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Editors
Karol Daliga
Dominika Wróblewska
Jakub Szulwic

Photography
Karol Daliga
Dominika Wróblewska

Cover design
Karol Daliga
Dominika Wróblewska

Editors and Publisher
Gdansk University of Technology
Faculty of Civil and Environmental Engineering
Department of Geodesy
Narutowicza Str. 11/12
PL-80-233 Gdańsk
tel. (+48) 58 347 10 12
fax (+48) 58 347 13 03
bgc@geomatyka.eu
www.wilis.pg.edu.pl
www.bgc.geomatyka.eu

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Abstracts of papers send for 2017 Baltic Geodesy Congress (Geomatics) - as of 25th May, 2017.

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4D RECONSTRUCTION AND VISUALISATION OF KRAKOW FORTRESS (0108)

Beata Hejmanowska*[1], Ewa Glowienka[2], Piotr Opaliński[3], Sławomir Mikrut[4], Krystyna Michalowska[5], Pitor Kramarczyk[6]

The specific aim of the European project Cultural Heritage Through Time (CHT2), reported in this paper is fully integrate the fourth dimension (4D) into Cultural Heritage studies for analyzing structures and landscapes through time. Krakow – the Fortress City (Poland) is the one of four case studies of the CHT2 which, are used for the time varying reconstruction, analysis, visualization and safeguarding. The goal of the project is produce time-varying 3D products, from landscape to architectural scale, to envisage and analyze lost scenarios or visualize changes due to anthropic activities or intervention, pollution, wars, earthquakes or other natural hazards. The results of the case studies will be the basis for web-publication.

The Krakow Fortress is a UNESCO site built in 19th century, during the Age of Partitions, by the Austro-Hungarian Empire which decided to transform Krakow into a fortress city in order to defend it from another partitioner of the Polish land - the Russian Empire. Nowadays, the majority of the erected fortifications are forgotten and neglected, some are destroyed and only few are restored and visible.

Selected objects belong to I and V Circuit Defence. It was the sector with the greatest strategic importance in Krakow Fortress because of its proximity to the Russian border. Within the study objects of Fortress were divided into three categories: I. Fortifications of the most interesting in terms of military significance and architectural form, II. Fortifications important, III. Fortifications other. The time-varying material useful for the project activities was identified in collaboration with the heritage experts and associate partners involved in the project. All available data which might be interesting for 3/4 D presentation were implemented. For the selected objects archival data are collected, mainly historical plans, maps, photographs etc. Historical 3D models were prepared in CAD software from the scanned plans with assistance of the specialist, experienced with the Cracow Fortress history. The spatial data: maps, orthophotomaps, Digital Terrain Models (DTM) were obtained from Poland the Main Office of Geodesy and Cartography (Główny Urząd Geodezji i Kartografii GUGIK). New registrations were also performed in 2016 using Terrestrial Laser Scanning (TLS) Z+F IMAGER® 5010C, 3D Laser scanner and Unmanned Aerial Vehicle (UAV) Phantom 3 Professional DJI. All new collected data were automatically processed in Agisoft PhotoScan software. The next stage of research is to prepare 4D data for publication on websites and creating a geoportal, where

[1] AGH University of Science and Technology, Krakow, Poland, e-mail: galia@agh.edu.pl
[2] Kielce University of Technology, Kielce, Poland, e-mail: eglowienka@tu.kielce.pl
[3] Historical Museum of the City of Krakow, Krakow, Poland, e-mail: p.opalinski@mhk.pl
[4] AGH University of Science and Technology, Krakow, Poland, e-mail: smikrut@agh.edu.pl
[5] University of Agriculture in Krakow, Krakow, Poland, e-mail:k.michalowska@ur.krakow.pl
[6] AGH University of Science and Technology, Krakow, Poland, e-mail: gorgany100@o2.pl

available 3D/4D data will be integrated and properly visualized.

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Key words: Cultural Heritage, time-varying 3D models, 4D, Fortifications, Laser Scanning, UAV

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A COMPARISON OF HOUSING PRICES CALCULATED THROUGH FLOOR PREMIUM AND HOUSING PRICES CALCULATED THROUGH VALUATION REPORTS (0104)

Birol Alas[1]

According to the current Turkish legal regulations regarding shared property, floor premiums are used in the calculation of the land share allowed to each independent unit to the plot on which the apartment building was constructed, proportional to the unit's location and size. Another area where floor premiums are commonly employed is related to the prices of the apartments in a housing project by taking their varying features into account. When it comes to housing pricing, particularly when housing estates are concerned, determining price differences based on varying features is an important aspect. These price differences which are known as floor premiums (şerefiye payları) are calculated differently by various persons and bodies via a selection of methods. The consequences of these differing methods can be observed in the calculations made and reports prepared by engineering offices, law offices and universities. In fact, there are no standard ways to specify the impact of the features of independent units, thus the preference of different parameters by different researchers, it is difficult to make a fair and accurate valuation. First of all, one has to find out whether floor premium adjustments in housing prices are necessary at all. If the current valuation procedures provide a result compatible with the market conditions, then it will not be necessary to make floor premium adjustments. One way of figuring out the answer to this question is to examine whether various features of apartments have any impact upon their sales prices in the free market. Another way is to make a comparison between the prices with floor premium rate adjustments and those without them by employing the relevant statistical techniques in order to determine if there is a significant difference between the two. This paper addresses the question whether floor premium rates calculated through various features of an apartment have a meaningful effect on housing prices. Thus, parameters thought to influence housing prices have been weighted to find out the prices of all available apartments in a housing estate, the total cost of the project being unchanged, and these prices have been compared to those derived through valuation reports. Prices of the valuation report have been obtained through comparison with similar units, and the impact of three other criteria, namely the location of apartment, its geographical direction, and the availability of elevator have been considered. Analyses show that there is a significant difference between the prices of apartments when calculated through floor premiums and those of apartments when established as a result of an evaluation report.

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Key words: Estimation, Cost benefit analysis, Statistical analysis

[1] Okan University, Vocational School, Kadıkoy, Istanbul, Turkey, e-mail: birol.alas@okan.edu.tr

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A METHODOLOGY FOR MAPPING AREAS POTENTIALLY UNSTABLE. APPLICATION TO THE REGION BEJAIA. ALGERIA (0004)

Hocine Bendadouche*[1], Merabet Smail[2], Kaddour Khammoudj[3]

Planted on land made of hillsides, the coastal town of Bejaia is subject to many landslides. Observations show that these events are due to an excessive overload of the land, the presence of water and poor soil quality. To minimize the socio-economic impact of the landslide, we opted for a GIS (geographic information systems) as a tool for decision support on the choice of assignable building-sites and preventive measures to reduce risks.

A first database was compiled from existing documents, surveys and a campaign investigation of the soil. Various existing maps (topography, geology, settlements ...) are digitized and organized in the GIS to be superimposed on each other. It is very easy to understand the spatial organization of different objects. The purpose of this paper is the mapping of various instabilities and their ranking according to degree of potential. This method was applied to the agglomeration of the city of Bejaia (Algeria) known for its humid climate, rainy and densely populated. Thus, a map of intrinsic vulnerability and thematic maps have been established for the said town using a Geographic Information System (GIS). The interest of this work is that it provides a tool for the decision on the choice of preventive measures to reduce the risk of landslides. It provides an accessible tool to the authorities of Bejaia as basic elements to develop an integrated land management in relation to natural hazards in order to reduce the number of victims and reduce economic losses.

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Key words: lithology, evaluation, instability, cartography

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[1] Laboratory Engineering Construction Architecture University A. Mira, 06000 Bejaïa, Algeria, e-mail:bendadouche@yahoo.fr
[2] Laboratory of Applied Hydraulics and Environnement, University A. Mira, 06000 Bejaïa, Algeria, e-mail merabetsmail2003@yahoo.fr
[3] Laboratory of Applied Hydraulics and Environnement, University A. Mira, 06000 Bejaïa, Algeria, e-mail : khemmoudjkaddour@yahoo.fr

A NOVEL APPROACH OF LASER SCANNING POINT CLOUD QUALITY ASSESSMENT USING WAVELET ANALYSIS (0027)

Anna Fryskowska*[1]

3D point clouds are essential sources in acquiring information for many applications such as cultural heritage protection/restoration, building information modelling and management or architectonic documentation. The quality of TLS point clouds is very important in such applications because of its completeness, and structural information capacity. With a growing demand on photogrammetric products accuracy, point cloud quality assessment has become more and more important topic. The goal of point cloud quality assessment (PCQA) is to define its inner accuracy and the discrepancies between point cloud and reference data. There is several statistical method for 3D point cloud quality evaluation, some of them are presented in [1, 2].

In this paper a novel point cloud quality assessment method is presented on the basis of hypothesis that wavelet analysis enables distinguishing artefacts in unorganized data set [3]. The mail factor influencing on the point cloud quality is noise. Noise is present for example around the sharp object's edges. Other artefacts could be caused by high incidence angle, long distance to the object or building material with unfavorable albedo. Wavelet transform was used in point cloud processing, for example in [4], and could be a good tool in quality analysis.

Proposed approach can be investigated in two ways: global and local analysis. In local approach, point cloud have to be divided into sub-regions representing particular artefacts. Then, points are processed as a multiresolution XYZ signal or as a 1-D independent signals for each coordinate. Then, several features of given point clouds are extracted in a wavelet domain. Approximations and details at different decomposition levels are processed. The extracted features are then compared to natural ideal representation of the object (edges - lines, walls - plains etc.). In this step decomposition coefficient are analyzed for searching noise and other discrepancies in point clouds in local regions. In research, different wavelet families and decomposition levels have been examined. As a result adequate form of signal (1-D or 3-D) as well as appropriate wavelet and decomposition were assigned to each artefact. The results were compared to other point clouds quality metrics and reference data.

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Key words: accuracy, wavelet transforms, measurement by laser beam, quality

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[1] Military University of Technology, Faculty of Civil Engineering and Geodesy, Department of Remote Sensing, Photogrammetry and Imagery Intelligence, Kaliskiego str. 2, Warsaw, Poland anna.fryskowska@wat.edu.pl

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A NOVEL METHOD OF CHROMATIC ABERRATION DETECTION AND CORRECTION USING WAVELET ANALYSIS (0037)

Anna Fryskowska[1], Michal Kedzierski[2], Michalina Wojtkowska*[3], Aleksandra Grochala[4]

Wave-length dependent imaging errors of the optical components and different characteristics in colour channels yield various geometric errors of the RGB image. Chromatic aberration has a very large direct impact on the quality of a digital image correlation and indirect on the geometry of the image. [1] This is particularly important when recording black and white images on the RGB array. Modern professional digital cameras are free from chromatic aberration, but it is still present in the low-cost cameras, increasingly used in UAV applications and modern photogrammetry [2 - 4].

In the paper a novel method of detection of chromatic aberration with the use of wavelet analysis has been proposed. The preliminary objective of the following empirical tests was to investigate the detection of chromatic aberration in an image for specific test filed images using wavelets. For the purpose of these studies two types of tests were designed and developed. Tests are black, simple figures printed on white sheets of paper. The experiments were performed with a non-metric low-cost digital camera - Panasonic Lumix DMC-FX35 camera.

A novel method of detection and correction of chromatic aberration for digital images using wavelet analysis has been developed. A practical analysis of the detection and correction of chromatic aberration was conducted in Matlab. The method is based on the decomposition of the image using particular wavelet that gives an approximation and a given number of details. [5] Chromatic aberration, due to its nature, will be represented by the last decomposition level of details depending on the type of wavelets. Then, the signal is reconstructed omitting the detail representing an error. Theoretically we obtain an image free from chromatic aberration. However, in the areas on the image where the aberration was detected, a blurring will occur as a result of the averaging of naighbouring pixel values.

Due to the very large number of wavelets and possible levels of decomposition, the research process has been limited to the wavelets, for which the theoretical assumptions gave a high probability of achieving success. The research revealed that the chromatic aberration, can be detected not only in the last decomposition level. Based on experience and conducted studies related to the images,

[1] Department of Remote Sensing, Photogrammetry and Imagery Intelligence, Geodesy Institute, Faculty of Civil Engineering and Geodesy, Military University of Technology, 00-908 Warsaw, S. Kaliskiego 2, Poland, e-mail: anna.fryskowska@wat.edu.pl
[2] Department of Remote Sensing, Photogrammetry and Imagery Intelligence, Geodesy Institute, Faculty of Civil Engineering and Geodesy, Military University of Technology, 00-908 Warsaw, S. Kaliskiego 2, Poland, e-mail: michal.kedzierski@wat.edu.pl
[3] Department of Remote Sensing, Photogrammetry and Imagery Intelligence, Geodesy Institute, Faculty of Civil Engineering and Geodesy, Military University of Technology, 00-908 Warsaw, S. Kaliskiego 2, Poland, e-mail: michalina.wojtkowska@wat.edu.pl
[4] Department of Remote Sensing, Photogrammetry and Imagery Intelligence, Geodesy Institute, Faculty of Civil Engineering and Geodesy, Military University of Technology, 00-908 Warsaw, S. Kaliskiego 2, Poland, e-mail: aleksandra.grochala@wat.edu.pl

it can be said that the percentage of occurrence of chromatic aberration in the *i*-th detail is dependent on the nature of the edge (arc or straight). An edge detection technique which would be used in this case is the calculation of the first derivative of the fuction describing the changes in pixel values on the image. An additional advantage of this solution is the fact that for more blurred edges (smoother edges) the maximum of the first derivative has a lower value. That will also appear in the case of chromatic aberration. We can therefore say that the gradient of the image in two directions, *x* and *y*, will be smaller in that case. There is a relationship that the level of decomposition is inversely proportional to the gradient of the image. So in this case, chromatic aberration can occur at the level n/2, where n is a level of decomposition.

The proposed method of detection and correction of chromatic aberration can be applied in photogrammetric and remote sensing products generated on the basis of images from cameras mounted on UAVs.

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Key words: image analysis, wavelet transforms, noise, correction, chromatic aberration

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A STATISTICAL APPROACH FOR MAPPING AREAS POTENTIALLY UNSTABLE. APPLICATION TO THE REGION BEJAIA. ALGERIA (0005)

Hocine Bendadouche*[1], Merabet Smail[2], Kaddour Khammoudj[3]

Located on land consisting of hillsides, the coastal town of Bejaia is subject to many landslides. Construction on sloping land and altered as is the case in the south side of the city of Bejaia, generated massive landslides. The interest of this work is that it constitutes a decision-making tool relative to the choices of the precautionary measures of reduction of the risks of landslides brings a tool accessible (approachable) to the authorities of Bejaia as one of the basic elements to develop a management integrated of the territory in comparison to the natural hazards and to limit the number of the victims and to reduce the economic losses.

Numerous authors made attempts for the evaluation of the vulnerability and established a little bit empirically the maps of hazards by an evaluation of the importance of every gradual factorin a elementary way (arithmetic) then classified in digital scales. So in 1968, Lacroix used an arithmetical method deterministo realize the map) of hazards of Rif Marocain. It listed the lithologie, the average heights of the precipitation, the topography, the plant place setting and the conditions of flow of waters

Abdelkader and Margaa, 1998) also applied this empirical method to study the mapping of the potentially unstable zones of the region of Al Hoceima (Morocco).

In this work, we present a method of assessment and vulnerability mapping slip. For this, we introduced a vulnerability index S, considering for parameters. This index is the weighted sum of the effect of these for parameters characterizing the soil shear (*f*, *c*) the relief (*p*) and *h* height piezometric. This weighting is based on the linearization formula Fellenius.

To minimize the socio-economic impact of the landslide, we opted for a GIS (geographic information systems) as a tool for decision support on the choice The weighting of the three parameters were determined by susceptibility testing followed by multiple linear regression analysis performed on control wells. This method was applied to the agglomeration of the city of Bejaia (Algeria) known for its humid climat, rainy and densely populated. Thus, a map of intrinsic vulnerability and thematic maps have been established for the said town using a Geographic Information System (GIS).

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Key words: lithology, evaluation, instability, cartography

[1] Laboratory Engineering Construction Architecture University A. Mira, 06000 Bejaïa, Algeria, e-mail: bendadouche@yahoo.fr
[2] Merabet, Laboratory of Applied Hydraulics and Environnement, University A. Mira, 06000 Bejaïa, Algeria, e-mail: merabetsmail2003@yahoo.fr
[3] Laboratory of Applied Hydraulics and Environnement, University A. Mira, 06000 Bejaïa, Algeria, e-mail : khemmoudjkaddour@yahoo.fr

REFERENCES:
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ACCURACY OF SINGLE POINT POSITIONING DERIVED FROM DIFFERENT GENERATIONS OF GPS RECEIVERS (0055)

Paweł Wielgosz*[1], Joanna Iglińska[2], Marta Krukowska[3]

Single Point Positioning (SPP) is a basic, well-established GPS technique. It offers position accuracy of several meters in real-time anywhere in the world. However, this level of the accuracy does not fulfill requirements from different groups of users, applying GPS measurements in, e.g., precise navigation or Geographical Information Systems (GIS). The SPP accuracy depends on various factors, mostly related to environmental effects, like ionospheric and tropospheric delays, signal multipath, but also on accuracy of the satellite orbits and clock corrections as well as the precision of the collected pseudoranges. Also, the positioning algorithms influences the results. Nevertheless, due to rapid developments in receiver and antenna hardware, the precision of the pseudoranges is being constantly improved. The current geodetic-quality receivers can collect code measurements with noise at the level of 20-30 cm. Therefore, one of the accuracy-defining factor is the generation of GPS receivers. Currently, navigational users use receivers of different generations, even over 20 years old. Hence, in this contribution we aim at evaluation of the quality of their observations and also accuracy of the resulting navigational position.

Nowadays, navigational GPS users usually rely on satellite ephemeris transmitted in the system navigation message. Currently the accuracy of these data is estimated at around 1.5 meter. However, since 2013, the IGS provides precise orbit and clock corrections in real-time (IGS-RTS). Studies show that accuracy of the IGS corrections is better than 1 decimeter. Hence, the second aim of this study is the evaluation of the influence of the IGS-RTS corrections on the accuracy of the resulting SPP position.

Several field experiments were carried out using 6 types of GPS receivers representing different equipment generations. Also several different types of GPS antennas were used. The GPS test observations were collected simultaneously and processed in self-developed software using the same algorithms to obtain single point positioning solution using navigation orbits and also IGS-RTS products. The resulting positions were compared in terms of accuracy with respect to the reference position. In addition, the derived positions' repeatability was analyzed. The results showed clear advantage of IGS-RTS products and also confirmed better ranging performance of new generation receivers.

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Key words: GPS, SPP

[1] University of Warmia and Mazury in Olsztyn, e-mail: p.a.wielgosz@gmail.com
[2] University of Warmia and Mazury in Olsztyn
[3] University of Warmia and Mazury in Olsztyn

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ACCURACY TESTS OF VERTICAL COMPONENT OF RTK GNSS MEASUREMENTS CORRECTED BY THE LASER SYSTEM (0067)

Toomas Orason[1], Tarmo Kall*[2], Martin Sirk[3], Aive Liibusk[4]

In the light of rapidly developing RTK GNSS positioning and ground-based machine control systems, new challenges have arisen regarding the vertical accuracy. Estonian road construction legislative acts determine the maximum discrepancies allowed in the construction process. The strictest requirements for deviation of points on the road surface reach up to ±2 cm relative to the control network points [1].

RTK GNSS method is commonly used at the 3D machine control systems. Position corrections are received either from the individual GNSS base station or from the RTK GNSS network (RTN). Accuracy up to ±1 cm + 2 ppm on horizontal and ±2 cm + 2 ppm on vertical direction is generally achieved in good conditions [2]. In addition, robotic total stations are used to provide the absolute position of construction machines. Total stations are crucial in the conditions where RTK solution is not possible.

RTK GNSS solution corrected by the laser level system or so-called millimetre GNSS (mmGPS, [3]) has been designed to improve the vertical accuracy of the RTK GNSS positioning. An optical sensor and a GNSS rover receiver both are attached to the construction machine. Sensor receives the signal from the rotating laser level and corrects vertical position based on the RTK GNSS solution. Based on the manufacturer's claims, sub-centimetre accuracy for the vertical position can be achieved [3].

Purpose of this study was to verify mmGPS technology in different situations. Test measurements in three test areas were carried out to test the accuracy, working radius, and height zone of the mmGPS. Heights of the test points were determined by using five different measurement methods: 1) geometric levelling using Trimble DiNi digital level; 2) trigonometric levelling using Leica TS15A total station; 3) RTK GNSS measurements with Topcon base station and Hiper+ rover unit; 4) RTN measurements with Hiper+ rover unit; 5) mmGPS with Hiper+ rover unit and RTN measurements.

All results were compared with the heights from the geometric levelling, which is known as the most accurate levelling method. The tests showed good performance of the mmGPS system at manufacturer's specified conditions. The mmGPS system provides sub-centimetre vertical accuracy within 300 m working radius and ±5 m vertical zone from the laser level compared to the geometric levelling. In those conditions, the measurements had a good repeatability (±5 mm). Accuracy becomes

[1] Estonian University of Life Sciences, Department of Geomatics, Fr. R. Kreutzwaldi 5, 51014 Tartu, Estonia
[2] Estonian University of Life Sciences, Department of Geomatics, Fr. R. Kreutzwaldi 5, 51014 Tartu, Estonia, e-mail: tarmo.kall@emu.ee
[3] Estonian University of Life Sciences, Department of Geomatics, Fr. R. Kreutzwaldi 5, 51014 Tartu, Estonia
[4] Estonian University of Life Sciences, Department of Geomatics, Fr. R. Kreutzwaldi 5, 51014 Tartu, Estonia

worse from the distance 300 m until the signal disappears at ~400 m.

Tests of the mmGPS at height differences between 5–20 m produced large discrepancies compared to the geometric levelling. Discrepancies between mmGPS and geometric levelling were up to ±6 cm. In conditions of large height differences, RTK or RTN GNSS solution without assisting laser level performed much better. Trigonometric levelling proved to be most accurate and stable method.

Accuracy of the vertical component by using RTK or RTN GNSS method alone is not good enough for the measurement of the road points. Repeatability of the RTK and RTN GNSS measurements often exceeded ±2 cm.

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Key words: Global navigation satellite system, Machine control, Measurement by laser beam, Level measurement

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ADVANTAGES OF COMBINED GNSS PROCESSING DEPENDING ON THE LIMITED NUMBER OF VISIBLE SATELLITES (0019)

Kamil Maciuk[1]

Rapid growth of Global Navigation Satellite Systems (GNSSs) can be observed in the last couple of years, including Galileo and BeiDou systems. First two fully operable GNSS, i.e. GPS and GLONASS, have also been modernised in the recent years [1]. Nowadays, integrated multiple GNSS observations are essential for development of satellite positioning algorithms. Combined multi-GNSS positioning has a few advantages over a single GNSS system when it comes to accuracy, reliability, availability or positioning in obstructed areas [2]. However, multi-GNSS positioning presents also several disadvantages, major of them being: different time scales, reference frames and, due to multi-frequency, necessity of applying new algorithms and strategies for ambiguity resolution [3].

There are two well-known techniques in precise satellite positioning, absolute and relative positioning. Relative (differential) positioning using carrier phase double difference method mostly is most accurate and commonly used. Relative positioning relies on simultaneous observations from two or more receivers where at least one of them is stationary [so called reference station(s)] with known coordinates. The unknown position of a receiver is determined on the basis of one of multiple reference stations with use of differential carrier phase observations and baseline or network approach for station's position estimation [4]. The main disadvantage of differential positioning is the fact that at least two GNSS receivers are required and at least four satellites have to be tracked simultaneously at the same time. Satisfying these conditions is not always possible e.g. in mountainous or urban areas especially for single-GNSS observations.

In geodesy and other precise engineering studies millimetre position determination accuracy is required. Currently, this level of accuracy can be provided only by static relative measurements under certain conditions. The accuracy of static measurements depends mainly on the duration of measurement session which can range from a few dozen minutes to several days. Furthermore, static measurements quality is influenced by other factors including e.g. atmospheric delays, distance from the reference station or number of visible satellites. In order to reduce some errors elevation cut-off angle is used to eliminate signals from the lowermost above horizon satellites. Number of available satellites can also be limited by natural or artificial horizon obstacles. Integrated GNSS measurements can be used to solve the problem of too small number of observations resulting from insufficient number of visible satellites [5]. The article presents the results of daily static measurements solutions depending on the number of visible satellites. The analysis was conducted for 90 consecutive daily observations on two permanent EPN stations with single reference station. Calculations were performed with use of Bernese GNSS Software 5.2 software for three different sizes of elevation cut-

[1] AGH University of Science and Technology, Faculty of Mining Surveying and Environmental Engineering, Department of Integrated Geodesy and Cartography, Krakow, Poland, e-mail: maciuk@agh.edu.pl

off angles in three variants: GPS, GLONASS and hybrid GNSS. The analysis of accuracy was based on daily EPN solutions at the observation epoch.

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Key words: Global navigation satellite system, Geodesy, Geophysical measurements

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ALS POINT CLOUD UPDATE BY USED OF THE TLS AND THE LOW-LEVEL AERIAL PHOTGRAMMETRY (0080)

Adam Inglot*[1], Paweł Tysiąc[2]

Laser scanning technology is a technique for gathering the spatial data information which is commonly used all over the world. Systems where the red-light beam are used, are divided into: terrestrial, mobile (also a new approach in Poland- Marine [2]) and airborne scanning systems. The main differences between those are the accuracy, the measurements solution (f. e. in the ALS besides of the laser scanner, the inertial navigation system is required) and the covered area in one mission campaign. In addition to the type of the project, the systems could be used and merge as one to create precise, accurate 3D point model of the terrain without any gaps.

Collecting the spatial data with the use of airborne laser scanning is very problematic. Two of the main issues are the total costs of the system and measurement mission [3]. In Poland, the most of the country is covered by the point cloud from the ALS system in addition to the IT system of the Country's Protection Against Extreme Harazds (ISOK) The data are available through the main office of the geodetic and cartographic documentation center. For the scientific purposes, 3D data is available for free, but very often the informations provided are need up to date. With measurements characteristics, where the spatial information about a large surface could be collected. Gaps, created during measurements might be filled in another campaign with the use of the Airborne Laser Scanner. This denouement generates costs and big uncertainty of the measurements.

In this paper, authors presented the solution of dense the point cloud from the ALS by the use of terrestrial laser scanning system and low-level aerial photogrammetry to reduce the total costs of filling ALS point cloud. TLS is a very effective tool, because of its usefulness with the informations provided which are missed in the ALS (for example wall of the buildings) and the possibility to increase the accuracy of the 3D objects [1]. It is very difficult to obtain the spatial information about the roofs, but in this particularly case, the low-level aerial photogrammetry could be used. In addition the evaluation of the accuracy of the data was performed.

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Key words: Remote sensing, Geographic information systems, Geodesy

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[1] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Geodesy, Narutowicza 11-12, 80-233 Gdansk, Poland, adam.inglot@pg.gda.pl

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AN ANALYSIS OF THE INFLUENCE OF PLANNING CONDITIONS ON PROPERTY VALUE (0072)

Ryszard Cymerman*[1], Lech Kotlewski[2]

Space consists of surface, linear and point elements. The main attributes of space are limitedness, resistance and variation. Property owners and the provisions of national and local laws determine the manner in which land and space can be used. Local regulations include zoning plans which set forth the permitted types of land use, the conditions for planning and development, and the principles of land management. At the municipal level, land use type and planning conditions are set forth by the local zoning plan. If a local zoning plan is not available, planning conditions are issued by the responsible authorities in the form of a zoning decision. Municipalities also develop local land use plans – zoning plans detailing local planning policies which are binding for local zoning plans, but not for zoning decisions. Every planning decision describing planning conditions and the principles of land management influences the value of property. This study does not analyze the influence of all planning decisions on property value, and the scope of the analysis has been narrowed down to planning decisions and planning conditions set for residential property and land zoned for residential development.

This study investigates the influence of basic planning conditions applicable to land zoned for residential development (single-family detached homes and multiple occupancy homes), set forth in zoning plans, on the value of property. The influence of the following factors was evaluated: the availability of zoning decisions, width of the front elevation, development density, maximum developed area and potential developed area (determined by the setback line).

The study was conducted in two counties based on the prices of traded property in 2011-2015. The applied research methods involved analyses of the literature and source data, comparative analyses (including statistical analyses) and inference.

The results of the study indicate that each of the analyzed factors influences property value. Development density was the most influential factor, whereas the availability of planning decisions was the least influential factor.

The study also presents theoretical analyses investigating the influence of municipal zoning plans on property value.

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Key words: land planning, property, value

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[1] University of Warmia and Mazury in Olsztyn, Prawocheńskiego 15, 10-720 Olsztyn, Poland e-mail: rcymer@uwm.edu.pl
[2] University of Warmia and Mazury in Olsztyn, Prawocheńskiego 15, 10-720 Olsztyn, Poland e-mail: lech.kotlewski@uwm.edu.pl

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AN ANALYSIS OF THE PERFORMANCE AND COORDINATES TIME SERIES OF CORS NETWORK LITPOS (0057)

Rimvydas Baniulis[1], Karolis Galinauskas[2], Leonardas Marozas[3], Eimuntas Paršeliūnas[4], Marius Petniūnas[5], Vytautas Puškorius[6]

LitPOS (Lithuanian Positioning System), the network of continuously operating GNSS stations, became operational in July 2007. It provides data both for real-time and post-processing applications. LitPOS stations cover the whole territory of Lithuania. Total number of LitPOS GNSS stations during is 30 stations. Also LitPOS network includes 3 ASG-EUPOS (Poland) and 6 LATPOS (Latvia) stations.

