinformation system (GIS), through the capabilities of modern software of part of the water supply and sewerage network for the needs of Water Supply and Sewerage Berkovitsa LTD, Berkovitsa.

The developed GIS has the ability to:

• Working with geometric primitives - creating, deleting, editing and manipulating geometric primitives;
• Creating and maintaining a spatial database;
• Input and output of information from and to different vector and raster formats;
• Modeling - creation of spatial and non-spatial object classes with different geometric and attribute characteristics;
• Defining relationships and dependencies between object classes;
• Quick and easy creation of objects from the environment of the user interface through pre-prepared forms (templates);
• Performing spatial analyzes;
• Visualization of the spatial information according to the needs of the user;
• Generate reports (registers) for database objects through pre-created forms.

This article is a part of master thesis.

Keywords: *GIS; underground pipeline infrastructure and facilities; restriction zones; digital models; specialized maps*

S9.O52

Landuse/Landcover Change with CORINE Data: Case of Turkey

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Abstract

Land use and land cover have been in a state of continuous change since the onset of human impact on the earth. Land use, like everything else, is changing rapidly in today's world. Therefore, methods and projects have been developed to monitor and evaluate changes in land use in order to prevent the negative consequences of uncontrolled continuation of this process. Corine (Coordination of Information on the Environment) is an environmental monitoring project conducted under the Copernicus Project. Corine was designed primarily to produce a land use map for all member countries, to create a standard database and to guide environmental policies. In this study, land-use changes of Turkey were analyzed using Corine data in four main land use categories including urban areas, agricultural areas, forest and natural areas and wetlands and water bodies. The land use change among different years was evaluated in GIS environment. The result of landuse/landcover change analyses indicate that, the changes related to urban occurred due to population, tourism and industrial activities. Additionally, built of dams played an important role at wetlands and water bodies' changes.

Keywords: *Land use, Land cover, CORINE, GIS* ***S9.O53***

Analysis of GNSS Satellite Visibility According to the max(GDOP) Criteria for the Region of Turkey

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Abstract

Global Navigation Satellite Systems (GNSS) provide globally the geospatial positioning needs. The GNSS systems mainly consist of four independent satellite systems, namely, GPS, GLONASS, GALILEO and BeiDou. The reliable positioning capability with GNSS satellite systems is related to the number of visible satellites and their distribution in the space. Therefore, the contribution of the use of GNSS satellite systems together has been discussed in many studies as multi-GNSS.

In this study, the use of the GNSS systems for Turkey and its immediate surroundings has been examined. The utility of GNSS satellite systems in the worst visibility situation was identified according to the GDOP value with 10 degrees elevation for GPS, GLONASS, GALILEO and BeiDou in their ground truck period to test which system is individually enough for positioning.

The GDOP estimation performed use of each satellite systems precise orbit data. The process achieved by in house Matlab program developed in this project. The region selected for covering Turkey district. The selected region border limit is (11°-47°) north latitude and (12°-60°) east longitude. The grid size of the region selected as 3°x3°. The GDOP value estimated for each satellites system ground track period in five minutes interval for each grid point.

It was observed that the GPS system fully met the expectations. Others were found to be insufficient in their ground truck period. The second simulation performed for pairs of satellite system combination except GPS. The combination uses of GLONASS/GALILEO, BeiDou/GLONASS and GALILEO/BeiDou was analyzed to find out which combination is performing. The results are intensely discussed in this study.

Keywords: *GNSS; GDOP; Satellite Visibility; Ground Truck Period* ***S10.O54***

Analyses on High Resolution Global Digital Terrain Model Qualities and Their Use in Gravity Reductions