LitPOS network data re-processing was done using Bernese (BSW5.2 update 2016 01 08) software. Software was slightly improved by editing scripts and writing procedures for RINEX files preparation, for downloading other necessary data, and for getting two processing solutions from single BPE (Bernese Process Engine) process (total network and sub-network without Polish and Latvian stations).

The analysis of coordinates time series was done with Matlab routine „GITSA“ (GPS Interactive Time Series Analysis) and Bernese program FODITS. In this paper the review of obtained coordinate time series will be given, in addition error tracking and some of the results will be assessed. An analysis of discontinuities and outliers with possible problem solutions will be provided. As a result more consistent accumulated multi-year solution is presented.

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Key words: geodesy, data processing

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[1] Vilniaus Gedimino technikos universitetas, Sauletekio al. 11 LT-10223 Vilnius, Lithuania, e-mail: rimvydas.baniulis@vgtu.lt
[2] Vilniaus Gedimino technikos universitetas, Sauletekio al. 11 LT-10223 Vilnius, Lithuania, e-mail: karolis.galinauskas@vgtu.lt
[3] Vilniaus Gedimino technikos universitetas, Sauletekio al. 11 LT-10223 Vilnius, Lithuania, e-mail: leonardas.marozas@vgtu.lt
[4] Vilniaus Gedimino technikos universitetas, Sauletekio al. 11 LT-10223 Vilnius, Lithuania, e-mail: eimis@vgtu.lt
[5] Vilniaus Gedimino technikos universitetas, Sauletekio al. 11 LT-10223 Vilnius, Lithuania, e-mail: marius.petniunas@vgtu.lt
[6] Vilniaus Gedimino technikos universitetas, Sauletekio al. 11 LT-10223 Vilnius, Lithuania, e-mail: vytautas.puskorius@vgtu.lt

ANALYSIS OF FACTORS AFFECTING PRIVATE LAND MARKET IN LITHUANIA (0107)

Audrius Aleknavicius*[1], Marius Aleknavicius[2], Giedrius Balevicius[3]

This article represents the analysis of private land sales in Lithuania over the period of 2015-2016. The main purpose of this study was to identify causes that affect land market intensity and land prices, which might differ along the municipalities.

The analysis focuses on those types of properties that have the most active land market, namely agricultural land used for farming, parcels of gardeners' associations and household plots. The data used for the research represent the statistical data of transactions recorded in Real Property Register, the mean values of property from mass-valuation models in different municipalities, soils quality data, agricultural production data and data from spatial planning documents.

Regression analysis revealed the following factors having impact on agricultural land market intensity – land economic value, land use intensity, size of towns in municipality and the average area of farm tenures. Most of these factors also had an impact on average land market value in the municipality. Market intensity for land plots bought for residential purposes has shown dependence

on size of towns in municipality, useful floor area per one inhabitant and the average wage. Average market value for household plots depended on the size of town, distance from town to a bigger city and the growth rate of population in town.

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Key words: private land, land market, agricultural land, households plots

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[1] Aleksandras Stulginskis University, Studentu 11, Akademija, Kauno r., Lithuania, e-mail: Audrius.aleknavicius@asu.lt
[2] Aleksandras Stulginskis University, Studentu 11, Akademija, Kauno r., Lithuania, e-mail: Marius.aleknavicius@asu.lt
[3] Aleksandras Stulginskis University, Studentu 11, Akademija, Kauno r., Lithuania, e-mail: gbalevicius@gmail.com

ANALYSIS OF GEODETICAL MEASUREMENTS ACCURACY FOR BLOCK NETWORK IN STATE FOREST (0036)

Ina Bikuvienė*[1], Ina Živatkauskienė[2], Aurelijus Živatkauskas[3], Marek Ogryzek*[4], Krystyna Kurowska[5]

This article presents the analysis of state forest block network geodetical measurement accuracy. Geodetic measurement network is compared to the pre-formed block network, which is registered in the State Forestry cadastre. State Forestry cadastre is a part of Lithuanian state register cadastre. This cadastre is updated every year with actual information from stand-wise forest inventory data and data obtained from forest enterprises or other suppliers about completed logging operations or cadastral data changes. The block network measurement was carried out in order to form the basis for georeferenced forest cadastre with well-defined spatial data. Together with the forest block network measurements there was also established the position of other static forest objects, such as roads and drainage channels, because they are an important part of a forest cadastre too. Georeferenced forest cadastre is formed in order to create a GIS database with static space objects, which does not change depending on the operator's ability to vectorize field measurement data.

For measurements we used a geodetic device GPNS Trimble R8s, which can work with all of today's satellite systems. In cases where due to inadequate conditions of measurement it was not possible to work with a GPS device - we used an electronic total station Trimble M3. Preliminarily shaped blocklines of network are geodetically measured with analogous points *X* and *Y*, then the coordinates were adjusted to blocks at intersection points. The axial line of objects was determined by estimating the linear object design width with accuracy of no less than 0.25 m and marked its middle. The coordinates of points determined at least 0.3 m accuracy at the outer limit of the forest and 0.5 inside. Accuracy of measurements is calculated as „*X*“ and „*Y*“ coordinate diference between geodetical measured network points and same points in a pre-formed block network. The study used as a basic georeferenced cadastral data set GDR10LT, in which static ground of natural and anthropogenic objects are registered. Study was performed in Tytuvėnai State Forest Enterprise. Results showed, that intersection of forest block network lines in „*X*“ axes was ± 2.62 m, and in „*Y*“ axes ± 2.9 m. Average distance between measured and pre-formed block points - ± 4.39 m. The difference between pre-formed block network line intersection and the geodetic measured block network line intersection varies from 0.00 m and 12.04 m. In this study the accuracy of coordinates is

[1] Department of Enviromental Engineering, Kaunas University of Applied Sciences, Lithuania, e-mail: ina.bikuviene@go.kauko.lt
[2] Department of Enviromental Engineering, Kaunas University of Applied Sciences, Lithuania, e-mail: ina.zivatkaukiene@go.kauko.lt
[3] Department of Enviromental Engineering, Kaunas University of Applied Sciences,, Lithuania,Lithuania, e-mail: aurelijus.zivatkaukas@go.kauko.lt
[4] Department of Planning and Spatial Engineering, Faculty of Geodesy, Geospatial and Civil Engineering, University of Warmia and Mazury, Olsztyn, Poland, e-mail: marek.ogryzek@uwm.edu.pl
[5] Department of Planning and Spatial Engineering, Faculty of Geodesy, Geospatial and Civil Engineering, University of Warmia and Mazury, Olsztyn, Poland, e-mail: kurek@uwm.edu.pl

measured by GPNS devices and the „STATIC“ method according to the season of the year.

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Key words: block network, State forestry cadaster(SFC), geodetical measurements

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ANALYSIS OF NUMERICAL MINIMIZATION METHODS APPLIED TO GEODETIC NETWORK ADJUSTMENT (0094)

Joanna Janicka*[1], Jacek Rapiński[2]

Optimization is an important tool in decision science and in the analysis. From the mathematical point of view optimization is the minimization or maximization of a function, subject to constraints on its variables. In the process of the geodetic networks adjustment the least squares method is most commonly used. Minimizing the objective function using the least squares method is not possible without linearization. But, not every non-linear equation can be linearized or it is not possible to achieve the desired accuracy of approximation. However, there are many numerical minimization methods described in the literature. The authors of this paper are looking for the benefits of the use of numerical methods applied to geodetic network adjustment.

Optimization algorithms are usually iterative, it means that they begin with some initial value of the variables and through the sequence of approximations are looking for the optimal solution. The strategy to achieve the final solution distinguishes the various methods. Considering the three basic parameters: robustness to outliers, accuracy and computational efficiency one can guess that one parameter will exclude the another. The aim is to examine if the selected algorithms differ in terms of: robustness, computational efficiency and accuracy because these goals may conflict. The method that allows rapidly obtain the optimal solution may require too much computer storage or the required accuracy will not be impossible to achieve. On the other hand, robust methods may also be slowest. The selected methods are also analyzed in terms of constraints. Constrained optimization problems arise from models that include explicit constraints on the variables.

An analysis performed using real data and on the artificial test network. The real object includes about 50 points and covers the area of 10×10 km. The coordinates of these object are defined in the Geocentric Coordinate System. The artificial object includes about 20 points and covers the area 5×5 km and the coordinates are also defined in the same reference frame.

Computations were performed using the Python programming language. Python has a large and comprehensive standard library and additional libraries for example: SciPy. SciPy is an open source Python library used for scientific computing and technical computing. This library has a number of implemented functions, which can be easily used in a calculation. To perform calculations with the use of numerical optimization methods has been used library package, which included selected methods. The minimum of the same objective function was calculated with the use of different numerical optimization methods: Nelder-Mead, Powell, CG, BFGS, Newton-CG, L-BFGS-B, TNC, COBYLA, SLSQP, dogleg and trust-ncg. The paper presents selected minimization methods applied to geodetic network adjustment and the results. The authors of this paper compared results obtained

[1] Institute of Geodesy, University of Warmia and Mazury in Olsztyn, Poland, joannasuwm@gmail.com
[2] Institute of Geodesy, University of Warmia and Mazury in Olsztyn, Poland, jacekrapinski@gmail.com

using the described methods and presented the advantages and disadvantages of these methods.

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Key words: geodesy, numerical analysis, minimization methods

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ANALYSIS OF RECONNAISSANCE IMAGERY ACQUIRED IN THE DIFFERENT SPECTRAL RANGES OF ELECTROMAGNETIC SPECTRUM (0028)

Michal Kedzierski[1], Damian Wierzbicki*[2], Paulina Delis[3], Marcin Walkowiak[4]

Technological advances and an increased demand for reconnaissance images acquired in different spectral ranges of electromagnetic spectrum for Imagery Intelligence have contributed to the construction of reconnaissance pod system DB-110. Wide capabilities of this system are characterized by a large amount of advantages and allow to take pictures both ruring a day and at night in different modes of an aviation mission.

The main aim of this article is a description of the research, which were performed by using images recorded by the reconnaissance pod. The research was based on performance comparison of pictures and information, which were acquired in visible, near-infrared and mid-infrared ranges. The selected research method compares the data with each other phenomena, in this case, reconnaissance images, in order to determine the partial, complete or difference identity. The analysis was carried out by comparing the general construction and statistical data images, and their relevance for the evaluation of the terrain, the characteristics of individual objects, conducting various types of spatial analysis and the usefulness of the process of photo interpretation. The study used methods of digital image processing of the original image through the use of software. Image processing is performed by the appropriate transformation point and context in photos, such as histogram equalization, normalization, binarization, thresholding, raster color slices, filtering, change the contrast, sharpness and resampling in order to improve image quality for better analysis and interpretation and recording of images in a convenient format for the software. The study allowed to perceive similarities and differences between the compared images acquired in different spectral bands and the characteristics of the imaging system. An important element of the analysis was a description and a characterization of the same objects that are in different ways in photos of various ranges of the electromagnetic spectrum. The analysis was performed based on the description of the characteristics of different types of terrain objects and selected materials registered in the pictures. These include construction object and their infrastructure, water, vegetation, metallic and non-metallic materials and certain minerals. In addition, the research process has been extended in aspect of determine

[1] Department of Remote Sensing, Photogrammetry and Imagery Intelligence, Geodesy Institute, Faculty of Civil Engineering and Geodesy, Military University of Technology, 00-908 Warsaw, S. Kaliskiego 2, Poland, e-mail: michal.kedzierski@wat.edu.pl
[2] Department of Remote Sensing, Photogrammetry and Imagery Intelligence, Geodesy Institute, Faculty of Civil Engineering and Geodesy, Military University of Technology, 00-908 Warsaw, S. Kaliskiego 2, Poland, e-mail: damian.wierzbicki@wat.edu.pl
[3] Department of Remote Sensing, Photogrammetry and Imagery Intelligence, Geodesy Institute, Faculty of Civil Engineering and Geodesy, Military University of Technology, 00-908 Warsaw, S. Kaliskiego 2, Poland, e-mail: paulina.delis@wat.edu.pl
[4] Department of Remote Sensing, Photogrammetry and Imagery Intelligence, Geodesy Institute, Faculty of Civil Engineering and Geodesy, Military University of Technology, 00-908 Warsaw, S. Kaliskiego 2, Poland, e-mail: walkowiak_marcin@wp.pl

scale NIIRS and geographical coordinates of the indicated places, performed measurements on various types of reconnaissance photos and analyzing the results. The research work made it possible to determine that reading information from the reconnaissance images are affected by weather conditions, time of the day, sensor angle, the range of the electromagnetic spectrum, spatial resolution and defects of the imaging system. Based on these analysis, it was found that the images from the electrooptical scanner are a better source in photo interpretation process in identification and analysis of individual objects than registered by a thermal scanner. It has been also proved that the thermal photos enable detection of objects that are not detectable in the pictures of the visible and near-infrared spectral ranges of electromagnetic spectrum. There is a need to conduct further research of the qualities and characteristics of objects registered in other ranges of the electromagnetic spectrum. In particular, the scope of research should be expanded in terms of analysis of thermal images acquired during the night.

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Key words: digital images; image analysis; infrared imaging; object detection

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ANALYSIS OF THE IMPACT OF GALILEO OBSERVATIONS ON THE TROPOSPHERIC DELAYS ESTIMATION (0124)

Zofia Baldysz*[1], Grzegorz Nykiel*[2] , Mariusz Figurski[3]

In the 1999, the European Union have started to develop the new global and civilian navigation system, called Galileo. Its satellite constellation still does not provide full global coverage (14 satellites in January 2017) but on 15th December 2016, the European Commission announced the Early Operational Capability (EOC) of the system, what allowed users to start using Galileo for the positioning. After the EOC, the Galileo has started to play an increasing role in position determination. As in the case of other navigation systems, the Galileo signals can be used not only for the purpose of positioning but also to study the atmosphere properties.

In this study we present analysis of the impact of Galileo observations on the tropospheric parameters estimation, such as ZTD and tropospheric gradients. The tropospheric parameters were obtained in different scenarios, which differ in used satellite systems: Galileo only, GPS only, GPS + Galileo, and GPS + GLONASS + Galileo. Firstly, the results of ZTD estimated on the basis of only Galileo signals are presented. Secondly, the impact of Galileo signals on the ZTD estimation with other satellites system is shown. As a reference, we adopted the GPS+GLONASS solution, which is commonly used as a source of tropospheric products on such reference network as e.g. EPN (EUREF Permanent Network). In our analysis we used observational data from selected stations in Europe and then processed them using Bernese 5.2 software and differential approach. Analyzed period covers a period of several weeks before and after the Galileo EOC.

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Key words: Global Navigation Satellite System, Galileo, tropospheric parameters, ZTD

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[1] Military University of Technology, Poland, e-mail: zofia.baldysz@wat.edu.pl
[2] Gdansk University of Technology, Poland, e-mail: grzegorz.nykiel@pg.gda.pl
[3] Committee for Space and Satellite Research, Polish Academy of Sciences, Poland, e-mail: figurski@k-lab.org.pl

ANALYSIS OF THE USE OF GNSS SYSTEMS IN ROAD CONSTRUCTION (0070)

Slavomír Labant[1], Gabriel Weiss[2], Marcela Gergeľová[3], Juraj Gašinec[4]

In road construction, construction machines are used for levelling and adjusting the earth's surface. These modern construction machines use a 3D GNSS levelling system to achieve the projected shape and elevation of terrain with the required accuracy within permitted setting-out deviations according to the project. Every road must pass the inspection of geometric parameters, several times during the construction of its layers. In the area of interest, geodetic check measurements of created landforms during the construction of the expressway were realized. The aim was to objectively assess and evaluate the practical applicability of connection between a construction machine and precise surveying instrument for determination of position and height in real time. And also, if the created landforms meet the required accuracy specified by the construction project. The accuracy checking is realized by comparing the real values of geometric parameters with values required for the control specified in technical standards [1, 2], project documentation or inspection schemes. The terrestrial spatial polar method was chosen for check measurements, due to the independence and complete elimination of inaccuracies of satellite systems when determining the position and height of control points. Check measurements were based on the same reference points as were used for 3D GNSS levelling system of the construction machine in surface adjustment. The surveying instrument used for check measurements provided surveying results of required accuracy. Subsequently, the obtained data were used as input data for further processing using specialized software to make it possible to compare the projected and the realized state based on specified criteria. Height deviations of check points, deviations of downflow lines of cross-sections and deviations of the cubic content of laid material of individual sections were defined. The resulting deviations were evaluated based on the statistical hypothesis testing by selected statistical tests. For the verification of the null hypothesis H_0, that the corresponding deviation is either statistically insignificant or significant, the following procedure was applied. For each of the resulting deviations, testing criteria were determined on the given significance level, and these were subsequently compared with critical values of the corresponding statistical test. Based on practical experience in the experimental measurements and results of observations, it is possible to assess the need to pay the attention to the list of the most common potential failures when working with a construction machine controlled by a 3D GNSS levelling system. This can significantly affect the resulting work

[1] Institute of Geodesy, Cartography and GIS, Faculty of Mining, Ecology, Process Control and Geotechnology, Technical University of Košice, Letná 9, 042 00 Košice, Slovak Republic, e-mail: slavomir.labant@tuke.sk
[2] Institute of Geodesy, Cartography and GIS, Faculty of Mining, Ecology, Process Control and Geotechnology, Technical University of Košice, Letná 9, 042 00 Košice, Slovak Republic, e-mail: gabriel.weiss@tuke.sk
[3] Institute of Geodesy, Cartography and GIS, Faculty of Mining, Ecology, Process Control and Geotechnology, Technical University of Košice, Letná 9, 042 00 Košice, Slovak Republic, e-mail: marcela.gergelova@tuke.sk
[4] Institute of Geodesy, Cartography and GIS, Faculty of Mining, Ecology, Process Control and Geotechnology, Technical University of Košice, Letná 9, 042 00 Košice, Slovak Republic, e-mail: juraj.gasinec@tuke.sk

of the machine, or changing the levelling system for the system that is more precise should be considered. A construction machine in coordination with correctly working 3D GNSS levelling system from any manufacturer can positively affect the construction process in terms of the reduction in cost and reduction of the time needed for surface treatment into the shape and height required by the project

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Key words: Global navigation satellite system, Statistical analysis, Land surface, Digital elevation models

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ANALYSIS OF THE VARIABILITYOF THE MOTORWAY ON AGRICULTURAL LAND AS AN EXAMPLE A4 MOTORWAY SECTION (0031)

Stanisław Bacior[1] , Wojciech Przegon[2]

The developed innovative method for estimating the motorway impact on agricultural land allows specifying all the losses associated with the directions of this interaction. The basis for determining losses is the analysis of variability of land use and quality classes and arrangement of access roads to the land along the axis of the planned motorway. The adopted measure of the multi-direction motorway impact on agricultural land is a specified change in the value of land, at which determination only the diversity of the land suitability for agricultural production was taken into account. To conduct an analysis it is necessary to determine the variability of soil quality on the route of the motorway, location of road and motorway overpasses, agricultural land area, to which access roads are associated with crossing motorway lane, parameters of layout of the plots cut by the motorway and the location of the protective green belts. The above data serve as the basis for determining the variability of these characteristics of land under the influence of motorway construction. These features determine land production suitability and are used to estimate the overall impact of motorway construction on agricultural land.

The method for estimating the motorway impact on agricultural land allows to estimate the impact of the motorway on agricultural land including all the major directions of the impact of the motorway on agricultural land, that is, the loss of land taken under the road belt, reduction of the production capacity of land located near the motorway and deterioration of the farm layout cut by the motorway. Thanks to the simplified nature of the used method, its workload has been greatly reduced, which allows its use in assessing the various options of the motorway route, yet at the stage of the preliminary design. The calculation procedure was automated using a program written in Visual Basic, which used Microsoft Excel spreadsheets.

To determine the parameters, it is necessary to draw the axis of the planned motorway on the cadastral map.

Along the axis of the motorway should be marked and numbered points, in which classification or use of land change. Intersections of the motorway axis with access roads to land should be taken into account as well as all access roads to the land including those, which have been classified as agricultural land and are important for the local transport.

The resulting sum of the road sectors lengths running through highlighted land and their quality classes allow to estimate the differences in the type and quality of land along the lane motorway.

An important element is to estimate the lengths of the areas supported by the given road, which can be ac-cessed through the motorway. The product of the length and width of the area is equal

[1] University of Agriculture in Krakow, Poland, rmbacior@cyf-kr.edu.pl
[2] University of Agriculture in Krakow, Poland, w.przegon@interia.pl

to area, to which access requires crossing the motorway lane. The number of plots cut by the axis of the motorway and the characteristics of their layout enables to estimate the impact of the highway on the shape and size of plots.

On the basis of information about the presence of the protective green belts the area occupied under construction is calculated and the scale of the reduction in the value of land located near the motorway. While on the basis of the study of variability of quality of land located along the axis of the motorway it is possible to estimate the quality of land located in the zone of influence of the motorway.

The developed method of the determination of the motorway impact on agricultural land is shown on the example of the planned motorway section.

The construction of one kilometer of the motorway section will reduce the value of agricultural land on average of 1400 cereal units. Taking over the land for the motorway construction and its negative impact covers about 80 % of the total loss of value of agricultural land. The remaining 20 % of the loss of the land value is associated with the increase of the transport and deterioration of the plots layout.

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Key words: value of agricultural land, the impact of the motorway, farm land layout

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APPLICATION OF AHP METHOD FOR SELECTION OF FLOATING HOUSES LOCATION (0020)

Emilia Miszewska-Urbańska*[1], Beata Grzyl[2], Magdalena Apollo[3]

The paper presents an example of multi-criteria analysis method application (AHP - Analytic Hierarchy Process) in the selection process of suitable mooring place for floating houses.

Floating houses (commonly called "Houses on Water"; HoW) are built, among others, in order to meet the year-round housing needs of its owners as well users. It is possible provided finding a suitable mooring place. In the paper it is suggested that in the process of choosing appropriate location one should take into consideration technical, economical as well formal and legal criteria. At a further stage of analysis, the optimal solution emerges from the available options.

In order to determine the impact of individual criteria [1], the authors use multi-criteria analysys method (AHP). This method was developed by Saaty [2] and is primarily used to support analysis related to decision making process of choosing optimal variant. Numerous applications of the method in the economical, technical as well social decision support process confirm its usefulness especially in cases where some of the evaluation criteria are of qualitative nature, while the experience and expert knowledge represent an essential source of evaluation of subjective nature [3].

It is assumed that the research procedure conducted by the authors is carried out in accordance with the assumptions proposed by Saaty. Based on pairwise comparisons of various criteria and decisions variants (taking into account these criteria) a scale vector is created, which components enable ordering the decision variants and to choose the optimum variant. For comparisons the authors use 9-degree rating scale (so called Saaty's scale). The hierarchy is multi-level, which means that the criteria considered are divided into sub-criteria, and the overriding objective, which is convenient for the user floating house location, the authors situate at the highest level of the hierarchy. The main objective is therefore decomposed into independent assessment criteria, set by the preferences of the decision maker – the user. The criteria used in the article include: mooring system (eg. piles, booms, Seaflex anchors), means of communication with the mainland, access to media, storage place for municipal waste, parking space, etc.

The analysis on the following hierarchy levels and taking into account various criteria, is aimed to identify the optimal location of floating houses [4]. In the article the authors confront the results obtained using AHP analysis with the results of qualitative analysis presented in the publication "Analysis of the HoW location on the example of the city of Gdansk" [5].

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[1] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Narutowicza 11/12 Str.,80-233 Gdansk, Poland, e-mail: emiurban@pg.gda.pl
[2] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Narutowicza 11/12 Str.,80-233 Gdansk, Poland, e-mail: beata.grzyl@wilis.pg.gda.pl
[3] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Narutowicza 11/12 Str.,80-233 Gdansk, Poland, e-mail: magdalena.apollo@wilis.pg.gda.pl

Key words: Decision support systems, Urban area, Land use planning

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APPLICATION OF BAYESIAN NETWORKS IN RISK DIAGNOSTICS ARISING FROM THE DEGREE OF URBAN REGENERATION AREA DEGRADATION (0018)

Magdalena Apollo*[1], Beata Grzyl[2], Emilia Miszewska-Urbańska[3]

Urban regeneration as a complex project, generates many extremely specific threats affecting the increase of investment risk [3]. Furthermore, its unique nature causes that probability parameter, normally applied in the process of risk quantification, is extremely difficult to estimate in terms of frequentist approach. Due to lack of historical data impending the determination of probability of occurrence of threats involved in the process, urban regeneration related activities are therefore associated not so much with risk as with uncertainty. As a consequence, the subject addressed in this paper relates to the issues of decision-making in conditions of limited information [1, 2].

According to the authors, a useful tool for resolving the above mentioned issues may prove to be Bayesian networks, where probability distribution is interpreted as a measure of credibility concerning the possibility of occurrence of specific event, assuming incomplete knowledge on the subject. Beliefs based on expert knowledge should be considered as a subjective measure, nevertheless Bayesian networks also allow to combine this information with objective results of conducted research [5].

What is important in the context of complex projects, Bayesian networks allow to model risk taking into account mutual relations between different elements of the process [4]. For that purpose one has proposed to build a model representing various urban regeneration risk areas, where the analysis contained in the paper covers only degradation of the urban regeneration area, which is defined as one of substructures (objects) of the global model. The article also proposes and presents selected parameters (symptoms) allowing for diagnostics of the technical condition of buildings, road pavement and underground infrastructure in the area covered by urban regeneration. Therefore in the situation, when the direct evaluation of the technical condition of structural element / building object (for example through technical expertise) can't be performed, there is a chance for the indirect estimation through observations introduced into the symptom variables.

Apart from diagnostics of technical condition, the presented model was used to simulate the level of urban regeneration investment risk resulting from the degree of area degradation. The use of sensitivity analysis, based on Tornado graphs, allowed also to present a ranking of critical risk factors, along with the probability of their occurrence.

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Key words: Bayes methods, condition monitoring, degradation, urban areas.

[1] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Narutowicza 11/12 Str.,80-233 Gdansk, Poland, e-mail: magdalena.apollo@wilis.pg.gda.pl
[2] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Narutowicza 11/12 Str.,80-233 Gdansk, Poland, e-mail: beata.grzyl@wilis.pg.gda.pl
[3] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Narutowicza 11/12 Str.,80-233 Gdansk, Poland, e-mail: emiurban@pg.gda.pl

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APPLICATION OF ROBUST ESTIMATION METHODS TO DISPLACEMENTS DETERMINATION IN GEODETIC CONTROL NETWORK OF DAM (0051)

Marek Banaś[1]

The paper presents results of research designed to estimate the usefulness and efficiency of robust estimation methods in the procedure of points displacements determination in the geodetic reference control network established for an earth dam. The beginning of the paper shows the most important types of horizontal reference control networks and introduce rules of point displacements determination in these networks. Further part of the paper is a short presentation of M-estimation, algorithm of iteratively reweighted least squares method and robust estimation methods used in research. Detailed study was given to 4 methods, i.e. Huber, Hampel, Danish and method called as linear. Description of the individual methods contain proposals for the tuning constants got from the literature depending on the type of adjustment problem. The next part of the paper is devoted to presentation of geodetic reference control network which was established for displacements and deformations measurements of the earth dam located in Wilcza Wola, Subcarpathian Voivodeship, in south-eastern part of Poland. The subject horizontal control network consists of 7 ground points what gave 32 distance and 25 angle observations. Author carried out two measurments campaigns and obtained two independent sets of observations. The information about instrument (total station), equipment and technique of measurement can also be found. The following part deals with research on the use of robust estimation methods for estimating the coordinates of the points being a part of periodically observed geodetic control network. The way of preparing intentionally contaminated with outliers sets of observations used in numerical tests (experiment) was presented. Contaminated sets of observations with outliers of known values were adjusted using ordinary least squares and robust estimation. The study presents numbers of iterations carried out by author's own application using tested robust estimation methods, average coordinates differences between results of least squares adjustment and individual robust estimation methods and average standard deviation. There is also shown the effect of points' stability evaluation and estimated displacements after least square and robust adjustment. The paper shows the advantage of robust estimation methods to reduce the influence of outliers on estimated network parameters over the ordinary least squares adjustment. Robust estimation methods allow to obtain lowest variance for coordinates of points in reference control networks and it leads to minimization of the displacement's components variance, which is a key parameter to define the criterion for significance of estimated displacement.

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Key words: displacement measurement, position measurement, robustness, stability analysis, parameter estimation

[1] The Bronisław Markiewicz State Higher School of Technology and Economics in Jarosław, Institute of Technical Engineering, 16 Czarnieckiego St., 37-500 Jarosław, Poland, e-mail: marek.banas@pwste.edu.pl

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APPLICATION OF THE FUZZY SET THEORY TO DETERMINE THE PARTIAL FACTOR OF SAFETY (0091)

Ewa Daniszewska[1]

The paper focuses on techniques and the motivation for incorporating one's knowledge and experience derived from the field of engineering into geotechnical calculations by applying the fuzzy set theory and fuzzy logic in order to achieve representation of knowledge. Some issues of fuzzy logic and the theory of fuzzy sets, such as definitions, concepts and the basic laws governing the fuzzy worlds have been described. A practical example using the fuzzy representation of knowledge is presented in order to illustrate the theoretical knowledge and to prove that fuzzy logic is applicable to geotechnical engineering.