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Abstract

DTMs (Digital Terrain Models) are widely used in various applications from different disciplines which are mainly geodesy, geophysics and geology. In geoid determination, gravity anomalies are essential. Gravity of a point on Earth is affected by the topographic masses around it. In order to remove the attraction of these topographic masses, TC (Terrain Correction) calculations are made and TCs are applied to gravity reductions. DTMs are commonly used for computing TCs. This study mainly aims to determine an optimal DTM resolution for TC calculations and see the effects of TCs, which are derived from different resolution DTMs, on geoid. The DTMs that are used in this study are SRTM (1″× 1″, 3″× 3″ and 30″× 30″), ASTER GDEM2, AW3D30, TSYM3, EU-DEM, GTOPO30, GMTED2010 (7.5″× 7.5″ and 30″× 30″) and HGM DTED-2 for the selected area of Turkey. Different global and regional high resolution DTMs are compared with each other. The DTMs are tested with GPS/leveling data and compared with the national vertical datum (TUDKA99A), the regional geoid model (TG99A) and the global geopotential models (EGM96 and EGM2008). TCs are computed by using different resolution DTMs (1″× 1″, 3″× 3″, 30″× 30″, 1′× 1′, 2.5′× 2.5′ and 5′× 5′ HGM DTED-2) with the same integration radiuses. Then, TCs are calculated with different integration radiuses for the same resolution DTM. The effects of TCs on geoid, the indirect effects on geoid and geoid undulations are calculated by using different resolution DTMs. Geoid undulations are tested with GPS/leveling data. Since the TCs from 1″× 1″ and 3″× 3″ resolution DTMs do not show significant differences in statistics and do show a significant difference in processing time, using 3″× 3″ DTM instead of 1″× 1″ DTM would be beneficial for obtaining same results in a shorter time. It is concluded that using the desired integration radius as outer radius rather than inner radius saves a lot of time in the TC calculation process. The statistics of the indirect effects on geoid are almost the same. Therefore, it can be deduced that the main factor which causes the changes in geoid undulations is the effect of the terrain corrections on geoid. It is seen that the amount of differences between the calculated geoid undulations and the GPS/leveling geoid undulations vary between 0 and 0.058 cm for different resolution DTMs and are not considerable.

Keywords: *digital terrain model; terrain correction; gravity reduction; geoid modelling* ***S10.O55***

Assessments on Temporal Variations of Earth Gravity Field with GRACE Observations Using Different Computation Services

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Abstract

Water is one of the most important needs of human life and plays a very important role in maintaining a healthy life. Nowadays, because of reasons such as global warming, water resources are under threat. Hence, humanity may face such a problem as water scarcity. Therefore, continuous monitoring and control of the water resources is necessary and essential, but since water basins are very large areas, it is difficult and expensive to carry out these observations using ground-based measurements accurately. In addition, these analyses are possible using satellite gravimetry.

The gravitational field of the Earth continuously changes depending on time, and the redistribution of the water reservoir, which makes up three quarters of the globe, play vital role for gravitational field of the Earth. The vertical variation of these water bodies distributions can be investigated using the GRACE satellite pair, launched in 2002 by NASA. There are 4 different types of GRACE data and several analysis centers that provide and evaluate these data. Based on these, the problems come into minds such as how to model GRACE data and which GRACE data product must be used for more precise analyses and predictions. In addition, the interfaces or applications in which this data will be compiled is a separate problem and will be considered in this study.

In the study, the Euphrates / Tigris basin, which is located between 30°-40° north latitudes and 37°-52° east longitude, is selected as the study area, and the Equivalent Water Thickness(EWT) based on these mass changes is calculated with GRACE (Gravity Recovery and Climate Experiment) satellite gravimetry data. The study was conducted in 3 different interfaces (applications): IGiK-TVGMF, EGSIEM Plotter and ICGEM. Common data set must be selected to investigate the differences between the results obtained in these different interfaces. In this context, Level-2 GRACE product with the DDK5 filtered was chosen, which was published by Astronomical Institute of the University of Bern (AIUB).

Keywords: *Earth gravity Field; Temporal Variation; IGiK-TVGMF; EGSIEM; ICGEM* ***S10.O56***

Precise Orbit Determination (POD) of LEO Satellite Missions

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Abstract

Low Earth Orbiters (LEO) are orbiting satellites at an altitude of 200 and 2000 km above the earth, such as GRACE, SWARM, SENTINEL satellites. The orbits of these satellites rotating the earth need to be precisely determined for geodetic purposes. Precise orbits of a LEO that is equipped with a GPS (Global Positioning System) receiver can be determined by GPS observations. There are two main models of POD: kinematic orbit determination and reduced-dynamic orbit determination. Kinematic orbit determination of a satellite depends on getting three-dimensional coordinates on GPS observations without considering the external forces acting on the satellite. The result of the kinematic solution is discrete and has data gaps. Reduced-dynamic orbit determination takes external forces into account in position models of satellite. Although this study mainly focused on kinematic orbit determination, both two models that are introduced were produced. In this study, POD of one-day SENTINEL-1, SENTINEL-3 and SWARM-A were performed. The processing strategy depends on precise point positioning (PPP) technique and zero-differenced LEO GPS data. The PPP technique is a zero-difference processing in which satellite final orbit, clock information, and biases are introduced in solution equations. The process was carried out for each satellite in Bernese GNSS Software version 5.2 that is GNSS (Global Navigation Satellite System) data processing software for geodetic purposes improved by University of Bern. In the term of POD, it is possible to process LEO data manually or automated Bernese PCF (Processing Control File) mode. In the process, CODE (Center for Orbit Determination in Europe) final products that are GPS final orbit and clocks were used. The main results of process are Kinematic and Reduced-dynamic orbits of each satellite in 10s sampling. When SENTINEL-1 and SENTINEL-3 results is compared to ESA (European Space Agency) solution, the difference in results is in mm level. On the other hand, SWARM-A satellite results have 10-15 cm difference compared to Astronomical Institute of University of Bern solution. Due to the lack of antenna phase center corrections of GPS receivers on swarm satellites and specific satellite information, they could not be used in this process. It can be stated that it should be evaluated in further researches whether these differences result from indicated situations for SWARM satellites.