The author suggested her own way of calculating the partial factor of safety, which takes into account both subjective evaluation and uncertainty regarding the information about the ground. A procedure for calculating the partial factor of safety to the classic formula contained in Polish standard PN 81/B-03020 and including some elements of the fuzzy set theory was presented. The approach to calculating values of the partial factor of safety discussed in this paper is a merger of the former customary solution applied to determine mechanical properties of ground with the recommendations of Eurocode 7. A few selected cases were presented in detail of how to determine a fuzzy set whose elements represent degrees of the strength of ground.

The proposed method based on the application of elements of fuzzy sets enables the user to include experimental elements into the determinations. The user's experience and expectations concerning the reliability of laboratory tests was expressed by a greater or lesser fuzziness of the set. This means that the range of fuzziness of a given set was defined adequately to the reliability of the available information. When viewing a set of parameters identifying ground as a fuzzy set, it was possible to include the following: reliability of data, flexibility of judgment and difficulty in processing data. For calculations of the partial factor of safety that serves to determine computed values of strength parameters, a higher range of uncertainty was assumed for the cohesion of soil than for the angle of internal friction. Thus, this set was characterized by greater uncertainty than the fuzzy set used for calculating the partial factor of safety. The outcome of such calculations consisted of two fuzzy numbers which, to a different degree, belonged to a fuzzy set. Values of the partial factor of safety suggested in Euocode 7 EN 1997-1 and calculated according to the statistical method comprised in Polish Standard PN 81/B-03020 were compared to the values achieved through simple operations on fuzzy sets. The values of the partial factor of safety obtained for cohesion $\gamma_m{}^c$ and the partial factor of safety for the internal friction angle $\gamma_m{}^\phi$ differ from each other and therefore are not the same value as resulting from calculations conducted according to the statistical method, where

[1] Faculty of Geodesy, Geospatial and Civil Engineering, University of Warmia and Mazury in Olsztyn, Oczapowskiego 2, 10-719 Olsztyn, Poland, e-mail: ewa.dybiec@uwm.edu.pl

$\gamma_m{}^c = \gamma_m{}^\phi$. The suggested solution is closer to the recommendations of Eurocode 7, as it incorporates both knowledge and experience of an engineer, combining them in the two in formalized mathematical.

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Key words: Civil engineering, Geoengineering, Soil properties, Material properties, Fuzzy set theory, Fuzzy sets.

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APPLICATION OF THE TRIANGULATED IRREGULAR NETWORK (TIN) METHOD IN THE CREATION OF MODELS OF HISTORICAL BUILDINGS (0048)

Joanna A. Pawłowicz[1]

Renovation or modernization of a historical building involves creating its model. An accurate 3D representation of a building can be used e.g. to analyse the possibilities of renovating or recovering its damaged elements.

The Terrestrial Laser Scanning (TLS) method is an alternative way of taking the measurements required to prepare the necessary technical documentation of a building. This technology allows collecting digital data in the form of a point cloud, which can be used to create a 3D model of a building, including nearly all of its architectural details. 3D data obtained by means of a scanner is highly accurate and, therefore, increasingly popular in reverse engineering. Reverse engineering allows to create digital images of existing objects. This method consists in digitizing an object situated in a physical space by means of 3D scanning and other engineering methods, as a result of which it can be brought into the virtual reality. Reverse engineering covers activities related to collecting geometrical data of objects, recreating the geometry of measured objects and processing data to arrive at images supported by CAD systems. Creating good models requires highly accurate field data. It is very important to select the right measurement parameters to be able to create models of damaged details and use them to replace the originals.

This paper discusses examples of how helpful 3D laser scanning can be in creating models of historical buildings. This technology is of particular importance when it comes to representing decorative architectural details. To create a 3D image of a building using reverse engineering one must first gather on-site data by means of terrestrial laser scanning in the form of a point cloud. This paper describes the process of creating a model of a historical building by means of the TIN method using Leica's Cyclone programme. The on-site measurements were taken using a ScanStation C10 scanner, also by Leica.

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Key words: architectural detail, point cloud, reverse engineering, technical documentation, 3D model

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AUTOMATION OF DOT MAPS PRODUCTION SUPPORTED BY BDOT10K DATABASE (0049)

Stanisław Szombara[1]

Dot maps are one of the quantitative cartographic presentation methods used for geovisualization. Dots of specified value represent spatial distribution of particular phenomenon. Traditionally, it was the task of a qualified cartographer to distribute dots in the map. Nowadays, when maps are prepared not only by specialists, it is necessary to develop methods for automatic production, which will be accessible for a wide range of GIS users. Used for presentation of cropland, pastureland, production effects and population, dot maps can show statistical phenomena and their changes in time. The most important stage of a dot map production is choosing of proper dot size and value. With use of the developed algorithm, a cartographer can check and compare population maps prepared with various dot sizes and value.

In the paper author concentrates on maps in medium and small scales, presenting distribution of people with use of dots map. In the study the Database of Topographic Objects BDOT10k was used. This database contains, among others, spatial information on built-up areas. Use of BDOT10k for analysis of economic and social phenomena builds up another trend of applying for this database and extends even more the wide range of its usefulness [1]. In the study, the BDOT10k information on built-up areas, was combined with statistical data on population of particular administrative units. A new algorithm for distribution of dots of given value was applied, which uses both: buildings obtained from BDOT10k and statistical information. Dots are distributed with use of hexagonal tessellation with variable size of a cell. The algorithm enables to distribute coalescing and noncoalescing dots. Noncoalescing dots are better if recovery of original data and estimation of dot number is important [2]. Further stages of dots map production, such as automation of distribution for already created dots have already been treated in research papers [3]. Examples of maps using the described method were prepared for a couple of districts of Małopolskie Province. Maps were prepared with use of ESRI ArcGIS software.

Automation of dot maps production reduces time spent on distribution of dots and choosing the proper dot size and value. In addition to this, a cartographer can perform transformation of the properly prepared dot map into a choropleth map, a chorochromatic map, an isoline map or a proportional point map symbol [4].

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Key words: Spatial databases, Geospatial analysis, Rural areas, Urban areas

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[1] AGH University of Science and Technology, Faculty of Mining Surveying and Environmental Engineering Department of Integrated Geodesy and Cartography, Krakow, Poland, e-mail: szombara@agh.edu.pl

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BEHAVIOUR OF NATURAL AND PROTECTED BEACH OF THE DZIWNOW SPIT THROUGHOUT SIX MONTHS PERIOD (0084)

Natalia Bugajny*[1], Kazimierz Furmańczyk[2]

Visiting the beach at the dune coast provides an opportunity to observe changes occurring there. The magnitude of those changes depends on hydrodynamic factors [1].

Authors investigated changes of selected morphodynamic parameters from two beaches: natural beach and the one protected by groynes within Dziwnow Spit for a period of 6 months in 2012. For this purpose, 13 series of beach profiles were measured in a 100 or 200 m distance from each other along approx. 2 km long section at both areas. Diverse hydrodynamic conditions, in form of wave parameters from WAM model applied to the Baltic Sea [2] and water level from tide gauge located in Dziwnow harbour, occurred between survey campaigns. Beach profile measurements were carried out by means of differential GPS RTK with an application of reference points that had been determined earlier. Also, a few of fixed control points were set up. Measurements were being carried out along defined profiles from dune foot to a water depth of ca.1 m [3].

On the basis of the measurement results, shoreline displacement on both types of coast were analysed and mean value and standard deviation were also calculated. Moreover, average elevation of dune foot and beach width together with their standard deviations were calculated along these two types of beach.

It was proved that beach at the natural coast is slightly wider than at the protected one on average, but its width is more diverse at the same time. On the contrary, the dune foot is located slightly higher at the protected coast and its diversification is greater. The mean value of dune foot elevation at the beginning and the end of measurement period was stable and equalled 2.67 m on the natural coast and 3.02 m on the protected one.

To supplement the studies, beach volume changes for both areas were analysed as well. Solid stability of this parameter was stated. A slow growth is observed in general, however, stabilization and even small diminish can be noticed. The difference between beach volume at the beginning and the end of measurement period was + 31 m^3/m both on the natural and the protected coast.

The lowest value of beach volume was observed in late June, while the highest - in late November on the protected coast and early December on the natural one. A difference between maximal and minimal values of beach volume was 57 m^3/m for the natural coast and 46 m^3/m for the protected coast, whereas the greatest changes between subsequent surveys equalled to 21 m^3/m at the natural coast and 16 m^3/m at the protected coast. This prove of greater dynamics of the natural coast and smaller changes at the protected coast.

[1] University of Szczecin, Institute of Marine and Coastal Sciences ,Mickiewicza 18, Szczecin 70-383, Poland, e-mail: natalia.bugajny@univ.szczecin.pl
[2] University of Szczecin, Institute of Marine and Coastal Sciences ,Mickiewicza 18, Szczecin 70-383, Poland, e-mail: kaz@univ.szczecin.pl

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Key words: Global Positioning System, Coastal changes, Dune coast

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CARTOGRAPHIC VISUALIZATION IN THE REAL ESTATE MARKET INVESTIGATION WITH THE USE OF GIS TOOLS (0044)

Patrycja Pochwatka[1], Tomasz Teterycz[2], Urszula Litwin[3], Agnieszka Bitner*[4]

The analysis of spatial data requires many operations in order to obtain new information contained in the data. Automation of the analytical process makes the process easier and shortens the time needed for obtaining the information. There are two ways to automate tasks in ArcGIS: using Python as a programming language and applying ModelBuilder. ModelBuilder enables creating geoprocessing models and scripts, which are presented graphically [1]. Models created by users can be added to a tool box and used for creating other models and scripts.

This paper presents a model created with the use of ModelBuilder, which is applied to the analysis of the real estate market of urbanized areas. The model enables visualization [2] of the spatial distribution of land prices. There are the following input data: property location, its unit price and location of the centre of the city. As a result this model provides average property prices in a series of concentric circles located around the centre of the city. This way we are able to assess the impact of the distance from the city centre on property prices. It is easy to modify the model and to change its parameters, for example the width of the circles. The model can be applied to various types of real estate property.

The application of the model is shown in the example of the city of Lublin. The analyzed area comprises the North-Western part of Lublin. The analysis began with the delimitation of the point, which was the centre of the city. It was a crucial stage of the analysis as the correctness of delimiting that point determined the correctness of the further analysis. In the case of Lublin it was difficult to indicate such point unequivocally because the area of the city centre comprised several locations which could be considered to be central. The centre of the city of Lublin covers quite an extensive area, which extends from the Castle Square to the end of the elegant Krakowskie Przedmiescie Street. The distance between the uppermost points of this area is almost 1,5 km. Therefore three methods were used to delimitate the centre of the city: (1) geometrical – the centre of the city is the centre of gravity of the polygon comprising the area of the city, (2) surveys – the respondents could choose from among seven answers, (3) the analysis of historical documents and maps. Eventually, the centre of the city was delineated mainly thanks to the use of the third method.

The transactional data come from notarial deeds and they pertain to unbuilt land designated for

[1] Department of Environmental Engineering and Geodesy, Faculty of Production Engineering, University of Life Sciences in Lublin, Lublin, Poland, e-mail: patrycja.pochwatka@up.lublin.pl
[2] Department of Agricultural Land Surveying, Cadaster and Photogrammetry, Faculty of Environmental Engineering and Land Surveying, University of Agriculture in Krakow, Krakow, Poland, e-mail: t.teterycz@tlen.pl
[3] Department of Agricultural Land Surveying, Cadaster and Photogrammetry, Faculty of Environmental Engineering and Land Surveying, University of Agriculture in Krakow, Krakow, Poland, e-mail: u.litwin@ur.krakow.pl
[4] Department of Agricultural Land Surveying, Cadaster and Photogrammetry, Faculty of Environmental Engineering and Land Surveying, University of Agriculture in Krakow, Krakow, Poland, e-mail: rmbitner@cyf-kr.edu.pl

single and multifamily housing. The transactional data were verified before they were entered into the model. Any transactions that could not be treated as free-market ones were removed from the database. The transactional data come from the period between January 2014 and October 2015 and they were obtained from The Register of Prices and Values for Real Estates kept by the Office of Geodesy and Cadastre for the City of Lublin. The analysis revealed that the land prices considerably decline as the distance of the land from the city centre increases. Additionally an increase in property prices was observed in the circles located in a radius of about 5 km from the city centre. The model made it much easier to obtain real estate market information and it will provide a useful tool for further analyses.

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Key words: Real estate market analysis, Geospatial analysis, Urban areas, Data Visualization, GIS applications

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COKRIGING METHOD IN THE MAPPING OF LAND VALUE (0011)

Radosław Cellmer*[1], Sabina Źróbek[2]

It is proved that information about prices and real estate values significantly determines the effectiveness and relevance of the decisions concerning the management of real estate. The real estate market is created by complex processes in both spatial and non-spatial, which together affect the level of value and as a result the level of real estate prices. They depend not only on location but on many elements of both exogenous and endogenous too, which must be taken into account in the analysis of the market. In fact, a market analysis should lead to determine the impact of location factors, which form the basis of cartographic visualization of real estate values. The values of the land presented in the cartographic form may be the result of spatial interpolation transaction price using both methods of deterministic and geostatistical using, for example, the phenomenon of spatial autocorrelation. Their use, however, faces some limitations, among others with insufficient number of sales transactions and their irregular distribution on the area under consideration. The solution to this problem may be the use of hybrid models, which assume that the primary variable is correlated with certain features of the space that can be identified at each point of the analyzed area.

The study area was the city of Olsztyn in north-eastern Polish. In the first stage of empirical research the land value map was created using ordinary kriging. There are a number of imperfections such studies. Problems relate to the interpretation of land value in such case results from individual characteristics of the real estate as well as irregular spatial distribution of data. In areas where market activity is low, the result of spatial interpolation does not bring reliable information about the value of the land.

In the second stage of research, on the literature background (eg. Chica-Olmo 2007; Hengl et al. 2007, Subramanyam, Pandalai 2017) the general principles of geostatistical models with additional variables were presented. These variables in that case have continuous nature, which results from the characteristics of the site.

Additional variables can be used to cokriging, if they are significantly correlated with the main variable (unit price). Thus, in the course of empirical regression model was built with the price as the dependent variable and the explanatory variables representing the spatial conditions (the intensity of the building, distance from specific places and objects, accessibility, etc.). In addition, the model takes into account area of the parcels and the specific function (single or multi-family buildings). This model has allowed for the development of the theoretical distribution of the value of land in the city. This distribution were obtained by summing up the raster layers obtained on the basis of the distribution of the explanatory variables. The values from obtained resulting raster layer were then used as an additional variable in the spatial interpolation with the use of cokriging method. This

[1] University of Warmia and Mazury in Olsztyn, Poland, e-mail: rcellmer@uwm.edu.pl
[2] University of Warmia and Mazury in Olsztyn, Poland, e-mail: zrobek@uwm.edu.pl

made it possible to adjust the distribution of the worth of land in such a way as to reflect not only the price of the transaction but also the spatial conditions related to a specific location. The paper presents the results of experiments in which the interpolation of transaction prices by ordinary kriging and cokriging were compared. Presented procedure may be an alternative for the construction of models of regression-kriging, which use the method of successive iterations (Hengl et. Al. 2007), and the results indicate that it may have particular application in situations where it is necessary to extrapolate the valuables out of the presence of transaction.

As an additional research universal kriging and kriging with external drift were also used. Some of cartographic elaborations showing the value of land in urban areas in conditions of irregular disposition of the transaction is the result of the study. The results indicate that the integration of data and use of information about spatial correlations of variables provides the additional information about the value of the land and can be more reliable and thus more useful in the real estate management.

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Key words: geospatial analysis, market research, urban areas

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COMPARATIVE ANALYSIS OF 3D MODELS MADE WITH VARIOUS TECHNOLOGIES ON THE EXAMPLE OF ALTAR IN THE WANG TEMPLE IN KARPACZ (0088)

Michał Strach*[1], Paulina Lewińska[2], Alicja Tama[3]

The aim of this paper is a scientific description and comparative analysis of 3D models made on the basis of photographs from a nonmetric digital camera. Models were created with the use of two software's: Agisoft Photoscan and Context Capture. Obtained point clouds were later compared with point clouds from terrestrial Z+F laser scanner. Bentley Pointools software was used for this porpoise. The object used for this study was the alter of Wang Temple in Karpacz.

Mountain Church Of Our Savior in Karpacz, commonly known as Temple Wang, was built at the turn of the twelfth and thirteenth century in the village of Wang, in Norway. It is an example of Scandinavian wooden sacred architecture. The largest decoration of the building is the altar located in the central part of the church, which symbolism refers to the culture of Non-Christians from XII century, northern Europe. Fragments of the altar, were used for assessment of the accuracy of mentioned software's.

Initially, for the propos of creating the 3D models of the altar in Wang temple, two software's were used (Agisoft Photoscan, Context Capture), which perform photogrammetric processing of digital images and generate 3D spatial data. In order to build the 3D models of the structure, programs require minimum of two, correctly done photographs of the object. Correctly done means, among others, taking photographs with minimum 60% coverage between them. It is also important to take photographs parallel to the object and avoid camera rotation.

To build 3D models, 35 photographs were taken with Fujifilm camera (S4200 model). Photographs were made from four base lines. Between them was kept a few meters distance. Working with Agisoft Photoscan and Context Capture, it was important to set appropriate value of various parameters during all processes. In case of Agisoft Photoscan, the most important operations were: „Align Photos", „Build Dense Cloud", „Build Mesh" and „Build Texture". Second software – Context Captures workings were based on "Aerotriangulation", „Build Mesh" and „Build Dense Cloud" processes. In this case "Aerotriangulation" stands for similar process as „Align Photos" – finding pares or groups of photographs that can be used for creating stereoscopic effect, this process also includes finding tie points – explicit elements visible on at least two aligned photographs. Third software - Leica Cyclone was used to combine/register all point clouds dome during laser scanning season and create one, single point cloud for further purposes. Used point clouds were obtained from the measurements done with Z+F laser scanner.

The comparative analysis has been considered with regard to three aspects: stretches, that occur at the edges of objects, the accuracy of fit points in the model and measured the length of the same

[1] AGH University of Science and Technology, al. Mickiewicza 30, 30-059 Kraków, email: strach@agh.edu.pl
[2] AGH University of Science and Technology, al. Mickiewicza 30, 30-059 Kraków, email: lewinska.paulina@gmail.com
[3] AGH University of Science and Technology, al. Mickiewicza 30, 30-059 Kraków, email: alicja.tama@gmail.com

section of the models. For comparison purposes, object such as altar, cross, font and pulpit were used. All analysis were done in Bentley Pointools, where the point cloud from Leica Cyclone and 3D models from Agisoft Photoscan and Context Capture were compared. This point cloud was used as a base since the accuracy of used scanner falls within mm and is decisively smaller than error of clouds done with photographs.

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Key words: accuracy, architecture, data analysis, object oriented modeling, process modeling

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COMPARING THE EFFECTIVENESS OF ANNs AND SVMs IN FORECASTING THE IMPACT OF TRAFFIC-INDUCED VIBRATIONS ON BUILDINGS (0053)

Anna Jakubczyk-Gałczyńska*[1], Adam Kristowski[2], Robert Jankowski[3]

Traffic – induced vibrations may cause damage to structural elements and may even lead to structural col-lapse. Laborious and costly measurements shall be performed in order to determine the impact of vibrations on structures.

The aim of the article is to compare the effectiveness of methods of forecasting the impact of vibrations on buildings using the machine learning methods. The paper presents two alternative algorithms: Artificial Neural Networks (ANNs) and Support Vector Machines (SVMs).

According to the authors' knowledge, the machine learning has not been applied so far to estimate impact of traffic-induced vibrations on buildings in relation to the Polish standard PN-85 B-02170 *Evaluation of the harmfulness of building vibrations due to ground motion* [3]. Vibration studies to determine the influence are performed for regular loadings, i.e. occurring above 30 minutes a day. During the performance of tests, different measuring situations were classified according to the specific criteria, which were later applied to build a system based on ANNs and SVMs. Then, the analysis was performed according to the standard [3]. Depending on the size of vibrations, the resulting chart is located in one of the five zones of danger. Data collected by the Geo-graphic Information System (GIS applications), for example a type of soil on which the building is erected, are the important element to determine the input parameters.

The construction of the ANNs was based on the factors described in [2, 3, 5]. The first step was to create the database. Then, the network itself was created [4]. Factors that may affect traffic-induced vibrations, such as distance, type of soil, building condition, condition of the road surface and type of the vehicle, were adopted. Various networks were created in the *Statistica Data Mining* program. For each network 48 samples (70 % - learning samples, 15 % - verifying samples and 15 % - testing samples) were adopted. All neural networks with one hidden layer were created. They were different from one another by the number of neurons in the hidden layer and internal function.

SVM is one of the techniques of machine learning. The aim of SVM is to solve the optimization problem by minimizing the target function. The algorithm of SVM was used to solve the optimization problem, which was a minimized margin (soft margin) [1]. It was established by two classes of sets: a set of variable for which there is a risk of impact of vibrations and safe cases set. Example cases were used to create algorithm of SVM in the *Statistica Data Mining* program. For each model,

[1] Department of Metal Structures and Construction Management, Faculty of Civil and Environmental Engineering, Gdańsk University of Technology, G. Narutowicza 11/12, 80-233 Gdańsk, e-mail: annjakub@pg.gda.pl
[2] Department of Metal Structures and Construction Management, Faculty of Civil and Environmental Engineering, Gdańsk University of Technology, G. Narutowicza 11/12, 80-233 Gdańsk,, e-mail: kristowski@pg.gda.pl
[3] Department of Metal Structures and Construction Management, Faculty of Civil and Environmental Engineering, Gdańsk University of Technology, G. Narutowicza 11/12, 80-233 Gdańsk, e-mail: jankowr@pg.gda.pl

48 cases (70 % - learning samples, 15 % - verifying samples and 15 % - testing samples) were adopted similarly as for ANNs.

The results of both methods are similar. However, after a thorough analysis, it turned out that the SVM method is more reliable, since more number of cases were classified correctly. Anyway, the results show that methods of machine learning might be a good tool to estimate the impact of traffic-induced vibrations on residential buildings.

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Key words: vibrations, machine learning, buildings

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COMPARISON OF MODERN TECHNOLOGIES USED FOR RAW MATERIALS VOLUME DETERMINATION (0065)

Jūratė Sužiedelytė Visockienė[1], Romuald Obuchovski*[2], Dominykas Šlikas[3], Arūnas Būga[4], Raimundas Putrimas[5], Darius Popovas[6]

One of the most frequent problems being solved by surveyor is a volume estimation of raw material piles; however these piles are difficult to measure due to their size, difficulty of traversing, and non-uniform shapes. Traditional measurement methods like GNSS, terrestrial and airborne laser scanner or total station are widely used for this purpose. Accuracies and performance of traditional instruments are well known and sufficient for very precise volume determination. With introduction of new modern digital image processing applications the photogrammetric measurement method is regaining its popularity and is used more often. The relatively low price and data capture simplicity of close range photogrammetry, makes it very attractive tool for data capture and analysis. Authors have used reality modelling software from Bentley. 3D models were created by using photogrammetric method to process sets of overlapping photographs. Relative simplicity has made photogrammetry a cost effective way to create 3D objects without employing expensive laser scanners or other instruments. Photogrammetry is now replacing digital elevation model data as the accuracy of modern digital cameras improves and digital photogrammetry is able to generate a much higher resolution and accuracy for 3D models. Photogrammetric 3D modelling system is a low-cost, automated sensor technology which is evolving in the many directions and being used in many engineering fields. By using this modern reality capture technology authors provide fast, straightforward, and accurate 3D modelling of objects and their volume determination. This paper presents an analysis and comparison of several surveying methods used for raw material volumes determination. The methods were compared using several criteria, namely: efficiency, performance, degree of automation and accuracy achieved in relation to the system costs. Also insights on advantages and disadvantages of analysed methods and instruments are presented along with recommendations for users.

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Key words: geodesy, size measurement, digital cameras, digital photography

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[1] Vilnius Gediminas Technical University, Lithuania, e-mail: jurate.visockiene@vgtu.lt
[2] Vilnius Gediminas Technical University, Lithuania, e-mail: romuald.obuchovski@vgtu.lt
[3] Vilnius Gediminas Technical University, Lithuania, e-mail: dominykas.slikas@vgtu.lt
[4] Vilnius Gediminas Technical University, Lithuania, e-mail: arunas.buga@vgtu.lt
[5] Vilnius Gediminas Technical University, Lithuania, e-mail: raimundas.putrimas@vgtu.lt
[6] Vilnius Gediminas Technical University, Lithuania, e-mail: darius.popovas@vgtu.lt

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COMPARISON OF QUALITY OF METRIC PHOTOS RELATIVE ORIENTATION IN MICMAC AND PHOTOSCAN (----)

Krystian Pyka[1]

This article presents the results of the study of the aerial photography relative orientation based on the automatic matching according to the SIFT algorithm. The purpose of the study was to determine whether this matching method could replace older but well-proven methods used in classical photogrammetry, using specialized metric cameras. As a measure of quality, the standard deviation of y-parallax and the mean errors of orientation parameters were used.

The study was conducted on one pair of aerial photographs, but both original photographs and photos processed by various methods were tested, resulting in a total of 6 data sets. Automatic tie point detection was performed in Micmac and PhotoScan, representing open source and proprietary applications. On the basis of the received tie points, relative orientation was calculated using the method known in classical photogrammetry, where the parameters are two angles of orientation of the first image and three angles of the other image. With PhotoScan, the ability to control the number of tie points was used, which increased the set of tests by 5 variants for each of the six sets.

The study shows that both SIFT implementations leave a number of fatal errors, even of a few dozen pixels, and in some cases, of even more. Due to the considerable advantage of good tie points, fatal errors deform orientation parameters only slightly. However, from the point of view of the requirements of relative orientation in classical photogrammetry, it is inappropriate to leave such errors in a set of tie points. The y-parallax equation used in the studies enables us to detect not only flawed fatal errors but also tie points of poorer quality. After elimination of the worse tie points, in most cases, the mean y-parallax error is less than or close to 1/3 pixel, which is expected in classical photogrammetry. The study has shown that a image pre-processing can produce both positive and negative effects on the quality of relative orientation. Poor results were obtained for smoothed and reduced resolution images. Replacing color photos with black and white photos has no effect on the quality. Changes of local contrast with wavelet method for controlling the number of tie points have also been rated as positive.

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Key words: Stereo image processing, Image filtering, Object detection

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[1] AGH University of Science and Technology, Krakow, Poland, e-mail: krisfoto@agh.edu.pl

COMPLEX MONITORING OF THE COASTAL CLIFF'S ON THE EXAMPLE OF CLIFF IN JASTRZEBIA GORA, POLAND (0029)

Rafał Ossowski[1], Paweł Tysiąc*[2]

Coastal cliffs could be divided into three different types of the cliffs in the matter of abrasion activity. First, we call an active cliff- which is placed in the zone where the waves which are coming from the sea have its influence on the susceptibility of the cliff. Secondary, an inactive, when the cliff is placed in a zone besides the influence of the abrasion factors, and the last one- "rejuvenated" cliff, when the cliff stay inactive, but could be sensitive to degradation because of the terrain level decreasing, increasing the sea level or periodically in the time of the storms.

In Poland, the protection of the coastal cliffs is a major issue, because in the past several years, the change of the climate could be noticed. In the results of this process, the detrimental factors like intensification of the sea waves forces or growth of storms frequency appears. The results of these actions could be observed in progressive degradation of the cliffs.

The mean regression of the study object which is seacliff in Jastrzebia Gora, exalt over a 1.5 meter in the scale of the year based on the information provided by the Institute of Hydroengineering of Polish Academy of Sciences PAN in Poland. Besides of natural factors causing the degradation, there is also an anthropogenic activity, which speed up the abrasion process.

The Jastrzebia Gora cliff abrasion process in last 30 years was decribed in paper [2]. There were several attempts to use different engineering solutions to reinforce the cliff's slope, but none prevailed the forces of nature. The problem of estimation of geotechnical stability of the cliff is a complicated one, due to several factors: sea storms hydrodynamic impact, water flow through the cliff body and human engineering activity.

Based on these informations, the monitoring of the cliffs susceptibility is important, not only in reference to its geometry but also for geomorphological aspects. In case of the geometry monitoring, there are many forms to claim the regression of the cliffs [3], [4]. The most precise and accurate is the use of the laser scanning technology, which is grounded on the creating the model of the terrain, where the analysis could be performed. There are many forms of using this technology to monitor the cliffs, including the new approach in Poland, described in the article [1].

The main goal of this paper is to propose the accurate and cost-efficient application for cliff monitoring and degradation prediction places by using the example of the cliff in Jastrzebia Gora, while the results clearly demonstrate that the proposed approach could be very useful in creating area development plans, valuation of risk by coastal erosion or preservation of highly appreciated landscape.

[1] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Geotechnics, Geology and Marine Civil Engineering, Narutowicza 11-12, 80-233 Gdansk, Poland, e-mail: ross@pg.gda.pl
[2] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Geodesy, Narutowicza 11-12, 80-233 Gdansk, Poland, e-mail: pawel.tysiac@pg.gda.pl

The described methodology takes into account the geological structure of the cliff, which is specific for polish coast. The crossection of the cliff shows almost horizontal strata of soils, slightly inclined west, composed of layers of sandy clays, sands, clayley and silty sands. Some aspects of modeling the geotechnical stability of the cliff are discussed as well.

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Key words: LiDAR, terrestrial laser scanning, photogrammetry, seacliffs monitoring, geomorphology

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CYBERDOG – K-9 MONITORING AND CONTROL SYSTEM FOR LAW-ENFORCEMENT FORCES SPECIAL ACTIVITIES (0041)

Maciej Wrona[1], Marcin Szoucha[2], Mariusz Kastek[3], Piotr Sienkiewicz[4], Marek Grzelec[5]

This paper describes preliminary results of the interdisciplinary research and development venture. General idea of the project comes from boarder control and law-enforcement forces whose big scope of work is related with K-9 dogs activity. The main functionality of the system is to monitor and control the K-9 dog during high level risk operations.

The main task of the project is to develop remote solutions that support dogs guide during different special activities. According to the law-enforcement operational procedures, system has been designed basing on three different modules: special dogs electronic vest, mobile command center and supporting UAV (Unnamed Airborne Vehicle) platform. Project integrates such technologies as GNSS (Global Navigation Satellite System), IMU (Inertial Measurement Unit), TLS (Terrestrial Laser Scanning) and UAV platforms as a support device. The biggest challenge of the project is to develop official training and operational procedures suitable to the applied technology. The first stage of validating the low TRL (Technical Readiness Level) version of the system includes laboratory tests with different measurement, communication and computation devices expected to be a part of the final version of the system (at the final TRL). Three-dimensional spatial mapping for room recognition purposes is one of the required functionalities of the electronic vest. First laboratory tests were taken with 3d spatial mapping tools based on structural light and mobile and terrestrial laser scanning. The main task of these tests was to establish the best performance and quality in relation to weight and spatial capacity. Second set of tests has been taken with GNSS method to establish efficient and disturbances-free positioning system. Testing process contains different receivers (single and multi-frequency) and positioning methods (DGNSS – Differential GNSS; SPP – Single Point Positioning; RTK – Real Time Kinematic) expected to be used for positioning of CYBERDOG system modules (dog's vest, guide, crew, mobile command center and UAV). Optical video modules designed specially for project purposes have been tested.

The big part of present work is to develop standards for communication method between the dog and the guide. According to present training scenarios, special dogs are being learned to communicate with the guide by gestures. For example, when the special dog finds a required object, it does not bark (because it may induce bomb exploding), but communicates this fact to the guide by sitting still next to the object. On the assumption of remote presence of a guide during the action, this gestures need to be recognized to provide bidirectional communication. For this

[1] Military University of Technology, Warsaw, Poland, e-mail: maciej.wrona@wat.edu.pl
[2] Military University of Technology, Warsaw, Poland
[3] Military University of Technology, Warsaw, Poland
[4] Military University of Technology, Warsaw, Poland
[5] Military University of Technology, Warsaw, Poland

purpose set of IMUs are being used for dogs gestures recognition and interpretation with simple machine learning methods. Testing procedures, scenarios and results are presented. Global result of the described tests shows potential of using the multi-sensor equipment for remote geospatial recognition, measurement and communication during K-9 special activities.

General concept of the system and the results of preliminary tests of special dogs electronic vest are described in this paper. Possibilities of project application areas are also shown here in details.

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Key words: GNSS, IMU, TLS, UAV, RTK

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DESIGN OF GEODETIC NETWORKS USING CONTROLLED COMPUTER SIMULATION (0016)

Paweł Postek*[1], Wojciech Pachelski[2]

The topic of design of geodetic networks covers many aspects involving parameters and geometry of a network. However, all geodetic networks seem to share a superior goal, which is to meet the established network quality criteria, namely accuracy, reliability and cost. For this purpose, it is recommended to carry out an optimization, where those criteria become the boundary values that determine the calculation process. The observation plan, co-responsible for the configuration of the network is one of the elements undergoing optimization. The dominant purpose of this paper is to discuss the possibility of using the controlled computer simulation in a process of optimization of the observation plan, as an alternative for numerous analytical methods. The conducted research was based on the software developed by the authors themselves, the functionality of which allows making simulated optimizations by using two principal methods - adding observation data to the set that does not have any observations and by subtracting of observation data from the set of a maximum number of uncorrelated observations. What is more, the research results that were based on optimization of many geodetic networks, originally designed for implementing of specific construction and assembly works, show high efficacy of both optimization methods for the reduction of the high number of observations. The example of one of the networks is going to be presented. Additionally, practical considerations are included with a specific purpose of answering the question of which of the methods is more effective.

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Key words: Computer simulation, Design optimization

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[1] University of Life Science, Faculty of Production Engineering, Akademicka 13, 20-001 Lublin, Poland, e-mail: pawel.postek@up.lublin.pl
[2] Military University of Technology in Warsaw, Faculty of Civil Engineering and Geodesy, Kaliskiego 2, 01-476 Warsaw, Poland, e-mail: wojciech.pachelski@wat.ed.pl

DETERMINATION OF LAND DEGRADATION FOR SUSTAINABLE DEVELOPMENT OF MUNICIPAL TERRITORIES (0083)

Velta Parsova*[1], Anda Jankava[2], Irena Kukule[3]

Land is a non-renewable resource with limited accessibility which implies that the question of the quality preservation of land usable resources, comprehensive and sustainable land's use is very important. Because of different economic activities and the influence of natural conditions, land and soil degradation process has been observed which has led to the formation of degraded territories. Degraded territory is land which has been damaged by either industrial and other activities or no activities at all to the stage where any economic activity is impossible unless special renewable measures have been made. One of the aims of sustainable environment resolutions adopted by the United Nations General Assembly on 25 September, 2015 was 'to restore degraded land and to aim to achieve having a world neutral to land degradation'[1]. This is the first worldwide document where universal and comprehensive actions regarding land degradation are provided. The problem has been defined on international and European levels, but also it is a very topical problem in Latvia. Regarding the risks of land degradation and their prevention in Latvia, Land Management Law has come to force on 1 January, 2015. The law defines the term of land degradation and obliges local authorities to display degraded territories on territorial planning documents, while land owners are obliged to carry out prevention measures of land degradation. But, despite the law, specific criteria or classification to identify land and soil degradation in Latvia is still not designed or approved, as well as there is not a regulation of how to find and evaluate a degree of current land degradation or its possibility while taking into account current and planned types of land use or how to determine land degradation prevention measures. From 2018 the government is obliged to make a review every 5 years including the information about degraded territories and the areas they are covering. Obligations regarding the determination of degraded land and responsibility of their formation and prevention measures are included in the Land Management Law. But taking into account the fact that there are not any unequivocal criteria, the determination of degraded land is subjective and it is not comparable at national or municipal level causing great incomprehension between land owners, local authorities and the state. The aim of the study is to develop scientifically based proposals for the identification of land and soil degradation so it would be possible to classify and evaluate land degradation in Latvia, as well as to develop the sequence of gradual prevention of those processes. The proposals serve as the basis for development of corresponding regulations of the Cabinet of Ministers delegated by the Land Management Law. To achieve this point, information about types and signs of present land and soil degradation has to be summarized. The authors of the study have evaluated the information about land degradation in regulations of Latvia and how degraded territories are

[1] Latvia University of Agriculture, Latvia, e-mail: velta@parsova.lv
[2] Latvia University of Agriculture, Latvia, e-mail: anda.jankava@llu.lv
[3] Latvia University of Agriculture, Latvia, e-mail: irena.kukule@llu.lv

displayed in territorial plans of local authorities. They also have researched international experience and have had discussions and interviews with competent specialists in public institutions of Latvia. The results of earlier studies in Latvia show that degraded land does not have one significant sign which would allow determining it as a “typical” degraded territory. Each territory has some differences which may vary because of different location, different kinds of land pollution, problems with accessibility to the land and many more. Furthermore, it is impossible to fully use the experience of other countries when developing the determination criteria of land degradation. For example, in our neighboring country Lithuania [2], research activities are mostly related to soil not land degradation which is a wider problem and covers both rural and urban territories. After the surveys carried out in Riga city territories it was recognized that signs for the determination must be chosen differently for each city because of different environment and needs. Thereby, analyzing a functional aspect, it was possible to divide land degradation in the following types: non-effectively used industrial territories; former military territories; residential buildings in critical conditions; former landfills – polluted areas; abandoned or non-effectively used territories of transport infrastructures etc. [3] The determination of degraded territories (also objects) is a very essential part of territorial and land use planning which is strongly related to the implementation of sustainable development programs and the planning of further actions in all municipalities. But display of degraded land in territorial plans and determination of their use requirements and restrictions is not enough. It is necessary to develop a special strategy, guidelines or a program, a special complex of measures which contribute to restoration and development in order to revitalize degraded territories [4].

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Key words: degradation, environment, land use planning, soil, sustainable development

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DIGITAL ZENITH CAMERA'S RESULTS AND ITS USE IN DFHRS V.4.3 SOFTWARE FOR QUASI-GEOID DETERMINATION (0054)

Katerina Morozova*[1,2], Ansis Zarins[3], Janis Balodis[4], Augusts Rubans[5], Reiner Jaeger[6]

Design of digital zenith camera in Institute of Geodesy and Geoinformatics of the University of Latvia commenced in 2010. During these years the prototype of digital zenith camera has been developed. Now, after tests of a prototype, improvements of design and manufacturing of the second version, it has reached operational status. This paper describes the construction of digital zenith camera, features of its control software. The results of vertical deflections' measurements are discussed. At the moment measurements are done in Riga region and are used in DFHRS v.4.3 software in order to check and improve local quasi-geoid model. It's a new method of quasi-geoid model determination and has not been used in Latvia before.

DFHRS (Digital Finite element Height reference surface (HRS)) v4.3. software has been developed by Karlsruhe university, Institute of Applied Research. It is based on parametric modeling of the HRS as a continuous polynomial surface. The access to the parametric HRS model is enabled by DFHRS_DB data-bases and access-software, which allow direct conversion of GNSS-heights *h* into physical normal heights H. DFHBF_DB stores polynomial p parameters.

DFHBF v4.3 includes all types of geometrical input data: both ellipsoidal and normal/orthometric heights, geoid/quasi-geoid heights, vertical deflections, derived from Earth Gravitational Model (EGM 2008) or grids, and observed vertical deflection measurements, as well as gravity data derived from EGM2008.

Analysis of impact of vertical deflection's measurements on local quasi-geoid model determination for Riga region is presented.

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Key words: digital zenith camera, DFHRS, EGM2008, quasi-geoid determination

[1] University of Latvia, Institute of Geodesy and Geoinformatics, Boulevard of Rainis 19, LV-1586, Latvia e-mail: katerina.morozova@lu.lv
[2] Riga Technical University, Faculty of Civil Engineering, Kalku street 1, LV-1050, Latvia e-mail: katerina.morozova@edu.rtu.lv
[3] University of Latvia, Institute of Geodesy and Geoinformatics, Boulevard of Rainis 19, LV-1586, Latvia e-mail: ansiszx@inbox.lv
[4] University of Latvia, Institute of Geodesy and Geoinformatics, Boulevard of Rainis 19, LV-1586, Latvia e-mail: janis.balodis@lu.lv
[5] University of Latvia, Institute of Geodesy and Geoinformatics, Boulevard of Rainis 19, LV-1586, Latvia e-mail: augusts.rubans@lu.lv
[6] Hochschule Karlsruhe – University of Applied Sciences, Institute of Applied Research, Moltkestrasse 30, 76131, Karlsruhe, Germany e-mail: reiner.jaeger@web.de

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DIRECT TESTING OF THE DIGITAL IMAGE CORRELATION SYSTEM ACCURACY USING STRAIN GAUGES (0010)

Andrzej Rutkiewicz*[1], Edyta Kowalska[2], Małgorzata Szumiło[3]

The paper presents an empirical study on the usefulness of the Digital Image Correlation (DIC) measurement system in civil engineering material tests. The photogrammetric technique, due to its advantages of the whole surface measurement in a contactless way, can oust methods established for decades in material testing such as the mechanical (MSG) and electrical resistance strain gauges (ERSG). The only limitation is the accuracy and precision of the system, which was studied in the paper by combining three of the above mentioned measuring methods in one uniaxial tension test on a stainless steel rod of dimensions 100x20 mm^2. The specimen was prepared by gluing the ERSG to the surface and mounting the MSG. The remaining free area was sprayed in order to obtain the stochastic pattern necessary for the DIC. The specimen was gradually tensioned in a testing machine, recording values of linear technical strains and linear displacements between reference points, and taking pictures by the system at each loading step (three per step). The tests were performed four times, in two cases the DIC was positioned directly in front of the analyzed surface and in another two, at a 45 degree angle between the surface and the cameras main axe.

After the tests, an analysis of results was performed in which the readouts of the ERSG were considered as exactly precise (accuracy at least a hundred times greater than two other devices) and the results of the MSG and the DIC system were compared to it. With such assumptions, the relative error (RE) and relative standard deviation (RSD) calculations of each loading step were performed. Additionally, the calculations of the DIC were performed utilizing different facet network size (15; 30; 45 pix), five facet sizes (19x19; 29x29; 38x38; 48x48; 57x57 pix^2) and three different lengths of measurements – distances between reference points (5; 10; 20 mm). The settings were analyzed in order to find the most accurate and precise DIC adjustment.

The analysis of all four tests for every load step showed that the limit for sufficient linear technical strain readouts is $35*10^{-5}$ (i.e. a displacement of $1{,}75*10^{-5}$ m on a distance of 0,05 m) in case of utilized DIC system. For values greater than the limit, the RE maximal values did not exceed 10,3 % with a mean value of 4,13 % and median of 3,82 %. The RSD maximal value was 7,4 %, the mean value was 1,91 % and the median was 1,91 %. This values are sufficient for testing materials such as wood, steel or concrete and enables the DIC to be a substitute of the currently established two methods. In case of the internal system settings, the minimal subset size for minimalization of the RE

[1] Faculty of Geodesy, Geospatial and Civil Engineering, University of Warmia and Mazury, Oczapowskiego Street 2, 10-719 Olsztyn, Poland, e-mail: andrzej.rutkiewicz@uwm.edu.pl
[2] Faculty of Geodesy, Geospatial and Civil Engineering, University of Warmia and Mazury, Oczapowskiego Street 2, 10-719 Olsztyn, Poland,
[3] Faculty of Geodesy, Geospatial and Civil Engineering, University of Warmia and Mazury, Oczapowskiego Street 2, 10-719 Olsztyn, Poland,

is 29x29 pix^2 - incensement has an insignificant influence, while using smaller sizes decreases the accuracy. The subset size for minimalization of the RSD is 57x57 pix^2. The facet step is optimal for 15x15 pix^2, as manufacturer claimed - increasing it does not decrease the RE and RSD. Finally, the measurement length was influencing negatively the RE and RSD when using 5 mm distance, therefore a length of at least 10 mm or 20 mm ought to be utilized.

The performed tests proved that the system is able to perform valuable tests on structural materials such as wood, steel, aluminum and concrete, where the values of first readied strains are greater than $350*10^{-5}$. The literature review presents that such tests are performed, where the DIC system plays a supporting role to the MSG and ERSG, and the consistency between the systems is great [1, 2]. In case of the RE and RSD analysis when considering system settings, the literature review on DIC confirmed similar tendencies in other authors tests -see [3, 4].

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Key words: image analysis, strain measurement, materials testing

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E-KNOT – E-GNSS KNOWLEDGE TRIANGLE H2020 PROJECT, GALILEO CALL (0120)

Karol Brzostowski*[1], Fabio Dovis[2]

Several studies and surveys highlighted that one of the main obstacles for the development and sustainability of the European space industry (and the delivery of cutting-edge scientific achievements) is the lack of scientists, engineers and technicians with specific interest on the area of space research and development.

Galileo, EGNOS and the satellite navigation field at large, are as well affected by this lack of skills and competence, and looking at the topic from an end-users perspective, space is only a part of a more complex knowledge system, needed to exploit the satellite navigation opportunities. Communications, applications development skills, creativity, and business competences are as relevant and essential to leverage on the Galileo and EGNOS initiative to make Europe a credible player in this international context and satellite navigation a concrete asset for the European economy in terms of innovation, market development resulting in job creations. With respect to the growing competition and resource optimization the sustainable success of industry is crucially linked to effective identification and transfer of knowledge, innovative technologies and available solutions.

The scope of the e-KNOT project is to strengthen the interaction between the areas of education-research-industry in Europe, leveraging on past activities already undertaken in this field, in order to consolidate a strong EGNSS knowledge triangle, i.e. a solid network for the creation of a critical mass involving the relevant actors in the three areas with the final objective of supporting the European economy development.

The project approach is in line with the general policy of the H2020 programme, for the capacity building and critical mass creation in strategic areas, so to increase Europe competitiveness and attract investments from outside Europe. In GNSS this can only be realized by investing on a strong coordination among universities, research centers and industry to fill the gap with respect to other areas of the world.

The focus of the e-KnoT project is on the innovation transfer to industry, the support to the creation of innovative downstream applications and the consolidation of the links and of the initiatives beyond the project duration.

e-KnoT relies on concrete results of previous projects in this field of Education in GNSS and on educational initiatives already in place in Europe, and it implements concrete actions and events for companies, students and professionals.

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Key words: Global Navigation Satellite System, knowledge transfer

[1] Astri Polska sp. z o. o., Warsaw, Bartycka str. 18A, Poland, karol.brzostowski@astripolska.pl
[2] Politecnico di Torino, corso Duca degli Abruzzi, Italy, Fabio.dovis@polito.it

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ELECTRIC VEHICLE CHARGING TERMINALS LOCATION - PROPOSAL OF AN ALGORITHM SUPPORTING DECISION MAKING PROCESS (0097)

Marek Walacik*[1]

Development of different forms of mobility that are sustainable, energy-efficient and respectful for the environment has become significantly important nowadays due to a number of worldwide initiatives aiming at decarbonizing transport or supporting green energy increase. Technical innovation including electric vehicles or intelligent transport contribute to achieve this goal. In order to make electric vehicles possible one of the most important aims that have to be accomplished is the provision of charging terminals infrastructure. The following paper presents the proposal of an algorithm supporting decision making process of electric vehicles charging terminals location. The process of algorithm formation required multi-faceted and multi-criteria analysis including technological and procedural requirements of terminal location (analysis of source materials), analysis of areas excluding terminal location (method of deductive reason), analysis of preferable location factors (questionnaire studies). All the analysis were carried out with the support of GIS tools and the methods of assessment and valorization of the landscape. In order to indicate the possibility of a preliminary determination of terminal location the Bajerowski method based on cartographic research was proposed.

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Key words: sustainable development, renewable energy sources, data analysis, electric motors

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[1] The University of Warmia and Mazury, Prawochenskiego Street 15, Olsztyn, Poland, e-mail: marek.walacik@uwm.edu.pl.

ENVIRONMENTAL EFFECTS FROM SANDS-GRAVELS EXPLOITATION IN ALBANIAN RIVERS BEDS (0076)

Ylber Muceku[1]

The Albanian area is crossed by a dense of rivers network and their tributaries, as Drini, Buna, Kiri, Mati, Ishmi, Erzen, Shkumbini, Semani, and Vjosa, which generally flow from east to the west. On the western part of Albania-flat area, the most of the rivers receive their important tributaries, which have deepened and enlarged their beds. Beside of them, in this part, they have discharged and accumulated the alluvium deposits with a huge quantity reserves (building material-gravels and sands) estimated. Rivers have been and are important natural resources for the Albanian economy because they are using as i). building material-gravels and sands, ii). electrical production, iii). Agriculture's irrigation and iv). tourism development. The present's paper treats the results of engineering geology investigations, which were carried out during 2002-2008 and 2009-2013 years (Muceku, 2008 and 2013), for the determination of the damages level of environmental (beach sands, rivers banks) and engineering objects (roads and bridges) in western part of Albania along of main rivers valleys as Drini, Buna, Kiri, Mati, Ishmi, Erzen, Shkumbini, Semani and Vjosa caused from mining's activity-sands-gravels exploitation and river erosion, as well. The broad reaches of the damaging event were observed after rainfall period of 2002, 2004, 2010, 2011 and 2013 years. According to sands-gravels exploitation in above-mentioned river beds was worked from Albanian Geological Survey since 1994 year, which has given the quality and quantity reserves, as well as the exploitation methodology of the aggregates (gravels and sands). But, as result of requirement growth of private civil companies for construction purpose after the 2000 year began a horrible of raw materials (sands-gravels) exploitation along of Albanian Rivers associating with vast damage of environmental and engineering objects from erosion development. Actually, in Albania there are 52 deposits of river-bed aggregates (sand and gravel) with a huge quantity reserves that are certified from Albanian government. From these aggregates, deposits are exploited about 3.5-4.0 million m3/year, which have been used to support the construction industry (buildings, roads etc.). It should be noted that most of them are still continue to be exploited in uncontrolled manners, which have disturbed the normal regime of these rivers waters. In these conditions, there are increased the land erosion on both sides of river banks, especially in rivers sites of Kiri (Shkodra town-Kuq village), Drini (Ganjolla-Kosmaç-Kuç villages), Buna (Shirq-Dajç villages), Mati (Fushe Milot-Tale villages), Erzen River (Mulleti-Rrushkull villages), Shkumbini (Elbasan Town-Çerma village), Tirana River (Babru-Valias area) and Vjosa (Permeti-Tepelena-Memaliaj towns to Novosela village). As a result of such exploitation of the river's beds aggregates (sands and gravels), in the last 20 years, 50-70 % of protective engineering objects (embankments, levees), which have been built against bank erosion

[1] Department of Geology, Institute of Geosciences, Energy, Water and Environment, Polytechnic University of Tirana. Street: Don Bosko, nr.60, Tirana, Albania. e-mail: y.muceku@geo.edu.al

and flooding are damaged. It should be emphases that, in period 1960-1990 years at the national level, were built more than 800km protective levees. During 2011 and 2013 years the floods events occurred in Shkodra, Lezha and Maliq areas, have verified that about 50% of embankments were destructed. From the uncontrolled exploitation of aggregates (sand and gravel), were affected the coastline, which has changed from 1990 to nowadays. It has been occurred due to the deficiency of rivers bed loads to Adriatic Sea waters. So, there was disturbed the balance between sediments accumulation and sea water erosion. In this condition the sea water has advanced towards the land, and eroded mainly the beach sands in many sites from Velipoja village (north) to Vlore town (south). By the engineering geological mapping [1 - 4] carried out in this area, was observed that in 92 sites of the Adriatic coast were eroded ranging from 20.0-50.0 m up to 200.0 m (Qerret village), 450.0 m (Lalzi Bay). The Golem-Kavaja coast zone has had a belt with pines which protected the land from wind erosion. This belt is already quite damaged, although it is a very important tourist area for Albania. In the south of Mati River delta, the erosion has completely damaged the Patoku Beach. The uncontrolled exploitation of aggregates (sand and gravel), has contributed to changing the delta's position of some rivers as Shkumbini, Semani and Mati etc. Furthermore, since 1990 year, as result of uncontrolled exploitation of river's deposits, the erosion effects have been catastrophic. Consequently, there are destructed several engineering objects as bridges, embankments and the loss of many hectares of agriculture area. Here we have presented some particular cases of 6 bridges, which were destroyed by the uncontrolled exploitation of aggregates. In the end of this work, we have given conclusions and recommendations for the remedial and protective measures of the engineering's structures and the environment.

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Key words: rivers, aggregates, floods, environmental, coast, levee

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EVALUATION OF LIME PERFORMANE ON RESISTING MOISTURE DAMAGE OF ELVALOY MODIFIED ASPHALT AT NANO SCALE (0006)

Abdullah Al Mamun*[1], Md Arifuzzaman[2]

Moisture damage in asphalt pavement indicates the loss of adhesion between asphalt binder and aggregate surface due to moisture and it is very critical to the long-term performance of asphalt pavement. This damage can be reduced in different ways. Asphalt modification with elvaloy is one of the ways as elvaloy decreases the moisture susceptibility of asphalt [1]. Elvaloy modified asphalt (EMA) provides the bonding integrity during storage and transportation which is also very important for moisture resistance. But the most common practice is to use some chemicals or moisture resisting agents in asphalt pavement sector. Those agents improve the adhesion force between aggregate and bitumen by promoting more affinity for each other. It also improves the physico-chemical bond between the aggregate and bitumen to improve moisture resistance by decreasing the surface tension of the bitumen. These adhesion promoter chemicals are known as "Anti-stripping Additive" or Anti-Stripping Agents (ASA). A large number of natural and commercial ASA is available but among them the most frequently used natural ASA is lime. Use of lime within a certain range reduces the moisture damage. But getting best performance of applied lime by selecting the most competent percentage of lime for a binder is a challenging task. Moreover, without having proper comparison, choosing any percentage of lime for a specific binder (modified/unmodified) might not be effective. Lime should be applied based on the property of asphalt binder and type of modifier. So it is important to evaluate the performance of lime thoroughly and ranking them according to their moisture damage resisting capacity in a promising way. This ranking will direct to select an optimum amount of lime for a specific asphalt binder. Therefor to select an optimum amount of lime for any asphalt binder, we should scrutinize the moisture damage mechanism of that asphalt binder in presence of lime. But evaluation of moisture damage in asphalt mixtures is a challenging task as it has a complex mechanism with various interacting factors. To explore the moisture damage problem a wide range of research around the world carried out for last few decades at macro level. However, the comprehensive details about the reason of moisture damage is still unexplored and the exact moisture damage phenomena are still ambiguous as the traditional macro-scale and micro-scale test cannot explain the damage thoroughly [2]. So the moisture damage of asphalt should be analysed at nano level which is carried out in this study by using an Atomic Force Microscopy (AFM).

In this paper nano scale moisture damage of EMA was evaluated by AFM in presence of lime. Moisture damage is stated in term of adhesion loss. This adhesion loss in asphalt is a consequence of broken bond between asphalt and aggregate which occurs at a nano scale. Strength loss in asphalt

[1] Department of Civil and Environmental Engineering, King Fahd University of Petroleum and Minerals, Dhahran 31261, Kingdom of Saudi Arabia, e-mail: g201401740@kfupm.edu.sa
[2] Department of Civil Engineering, University of Bahrain, Isa Town Campus-Kingdom of Bahrain, e-mail: arafiquzzaman@uob.edu.bh

due to moisture can be anticipated by evaluating the bond strength or adhesion/cohesion force between aggregate and asphalt. This adhesion/cohesion force in HMA is regulated by the surface energy of the asphalt [3]. It is considered that evaluation of surface adhesion/cohesion as a function of surface energy is the meticulous way to evaluate moisture damage in asphalt [4]. So in this paper, nano scale moisture damage of asphalt was characterized by observing the surface adhesion/cohesion using AFM tips. But simulation of internal adhesion and cohesion of asphalt requires tips functionalization according to the chemistry of asphalt. Asphalt chemistry indicates that existing functional groups in asphalt binder are: ammin (–NH3), methyl (CH3), carboxyl (COOH), and hydroxyl (OH)[5]. In this study, tips were functionalized using four of above mentioned group to simulate internal adhesion of asphalt. This functionalized tips simulating the asphalt bond strength gives an indication of moisture damage in term of adhesion loss at nano level. This is a robust indication which directs to select an optimum amount of lime for EMA to minimize the moisture damage at nano level.

Based on the evaluation for EMA (0.5 % ,0.75 % and 1.5 % of elvaloy) and lime (0.5 %, 1.00 % and 1.5 % of EMA) it is seen that for any specific percentage of lime, moisture damage decreases with the increase in percentage of elvaloy and thus minimum moisture damage for any specific percentage of lime is observed for 1.5 % EMA. Use of 0.5 % percent lime for any of EMA have minimum moisture damage, thus increase in percentage of lime form 0.5 % results in increase of moisture damage. So, 0.5 % lime with 1.5 % EMA outperform all other combination of lime and EMA to resist moisture damage. According to traditional macro level test, all of the above mentioned combination reduces moisture damage apparently but the uniqueness of this AFM based study is that, it can compare the moisture resisting capacity at nano level and indicates that 0.5 % lime with 1.5 % EMA will be the best choice.

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Key words: Asphalt binder; Moisture damage; Nano-scale; lime

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EVALUATION OF SURVEYING INVENTORY OF FAÇADE SCAFFOLDING CONDUCTED DURING ORKWIZ PROJECT (0089)

Łukasz Borowski*[1], Michał Pieńko[2], Piotr Wielgos[3]

Project ORKWIZ focuses on the study of probability of disaster occurrence on the facade scaffolds. As a part of an interdisciplinary consortium, four research centres have to prepare comprehensive model - a multi-dimensional array of technical, social, organizational, external and internal factors, which have an impact on the potential occurrence of a catastrophic event involving scaffoldings [1, 2]. For this purpose, 5 teams will carry out a comprehensive study of 120 façade scaffoldings, placed in Poland's selected voivodships. One of the components of the project is a surveying inventory of façade scaffolding installed on construction sites. Based on these survey, numerical models of façade scaffolding will be developed. The models will include actual imperfections, which have an impact on the static strength of scaffolding construction. This will be a base for further analysis, tests or simulations [3].

The publication focuses on this subject – surveying inventory of façade scaffolding. Various methods of collecting data were weighed up, having regard to surveying accuracy, staff expertise, time required to learn the proper way of measuring, health and safety regulations on construction site etc. Authors resigned to use rod with dial gauge and vernier calliper [4]. Only land surveying methods were considered, such as photogrammetry, laser scanning or total station [5]. Sample measurements were performed on the deployed scaffolding to test mentioned methods. Specific equipment was used: GOM Tritop system with invar scale rods, Leica C20 scanner and Leica TS50 total station. As a result a total-station method was chosen, despite of its relatively low time effectiveness. Authors present arguments for and against selected option.

Conducted test and known production dimensions of scaffold (width and height of the frame) provided information about realisable accuracy of surveying. The paper presents an analysis of the measurements for 10 scaffoldings, collected by one research team. It includes: the issues of measurements, obtained accuracy, conclusions and recommendations for the future surveying inventory.