Keywords: *Precise Orbit Determination; POD; LEO; GPS; Bernese; SWARM; SENTINEL* ***S10.O57***

Creation and Use of Digital Territory Models

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Abstract

The issues related to the creation and use of digital (computer) territory models, are extremely important in solving a number of problems in the field of urban and extra-urban territorial development, cadastral and thematic maps, architecture, engineering geodesy, cartography and in all areas of investment design. The article examines issues related to the nature of digital territory models (DTM), their content and identifies certain problems in their use for specific practical purposes, as it points out appropriate solutions to these very same problems.

Keywords: *Digital Territory Model, graphical and attribute database, graphic system, application program*

SP.P01

Ecological Monitoring with Multispectral Images

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Abstract

One of the biggest advantages of remote sensing is the ability which they provide for receiving information based on images, made in different spectral diapasons of the spectrum. Along with traditional frequencies of visible light to which correspond monochromatic and color images, continuously is growing and improving the usage of channels in ultraviolet, infrared and thermal zones from the spectrum. In this paper is made research about distribution of vegetation indices onto multispectral images. For this purpose, is used color infrared image, from which based on mathematical operations with spectral brightness of pixels are calculated different vegetation indices as normalized difference vegetation index and normalised difference water index. In conclusion, can be said that multispectral images can be used to define vegetation indices and researching the condition of vegetation itself.

Keywords: *electromagnetic spectrum, multispectral images, ecological monitoring* ***SP.P02***

Evaluation of Covariance Determination Procedure Using GOCE gradient data and Least Squares Collocation

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Abstract

Least Squares Collocation has been used in various fields of geodesy and geodynamics since 1963 when Kaula proposed a stochastic aspect of LSC in earth's gravity field determination for the first time with one of the first appearances in literature given by Krarup (1969). The most controversial part of the LSC is the covariance function which computes the correlation between different parameters involved within the procedure. The common way of determining the covariance function involves two steps: calculation of an empirical covariance function (ECF) and then fitting an analytical covariance model (MCF) to it under some assumptions, the expectation of the anomalous potential is equal to zero and the independency of the covariance function to spatial position and direction which are quiet violated in reality, especially in Iran with rough topography. In this study, the long-wavelength and topography/bathymetry effect have been removed from the radial in-orbit GOCE gradient data and then the ECF has been created by these reduced data based on Remove-Restore technique. GOCE observations do not have a well-distribution data on the ground and this is an additional barrier to estimate and fit ECF to MCF. So, to enhance the covariance determination, the effect of smoothing and averaging of the residual GOCE gradient has been analyzed. To make the assessment of the covariance determination possible, the residual vertical gravity gradient was divided into two datasets namely, observation and control points. The observation points served as an input data within the LSC procedure using Tscherning – Rapp covariance model and the control points used to evaluate the accuracy of the LSC gravity gradient predicting and then the covariance estimation. The results of this study show that the merely geometrical fitting of the ECF to MCF which resulted from the covfit module of the GRAVSOFT could not give the proper result. So, it is necessary to consider the distribution of the data and the non-stationarity and anisotropy of the covariance model.

Keywords: *Covariance determination; GOCE gradient; Least Squares Collocation; Remove-Restore*