Research material was collected from April to November 2016, with the use of Leica TS50 (1^{cc}, 1 mm + 1 ppm) by research team of The Faculty of Civil Engineering and Architecture Lublin University of Technology.

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[1] Lublin University of Technology, Lublin, Poland, e-mail: l.borowski@pollub.pl
[2] Lublin University of Technology, Lublin, Poland, e-mail: m.pienko@pollub.pl
[3] Lublin University of Technology, Lublin, Poland, e-mail: p.wielgos@pollub.pl

Key words: Civil engineering, surveying, façade scaffolding, geometric imperfections

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FRAGMENTATION OF HYDROGRAPHIC BIG DATA INTO SUBSETS DURING REDUCTION PROCESS (0013)

Marta Wlodarczyk-Sielicka[1], Andrzej Stateczny[2]

The article presented problems of fragmentation of hydrographic big data into smaller subsets during reduction process. Big data is being generated by multiple sources: systems, sensors and mobile devices. Hydrographic systems also collect very large amounts of information and there is a problem with their analysis. Bathymetric data has to be subjected to reduction process and it will be presented on bathymetric map. Data reduction is a processing of reduce the value of the data set, in order to make them easier and more effective for the goals of the analysis. Under reduction process of bathymetric data, regularly spaced GRID is created. The main aim of authors is to create new reduction method. The article presented the first stage of this method – fragmentation of bathymetric data into subsets. It consists of two steps: initial division of the area into a grid of squares and clustering using artificial neural networks. In the first step maximum level of division of the grid will be founded and its size will be determined. If the size of square is bigger than established threshold and the depth range in each square is bigger than predetermined tolerance, the square will be divided into four smaller squares. If they are smaller than predetermined values, the square will not be divided. In the second step of fragmentation each square will be divided into clusters using Kohonen network. Clustering is a partition of data into groups of similar samples. Each cluster consists of samples that are similar between themselves and dissimilar to features of other groups. The initial division and clustering depend on scope of input data, range of depth on the area and scale of output bathymetric map. The experiments were performed on test areas with different slope of the bottom. The results and conclusion were presented.

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Key words: Big data, Data processing, Clustering methods, Sea measurements, Sea floor

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[1] Maritime University of Szczecin, Waly Chrobrego 1-2, Szczecin, Poland, e-mail: m.wlodarczyk@am.szczecin.pl
[2] Gdansk University of Technology, Narutowicza 11-12, Gdansk , Poland, e-mail: a.stateczny@marinetechnology.pl

FUZZY SETS IN THE GIS ENVIRONMENT IN THE LOCATION OF OBJECTS ON THE SURFACE OF WATER BODIES (0075)

Adam Inglot[1], Jerzy Pyrchla[2], Krzysztof Pyrchla*[3]

The support of making decisions by the usage of the calculative intelligence was common in recent years. In this paper, the authors present the solution of simplify the objects localization process on the water's surface by using the mathematical solutions, which have advantages such as simplicity, fast solutions or reliable results. The main purpose of this work is to demonstrate the potential of fuzzy sets in GIS environment.

In addition to search and rescue actions, conducting on the different types of water areas in conditions which constrain the accuracy of observers localization which inform about the accidents, the region situation should be mapped with high precision, accuracy and topicality. The authors are presenting the method which could guarantee the care prepared safe plan which is based on maps. The integration platform, where the analysis was performed is GIS. GIS system is full scaled and it could be adapt in addition to the increasing requirements. The authors pay attention on insufficient set of tools that could be available in GIS environment. Fuzzy Membershipe is a commonly known tool that is used by analytical decisions making. The current available functions could not allow us to predict spreading with the relation of proper destination. Those kind of solutions may have great impact on eyes observations of the body of water. What is more, the connection of current and given tools may proceed in GIS solutions developments.

While eyesight observation, when we know the position of an observer and its distance, we may define the destination and area of search. Given tools may allow us to define probability of an exact zone within its localization from the given distance. We also need tools which are based on function of affililation. The probability of distribution is set on the deviation of angular between the exact position of the observer and analysis zone. In according to joint of both analysis , we can define zone search. The GIS environment is the key tool which we can visualize , analyze and verify the given zone search. The main advantage of this visualization is basically data of the ortophotomap or the seamap which was created by the vectors.

The presenting issue concentrates on the object's location problems. It is associated by an infinite number of point with water area description. To constrain such among of the data, the surface description by the adherence function and mathematical solutions were performed. Properly prepared set of environmental experiments with theoretic analysis helps with technical parameters acquisition

[1] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Geodesy, Narutowicza 11-12, 80-233 Gdansk, Poland, adam.inglot@pg.gda.pl
[2] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Geodesy, Narutowicza 11-12, 80-233 Gdansk, Poland, jerzy.pyrchla@pg.gda.pl
[3] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Geodesy, Narutowicza 11-12, 80-233 Gdansk, Poland, krzpyrch@student.pg.gda.pl

needed for simulation researches. The main goal of the experiment is to gather the data about the objects location in water areas by random observers. They consisted of object's exposure with known coordinates and localize attempt by the random observers. The simulations were conducting in GIS software, which could help tested differents of the scenarios in real seashores locations. In according to that solution, simulations were similar to a real environmental conditions. This paper present the connection of the fuzzy sets theory application in GIS environment. That connection creates the opportunity to plan the tactics plans and search and rescue actions at night.

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Key words: Fuzzy logic, Geographic information systems, Marine safety

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GEODETIC SURVEY AS A MEANS OF IMPROVING FAST MASW (MULTICHANNEL ANALYSIS OF SURFACE WAVES) PROFILING IN DIFFICULT TERRAIN/LAND CONDITIONS (0035)

Paulina Lewińska*[1], Rafał Matuła[2]

This paper revolves around newly designed and constructed system that can make 2D seismic measurement in natural, subsoil conditions and role of land survey in obtaining accurate results and linking them to 3D surface maps. Article shows a new type of land streamer, designed for shallow subsurface exploration in engineering applications. In land seismic data acquisition methods a vehicle tows a line of seismic cable, lying on construction called streamer. The measured points and shots are taken while the line is stationary, arbitrary placed on seismic profile. Exposed land streamer consists of 24 innovatory gimballed 10 Hz geophones. Mentioned construction eliminates the need for hand 'planting' of geophones, significantly reducing time and costs. With the use of current survey techniques all data obtained with this instrument are being transferred in to 2D and 3D maps of area topography. This process is becoming more and more semi-automatic allowing for field crews to be smaller and faster, and some data gets processed on side.

We tested our system in post-glacial, Poland Low-Land, where we attempted to image subsurface material at a depth of approximately up to 30 m was performed. We took two shots at each of 500 source points and covered distance of 1000 m achieving an average fold of 24. Typical occupation time for each station were less than half minute using only two people as a recording and acquisition team. Important issue, in regard to this specific acquisition method, is estimating correct spatial coordinates of measuring instruments. A GPS and tachymetric survey was done during the acquisition seasons. In this particular case time was of the essence, since almost all the results needed to be pre-processed on side. What is more, due to difficult field conditions some parts needed to be surveyed multiple times. A special set of travers was done, that would facilitate GPS and tachymetric survey before a geophysics team started there acquisition. It allowed for measuring important, form geophysical point of view, elements twice once with GPS an once with tachymeter. It was impossible to redo acquisition or the survey so everything had to be prepared correctly beforehand. Also a survey of general topography of the area was done (since no preexisting maps ware available). As a result a georeferenced 3D terrain model was produced and was tied to a number of 2D cross-sections of subsoil conditions. This allowed for better understanding how subsoil conditions effect shape of land and gave information for investors on how to correctly perform there building plans. What is important to mention, combining this new method of acquisition with GPS allows for only 3 people to perform all data gathering, half of how many is normally needed. What is more the visual 3D or 2D effect can be easily done, maintained and edited. This means that adding a news season of measurement in to existing model is doable and interpretation of changes becomes

[1] AGH University of Science and Technology, al. Mickiewicza 30, 30-059 Krakow, Poland, e-mail: lewinska.paulina@gmail.com
[2] AGH University of Science and Technology, al. Mickiewicza 30, 30-059 Krakow, Poland, e-mail: rmatula@agh.edy.pl

easy.

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Key words: MASW (multichannel analysis of surface waves), 3D/2D terrain and subsurface model, GPS

GEODETIC VERIFICATION OF THE MEASUREMENT SYSTEMS OF TRACK GEOMETRY TROLLEY (0092)

Michał Strach*[1], Przemysław Grabias[2]

Article examines accuracy of the measuring systems of the electronic track geometry trolley in determining the geometric parameters of the track. The research was conducted at Test Track in Żmigród (Poland), managed by the Railway Research Institute. The track is only such experimental facility in Poland and one of eight in the world.

Field work has been carried out on the section of track covering both nominally straight and circular arcs with different radii and transition curves. The track is divided into sections arranged in regular distances from each other, according to the mileage of the route. The article analyzed the results of measurements performed by electronic track geometry trolley. The results were compared with total station and leveling survey of railway track. Total station survey refers to railway geodetic control points. Measurements were done with the use of two precision reflectors mounted on the electronic track geometry trolley. They were placed over the left and right rail. Leveling measurements included determination of the height of the two rails in chosen cross sections.

Analyzes were performed for two geometric parameters in horizontal plane (gauge and gradient) and two in a vertical plane (cant and twist) in accordance with EN 13848-4 guidelines. The parameter values were obtained by two independent methods. Analyzes allowed to verify the results obtained from the measurement of electronic track geometry trolley to data obtained by geodetic methods (used as a reference).

The analysis also included verification of track trolley module responsible for distance measurement. Track mileage, obtained by track trolley measurements, were referred to the mileage from described survey. Detailed research and evaluation of accuracy (repeatability and reliability of results) done in different track geometry conditions is a necessary activity while testing new measuring devices. All measuring devices should provide full reliability in delivering accurate results, especially those that are designed for commercial applications.

Measurement of parameters characterizing the geometry of the rail route is necessary both in the process of building new tracks, and during periodic measurements of exploited track. Reliable measuring instruments used in diagnostic ensure the track to be maintenance in satisfactory condition. This has a direct impact on comfort of traveling and maintaining or improving the safety of operated track.

Field tests, presented in the article and the analysis of the results can be successfully used to verify all track geometry trolleys. After some modifications in surveying method it is possible to expand the test to track recording car. It is worth mentioning that it is necessary to closely cooperate with

[1] AGH University of Science and Technology, al. Mickiewicza 30, 30-059 Kraków, email: strach@agh.edu.pl
[2] AGH University of Science and Technology, al. Mickiewicza 30, 30-059 Kraków, email: pr.grabias@gmail.com

experts in field of geodesy, railway and mechatronics in the course of such research.

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Key words: railway engineering, geometry, geodesy, accuracy, data analysis

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GEOMETRY DESIGN AND STRUCTURAL ANALYSIS OF STEEL SINGLE-LAYER GEODESIC DOMES (0114)

Robert Szmit[1]

The research paper presents the results of a static analysis of selected geodesic domes. Geodesic domes are spherical architectonic structures formed by triangular, presenting great sturdiness while keeping the structure very light. For this reason they are quite popular. Geodesic domes, especially single-layered, due to their small mass compared to the applied loads must be carefully analysed, not only with respect to statistics, but also subject to modal analysis. The basis for generating geodesic domes rod can be polyhedra shapely such as octahedron or icosahedron. In the first part of the paper presented the historical development of geodesic domes. It shows the examples of geodesic domes in the world, grid domes in Poland as well as conceptual projects which use geodesic domes.

The work also discusses the issues related to the geometry of the geodesic domes. Platonic polyhedrons and methods of the division of spherical triangles are described. Moreover, virtues and defects in geodesic domes are presented. The last issue showed in the work is the presentation of the results and conclusions of the analysis carried out on geodesic domes with the base of octahedron and icosahedron, depending on the density of geodetic division. Domes were loaded with its own weight and the effect of the wind. The calculations were made for bars, nodes and glass panels.

The conducted analyses have proven that maximum vertical displacements of the vertices in a structure affected by wind load according to the quality standards EN 1991-1-4 are slightly lower (up to 10 %) than the wind load according to the distribution resulting from experimental tests. This is caused by the fact that in spite of an overall higher standardised wind load affecting the spherical surface of a dome, a considerably larger area is subject to suction, which relieves the construction. These small differences in the obtained results suggest that adopting a standardised wind load is definitely safe in most cases.

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Key words: structural engineering, numerical analysis, algorithm design and analysis, load modeling, geodesic domes

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[1] The Faculty of Geodesy, Geospatial and Civil Engineering, University of Warmia and Mazury in Olsztyn, ul. Heweliusza 4, 10-724 Olsztyn, Poland, e-mail: robert.szmit@uwm.edu.pl

GEOTECHNICAL MAPPING FOR URBAN PLANNING AND DEVELOPMENT IN ADRIATIC COAST, ALBANIA (0077)

Ylber Muceku[1]

In this paper, shortly is described the geotechnical mapping carried out for urban planning and development in Adriatic coast area, Albania. The studied are is located in western part of Albania along of Adriatic Seaside, extending from Velipoja village (north) up to Orikumi town (south). It represents the most beautiful area in Albania because there are many beaches, lagoons, and national tourist parks etc. For all of these reasons, the coastline of this zone has become heavily urbanized. So, the new millennium in Albania is characterized by a population's moving to Adriatic coastal area, where are associated with many engineering objects constructions such as the buildings, routes and green parks etc. Most of them are built on hills slopes without any engineering geological and geotechnics investigations. All of these, have occurred because of the urbanization in these areas is done in the way of uncontrolled and unmanaged by the responsible government institutions. Thus, there are built many residential buildings (touristic villages etc.), and other engineering's objects without performing any geotechnical investigations, which is very necessary to their safety. Moreover, urban development is close related to the environmental problems, which involve an increase of the interest in the rational use of landscape of geo-environment. That is why, during 2000-2008 years, a geotechnical mapping on scale 1: 25 000 for the urban planning purpose was carried out along of Adriatic coast, whereas 2010-2014 years, a geotechnical mapping on scale 1: 10 000 have been done for urban development in several areas as Velipoja-Shengjini, Kepi Rodonit-Durresi-Spille, Divjaka, and Zverneci-Vlora-Orikum zones [1 - 4]. For the geotechnical mapping on scale 1: 25 000, was carried out the surface geotechnical observations and excavation of many pits with depth 3.0-5.0m in whole studied area. There are taken a lot of soils and rocks specimens for analyzing in the laboratory for physical-mechanical properties. According to geotechnical mapping on scale 1: 10 000 was worked in the oriented profile with surface geotechnical observations, geotechnical boreholes with depth 10.0-30.0m and vertical electrical sounding (ERT). From boreholes in different depth are taken many soils specimens for determination of mechanical and physical properties in the laboratory. The geotechnical maps on scale 1: 25 000 and 1:10 000, were compiled basing in the geofactors as lithology characteristics of rocks and soils, geomorphologic conditions, physical-mechanical properties of rocks and soils, hydrogeological characteristic and geodynamic phenomena. Consequently, the studied area on both maps were classified into several engineering geological zones, which are the basic data for regional planning and urban development, a crucial tool to civil planners and designers.

- Geotechnical zone of strong rocks.

[1] Department of Geology, Institute of Geosciences, Energy, Water and Environment, Polytechnic University of Tirana. Street: Don Bosko, nr.60, Tirana, Albania. e-mail: y.muceku@geo.edu.al

- Geotechnical zone of medium strong rocks.
- Geotechnical zone of weak rocks.
- Geotechnical zone of very weak rocks.
- Geotechnical zone of cohesive soils.
- Geotechnical zone of cohesionless soils.
- Geotechnical zone of organic soils-peat.

Also, the engineering maps contains the hazard areas such as landslides, erosion, and flooding prone areas, as well as the geotechnical sites with the possibility of sands liquefaction. Finally, the present study gives the conclusions and recommendations, where there are noted the hazardous areas (landslides, unstable hill slopes, erosion sites, flooding and liquefaction sands areas), and the necessity of applying the protective engineering measures against these phenomena, as well as prospective areas for urban and tourism development.

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Key words: mapping, planning, development, hazardous areas, soil properties, rocks, urban areas, geodynamics, coast

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GIS TOOLS FOR ASSESSING WINETOURISM POTENTIAL IN SLOVAK REPUBLIC (0071)

Marcela Gergeľová[1], Slavomír Labant[2], Ladislav Mixtaj[3], Erik Weiss[4]

Solving the issue of tourism regarding its further sustainable development (progress) represents a socially important role. Each country aims to promote and raise the profile of its tourism potential as much as possible. In terms of content, the contribution is focused on the assessment of development potential of wine tourism with an emphasis on preserving its traditions and building further cultural awareness for the formation of new tourist destinations. All socially important trends, including the tourism sector, work with information of spatial significance. The content of the paper is oriented on the topic of wine tourism, as dealing with this issue currently represents a popular activity. The aim of various organizations in the tourism industry is to present different areas of interest with respect to the target group of interested persons as much as possible. In the Slovak Republic, solving the issue of wine tourism is becoming established increasingly. Various scientific contributions documenting its development in the Slovak Republic may serve as the evidence. For regions with the potential for the development of wine tourism, it is important to develop the progress of winemaking tradition in all directions. At that point of view, it is almost necessary to apply the latest technology, which should support the achievement of expected outcome to the maximum extent, into the process of solution of the selected topic. The spatial processing of the most interesting objects of wine tourism forms an integral part of the content of this contribution. Its spatial aspect is an essential part of further processing, which will be subsequently analysed. The contribution is based on the comparison and definition of individual objects that define the foundation of wine tourism. The methodology and methods of processing are dependent on the type and nature of the studied group of objects, whose spatial data are needed for the processing. For that reason, possibilities of GNSS technology, applied primarily for conditions of spatial data collection, will be included in the processing. Through their use, we expect the acquisition of spatial data that will include mainly data about the position and altitude of studied sample of objects. The post-processing will be focused on the area of spatial analysis in order to evaluate the potential for further development of wine tourism in the selected region. The professional spatial and graphical processing of data of the given importance requires an active application of geographical information systems tools into the environment of the solved issue. From the available set of GIS tools, analytical tools and the corresponding procedures, implemented based on criteria of selected indicators, will be preferred. Through the use of GIS, we

[1] Institute of Geodesy, Cartography and GIS, Faculty of Mining, Ecology, Process Control and Geotechnology, Technical University of Košice, Letná 9, 042 00 Košice, Slovak Republic, e-mail: marcela.gergelova@tuke.sk
[2] Institute of Geodesy, Cartography and GIS, Faculty of Mining, Ecology, Process Control and Geotechnology, Technical University of Košice, Letná 9, 042 00 Košice, Slovak Republic, e-mail: slavomir.labant@tuke.sk
[3] Institute of Earth Resources, Faculty of Mining, Ecology, Process Control and Geotechnology, Technical University of Košice, Letná 9, 042 00 Košice, Slovak Republic, e-mail: ladislav.mixtaj@tuke.sk
[4] Institute of Earth Resources, Faculty of Mining, Ecology, Process Control and Geotechnology, Technical University of Košice, Letná 9, 042 00 Košice, Slovak Republic, e-mail: erik.weiss@tuke.sk

expect to achieve the map expression of the potential of wine tourism in the selected area of interest. The acquired knowledge can be applied to support the development of tourism at a general level. Solving the issue of tourism regarding its further sustainable development (progress) represents a socially important role. Each country aims to promote and raise the profile of its tourism potential as much as possible. At that point of view, it is almost necessary to apply the latest technology, which should support the achievement of expected outcome to the maximum extent, into the process of solution of the selected topic.

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Key words: Geographic information systems, Geospatial analysis, Global navigation satellite system, Environmental management

GNSS RECEIVERS TESTING ENVIRONMENT SPACE GRADE RECEIVER TESTING CHALLENGES (0119)

Karol Brzostowski*[1], Stefan Sassen[2]

GNSS (Global Navigation Satellite System) is a complex system and environment with a large number of different applications and ways of usage. Nowadays, to be able to take benefits from all these GNSS based opportunities, a large number of different GNSS receivers are produced and used. This variety of receivers is really useful for optimal utilisation of GNSS systems performances for specific applications.

To be sure, that the used solution (receiver) is proper for particular application and is optimal from end-user requirements, necessary is to perform test campaign(s). The types and scopes of tests are always heavily depend on the receiver specification, application specification and end user requirements. In general all GNSS receivers tests could be divided into two main groups:

- Field tests – receiver is under test in the real environment with all the restrictions of such approach (e.g. not repeatable),
- Laboratory tests – tests in GNSS laboratory with usage of GNSS signal generator and special design and prepared scenarios.

One of the potential usage of Laboratory tests, is test campaign of Space grade GNSS receivers (receivers working in space environment). The example of such campaign is FLIRT-PL project.

FLIRT-PL – **F**itting **LI**ON **R**eceiver **T**ests in **P**o**L**and – ESA project realized by Astri Polska (Prime) together with Airbus Defence & Space from 1st of February 2015.

LION is a GNSS signals receiver for scientific, earth observation and telecommunication satellites which is able to reliably operate in LEO (Low Earth Orbit), MEO (Medium Earth Orbit), HEO (Highly Elliptical Orbit) and GEO/GTO (Geostationary/Transfer Orbits)orbits. Due its high robustness it is also suitable for launchers.

The main goal of FLIRT-PL project is to set up an assembly and test line for LION receivers in Poland.

LION modules are manufactured and pretested in Airbus Defence & Space and then, the final assembly and tests are outsourced to Astri Polska.

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Key words: Global Navigation Satellite System, Aerospace testing

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[1] Astri Polska sp. z o. o., Warsaw, Bartycka str. 18A, Poland, karol.brzostowski@astripolska.pl
[2] Airbus Defence and Space GmbH, Robert Koch Str. 1, Germany, stefan.sassen@airbus.com

IDENTIFYING REAL TRANSPORT NETWORKS IN RURAL AREAS ON THE BASIS OF CADASTRAL DATA (0002)

Jaroslaw Janus*[1], Piotr Bozek[2]

Land fragmentation parameters constitute a measurable effect of the evaluation of plots layout considering their surface, shape, and spatial arrangement. They are mostly used as an element enabling the evaluation of land spatial structure while planning land consolidation projects or during the evaluation of their effects. A number of existing land fragmentation indices take into account the distance between particular elements of a mathematical model of a studied area. Distance is among the key elements affecting the operating costs of agriculture, hence the great importance of distance-related indices in economic analyses and in the evaluation of land consolidation effects. However, while calculating these indices, rectilinear distances are generally used. The reason is the time-consuming nature of mass acquisition of data about distances calculated by taking into account the actual shape of the transport network. It is caused largely by the specificity of the process of determining access to lands in cases where plots have no direct access to roads and when they use internal roadways.

This article presents a comprehensive solution allowing the identification of approximate real transport networks in rural areas. It is based on the use of cadastral databases for the purpose of building a model of the area in question as well as graph algorithms identifying the shortest paths in the graph. The proposed algorithm of route calculation works well also in areas with extremely unfavorable fragmentation indices and in areas where plots have no direct access to the road network. The efficiency of the algorithm was tested on large objects. It was also used in the process of building a comprehensive system that implements and evaluates the effects of consolidation works.

The results are of significance in the process of analyzing land fragmentation. They indicate the possibility of replacing simplified indices, which utilize rectilinear distances, with indices based on the precise values of the actual shape of transportation network. It allows a detailed analysis of spatial parameters of agricultural areas and much more reliable evaluations of the effects of changes in their structure. Another aspect is the possibility to build more precise mathematical models for the optimization of the spatial layout of plots.

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Key words: Land use planning, Road transportation, Shortest path problem

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[1] University of Agriculture in Krakow, 31-120 Krakow, Al. Mickiewicza 21, Poland, e-mail: j.janus@ur.krakow.pl

[2] University of Agriculture in Krakow, 31-120 Krakow, Al. Mickiewicza 21, Poland, e-mail: p.bozek@ur.krakow.pl

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IMPACT OF GALILEO OBSERVATIONS ON THE POSITION AND AMBIGUITIES ESTIMATION OF GNSS REFERENCE STATIONS (0122)

Grzegorz Nykiel*[1], Mariusz Figurski[2]

In the frame of European Union, the Galileo civil navigation system has been developing, since 1999. The main goal of this system is to obtain independence from the US monopoly in the field of satellite navigation. The unit responsible for the construction and implementation of Galileo is the European Space Agency (ESA), which is supported by the Council of the European Union and many of the scientific and business consortia. Despite the fact, that Galileo satellite constellation still does not has a nominal number of satellites in space (14 satellites in January 2017), in December 2016 the European Commission inaugurated the launch of the system, whereas the missing satellites are supposed to supplement the constellation until 2020. Already some receivers in the reference networks, e.g. EUREF Permanent Network (EPN), are equipped with modules that allow to track Galileo satellites and perform position estimation using their signals. Usage of Galileo observations together with the observations from the other satellites navigation systems, can bring increased reliability and accuracy of the station position and consequently, the stability of the whole network. On the other hand, addition of another satellite systems to the calculations process, can cause numerical problems and may not result in such increasing of accuracy, as is expect by many of users.

In this study, we present two issues. Firstly, the positioning accuracy based on only Galileo observations is presented for the selected EPN stations. Secondly, impact of the simultaneous use of observations from various systems on the position determination process, baseline selections and ambiguity resolution, is discussed. On the basis of observations from 14 Galileo satellites and differential approach, similar accuracy as in case of GPS was obtained. Such high accuracy was possible to achieve due to the models and products from MGEX project [1], which were used in processing. Tests were conducted for selected GNSS reference stations in Europe using Bernese 5.2 software [2], which are prepared for collecting observations from Galileo system.

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Key words: Global Navigation Satellite System, Galileo, precise positioning, ambiguities resolution

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[1] Gdansk University of Technology, Poland, e-mail: grzegorz.nykiel@pg.gda.pl
[2] Committee for Space and Satellite Research, Polish Academy of Sciences, Poland, e-mail: figurski@k-lab.org.pl

IMPROVING OF TIE POINTS DETECTION USING WAVELET-BASED IMAGE PRE-PROCESSING: THE 10 CM AERIAL IMAGES CASE STUDY (0073)

Krystian Pyka[1]

Automatic tie points detection in aerial images is one of the fundamental steps in the modern photogrammetric workflows. The most popular tie points detector is the SIFT (Scale Invariant Feature Transform) due its scale and rotational invariance [1]. SIFT finds many points but a significant portion of the data is of poor quality. The points on trees or bushes are usually mismatched. The points on shadow contours are well recognized but its localization is changed during image capturing.

The aim of this paper is to explore a method which creates viable pre-processed images, focused on stable and clear visible terrain details for a SIFT detector. One possibility to creates such images is undecimated discrete wavelet transform [2].

The research was carried at using MicMac open source software, which includes an efficient implementation of SIFT [3]. The wavelet transform was conducted in the R software environment for statistical computing. The test materials used were a small set of images depicting a part of Krakow, taken by a DMC camera with 10 cm ground sample pixels. The images are chosen from a huge block which was adjusted using conventional workflow with manual measurement of tie points in a Gruber region. The interior orientation and distortion parameters were known due to use of a metric camera.

In the first step the test images were transformed in wavelet domain using a simple Harr filter. Then wavelets components, instead of source images, were used for tie points detection. Several components on various decomposition levels were tested. The SIFT based matching was conducted for all variants of the image pairs. Thereafter the relative orientation for stereo pairs was calculated using coplanarity equations. As the tie points quality benchmark the y-parallax of stereo models was used. Finally all different solutions were compared and statistically analyzed.

The best result was obtained when images were represented by a sum of wavelet component from the first and the second level of decomposition. Comparing the results from the source images, the number of tie points was drastically decreased but the quality expressed as y-parallax was significantly increased and was produced almost the same accuracy values as for manually measured tie points. Another conclusion, which is related to aerial images of city area taken in the form of a regular block, is the proposal to limit the tie-points detection only for the Gruber regions. This process is faster and the accuracy of relative orientation is more than sufficient.

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Key words: Image matching, Wavelet transforms, Stereo image processing, Open source software

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INTEGRATION OF THERMAL DIGITAL 3D MODELL AND A MASW (MULTICHANNEL ANALYSIS OF SURFACE WAVE) AS A MEANS OF IMPROVING MONITORING OF SPOIL TIP STABILITY (0034)

Paulina Lewińska*[1], Rafał Matuła[2], Artur Dyczko[3]

Spoil tips are anthropomorphic terrain structures built of leftover materials from underground or open pit mining. Usually the term spoil tips refers to those build out of unusable particles from coal exploration. As such they consist mostly of slate and various types of sandstone or mudstone, also include coal and coal dust. In order to maintain the stability of such structures it is important to build them in a certain way. However, still constant monitoring is in order. This process is done so to ensure that there are no spaces within the body of the tip. Spaces, expressly chimney-like, have a potential of accumulating highly explosive coal dust. If proper stack effect is implied a fire could be indicated. Coal soil tip fires are extremely dangerous due to the fact that putting it down can last for a few years and in the meantime cause an irreversible degradation to the environment. What is even more important usually fires start from the inside of the tip, it can take up to a year before outside effects are visible. By this time tips stability degradation, contamination of the water etc. can be saver.

Currently some spoil tips are being monitored. However this process is usually done in a traditional way. This means that person responsible simply walks the area and looks for fire, land slide or holes in the structure. In winter this survey also includes looking for places with vast vegetation or lack of snow cover. This may be unsafe for person responsible since spoil tips burring from the inside usually seem normal on the inside. Stepping on a tick cover may cause the hole to appear or poisonous gas to emerge. Also, not all tips are appropriately secured from public interference since they are assumed as being low hazard. However, more and more government organizations and mines see the potential problem of spoil tip hazard and are looking for ways of creating fast monitoring of spoil tips temperature and inside structure.

In order to test new ways of observing such an object an experimental monitoring technique was performed in the area of spoil tip of Lubelski Węgiel „Bogdanka" S.A coal mine on December of 2015. A survey consisted of creating a 3D model of the structures – done with the use of long range (10 km) Riegl laser scanner. This was done to check the slope and the shape of the structure. Then a 3D discreet thermal model was done with the use of Z+F IMAGER 5010 laser scanner equipped with T-Cam Rev 1.0 thermal camera insole. This was done in order to look for potential fire areas [1]. Lastly a MASW (Multichannel analysis of surface wave) was done in a selected part of a spoil tip in order to find potential spaces within the body of a tip. Later on, existing data was digitalized and a 3D model of objects outside and inside was produced. This model can be seen as a base for future monitoring

[1] AGH University of Science and Technology, al. Mickiewicza 30, 30-059 Krakow, Poland, e-mail: lewinska.paulina@gmail.com
[2] AGH University of Science and Technology, al. Mickiewicza 30, 30-059 Krakow, Poland, e-mail: rmatula@agh.edy.pl
[3] The Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Wybickiego 7, 31-261 Krakow, e-mail: arturdyczko@tlen.pl

of this object. What is worth to mention, all data was gathered and processed within 7 days. Much of the survey did not require the crew to move around the structure, thus ensuring there safety. This article provides results of this survey and informs about advantages of such an approach.

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Key words: GPR (Ground Penetrating Radar), thermal digital 3d model, Infrared camera

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INTERNET OF THINGS AND SELF-ORGANIZING FEATURE MAPS TO ANALYZE BICYCLES TRAFFIC FLOW SMOOTHNESS (0113)

Dariusz Słowiński[1]

Bicycles in most of cities all over the world have their own bicycles lanes. Bicycles traffic flow in some countries has significantly increased for last several years so more and more often it happens that insufficient capacity of bikes lane forces cyclists to ride at speed under free flow conditions. Strong correlation between crash risk of vehicle (including bicycle) and speed under free flow conditions is found [1]. Places and events along bicycle lanes where bikes traffic flow pace is especially low or bikes traffic flow is interrupted are the most dangerous for cyclists [2]. It is because of raised risk of bike stability loss. It is important to create and implement a procedure to examine bicycles traffic flow smoothness along the bikes lane, to detect where the traffic flow is interrupted and to identify reasons of the interruption.

In the paper here the procedure to examine bicycle traffic flow smoothness is described. It is based on analysis of current GPS position of the bicycles moving along the bikes route. According to Internet of Things ITU standard [3] bicycles are equipped with GPS sensors to report in real time their current positions to any suitable applications of computing cloud. Afterwards from obtained data points two sets of data are created. First of them is the bicycle route model (starting and ending route points and localisations of the points where the bikes route crosses different traffic flows: streets or bikes lanes). The model is created in interactive way within the application gathering GPS data from bicycle moving along the examined bike route. The other data set consists of information on bikes paces along the bike route, expressed as the number of points at speed within near to zero speed range per defined timespan. The speed range is obtained from self-organizing maps of Matlab Neural Network Toolbox [4]. Both of the sets are put together to point the places along the bike route where bicycles traffic flow is disturbed or interrupted.

As the result of the procedure used, the strong correlation is obtained between the highest numbers of the points at speed within near to zero speed range and occurrence of obstacles in bikes traffic flow. According to the result obtained, bus stops and entries to vast parking places should be included to the route model as additional traffic flow obstacle.

The procedure gives good results although it works on low precision data. The procedure can be used to raise and keep raised the bikes traffic flow security level on bikes lanes.

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Key words: bicycle traffic flow, global positioning system, internet of things, cloud computing, self-organizing feature maps

[1] Faculty of Geodesy, Geospatial and Civil Engineering, Prawocheńskiego 15, 10-720 Olsztyn, Poland,
e-mail: dariusz.slowinski@uwm.edu.pl

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INTERNET OF THINGS AND TIME-SERIES MODELLING TO DISCOVER DANGEROUS PLACES AND EVENTS ALONG BIKES LANES (0115)

Dariusz Słowiński[1]

It has been proven that speed under free flow conditions [1] can be one of the reasons of raised crash risk of vehicle (including bicycle). Referring to the bicycles it should be noted, because of the nature of bicycle, that any obstacles in bicycles lanes can be another reason [2]. Bicycles traffic flow in some countries has significantly increased for several last years so insufficient capacity of bikes lanes and the obstacles, especially if the obstacles are not permanent ones, but appear irregularly, force cyclists to ride at speed under free flow conditions. Places and events along bicycle lanes where bikes traffic flow pace is disturbed or interrupted are the most dangerous for the cyclists.

In the paper here using of time-series modelling [3] to analyze bicycles trips along bikes route is described. It was made using artificial neural network tools form Matlab Neural Networks Toolbox [4]. The bicycles are equipped, according to Internet of Things ITU standard [5], with GPS sensors to report in real time their current positions to any suitable applications of computing cloud. Gathered data are the ones of low precision but they are obtained from numerous trips along investigated bikes route. Current speed of the bicycles moving along the bikes route can be computed from the data. Time-series analysis of the bicycles current speed make possible to build trend of the bikes pace along the bikes route. Afterwards the trend is used to discover the data which are for example of significant lower speed than those from the trend. Discovered data can indicate positions of any obstacles and help to identify them.

The experiment proves that low precision data obtained from popular and cheap IoT standard devices, can be used to accurately discover and identify the dangerous places and events along bikes lanes. The procedure can be used to rise and keep raised level of bikes traffic flow safety along bikes lanes.

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Key words: bicycle traffic flow, global positioning system, internet of things, cloud computing, time-series analysis

[1] Faculty of Geodesy, Geospatial and Civil Engineering, Prawocheńskiego 15, 10-720 Olsztyn, Poland,
e-mail: dariusz.slowinski@uwm.edu.pl

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INVESTIGATION OF THE IMPACT OF ITRF2014 ON THE GNSS PRECISE POSITIONING AND ETRF REALIZATION (----)

Mariusz Figurski*[1], Grzegorz Nykiel[2]

In January 2014, the new International Terrestrial Reference Frame – ITRF2014 [1], was released. It has been developed, like the previous version (ITRF2008), based on the measurements carried out by four space geodetic techniques: Very Long Baseline Interferometry (VLBI), Satellite Laser Ranging (SLR), Global Navigation Satellite Systems (GNSS) and Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS). For the ITRF2014 realization, over twenty-year time series of recalculated coordinates from the IGS REPRO2 project, were used. Besides higher accuracy and consistency of the frame, an entirely new element – the post seismic deformations - are included. Moreover, the GNSS antenna models are better organize, by introducing inter alia absolute models for Galileo satellites and frequencies. In ITRF2014, also the definition of the fundamental points has been changed. All changes related to this new reference frame, caused consequences in the precise positioning using GNSS observations. In this paper, on the basis of results and analysis obtained from Bernese 5.2 packages [2], the most important changes, from the point of view of GNSS data processing, are presented. Our analysis show that the differences between ITRF2008 and ITRF2014 are minor. However, changing GNSS antenna models from IGS08 to IGS14 causes changes of reference stations coordinates up to several millimeters, especially for vertical one. This effect is mainly concern with new absolute antenna models that have been independently determined for GPS, GLONASS and Galileo signals. Such big changes of coordinates have also a negative impact on the implementation of the European Terrestrial Reference Frame (ETRF), which is developed based on the multi-annual analysis of EPN network. From our point of view, this problem of coordinates discontinuity can be solved by reprocessing archival GNSS observations derived from EPN network with taking into account new antenna models.

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Key words: International Terrestrial Reference Frame 2014, Global Navigation Satellite Systems

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[1] Committee for Space and Satellite Research, Polish Academy of Sciences, Poland, e-mail: figurski@k-lab.org.pl
[2] Gdansk University of Technology, Poland, e-mail: grzegorz.nykiel@pg.gda.pl

LEPTOKURTOSIS OF ERROR DISTRIBUTION AND ITS INFLUENCE ON ESTIMATION ACCURACY. THE CASE OF THREE ESTIMATES APPLIED IN ADJUSTMENT OF GEODETIC MEASUREMENTS (0008)

Robert Duchnowski*[1], Patrycja Wyszkowska[2]

The paper concerns leptokurtosis of error distribution which might influence the estimation results. Leptokurtic distributions, namely distributions with positive excess kurtosis, are sometimes present in the case of geodetic or astrometric measurements (e.g., Wiśniewski 2014). We are especially interested how such a property influence accuracy of three chosen estimates, namely the least squares estimates (LSE), R – estimates (Hodges-Lehmann estimates – HLE) and Mp estimates (MPE). The choice of such estimates was due to its practical application in the adjustment of geodetic observations. LSEs estimates are the most popular in such a context, HLEs are interesting especially in the case of deformation analysis and MPEs are steered among others by the excess kurtosis, thus that estimates consider anomalies in the error distributions.

The analysis is based on the Monte Carlo simulations, which are very useful and efficient in such a context (see, e.g., Duchnowski and Wiśniewski 2016). The simulations were carried out by assuming the normal distribution of measurement errors (mesokurtosis) as a reference computations or the family of the Johnson distributions (leptokurtosis), which are the main objective of the paper. In the ladder case we assume different values of the excess kurtosis. The computations were carried out for levelling networks which are numerically easy on one hand, and which reflect the general influence of the leptokurtosis of the distributions on the estimation accuracy on the other. The results show that leptokurtosis of error distribution might indeed influence the estimation accuracy and the influence itself depends on the value of the excess kurtosis and the estimation type. For example, the accuracy of LSEs does not depend on the excess kurtosis, while the accuracy of HLEs really does. Thus in some cases, for more leptokurtic error distributions, HLEs are more accurate that the traditional LSEs. The obtained results show that we should consider application of different kinds of estimates when the error distribution is suspected to be leptokurtic and we require the estimate with the highest possible accuracy (this especially concerns distributions with bigger excess kurtosis).

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Key words: parameter estimation, accuracy, Monte Carlo methods

[1] Institute of Geodesy, University of Warmia and Mazury in Olsztyn, 1 Oczapowskiego St., Olsztyn 10-957, Poland, e-mail: robert.duchnowski@uwm.edu.pl

[2] Institute of Geodesy, University of Warmia and Mazury in Olsztyn, 1 Oczapowskiego St., Olsztyn 10-957, Poland, e-mail: pwyszkowska@wp.pl

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LIGHTWEIGHT SINTERED AGGREGATE CONCRETE (0103)

Natalia Ciak[1], Marek Ciak[2]

An intensive increase in living standards requires securing energy which is possible through generation in large amounts. This evokes the necessity of processing equally large amounts of various fuels, most frequently hard coal and brown coal. As a result, waste products, so-called 'combustion by-products', are produced which are landfilled or used in many branches of industry including building engineering. Landfilled ashes and slags constitute an increasing problem. Attempts to produce artificial aggregates from such waste products have been made recently and such materials may be an alternative to natural and other light aggregates (e.g. expanded clay, lytag etc.). These aggregates are characterised by a relatively high compressive strength (when compared to other light aggregates). Moreover, this material is noise-damping, fire-resistant, vapour-permeable, frost-resistant and fungi- and mould-resistant. Light aggregates have been successfully used as filling material in concrete mixtures for a long time (lightweight aggregate concretes). The functionality of lightweight concretes, to a large extent is determined by bulk density, which is related to strength and ranges from 0.3 to 70 MPa. Depending on the offered parameters, lightweight concretes may be used for construction, insulation and construction, and solely for insulation.

This article presents the effect of using sintered aggregate in the lightweight aggregate concretes. Studies have been conducted in the Institute of Building Engineering at the University of Warmia and Mazury in Olsztyn. The paper includes study results of concrete mixtures and aggregate concretes obtained using landfilled ashes (varied granulation aggregates) and their modification by adding disperse reinforcement and superplasticizer admixture. The dispersant admixture reduced the water content in the concrete mixtures and formed concretes with low water/cement ratio and good workability maintained. Moreover, this article discusses the study results of the effect of the concrete modifications applied (disperse reinforcement, varied admixtures of superplasticizer) on the physical and mechanical properties of both concrete mixtures and hardened concrete. The application of admixtures such as a superplasticizer and disperse reinforcement has resulted in a decrease in concrete shrinkage and an increase in strength parameters of the tested concrete.

Key words: Civil engineering, Concrete, Lightweight concrete, Artificial aggregate, Strength, Absorbability, Thermal conductivity, Workability material testing, Material properties

[1] Institute of Building Engineering, University of Warmia and Mazury in Olsztyn; e-mail: n.ciak@uwm.edu.pl
[2] Institute of Building Engineering, University of Warmia and Mazury in Olsztyn; e-mail: mciak@uwm.edu.pl

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METHODOLOGY OF TECHNICAL VARIANTS EVALUATION WITH THE USE OF EXPERT SYSTEMS IN CIVIL ENGINEERING (0042)

Elżbieta Szafranko[1]

Numerous decision problems must be solved while planning a construction project. It is also necessary to analyse, for example, various possible locations, different functional, construction and material solutions as well as construction technologies. All of these are complex problems, which call for the involvement of many experts, whose opinions should be taken into consideration while proceeding with the analyses. What makes the whole procedure even more complicated is the obligation to comply with many legal provisos, standards and regulations. For an analytical process to provide us with the answers to questions, the input information must be collected and systematised in such a way that once it is ordered and submitted to calculations the expected outcome is achievable. The main problem arising when decisions must be made lies in selecting such a solution variant that will most faithfully satisfy the set of pre-defined criteria. This means that the goal and alternative ways of reaching the goal are identified prior to making a decision. When solving multi-criteria problems, an attempt is often made to express our expectations through a single criterion which aggregates all important consequences of a given problem. This approach is justifiable only in certain, rather simple cases. A single parameter is not recommended in a situation that involves a complicated development process. It is not completely reliable and lacks the properties which allow us to present and prepare a whole spectrum of issues and problems connected with the planning and preparing the construction of a building structure. A multi-criteria approach to making decisions, contrary to a single-criteria analysis, enables us to express a coherent family of criteria, an instrument of complete and exhaustive communication, which should help to create, substantiate and transform preferences during a decision-making process. Simple scoring methods as well as an MCE (Multi Criterial Evaluation) method can be distinguished among the most popular decision support methods. The MCE method consists of two steps. First, a group of criteria is defined on which the final decision will depend. Then, the fulfilment of these criteria by alternative solutions is assessed. Another approach which belongs to the above group of methods is the Analytic Hierarchy Process (AHP), where weights are assigned to criteria and the fulfilment of criteria by subsequently analysed variants proceeds in a pair-wise manner, while the criteria are classified into groups, thus laying the foundation for a hierarchical analysis. As well as being preceded by the determination of criteria essential for the selection of an optimal solution, all these methods share the same starting point, that is the collection of opinions by experts on questions asked in specially designed questionnaires. While analysing civil engineering projects, which can be highly diverse in character, we encounter a great variety of problems, with regard of which all analytical methods have certain advantages and drawbacks.

[1] University of Warmia and Mazury in Olsztyn, Faculty of Geodesy, Geospatial and Civil Engineering, Institute of Building Engineering, e-mail: elasz@uwm.edu.pl

Because of the specific nature of each method, it is impossible to state firmly which particular approach is more suitable in a given case. All analyses that serve to support decisions can be complemented by the graphic method, developed by the author, which allows the user to analyse investment alternative solutions by comparing their graphic profiles with a template prepared after evaluating the importance of each analytical parameter. The research output is a modified expert opinion system for the evaluation of a building development project. The system takes into account all subsequent procedural stages. By being versatile, it allows the user to analyse various building plans and has been successfully used in practice. The developed approach has been tested on construction projects performed in Warmia and Mazury. This method, designed by the author, is a novel approach to the assessment of variant solutions based on many decision criteria. Figure 1 shows the flowchart of the procedure.

The approach presented in this article shows an ordered series of actions that leads to the attainment of a goal such as the choice of a variant solution which will best satisfy the expectations of an investor and future users of a building or a building structure. The use of an expert opinion system enables us to secure better and more reliable effects. The whole system proposed above, by taking advantage of various features of the methods it includes, offers a wide range of possibilities in the assessment of alternative solutions in the construction industry.

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Key words: variants of construction projects, decision problems, expert system

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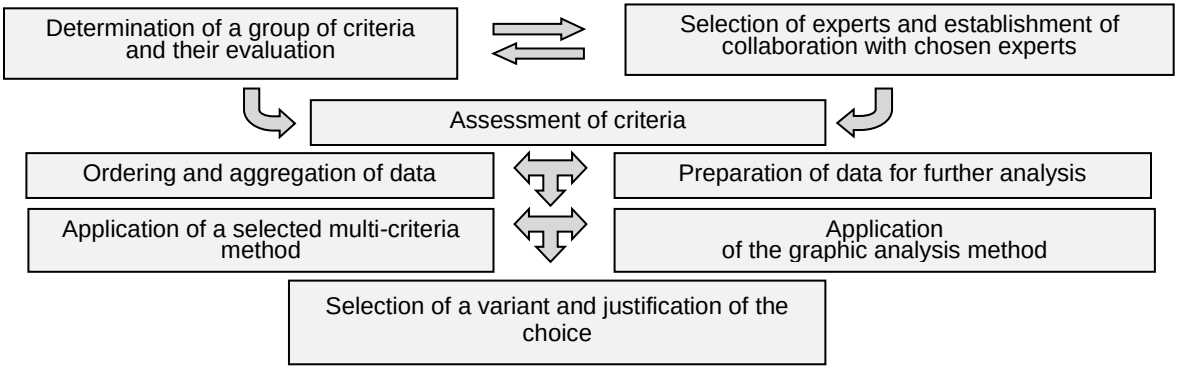

Fig. 1. A flow diagram of an assessment system applied to a development project, based on multi-criteria methods with expert opinions.

MONITORING AND PREDICTION OF THE COASTAL CHANGES SUPPORTED BY REMOTE SENSING AND MODELLING (0085)

Kazimierz Furmańczyk*[1], Natalia Bugajny[2], Łukasz Cieszyński[3], Paweł Andrzejewski[4], Joanna Dudzińska-Nowak[5], Andrzej Giza[6], Paweł Terefenko[7], Paulina Aniśkiewicz[8], Dominik Paprotny[9], Rafał Benedyczak[10], Tomasz Zawiślak[11]

Monitoring of coastal zone and subsequent prediction of changes occurring there has been a great challenge for researchers ever since. The zone undergoes morphological changes as it is constantly under influence of hydrological and meteorological factors. Such monitoring requires methods that allow to record huge areas in short time and one shall remember that the record becomes immediately out of date. Therefore, an identification of regularities/patterns of changes occurring in the coastal zone along with a determination of their root cause is that important, especially in terms of safe living and human activity.

This paper aims to describe an idea for a system that would record the effects and hazards from current and expected storm events at the Baltic Sea coastal zone [1].

Authors would like to show herein the assumptions to two system that monitor the changes in the coastal zone environment. Those are based upon introduced morphological data for the analysed section. Changes are being simulated by XBeach hydromorphodynamic model using morphology and prediction models of waves and sea level as an input.

Development of such system requires the preparation of practical and operational procedures as well as the commissioning of technical facilities allowing efficient, operational identification of the coastal zone environmental conditions.

Two systems that have been implemented as parts of MICORE and SatBałtyk are demonstrated here.

[1] University of Szczecin, Institute of Marine and Coastal Sciences ,Mickiewicza 18, Szczecin 70-383, Poland, e-mail: kaz@univ.szczecin.pl
[2] University of Szczecin, Institute of Marine and Coastal Sciences ,Mickiewicza 18, Szczecin 70-383, Poland
[3] University of Szczecin, Institute of Marine and Coastal Sciences ,Mickiewicza 18, Szczecin 70-383, Poland; West Pomeranian University of Technology Szczecin, IT Department, Żołnierska 49, Szczecin, 71-210, Poland
[4] University of Szczecin, Institute of Marine and Coastal Sciences ,Mickiewicza 18, Szczecin 70-383, Poland
[5] University of Szczecin, Institute of Marine and Coastal Sciences ,Mickiewicza 18, Szczecin 70-383, Poland
[6] University of Szczecin, Institute of Marine and Coastal Sciences ,Mickiewicza 18, Szczecin 70-383, Poland
[7] University of Szczecin, Institute of Marine and Coastal Sciences ,Mickiewicza 18, Szczecin 70-383, Poland
[8] University of Szczecin, Institute of Marine and Coastal Sciences ,Mickiewicza 18, Szczecin 70-383, Poland; Polish Academy of Sciences, Institute of Oceanology, Powstańców Warszawy 55, Sopot, 81-701, Poland
[9] University of Szczecin, Institute of Marine and Coastal Sciences ,Mickiewicza 18, Szczecin 70-383, Poland; Delft University of Technology, Faculty of Civil Engineering and Geosciences. Stevinweg 1 / PO-box 5048 2628 CN Delft / 2600 GA Delft, The Netherlands
[10] University of Szczecin, Institute of Marine and Coastal Sciences ,Mickiewicza 18, Szczecin 70-383, Poland
[11] University of Szczecin, Institute of Marine and Coastal Sciences ,Mickiewicza 18, Szczecin 70-383, Poland; West Pomeranian University of Technology Szczecin, IT Department, Żołnierska 49, Szczecin, 71-210, Poland

The conducted research and established procedures are modifications and extension of basic assumptions established for the storm impact forecasting early warning system (http://micore.ztikm.szczecin.pl), developed by a team of prof. K. Furmańczyk at Szczecin University as a part of MICORE project funded by the 7th Framework Programme of the European Union. The registration is based on a hydrodynamic XBeach model operating in the profiles of representative for six sections of Dziwnow Spit.

Storm impact indicators for the system have been developed and discussed with the Maritime Offices and local authorities. Each indicator threshold was chosen upon the degree of storm hazards for people who are living, resting, or doing business in the coastal zone. Expected or currently existing storm conditions are introduced into the XBeach model and the simulation results, in form of physical parameters generated by the model, are compared with the values of indicators in order to determine the degree of storm hazard and the size of the effects that resulted directly from this storm [2].

The second system was created as a part of "SatBałtyk" project (POIG.01.02.-22-011/09-00). To develop a research methodology of "SatBałtyk - Coast" subsystem, three experimental areas of length from 7 to 12 km have been selected. They include three different dune coast sections of Southern Baltic Sea. These are: Dziwnow Spit, Jamno and Bukowo lakes spit and a part of the base of the Hel peninsula. Morphology input data for XBeach model is obtained from the Maritime Offices and from field measurement campaigns. Sea level and wave datasets are acquired from models published on the Internet.

Sea – land impact indicators were divided into two groups: the effects of the storm caused and the effects anticipated. Proposed effects caused by the storm: the size of dune erosion; the volume of sandy material eroded from the coastal zone are stored in the database and presented on the website in graphical form. When selecting the effect ranges for graphical representation of storm changes, results obtained in the MICORE project as well as the scale of the hazard developed by Sallenger were used. The proposed anticipated storm effects: the possibility of occurring of the rip currents and the range of beach flooding. In these cases, an XBeach model simulation is being run daily with time step of 6 hours in 36 hour advance. For each time step, there are expected: the possibility of occurring of the rip currents and the range of beach flooding. These results are respectively to earlier group of effects stored in the database, and presented on the website in graphical form.

Indicators: beach flooding and dry beach width have been developed for the entire coast on the basis of simplified empirical model.

Actually, the system indicators are being validated.

The paper demonstrates the sample results of operation of both systems and validation of selected indicators.

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Key words: Environmental monitoring, Modeling, Early Warning System, Coastal Zone

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MULTI-GNSS ORBIT DETERMINATION USING SATELLITE LASER RANGING (0096)

Grzegorz Bury[1], Krzysztof Sośnica[2]

Satellite Laser Ranging (SLR) is a space technique that provides range measurements to geodetic satellites with a precision at the level of a few millimeters. SLR provides information on the origin of the International Terrestrial Reference Frame (ITRF), the global scale, gravitational constant GM, and low degree spherical harmonics of the Earth's gravity field. Owing to the fact that all satellites of new Global Navigation Satellite Systems (GNSS) carry laser retroreflector arrays (LRAs) and that a great part of GNSS constellation is included in the priority list of the International Laser Ranging Service (ILRS) stations, SLR serves as a validation tool for microwave GNSS orbits. However, determination of precise satellite orbits using range measurements to GNSS satellites is possible, as well.

The Multi-GNSS Experiment (MGEX) was established in 2011 due to emerging of new GNSS systems, i.e., European Galileo, Chinese BeiDou and Regional Navigation Satellite System (RNSS) such as the Japanese QZSS and Indian NaVIC. All satellite systems require precise orbit determination for precise positioning in geodesy and navigation. SLR technique is able to provide an independent orbit solution that is free from systematic errors typical for GNSS technique.

This paper covers the methodology of GNSS orbit determination using SLR data in the modified version of Bernese GNSS Software 5.2. We use MGEX products from Center for Orbit Determination in Europe (CODE) as a priori orbits and as a reference for the comparison with estimated orbits using SLR data. We chose CODE solution, because it was the first analysis center that provided a five-system orbit and clock MGEX solution, including GPS, GLONASS, Galileo, BeiDou and QZSS. We also use the same solar radiation pressure (SRP) model as CODE – the new Empirical CODE Orbit Model (ECOM2).

The results of the orbit determination for GLONASS and Galileo systems are very promising. The median RMS difference between the optical SLR and microwave GNSS orbits for the most effectively tracked satellite – GLONASS 107, decomposed into three directions equals to: 3.7 cm, 9.7 cm and 27.6 cm, for the radial, along-track and cross track component, respectively.

By analyzing the dependency of the number of tracking SLR stations on the RMS of differences between microwave and SLR orbits, we conclude that minimum 10 of SLR tracking stations are needed to determine the 3-day orbit with the median 3D RMS at the level of 65.4 cm. By increasing the number of stations from 10 to 15 the quality of orbits improves significantly and the 3D RMS decreases to the level of 26.3 cm. Increasing the number of tracking stations higher than 15 stabilizes the orbit solution and minimalizes the RMS which achieves the values of 12.0 cm and 7.6

[1] Wroclaw University of Environmental and Life Sciences, The Faculty of Environmental Engineering and Geodesy, Institute of Geodesy and Geoinformatics, address: ul. Grunwaldzka 53, 50-357 Wroclaw, email: grzegorz.bury@igig.up.wroc.pl
[2] Wroclaw University of Environmental and Life Sciences, The Faculty of Environmental Engineering and Geodesy, Institute of Geodesy and Geoinformatics, address: ul. Grunwaldzka 53, 50-357 Wroclaw, email: krzysztof.sosnica@igig.up.wroc.pl

cm for the number of 23 and 29 tracking SLR stations, respectively.

We conclude that it is possible to provide precise orbits for GNSS satellites using only SLR data with the accuracy of single centimeters. The accuracy of determined orbits strongly depends on the number of SLR tracking stations. Minimum 15 SLR tracking stations are needed to get the orbits quality at the level of 20 cm, whereas about 25 stations are needed to provide the GNSS orbit at the level of 10 cm in terms of the 3D RMS of orbits differences between SLR and microwave solutions. As a result one can deliver an independent orbit solution that is free of systematics typical for GNSS solutions, thus satellite laser ranging to global and regional navigation satellite systems should be performed continuously.

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Key words: Global Navigation Satellite System, Precise Orbit Determination, Satellite Laser Ranging

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MULTI-PERSPECTIVE VIEWS OF THE EFFECT OF OIL POLLUTION IN IJEODODO COMMUNITY LAGOS STATE, NIGERIA (0093)

Esther O. Makinde*[1], Ayodele S. Tologbonse[2]

Several oil pollution incidences on the environment, as a result of pipeline explosion caused by sabotage have created negative impacts in past times. The occurrence of it has increased in Nigeria specifically, Lagos State, bringing grave environmental and economic effects. This paper assesses the hazard and communities vulnerable as well as the response model needed in handling oil spill emergency operations

This study explored data from satellite imageries (Landsat 7 (2011), Landsat 8 (2014 and 2015) Enhanced Thematic Mapper Plus, ETM+) to social (questionnaires) and ecological surveys (water and soil samples) to achieve its aim. The images were processed and analysis performed. Further spatial analysis was carried out. Hazard was modeled from a buffer zone analysis around the source of oil hazard which is the oil pipeline, while, vulnerability was modeled by combining together the element at risk which is land cover layer and accessibility layer in single output algebra on ArcMap 10.2. The response model was modeled from two input data, the input source data which is the road network and the input cost distance source data which is the land cover. Water and soil samples were analyses for the presence of heavy metals concentration and the results were compared to the Controls and World Health Organization Standard.

Results showed that some of the affected settlements were within the pipeline corridor, and pipeline vandalization was encouraged by one or more cases of faulty and exposed pipeline and inefficient pipeline monitoring system. It further shows a rise in built-up areas of the Land cover classification, which was in total 58.9 % leading to the decline in vegetation (29.1 %), bare ground (7.2 %) and water body (4.8 %) between 2011, 2014 and 2015. The presence of heavy metals in water and soil were obvious, especially phosphate with the highest concentration of 289.370 mg/l, iron 3.021 mg/l, zinc 2.012 mg/l, and the least was lead with 0.020 mg/l in water. Also, in soil phosphate had 3.750 mg/kg, zinc 1.732 mg/kg, iron 0.231 mg/kg and lead 0.004 mg/kg in the impacted area (Ijeododo); which is about 6,337.9 m away from the control (Ikotun). Further findings indicate that the measure of insecurity (36.7 %) is a prevailing element and only a great measure of effective security (40.8 %), will pave a way out. An F-test in a 95 % confidence interval was done.