SP.P03

BalkanMed Real Time Severe Weather Service: Progress and Prospects in Bulgaria

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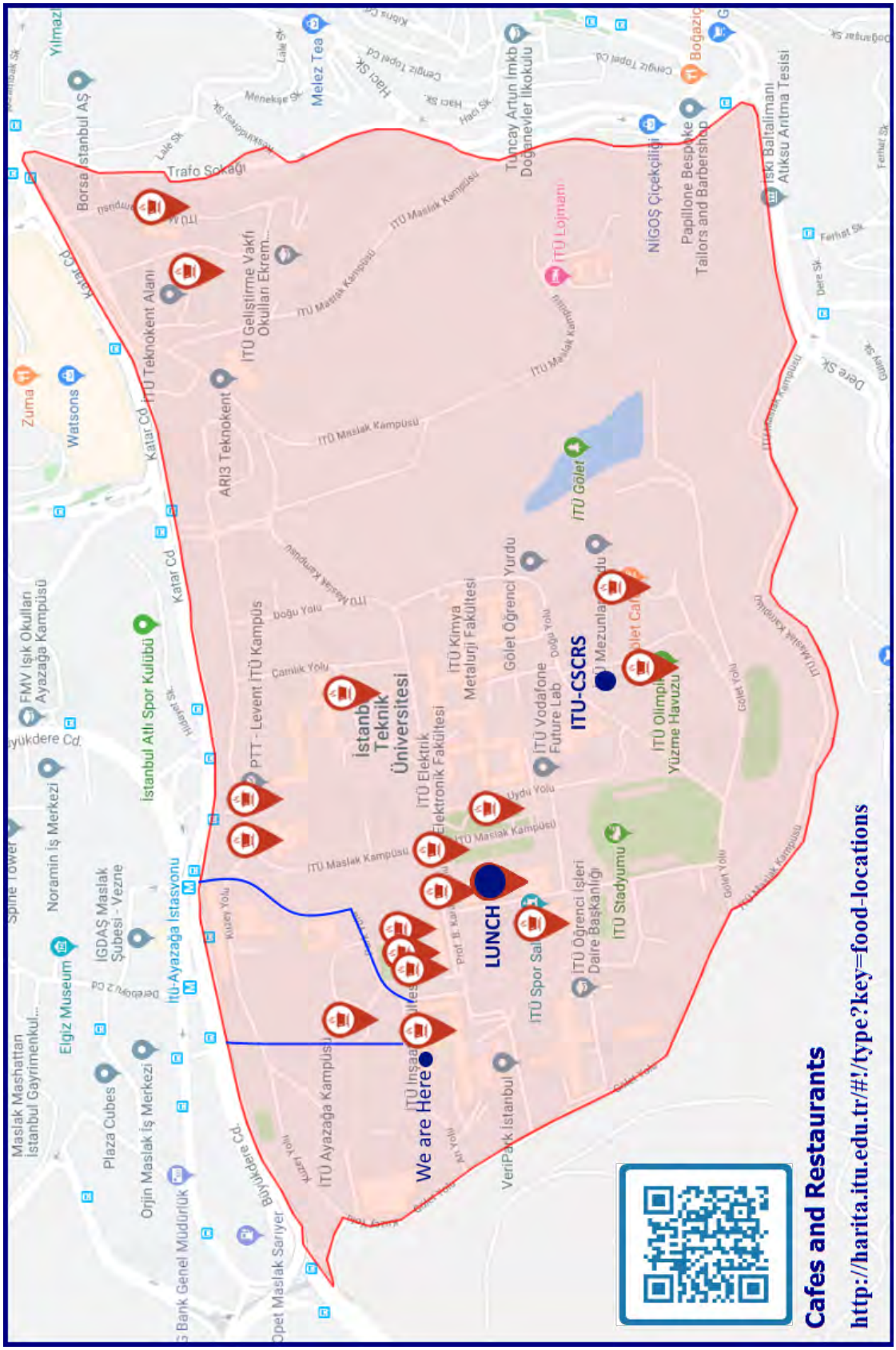
Abstract

Main objective of the "BalkanMed real time severe weather service" (BeRTISS, 2017-2019) project is to establish a pilot transnational severe weather service by exploiting Global Navigation Satellite Systems (GNSS) tropospheric products to enhance the safety, the quality of life and environmental protection in the Balkan-Mediterranean region. In Bulgaria severe weather events (intense precipitation, hail and thunderstorms) are common in the summer months and are associated with large economic losses for example in agriculture. The Bulgarian Hail Suppression Agency and the Sofia University are partners in the BeRTISS project with final aim to develop the Bulgarian Integrated NowCAsting tool (BINCA). BINCA will use data from the recently deployed ground-based GNSS network of 12 stations in Bulgaria. The GNSS, weather radar as well as surface atmospheric observation will be combined with the Weather Research and Forecast (WRF) model simulations covering Bulgaria. BINCA will provide products in near-real time on a publicly accessible web platform to facilitate the operational tasks in hail suppression in Bulgaria but also other operational and public services. In this work the BeRTISS progress and the future work in Bulgaria are discussed.

Keywords: *weather service; troposphere; GNSS; near-real time, weather forecast* ***SP.P04***

Note

Venue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