This study concludes that oil spill had negatively impacted the study area and proffers the urgent need to utilize emergency response plans, providing closeness to accessibility and response centres to handle oil spill incidence.

[1] Department of Surveying and Geoinformatics, Faculty of Engineering, University of Lagos, Akoka Lagos State, Nigeria, e-mail: estherdanisi@gmail.com, eomakinde@unilag.edu.ng

[2] Department of Surveying and Geoinformatics, Faculty of Engineering, University of Lagos, Akoka Lagos State, Nigeria, e-mail: ay20dec@gmail.com

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Key words: Oil Pollution, Model, Remote Sensing

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NATIONAL HEIGHT SYSTEM TESTING IN BALTIC COUNTRIES USING GNSS MEASURUMENTS (0062)

Armands Celms*[1], Ilona Reķe[2], Donatas Rekus[3], Giedrius Balevičius[4]

Since 1st December 2014 in Latvia as a national height system is determined the European Vertical Reference System realization in Latvia - Latvian Normal Height System 2000,5 (LHS-2000,5). After national height system replacement there is a transformation formula for point height difference theoretical value in any place of Latvia. Performing practical Global Navigation Satellite System (GNSS) measurements and obtained data mathematical processing, there is also a possibility to calculate point height difference between used and implemented height systems. There were thirteen class I levelling network points selected in territory of Latvia and got the height values of them using transformation formula and GNSS measurements. Theoretically the height values obtained using both methods should coincide, but just 3 of selected geodetic points the height difference comparing both method height values is close to zero and point height difference of all measured points differs in 17 cm amplitudes indicating problems with transformation formula or need to improve geoid model.

The works on development of the Lithuanian National Geodetic Vertical Network were finished in 2007. The new Lithuanian height system is called LAS07. It is started from the 1th of January in 2016. Approximately difference between the old (BAS77) and new height system (LAS07) in the middle of Lithuania is about 14 cm.

The study aim is to determine by transformation formula and GNSS measurements obtained height value differences between Baltic Normal Height System 1977, LHS-2000,5 and LAS07. To achieve the goal the following tasks are set: 1) to perform global positioning measurements in the national class I levelling network obtaining values of point height difference in two height systems; 2) to obtain point height difference using height transformation formula; 3) to compare the obtained values.

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Key words: Latvian Normal Height System, Global navigation satellite system, Sea level

[1] Latvian University of Agriculture Department of Land Management and Geodesy, Akadēmijes iela 19, Jelgava, LV-3001, Latvia, e-mail: armands.celms@llu.lv
[2] Latvian University of Agriculture Department of Land Management and Geodesy, Akadēmijes iela 19, Jelgava, LV-3001, Latvia, e-mail: ilona.reke@gmail.com
[3] Kaunas University of Technology Department of Building Technologies, Studentų str. 48, Kaunas, LT-51367, Lithuania, e-mail: donatas.rekus@ktu.lt
[4] Aleksandras Stulginskis Univesity Institute of Land Management and Geomatics, Universiteto str. 10, Akademija, Kaunas, LT-53361, Lithuania, e-mail: giedrius.balevicius@asu.lt

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ON THE QUALITY PARAMETERS OF THE MODERN GRAVITY SURVEY OF THE LITHUANIAN TERRITORY (0079)

Romuald Obuchovski[1], Petras Petroškevičius[2], Eimuntas Paršeliūnas[3], Vytautas Puškorius[4], Dominykas Šlikas[5], Povilas Viskontas[6], Evelina Zigmantienė[7]

The methodology and technology of the gravity survey of Lithuanian territory are presented. The stress on quality parameters of the gravity survey is done.

The previous gravity survey in Lithuania was done in the middle of the XX century. Research performed shows that gravity value taken from above mentioned gravity survey can contain errors up to 3 mGal. Such accuracy of gravity survey does not fit to nowadays requirements.

According to project the standard deviation of the gravity acceleration at the gravity survey points should not be worse than 60 μGal, and the standard deviation of Bouguer anomalies should be better than 80 μGal. The average distance between gravity points should be about 1.5–2 km. It is planned to determine gravity value at the 30000 points in total. At every point two cycles of measurements, 25 seconds duration each, are carried out. If gravimeter readings difference change is larger than 15 μGal, additional cycle of observations is performed. Observations data is reduced by taking into account the gravimeter calibration coefficient values together with effects of the Moon and the Sun. Further the day trip data is adjusted by using two reference points and by determining differences of gravity acceleration values at survey control points. Positioning of the gravity points applying LitPOS RTK service is foreseen. The accuracy of the gravity points coordinates should be better than 0.20 m, and the accuracy of the normal heights, applying geoid model LIT15G, should be better than 0.15 m. The gravity survey is based on the Lithuanian state gravity control network, which consists of 686 points. The standard deviations of the gravity acceleration at these points are not worse than 10 μGal.

The modern gravity survey of the territory of Lithuania was started in 2016. The gravity acceleration at gravity survey points is observed by Scintrex CG-5 gravimeter. In total 5 Scintrex CG-5 gravimeters are employed. The analysis of the calibration results of the gravimeters is presented also. Gravimeters in Lithuania are calibrated at the gravimetric baseline connecting gravimetric points EIŠIŠKĖS, VILNIUS, PANEVĖŽYS, SALOČIAI Gravimetric baseline points are situated along the meridian. The gravity value increase between bordering baseline points EIŠIŠKĖS and SALOČIAI is 201 mGal. The baseline length is 270 km. RMS errors of calibration coefficients were not exceeding 0.000061.

[1] Vilniaus Gedimino technikos universitetas Sauletekio al. 11, LT-10223 Vilnius, Lithuania, e-mail: romuald.obuchovski@vgtu.lt
[2] Vilniaus Gedimino technikos universitetas Sauletekio al. 11, LT-10223 Vilnius, Lithuania, e-mail: petras.petroskevicius@vgtu.lt
[3] Vilniaus Gedimino technikos universitetas Sauletekio al. 11, LT-10223 Vilnius, Lithuania, e-mail: eimis@vgtu.lt
[4] Vilniaus Gedimino technikos universitetas Sauletekio al. 11, LT-10223 Vilnius, Lithuania, e-mail: vytautas.puskorius@vgtu.lt
[5] Vilniaus Gedimino technikos universitetas Sauletekio al. 11, LT-10223 Vilnius, Lithuania, e-mail: dominykas.slikas@vgtu.lt
[6] Vilniaus Gedimino technikos universitetas Sauletekio al. 11, LT-10223 Vilnius, Lithuania, e-mail: povilas.viskontas@vgtu.lt
[7] Vilniaus Gedimino technikos universitetas Sauletekio al. 11, LT-10223 Vilnius, Lithuania, e-mail: gi@vgtu.lt

Based on the first measurements results the standard deviation of the gravity acceleration at gravity survey points is received about 20 μGal. The standard deviation of calculated Bouguer anomalies is about 23 μGal.

Accuracy of the gravity value and coordinates determined with GNSS should ensure suitability of the points for the future detailed gravity field research of Lithuanian territory.

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Key words: geophysical measurements, geodesy, data processing

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ONLINE GEOCODING SERVICES: A BENCHMARKING ANALYIS TO SOME EUROPEAN CITIES (0014)

Gianfranco Di Pietro[1], Fabio Rinnone*[2]

Geocoding is the computational process that allows to transforming an address of a place into a location on the Earth's surface using geographic coordinates. The quality of geocoding have a relevant importance in spatial analysis[2]. Furthermore, in recent years we have seen an enormous spread of Web technologies that have involved a growing number of users. At the same time have been born many Online Geocoding Service that support the increasingly webGIS consumer applications. It has been proposed efficient algorithms to dynamically determine which Geocoding Service is more accurate [3].

For these reasons, we present Gfgecoder, a tool based on a methodology capable to efficiently benchmark Online Geocoding Services. Gfgeocoder analyzes geocoding result obtained by some Online Geocofing Services, such as Google Geocoder, MapQuest and OpenRouteService. The tool is written in Java language and it allow to make parallel requests to the Online Geocoding Services, passing in input the files containing strings of addresses. We used as input results of geocoding strings of addresses, published by some European Municipalities in their official open data portals. Input files are formatted as couples of type (address; WGS84 coordinates). Gfgeocoder is a multiplatform tool executable from command line and it can be runned as a background daemon in Windows and Unix like servers.

Results obtained by Gfgeocoder are stored in tabular mode, in CSV format. At the end of the phase of geocoding, we done appropriate analyzes based on geometric and geodetic comparison of the distances between the strings of the coordinates obtained from Online Geocoding Services and the coordinates provided by Municipalities. In particular, we propose a benchmarking analysis performed using a parameter named "GA10", defined as “percentage of addresses that are less than 10 meters from the coordinates provided by Municipalities”.

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Key words: benchmark testing, geocoding, geographic information systems

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[1] Geofunction Srls, via Luigi Sturzo, 71, 93015 Niscemi CL, Italy

[2] Geofunction Srls, via Luigi Sturzo, 71, 93015 Niscemi CL, Italy, e-mail: fabiorinnone@geofunction.it

PRICING VISUAL ACCESSIBILITY OF ENVIRONMENTAL LAND USES IN HOUSING MARKETS: A GEOGRAPHICALLY WEIGHTED REGRESSION APPROACH (0009)

Jay Mittal[1], Sweta Byahut[2]

This paper uses a geographically weighted regression (GWR) modelling approach to assess the effect of visual accessibility of scenic land uses on the housing prices. It provides a methodology of estimating households' implicit willingness to pay (WTP) for the visual accessibility of privately-owned voluntarily-protected scenic-lands in a single family housing market in Worcester, Massachusetts, USA. The premium price effect was captured using the visual accessibility variable, developed as a combined weighted measure of visibility and proximity of such land uses from homesusing geospatial analysis. This variable was named as Gravity Inspired Visibility Index (GIVI).

The preserved scenic land uses are protected in perpetuity to conserve their natural, historic, and scenic characteristics. The privately preserved lands serve as public amenities, and offer direct and indirect environmental and health benefits to the local communities. In past, several parks, trails, waterways, and wildlife areas have been protected using this mechanism also called -- Conservation Easements in the United States. The Conservation Easements (CE) are legal agreements signed between private landowners' and a non-profits, or a government agencies, aimed to perpetually conserve the preservation-worthy lands. Per the agreement, the private landowners restrict any future development rights on their lands, but retain titles, and rights to own and use the land. Owners' also have the option to either donate or sell the restricted development rights, and claim equivalent value loss of restricted development rights via federal tax credits. Billions of dollars worth of public money is involved as tax credits to incentivize private landowners in conserving such lands. This paper offers useful insights to the local governments and conservation agencies in promoting and spatially planning conservation activities.

After providing a comprehensive review of eight different land uses that generated price contrubting environmental amenity effect (Mittal and Byahut 2016), this paper reviewed studies from multidisciplinary sources (real estate, urban planning, geography and environmental economics) and the review provided basis on significance of 'proximity' and 'view.' The paper provides a detailed methodology on developing the spatial interaction variable of GIVI developed using 3D GIS and viewshed (the viewshed identifies cells in an input raster that are visible from one or more observation points. Binary values are added to the output raster with 1 meaning visible and 0 means not visible) technology. This GIVI variable was used to estimate the capitalized premium from the preserved scenic land uses.

The paper uses geospatial analysis and employs geographically weighted regression modelling

[1] Planning and Real Estate, Auburn University, 7080 Haley Center, Auburn, AL, 36849, USA, e-mail: jay.mittal@auburn.edu; Ph: 334.844.8409 (Office)
[2] Planning, Auburn University, 7080 Haley Center, Auburn, AL, 36849, USA, e-mail: sweta.byahut@auburn.edu; Ph: 334.844.8436 (Office)

approach in estimating the effect. Both global regression model (*adjusted* R^2 = 0.52, *AICc* = 29828) and the geographically weighted regression (GWR) models (*adjusted* R^2 = 0.59, *AICc* = 29729) were calibrated to estimate the marginal price effect of scenic land uses as capitalized in neigboring homes (Mittal and Byahut 2017; Nakaya et al. 2014; Brundson et al. 199). The results indicated a capitalized premiunm of 3.4 % on an average observed on the mean home value of homes from the GWR model. The paper offers a useful framework for evaluating effects of scenic land uses, land protection for GIS, urban and regional planning and real estate scholars and professionals. It also offers useful insight to conservation agencies, local governments, professional planners, and real estate professionals for prioritizing land sites with scenic views and for property development.

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Key words: Geospatial analysis, Regression analysis, Land use planning, Urban areas, Environmental economic, Environmental factors, Visualization

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PROBLEMS CONCERNING FOUNDATION OF BUILDINGS ON FOAM CONCRETE SUBSTRUCTURES IN IRRIGATED SOILS (0116)

Robert Wójcik[1], Maria Tunkiewicz*[2]

Foam concrete produced directly on the construction site using mobile foaming–pumping devices is becoming increasingly popular. This capillary-porous material, formed by mixing cement mortar with technical foam, has a low density within the range of 250 – 1,600 kg/m^3, relatively good thermal properties and satisfactory compression strength. Additional features, such as incombustibility and being easy to lay (due to a liquid consistency which allows self-leveling) has expanded the use of foam concrete. Recently, foam concrete has been employed to provide foundation frameworks in harsh water and groundwater conditions. Following the example of Scandinavian solutions using extruded polystyrene for the foundation of communication objects on low-bearing and irrigated areas, there have also been attempts to use lightweight foam concrete foundations for low-rise pavilion buildings located on low-bearing soil in Poland.

On the basis of such projects, we started research studies to assess this kind of technology, which was directly caused by the occurrence of a state of emergency of one of the buildings erected using a foam concrete substructure. As a part of the study, the strength parameters of the polygon conditions mixtures were tested. In the laboratory, we tested the raw components that were used. The paper also presents the negative influence of adverse environmental conditions in the field of variable water conditions and maturation of the massif under conditions of the progressive deformation of the substrate.

Foregoing the use of the foam concrete, mainly as an insulating element in over-ground structures and as a filler in inner ceiling spaces in renovated buildings, does not raise concerns. Concrete foam acting as a cement screed or foundation basic layer laid on stable ground can also be classified as a proven application. However, the properties of foam concrete used in irrigated conditions, e.g. for filling massive excavations with water have not been recognized yet.

In the laboratory of the University of Warmia and Mazury, research was conducted on the impact of both moisture and, particularly, water pressure on foam concrete properties. The research was carried out based mainly on the few projects in which the relatively low price of this material prompted investors to use foam concrete for the foundation of light-frame buildings on low-bearing soils irrigated using a partial uplift. An "innovative" project, involving the conversion of an intermediate-designed foundation on stilts on an unreinforced massif foundation with foam concrete in the form of a plate, developed serious problems. The foundation area included low-bearing soil, wetlands and peat. The design envisaged that a massive plate with a thickness of approx. 200 cm, made on non-load bearing grounds, would carry the load using the buoyancy of the groundwater. The plate was made

[1] University of Warmia and Mazury in Olsztyn, Poland
[2] University of Warmia and Mazury in Olsztyn, Poland, e-mail: maria.tunkiewicz@uwm.edu.pl

in layers with a thickness of about 20 cm. The density of the lower layer was approx. 600 kg/m3 while the upper layer was 1,200 kg/m^3. As a result of the planned load, the lack of expansion joints as well as the uneven ground subsidence, the foam concrete plate was scratched and fractured, which led to the construction failure of the constructed building. In the presented case, although urgent remedial actions were undertaken, including stilts and additional strengthening of the structure of the building, many objects made in similar ground conditions are in operation without additional reinforcements.

The results of this research article relate mainly to the particular material and construction solutions, which led to the construction failure. The encountered problems encouraged broader research to be conducted including gathering information about the potential risks relating to similar cases in which deformations and cracks in foam concrete structures under long-term load may occur.

The research included the use of an X-ray spectrometer that identified the chemical composition of the material taken from various passages formed in the subsequent phases of technical foam concrete panels. What is more, a mercury porosimeter and air void analyzer defined pore distributions in the different layers of the plate. The combination of different methods of porosity testing enabled a thorough diagnosis of the contents of the air pores and macro and micropores responsible for convective capillary transport of water. Factors were determined, such as the absorbability for individual fragments of the plate with prolonged exposure to pressure water, and the transport parameters of the foam concrete skeleton in the field of capillary moisture in the layers located above the water level and the surface zone of direct impact of rainwater. The frost resistance of individual layers of the plate was also determined. It was shown that foam concrete has significant limitations and application restrictions, particularly in relation to massive foundations.

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Key words: Building materials, microstructure

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PROPOSAL OF USING THE OPTD METHOD IN THE EVALUATION OF THE ACCURACY OF RIVER AREA RECONSTRUCTION (0078)

Wioleta Błaszczak-Bąk[1], Anna Sobieraj-Żłobińska*[2], Beata Wieczorek[3]

The land surface is exposed to the action of natural and anthropogenic activities. The hydrological, geomorphologic processes such as the flow of inland waters, soil erosion and mining works are causing deformation of the land. In analyses of those changes the spatial visualization of terrain can be used. Its usefulness is determined by acquired for this purpose spatial data and methods of processing and modeling. An important factor is that both, data and these methods, should allow to obtain a model with fixed or the appropriate geometric accuracy, in particular the altitude. The data and methods also should enables the appropriate mapping surface detail of the terrain model, wherein the amount of data need to be optimal.

The study was focused on Biebrza River, located in the northeastern part of the Poland, in the Podlasian Province. It is one of the last, relatively unchanged by man, river in Europe with natural ecosystems. Every year in spring it floods the surrounding areas, what is a natural and welcome occurrence. The floodplain of this river is known as Biebrza Wetlands, which are the largest and best preserved in Europe with unique diversity of plants, animals and habitats. The Biebrza valley is especially important place for waterfowl. Most of this area is protected within Biebrza National Park. Almost the entire Biebrza is located in the park (approximately 155km of river, while the whole length is 165km). From 1995 this area is on the list of Wetlands of International Importance defined by Ramsar Convention. It is also included in the network of protected sites as NATURA 2000.

Biebrza River and its surroundings due to its ecological value are a subject of constant observation and monitoring of various species. They were recently presented in Chronicles of Biebrza National Park (2015). High biodiversity is attributed to the unique hydrological conditions, which are also a field of various studies and tests based on the spatial data. One of the common technology applied in the field of hydrology is laser scanning. It provides reliable spatial data in relatively short period of time. It is especially important in river area, where changes could be very dynamic. However, processing of obtained from laser scanning point clouds is time and work consuming due to amount of data. Therefore it is reasonable to reduced the spatial dataset.

Measurements covered one of meandering section of Biebrza River, near Goniądz. They were conducted in May 2012. The terrestrial laser scanner Scan Station C10 Leica Geosystems was used. Obtained data were processed by means of the OptD method (Optimum Dataset) which enables

[1] University of Warmia and Mazury in Olsztyn, Faculty of Geodesy, Geospatial and Civil Engineering, Institute of Geodesy, Oczapowskiego 1, 10-719 Olsztyn, Poland, e-mail: wioleta.blaszczak@uwm.edu.pl
[2] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Geodesy, Narutowicza 11/12, 80-233 Gdansk, Poland, e-mail: anna.sobieraj@wilis.pg.gda.pl
[3] University of Warmia and Mazury in Olsztyn, Faculty of Geodesy, Geospatial and Civil Engineering, Departement od Land Surveying and Geomatics, Heweliusza 12, 10-724 Olsztyn, e-mail: beata.zero@uwm.edu.pl

to find an optimum dataset in terms of adopted criterion or criteria (Błaszczak-Bąk, 2016). On the basis of the obtained dataset digital terrain model (DTM) and digital surface model (DSM) were created. They can be applied in various analyzes, simulations and modeling phenomena.

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Key words: optimization, data processing, numerical models, rivers

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REGIONAL IONOSPHERE MODELING BASED ON MULTI-GNSS DATA AND TPS INTERPOLATION (0099)

Paweł Wielgosz*[1], Anna Krypiak-Gregorczyk[2], Andrzej Borkowski[3]

Global Navigation Satellite System (GNSS) signals have become a valuable tool in studying the Earth's ionosphere. GNSS dual-frequency observables allow for calculation ionospheric total electron content (TEC). An important aspect in the electron content estimation at regional or global scale is adopting the appropriate interpolation strategy. The most popular global and regional ionosphere models provided by scientific organizations such as International GNSS Service (IGS), Center for Orbit Determination in Europe (CODE), European Space Agency (ESA) or Universitat Politècnica de Catalunya (UPC) are often used for ionosphere studies and surveying and engineering applications. However, their relatively low accuracy and low spatial and temporal resolutions are often not sufficient for studying the ionosphere on a regional scale. Recent studies estimated relative error of popular GNSS-TEC maps at the level of 20-30%. Additional comparisons to reference altimeter data show absolute TEC accuracy of 4–5 TECU (15–25% relative). This motivates research community to develop new modelling and interpolation methods. In this paper, we demonstrate new approach to GNSS-TEC estimation. In the new approach we use solely carrier phase multi-GNSS observables and thin plate splines (TPS) for accurate ionospheric TEC modeling. TPS is a closed solution of a variational problem minimizing both the sum of squared second derivatives of a smoothing function and the deviation between data points and this function. This approach is used in UWM-rt1 regional ionosphere model developed at University of Warmia and Mazury in Olsztyn (UWM). The model allows for providing ionospheric TEC maps for Europe with high spatial and temporal resolutions - 0.2x0.2 degrees and 2.5 minutes, respectively. For TEC estimation, EUREF Permanent network (EPN) and European Position Determination System (EUPOS) reference station data is used. In addition, we present the performance of our approach during one the most intense ionospheric storms of 24th Solar cycle that took place on March 17th, 2015 – so called St Patrick storm. During this storm, the TEC level over Europe doubled comparing to earlier quiet days. Our ionosphere maps were compared to the IGS and UPC global and CODE regional maps. The results showed that the accuracy of our maps was better with residuals lower by at least 50% comparing, e.g., to IGS and CODE maps. The final accuracy of the UWM-rt1 derived TEC maps is estimated at the level of 0.5 TECU.

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Key words: Ionosphere, TEC, GNSS, TPS

[1] University of Warmia and Mazury in Olsztyn, Poland, e-mail: pawel.wielgosz@uwm.edu.pl
[2] University of Warmia and Mazury in Olsztyn, Poland, e-mail: krypiakann@wp.pl
[3] Wroclaw University of Environmental and Life Sciences, Poland, e-mail: andrzej.borkowski@igig.up.wroc.pl

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REMOTE SENSING METHODS IN THE STUDY OF THE IMPACT OF LONG-TERM PROCESS OF SULPHUR MINING ON ENVIRONMENTAL CHANGES OF THE CARPATHIAN FORELAND (0090)

Krystyna Michalowska*[1], Ewa Glowienka[2], Beata Hejmanowska[3]

Based on multitemporal satellite images is obtained information about the spatial characteristics that allow the direct identification of natural phenomena and the state of environment or indirectly, may be used in modeling environmental changes or their prediction. They may be a valuable source of information about the condition of vegetation, coverage changes and the effects and reasons of the environmental degradation due to natural or anthropogenic factors.

The paper presents research on the extent of impact of sulphur mining process and post-mining activities upon properties of selected elements of the environment, as well as the assessment of the influence of indirect effects resulting from many years' process of exploitation of sulphur deposits in the areas of the Carpathian Foreland (Sandomierz Basin).

Research processes made use of data obtained from the satellite ceiling, i.e. LANDSAT multitemporal image data, made available thanks to the longest-standing programme of remote acquiring of the Earth images. They are downloaded from USGS server (https://earthexplorer.usgs.gov). In addition, measurement data concerning chemical properties of soil were used. The data were gathered by the Polish Institute of Soil Science and Plant Cultivation, Poland (IUNG) within the framework of the programme of "Monitoring the Chemism of Arable Soils in Poland" financed from resources granted by the National Fund for Environmental Protection and Water Management (online access). Additionally soil map of Podkarpackie Province and orthophotomaps, topographic maps (www.geoportal.gov.pl) were applied.

Remote sensing methods have been proposed. They are based on multitemporal data (indexes, colour compositions, map algebra results), and can be used in the process of identifying and examining the nature of environmental changes, determining the degree of transformations, and finding out the range of influence of indirect effects resulting from the many years' process of exploitation of sulphur deposits. Within the scope of research conducted, the assessment of the extent of impact of results connected with actual sulphur mining and post-mining activities upon properties of selected elements of the environment, i.e. the state and condition of vegetation, forms of land coverage and the chemistry of soils, has been made. Moreover, an attempt has been made at developing an image data processing algorithm to automate the process of detecting environmental changes.

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Key words: Multi-temporal analysis, Remote sensing, Environmental monitoring, Soil properties, Vegetation

[1] University of Agriculture in Krakow, Krakow, Poland, e-mail: k.michalowska@ur.krakow.pl,
[2] Kielce University of Technology, Kielce, Poland, e-mail: eglowienka@tu.kielce.pl,
[3] AGH University of Science and Technology, Krakow, Poland e-mail: galia@agh.edu.pl,

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RESEARCH ON STATISTICAL SIGNIFICANCE OF POINTS' DISPLACEMENTS (0052)

Marek Banaś*[1]

The paper is based on results of double measurement campaigns of geodetic horizontal control network consists of eight ferroconcrete observation pillars equipped with forced centring device which are located in The Bronisław Markiewicz State School of Technology and Economics Camp in Jarosław. The network is rectangular and pillars form 3 equal squares having 54m sides. In the original and actual survey distances and directions were measured from each station to the seven remaining points of the network. Horizontal displacements of four points were physically simulated before actual measurement. Methods for the preparation of the experiment (i.e. point displacements simulation), equipment and instrument used for measuring and technique of measuring can also be found. Method used to prepare sets of observations for adjustment was also described, i.e. accuracy assessment of the sets of observations obtained as well as minimally constrained adjustment principles. This part of the paper is completed with results of least squares adjustment of the control network. The final outcome of the least square adjustment is variance-covariance matrix of the adjusted point coordinates and parameters of standard error ellipses. In the following part of the paper there is description of two methods for testing statistical significance of points displacements. The first of them uses standard error ellipses for estimated displacements. The second one is based on test statistic using the magnitude of displacement and corresponding displacement's accuracy. Testing the significance of displacements in this method is based on critical value of the test statistic calculated with using empirical cumulative distribution function for each point. The cumulative distribution function is generated for each control pint on the basis of 100 000 iterations. Calculated, actual value of test statistic compared with critical value calculated at the assumed significance level is the basis for rejection of null hipotesis which assumes that point is stable. Results from each method were presented. The main conslusion from research is that significance of observed displacements with respect to accuracy of measurements should be effectivelly assessed according to actual, empirical distribution function of test statistic.

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Key words: displacement measurement, stability analysis, parameter estimation

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[1] The Bronisław Markiewicz State Higher School of Technology and Economics in Jarosław, Institute of Technical Engineering, 16 Czarnieckiego St., 37-500 Jarosław, Poland, e-mail: marek.banas@pwste.edu.pl

RISK DIAGNOSIS AND MANAGEMENT WITH BBN FOR CIVIL ENGINEERING PROJECTS DURING CONSTRUCTION AND OPERATION (0056)

Marian W. Kembłowski[1], Beata Grzyl[2], Adam Kristowski[3], Agata Siemaszko*[4]

The authors demonstrate how expert knowledge about the construction and operation phases combined with monitoring data (for example surveying measurements) can be utilized for the diagnosis and management of risks typical to large civil engineering projects. The methodology selected for estimating the probabilities of risk events is known as Bayesian Belief Networks (BBN). Using a project-specific BBN model one can keep on updating the risk event probabilities as new evidence (monitoring information/observations) becomes available. Furthermore, the probabilities estimated during the final period of the construction phase with the help the then-available observations serve as background (prior) information for the subsequent (operation) phase (in BBN lingo: the next object). The integrated two-object, construction-operation, model may be used to optimize the monitoring system from the perspective of information value and/or risk assessment precision, i.e., the entropy of risk events. To better show how the proposed approach works the authors use the example of the road tunnel constructed and operated under the Dead Vistula River in Gdansk, utilizing the data from tunnel construction subsidence measurements. The importance of the monitoring data collected during the construction activities to risk assessment during the project operation is demonstrated. In particular, we show how this information affects the estimates of operational risk event probabilities. One of the risk events that ought to be considered is the occurrence of leaks during the tunnel construction. Such leaks during the tunnel operation may lead to weakening of the tunnel body, and subsequently to growing cracks. The symptoms of this potential problem can be monitored during tunnel operation by measuring stresses in the (determined during the construction phase) sections of concern (using tensometers), as well as vertical and horizontal displacement of the tunnel body.

The major advantage of the proposed methodology lies in the fact that a created construction-operation risk model works as an integrating tool in which both past and current information about the project and its surrounding conditions is used to assess the risk problems' probabilities at any time of interest. The selection of optimal decisions and best mitigating actions, based on the assessed probabilities of risk events, may be performed, for example, from the viewpoint of the contracting entity (Gdansk Municipal Investments Sp. z o.o.). The application of such a Bayesian network model allows

[1] Faculty of Civil and Environmental Engineering, Gdansk University of Technology (GUT), Narutowicza 11/12, 80-233 Gdansk, Poland, e-mail: prof.mwk@gmail.com
[2] Faculty of Civil and Environmental Engineering, Gdansk University of Technology (GUT), Narutowicza 11/12, 80-233 Gdansk, Poland, e-mail: beata.grzyl@wilis.pg.gda.pl
[3] Faculty of Civil and Environmental Engineering, Gdansk University of Technology (GUT), Narutowicza 11/12, 80-233 Gdansk, Poland, e-mail: adam.kristowski@wilis.pg.gda.pl
[4] Faculty of Civil and Environmental Engineering, Gdansk University of Technology (GUT), Narutowicza 11/12, 80-233 Gdansk, Poland, e-mail: agasiema@pg.gda.pl

one to consider risks in the environment characterized by considerable uncertainty. The model combines the expert knowledge of the risk problem elements and the cause-effect relationships among them (whose strength is expressed by conditional probabilities) with new evidence (monitoring observations). The evidence from such observations is propagated throughout the whole network resulting in updated (a posteriori) probabilities of all the events/variables represented in the model. The updated risk probabilities that reflect the cumulative effect of all new evidence lead us in turn to new (updated) selection of optimal decisions and mitigating actions.

It is worthwhile to mention that the model variables and the relationships among them are represented by easy to understand, discuss, and modify graphs. This characteristic is of importance during the process of creating and testing the model by a group of problem experts and knowledge engineers.

Furthermore, as our knowledge regarding new factors influencing risk issues becomes broader one may readily incorporate the new relationships in our integral risk model. This is due to the elasticity of Bayesian nets, namely their ability to accept new interconnected events with multiple connections to the existing ones.

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Key words: Bayesian Networks, construction management, operation phases, risk, value of information

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'RUSLE' EROSION MODEL OPTIMIZATION BASED ON GEOSPATIAL DATA (0082)

Piotr Bozek*[1], Jaroslaw Janus[2]

Land consolidation works are procedures of technical, organizational, and economical nature and their task is to improve the conditions of agricultural activities. During land consolidation process, spatial structure of rural areas undergoes reorganization that leads to the improvement of farming conditions. When factors which may have a strong impact on agricultural production are disregarded during land consolidation, the whole process may lead to unsatisfactory results. One of such factor is the degree of soil erosion risk which determines possible erosion. Soil erosion has a damaging impact on soil productive capacity and often leads to its permanent degradation, making it useless for agricultural activities. There are numerous methods which can determine the degree of erosion risk. The most popular are those using GIS software and geospatial data (obtained with the use of ALS technology). The degree of erosion risk is assessed in RUSLE mathematical model, which predicts the amount of eroded soil.

The article discusses a complex methodology which allows to assess the influence of source data quality on the indices used in RUSLE. Geospatial data, obtained with LiDAR technology, was used in the study. The data is characterized by 0.2 m accuracy, with density of 4-12 ppm. The area studied was located in Southern Poland. In order to assess the influence of the degree of detail on the values of RUSLE indices, the data was generalized. Consequently, data with different degrees of detail was obtained. This was followed by RUSLE model computations of both source data and generalized data. The computations were completed in ArcGIS software and its tools including, among others, Map Algebra and in Python programming language.

The study shows that with increasing degree of detail of the input data, the clarity and applicability of the results during land consolidation decreases. This resarch investigates how decreasing the degree of detail influences the determination of model's components and the results of computation in RUSLE. The methodology described in this wok allows to optimize RUSLE so that it maintains high accuracy. The optimization allows also to visualize the results which will be useful during land consolidation works. The results prove that presented solutions can be used as an element of the systems supporting land consolidation process.

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Key words: Water erosion, Land consolidation, LiDAR, GIS

[1] University of Agriculture in Krakow, Poland, e-mail: p.bozek@ur.krakow.pl
[2] University of Agriculture in Krakow, Poland, e-mail: j.janus@ur.krakow.pl

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SAFETY ASSESSMENT OF THE REGIONAL WARMIA AND MAZURY ROAD NETWORK USING TIME-SERIES ANALYSIS (0112)

Joanna Żukowska*[1], Anna Górska-Pawliczuk[2]

Warmia and Mazury is a region of outstanding natural beauty, which at the same time due to the very low ac-cessibility of transport is still of a huge need for development and modernization of the existing road infrastructure, especially the regional road network. This development is a priority for both regional and national road authorities managing road infrastructure, but the implementation of these plans - for not only financial reasons is not an easy task and move on in time [1]. On the one hand, the growing public demand for high-quality transport services and on the other hand the desire to preserve environment make this process very complicated. Anyway this dilemma should be solved. It is difficult, however, to seek compromise when human life is at stake! It is not an easy task and a great challenge for the Warmia and Mazury.

The region of Warmia and Mazury still belongs to the areas with the smallest transport accessibility in Europe. Unsatisfactory state of road infrastructure is a major barrier to the development of the regional economy, im-pacting negatively on the life conditions of the population. In terms of road safety in 2015 Warmia and Mazury was unfortunately one of the most endangered regions. After several years of success in ensuring road safety in 2015 the region of Warmia and Mazury was at defeat: the number of victims killed has grown by 20 %. The threat occurs primarily at the rural area, a long term challenges are: accidents with the tree and pedestrians. This indicates the growing role of speed as a cause of accidents [2].

The analysis of road safety changes in Warmia and Mazury will be performed in the article using time-series analysis. Time-series analysis models serve as one of the main tools for measuring road safety exploring relation-ships between road accidents/injuries, road traffic exposure and other risk determinants and assessing impacts of road safety interventions. The application of time-series analyses for road safety purposes began several decades ago, where over time various methods were suggested to handle the data structure and interrelationships. Because of the nature of road traffic safety, it lends itself very well to modeling using time series. Observations of a series available in moment *t*, to forecast its future value *t+l*, is the basis for planning in economics, trade and production control [3]. Effective trend forecasting using historical data requires good quality data and models based on realistic assumptions. In the case of traffic, we assume that any changes in its future state and safety will occur in similar socio-economic conditions, i.e. no unexpected events are taken into account. The time series can be defined as a certain (stochastic) process where the subsequent observations change in time randomly. The observation may be e.g. the number of killed in road fatalities, injured or the total number of accidents over any discrete time, e.g. over a month, quarter

[1] Gdańsk University of Technology, joanna.zukowska@wilis.pg.gda.pl
[2] University of Warmia and Mazury in Olsztyn, a.gorska-pawliczuk@uwm.edu.pl

or year. This creates the time series, which we then use to build the model.

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Key words: accident prevention, time-series, regional roads, Warmia and Mazury

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SEA-LEVEL RISE IN THE BALTIC SEA DEPENDING ON THE LENGTH OF OBSERVATION PERIOD (0068)

Aive Liibusk*[1], Jakob Ansu[2], Tarmo Kall[3], Martin Sirk[4]

The United Nations' Intergovernmental Panel of Climate Change (IPCC) 5th Assessment Report (AR5) has concluded that anthropogenic warming in the climate system is unequivocal, and that as a result of the warming, global sea-level is rising at 1.9 mm/yr over the last century [1]. Part of this rise is caused by the thermal expansion of the sea water (theromosteric sea-level rise, ~0.5 mm/yr [2]), when larger part of it is caused by the melting of the ice-sheets and glaciers (Greenland, Antarctica, mountain glaciers and ice caps). Recent studies have shown, that the relative sea-level rise, or the sea-level rise relative to land motions, has significant regional variability depending mainly on vertical crustal motions, meteorological, oceanographic, geophysical, geomorphological factors. Additionally, different rate of sea-level rise is caused by the different datasets and timespans as well, e.g. it is reported that the regional sea-level rise during 1950–2011 is estimated at 3.2 mm/yr near the east coast of the Baltic Sea [3]. However, by using different datasets and time spans sea-level rise at 0.3 mm/yr (for 1900–1999) and 1.7 mm/yr (1970–2008) has been reported [4]. Therefore, exact knowledge of the extent and the magnitude of the regional sea-level rise on the Baltic Countries coastline is unclear.

Purpose of this study was to test the influence of different sea-level datasets and timespans to the linear sea-level rise trend values. For the test, Estonian historic (sea-level readings from staff gauges) and contemporary (pressure sensors) tide gauge records and their time series were analyzed and the sea-level rise for the Estonian coastline was calculated.

The sea level observations started already in 1842 in Tallinn, Estonia. In total, sea level observations have been carried out in 29 Estonian tide gauges over the time [5]. However, most tide gauges were operational for only a few decades and had longer or shorter gaps in sea level series. The long term and continuous sea-level records (over 60 years) are available only for the nine historic tide gauges. The readings were mostly taken four times daily (at 12 am, 12 pm, 6 am, 6 pm) in these gauges. The daily sea level changes larger than ±50 cm (i.e. indicating stormy conditions) were filtered out from the sea-level series. Thereafter, the daily average sea-level value was calculated in every station, and the sea-level rise was calculated in these nine tide gauges by estimating linear trend of different time spans (5, 10, 20, up to 60 years). In order to detect and reduce noise in the sea-level observations, the sea-level time series were compared with Stockholm tide gauge which has the longest and well-controlled sea-level time series in the world. The sea-level rise was corrected for

[1] Estonian University of Life Sciences, Department of Geomatics, Fr. R. Kreutzwaldi 5, 51014 Tartu, Estonia, e-mail: aive.liibusk@emu.ee
[2] Estonian University of Life Sciences, Department of Geomatics, Fr. R. Kreutzwaldi 5, 51014 Tartu, Estonia
[3] Estonian University of Life Sciences, Department of Geomatics, Fr. R. Kreutzwaldi 5, 51014 Tartu, Estonia
[4] Estonian University of Life Sciences, Department of Geomatics, Fr. R. Kreutzwaldi 5, 51014 Tartu, Estonia

the vertical crustal motion using the local (EST2013LU) and regional (NKG2016LU) land uplift models. The sea-level rise results of this study were compared with the different global and local sea-level rise model.

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Key words: sea measurements, sea level, time series analysis, global warming

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SINGLE FREQUENCY RTK POSITIONING USING SCHREIBER'S DIFFERENCING SCHEME IN THE MAFA METHOD (0022)

Dawid Kwaśniak[1], Sławomir Cellmer[2], Krzysztof Nowel[3]

The subject of the article is single frequency RTK positioning using Modified Ambiguity Function Approach (MAFA) method and Schreiber's scheme of carrier phase differencing.. First time idea of Schreiber's scheme of carrier phase differencing was proposed by prof. Roman Kadaj in the Beta method. In this contribution the idea of Schreiber's scheme of differencing was modified and implemented into Modified Ambiguity Function Approach method. The modification of the original idea is based on preparing only double differences (instead of triple differences as in the Beta method) and applying them to MAFA functional model. The advantage of this method is a fact that there is no need to designate a reference satellite.

Schreiber's scheme of carrier phase differencing was tested by authors. Tests showed that for single epoch positioning this method provides better results than traditional method of carrier phase differencing. In this research single frequency RTK positioning was carried out. The numerical tests were carried out using software created and tested by authors. Software consist of three programs, first one reads RINEX files, second one perform SPP, and the last one uses the MAFA method to obtain final results. The comparison of the results from the proposed method and a classic approach (with one reference satellite) was performed. The results of the tests are presented and analysed. Test were performed using only one frequency. Cheap, single frequency receivers are still widely in use that is why authors still see need to develop technologies of positioning with that type of receivers. Test were performed on short length baseline. Data from two International GNSS Service (IGS) stations were used.

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Key words: Satellites, Global navigation satellite system, Global Positioning System, Satellite constellations

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[1] University of Warmia and Mazury in Olsztyn, Oczapowskiego 2 10-719 Olsztyn, Poland, e-mail: dawidkwachu@wp.pl
[2] University of Warmia and Mazury in Olsztyn, Oczapowskiego 2 10-719 Olsztyn, Poland, e-mail: slawomir.cellmer@gmail.com
[3] University of Warmia and Mazury in Olsztyn, Oczapowskiego 2 10-719 Olsztyn, Poland, e-mail: krzysztof.nowel@uwm.edu.pl

SPATIAL ANALYSIS OF PRECONDITIONS FOR ENERGY EFFICIENT RENOVATIONS OF APARTMENT BUILDINGS IN PERIPHERAL REGIONS (0033)

Lauri Lihtmaa*[1] , Targo Kalamees[2]

In this paper we show how low real estate value becomes one of the most important barrier for deep energy renovation of apartment buildings. Our case is based on Estonian renovation subsidy program (2010-2014) that has provided financial aid for housing associations to motivate the start for deep energy efficient renovations. The subsidy covers 15-35 percent of final expenses of renovation project depending of the desired energy class. Remaining part of finances has to be provided by commercial banks. The lending policy of commercial banks allows financing renovation projects up to 10 % of the real estate value of the building. However, this amount might not be sufficient for renovation in peripheral regions due to the low property value.

Using real estate transactions reports for municipalities and optimal cost-effective building renovation expenses projections, we were able to model spatial exclusion of regions that are unable to take advantage of the subsidy to improve their living condition and conserve energy. The CO2 conservation potential is significantly lower that of the state's official claim. Moreover, this renovation barrier amplifies current regional disparities and exacerbates social inequality. Interestingly, there are some buildings that are actually renovated in those "impossible" areas. This calls for special case study to understand the drivers and preconditions that enabled those housing association to renovate their building. In order to construct more advanced projections of financial exclusions and to understand which social groups are affected, the real estate value must be modeled using actual transactions points and combining those with actual building locations that need renovation. Furthermore, it is clear that it is not rational to renovate every single building. Underused and abandoned buildings must be left out form the subsidy program while providing alternative strategies for.

Still, despite for some exceptions and study limitations, we conclude that there is urgent need for subsidy policy redevelopment and further research in order to provide equal opportunities for all regions and social groups.

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Key words: Energy Efficiency Renovation, Apartment Buildings, Regional Disparities, Spatial Distribution

[1] Department of Geomatics, Estonian University of Life Sciences, Estonia, e-mail: lauri.lihtmaa@emu.ee
[2] Department of Structural Design, Tallinn University of Technology, Estonia, e-mail: targo.kalamees@ttu.ee

SPATIAL APPROACH TO RISK PREMIUM DETERMINATION FOR RESIDENTIAL MARKET CLASSIFICATION (0066)

Małgorzata Renigier-Biłozor*[1], Maurizio d'Amato[2], Andrzej Biłozor[3]

Cities and regions wishing to achieve a dominant position in the network via their policy try to attract as many entities and types of activity as possible. When examining the structure and the character of the surrounding space, it is possible to determine whether there are attractive prospects, and whether there is growth potential in the analyzed area. The link between real estate markets and potential of urban growth was revealed a long time ago. Real estate markets play an increasingly important role in the global economy and attract a growing number of international investors, which is why the demand for reliable classification urban systems will continue to grow and become an essential tool in the process of investment planning. The positions of particular cities that will be developed according to established criteria can be crucial when choosing an investment location, and can affect the range of influence of the central site for the entire region.

The paper showed a possible application of spatial analysis to capitalization rate determination and risk premium maps. On account of the multi-faceted nature and multiplicity of factors determining the final result of the decision-making process in the real property market, it is possible to offer assistance by working out a certain system in the form of a risk premium maps classification structure which could ensure access to reliable and precise information. Classification of the real property market's potential on the basis of investment attractiveness of the analyzed urban space allows for its evaluation and, on the other hand, for inspiring its development and adjustment to current and future needs.

The research is thought to show the way to assess the potential and possibilities of reaching a certain stage of investment attractiveness by the market, considering the state and condition of the property markets within urban area. While literature is normally focused on the cap rate determination and his linkage with time series and with models such as band of investment analysis and their relationship with the equity determination, in this work a spatial approach to cap rate and risk premium determination is proposed. It will be shown how it is possible to use capitalization rate as a tool for real estate market analysis and urban area classification. Evidence from the application of spatial technique to capitalization rate and risk premium determination demonstrates the importance of this technique in the real estate market analysis. The analyses was conducted on the basis of transaction Italian residential properties from 2014-2015. The sample has an approximate normal distribution due to the Shapiro Wilk test showed the normality of the sample. In order to define

[1] University of Warmia and Mazury in Olsztyn, Faculty of Geodesy, Geospatial and Civil Engineering, Department of Real Estate Management and Regional Development , Prawochenskiego,15 10-724 Olsztyn Poland, malgorzata.renigier@uwm.edu.pl
[2] DICATECh, Technical University Politecnico di Bari, Via Calefati 272 Italy 70122 Bari, madamato@fastwebnet.it
[3] University of Warmia and Mazury in Olsztyn, Faculty of Geodesy, Geospatial and Civil Engineering, Department of Cadastre and Spatial Management, Prawochenskiego,15 10-724 Olsztyn Poland, abilozor@uwm.edu.pl

a spatial relationship between cap rates and spatial distribution, a kriging application was proposed.

The elaborate solution may have a potential for application to risk mitigation and for real estate market analysis and urban space classification. Analysis confirm the importance of the spatial dimension of risk premium showing variability of risk premium and capitalization rate in the analyzed urban space. A consequence is that financial procedures for risk premium and cap rate determination present limits to analyze reality.

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Key words: urban areas attractiveness, geospatial analysis, spatial distribution of market risk, property valuation, market investment classification

STABILITY OF EPN PERMANENT STATIONS NEAR BALTIC SEA SHORLINE (0039)

Kamil Maciuk*[1], Stanisław Szombara[2]

Before the era of satellite navigation the coordinates of a surveying grid determined with use of classic measurement methods were considered fixed until the update of their geographic position was conducted. Currently, the networks of GNSS reference stations gather and analyze the satellite observations continuously. This enables us to constantly follow and monitor the position of points and to determine and update the coordinates. If we consider observations from at least several years, we can determine velocity vectors and thus study the stability of permanent reference stations position. Research on stability of points position on the physical ground of Earth has been practically done since the beginning of satellite navigation systems. Apart from motion of tectonic plates, there are several factors affecting points position, i.e., among others: pole and ocean tides, nontidal ocean mass loading, snow and soil mass loading and other environmental contributors [1]. Studies prove that, at some of the reference stations, repeatable seasonal moves of coordinates components with the amplitude extending 5 mm can be observed [2]. However, out of all analysed periods, highest amplitudes could be noted for annual cycle. The second highest amplitudes were observed for half-yearly periods. In that case the amplitudes were about 5-6 times lower, though [3].

In this research the authors studied changes of positions of permanent GNSS reference stations near the Baltic Sea shoreline. Study was done on the basis of final weekly EPN solutions from years 1996-2016. IGSb08 coordinates that take account of tectonic plates motions were recalculated to a single observation epoch and transformed into the topocentric reference frame NEU. While choosing the stations to be analyzed, two criteria were applied. The first was location of the station not further than 20 km from the Baltic Sea shoreline. Second criterion specified that a station must have been conducting the observations for at least 4 years. There were 16 stations working in the time span from 1996 to 2016 that conformed to the selection criteria, among them one located within the territory of Poland (REDZ – Redzichowo). The cyclic repeatability of station position changes was analyzed on the basis of RMSE for periodic function adjustment. Simple sinusoidal function proposed by Bogusz and Figurski [4] was used as a fitting function for analysed time series'. Furthermore the authors determined fit coefficients of analysed function. It was also studied how the stability of reference station depends on the distance from the shoreline and the type of station foundation. At some of the reference stations the cyclic repeatability of history of the time series can be observed for particular components. Also, the results indicate a partial correlation between the above mentioned variables and values of amplitude of station position changes.

[1] AGH University of Science and Technology, Faculty of Mining Surveying and Environmental Engineering, Department of Integrated Geodesy and Cartography, Krakow, Poland, e-mail: maciuk@agh.edu.pl
[2] AGH University of Science and Technology, Faculty of Mining Surveying and Environmental Engineering, Department of Integrated Geodesy and Cartography, Krakow, Poland, e-mail: szombara@agh.edu.pl

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Key words: Global navigation satellite system, Geodesy, Geodynamics, Sea coast

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STRATEGIC PLANNING FOR COMPOSITE APPLICATIONS IN MULTIFUNCTIONAL EXPLORATION VEHICLES (0102)

Maxim Kireitseu[1]

Composite structures can offer the strategic opportunities for further development of exploration vehicles and increasing their performance, save weight and expand functional capabilities such as power storage and energy generation in planetary surface exploration missions. This research presents recent advancements in the application of composite materials and processing tecnologies allowing manufacturing of space vehicles and thier multi-functional structures with the advanced capabilities. In particular the development strategy will explain how solar cells panels could be integrated into ligh-weight composite design of vehicle body. The possibilities for using battery as core structure are discussed. The key technical benefits of integration of the battery in the structure lies in further design improvements, mass and volume reduction of space vehicles and better multi-functional capabilities of the system.

This research will cover and summarise the strategic development of multifunctional exploration vehicles in terms of composite technologies and the integration of power systems and advanced design materials. Several elements of the strategy will be covered.

First the design concept and benefits of the multifunctional structures (MFS) are explored and analysed for technical robustness and today's challanges of aerospace industry such as manufacturability, costs and life-cycle. In addition the application of multifunctional structures and composite materials is presented. Several examples of European R&D projects are analysed in terms of power system made of solar arrays, batteries technology to store this energy and distribute it; and a power management system.

Second, technological advacements are presented to support the key functional improvements including a) thermal conductivity, b) power generation abilities of integrated solar cells, and c) battery design and integration within composite body, and d) power management and connectivity of vehicle sub-systems.

The following elements of the strategic development in this area are presented:

1. Thermal conductivity of materials. Typically a high-performance cyanate ester resin with low levels of volatiles post processing and a high in-service performance temperature is used in prepregs enhanced with 50-70 % in volume of carbon fibres such as YS-80A in order to improve through-the-thickness and in-plane thermal conductivity of CFRP. A range of other fillers to increase thermal conducting properties can include expanded graphite, MWCNT, nanoBN, micro BN, MWCNT+nanoBN, Graphene Avanzare 179, Graphene Avanzare SG8. A balance between materials structure and thermo-mechanical properties as well as processability is hard to find; however, graphite and graphene-based fillers are found to provide better toughness

[1] Delft University of Technology, Delft 2628HS, the Netherlands, e-mail: m.kireitseu@tudelft.nl

and conductivity (approx. 100% and 25% respectivelly).

2. The application of integrated solar cells in power generation in autonomous vehicles is directed towards to the enhanced use of solar cells to provide power to a structure by means of a photovoltaic system whilst being embedded in a composite structure. The design integration process for composite panels with solar cells comprises two stages: manufacturing of CFRP skin by an autoclave curing and moulding of solar cells and glass-fibre woven roving layers, all of them are then integrated by a vacuum-bag infusion and curing process for the infused resin [1]. Challanging aspects of work on the interconnecting techniques for structural integrity of solar cells and composite panels are presented. Through different techniques, comprising metal alloys, an electrically efficient interconnection technology is validated.
3. Battery design with added functionality is the third key element of the technology planning. The application of commercial batteries is increasing in design and architecture of autonomous vehicles. Commercial batteries can offer more power storage and structural integrity. Lithium and polymer ion battery are checked against the application requirements such as the capability of cells to survive vibration and shock; costs of power elements; risks of chemical leaks and performance drom under extreme conditions. A numerical optimisation could be carried out to re-design battery cells and overall structure such as cell number, cell location, cell stack height, cell orientation.
4. The technology planning for cell interconnection is aimed to maximise battery lifetime, reduce size and mass and improve reliability of the electronics. In particular the research is directed to the maximum power point tracking (MPPT), charger controller algorithms definition, and the design of balance-of-systems (BOS) electronics. A multiple MPP tracker directly connected to the battery bus can be the most efficient solution. Battery Monitoring System is responsible for the balancing of PV cells but the charge/discharge protection of the BS is implemented by means of the multiple MPP tracker and the output switch, respectively.

Overall weight and volume savings due to design and composite integration can acieve over 50 % compared to metal / equivalen structures. The application of multifunctional architecture technology allow replacement of metals parts with composite ones; hwever, composite structures, if not a modular design, could present further challanges in maintanance and repair, “human induced” problems in remote locations. Future technology planning for autonomous vehicles made of multi-functional platform is directed towards to a prototype integrating PV solar cells, battery as structural element and interconnection between solar cells and batteries. Materials design and manufacturing process plays a vital role in structural integrity and advances in thermo-mechanical behaviour of composite structures. The multifunctional technology capabilities can facilitate further integration of autonomous vehicle modules with potencial to reach cost-efficient mass production of systems. Although current developments are focused on space rovers, the next research could also combine commercial space missions

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Key words: composite materials, strategic technology planning, manufacturing, power system, autonomous vehicles

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STRENGTH PARAMETERS OF SOIL INCLUDING SILT FRACTION – ASSUMPTIONS FOR THE ANALYSIS OF CYCLE FREEZING AND THAWING (0110)

Anna Górska-Pawliczuk*[1]

Changes in average and extreme temperature and precipitation are ones of global climate change impacts Europe. It is therefore necessary to adapt to these changes which have already occurred and to prepare for plausible scenarios of future climate changes [2]. In Poland, the temperature grown up by a few degrees in recent decades. The impact of this phenomenon on road infrastructure causes adverse volume changes, the upwards swelling of a pavement after freezing and deterioration of the bearing capacity of the structure after thawing [1]. In order to eliminate adverse reactions on road infrastructure, should use the materials which are resistant to harmful frost impact. Unfortunately, it is not always economical. According to the Polish standard of 1981 PN-B-02480, there are three types of soil due to the sensitivity frost: not susceptible to frost, doubtfully of a frost susceptible soils, susceptible soils to frost in nature. "Frost-resistant" means that occurs no damage to the structure in spite of the formation of ice-lenses during freezing and the periodical reduction of the bearing capacity during thawing [3].

This article presents assumptions of the analysis of cycle freezing and thawing. One of the most important element of this analysis is an overview of the methods of determining frost susceptibility, as well as the criteria of the frost susceptibility of soils. The other important part of this research project will be laboratory tests. It will cover the analysis seven mixtures of fine sand with clay about different proportions. Frost susceptibility will be determined on the basis of the following properties: the content of fine fractions < 0.075, <0.020, <0.002 mm; plastic limit wL; plasticity index Ip; sand equivalent SE4; methylene blue MBF and also the real value frost heave of the compacted soil mixture subjected to freezing in a cylinder. Prepared samples will be subjected to freeze-thaw cycles, and then repeated testing the mechanical properties and strength of the soil samples. Many papers have shown that the mineral content of fine particles affect on the frost susceptibility of soils. But detailed quantitative information with regard to the allowable contents of fine grains and specific (clay) minerals in order to provide your a certain degree of safety against freezing-thawing damage on roads, highways, railways, airfields, etc., is rarely available [3]. Based on the research the usefulness of the methods and criteria to evaluate the frost susceptibility of soils, which are used in Poland and other countries with similar climate zone will be analysis. It is a first stage of a broader analysis which aims to develop a method for solving a problem of frost the consequences of the phenomenon frost heavy on the destruction of the road surface. This problem is crucial for the every-day road maintenance.

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Key words: soil, soil properties, thermal factors, geoengineering, thermodynamics

[1] Faculty of Geodesi,Geospatial and Civil Engineering, University of Warmia and Mazury in Olsztyn, Oczapowskiego 2, 10-719 Olsztyn, Poland, e-mail: a.gorska-pawliczuk@uwm.edu.pl

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STUDY OF THE FLOW DYNAMICS OF SURFACE WATER MASSES IN THE AREA OF THE COASTAL GULF OF GDANSK (0074)

Martyna Leyk-Wesołowska[1], Krzysztof Pyrchla*[2], Monika Kijewska[3], Marek Kowalewski[4], Lech Kasyk[5], Jerzy Pyrchla[6]

The paper describes two methods for predicting the movement of surface water masses on the maritime areas adjacent to the port. One method uses the theory of graph and the second method use the numerical hydrodynamic model M3D. The results in virtual environment were related to the measurements taken in the real world. For experiments were used drifters whose construction allowed to move only with the surface water masses.

Coastal areas has specific hydromorphologic conditions because of fact that this is in the border of two environments: land and the sea. The bottom is rather shallow and subject to permanent metamorphoses. The movement of water masses are close connected with weather conditions. To this environment has also influent specific branches of industry connected with the sea eg. tourism, transport, mining industry. This area is also expose to external hazards as an split of oil from the ship. All of this have impact on quality of water. It is very difficult for the water to meet the requirements set forth in the European Water Framework Directive (2000/60/EC, 2000) to achieve a 'Good Ecological Status' (GES) (Directive, 2003, 2006). One of the elements of the hydromorphologic quality for the GES classification system of coastal basins is the size and flow dynamics of surface water.

Studies were carried out to provide the tools to determine the migration of contaminants generated in the port areas. During the experiment, we made a forecast for the object's movement using data from the hydrodynamic model M3D. The experiment was in the area where the model simulates sea currents with a resolution of 0.1 nautical miles (about 185 m). At every time step of the M3D model, which was 30 s, the displacement vector was calculated that allowed us to determine the new position of the object. The simulation drift results show that the data are a reliable source of information, even in coastal areas where the dynamics of the sea are very complicated.

During the study, the model based on graph theory was also used to provide forecast. The graph model is presented as a tool that allows us to predict the flow of surface water in the coastal zone. To capture the real condition, we took into account all barriers. The graph model used data

[1] Faculty of Navigation, Maritime University, Wały Chrobrego 1-2,70-500 Szczecin, Poland, e-mail: martyna.leyk@gmail.com
[2] Faculty of Technical Physics and Applied Mathematics, Gdańsk University of Technology, G. Narutowicza 11/12,80-233 Gdańsk, Poland, e-mail: krzpyrch@student.pg.gda.pl
[3] Faculty of Navigation, Maritime University, Wały Chrobrego 1-2,70-500 Szczecin, Poland, e-mail: m.kijewska@am.szczecin.pl
[4] Institute of Oceanonlogy, Polish Academy of Science, Powstańców Warszawy 55, 81-712 Sopot, Poland & Faculty of Oceanography and Geography, University of Gdańsk, Al. Marszałka Piłsudskiego 46, 81-378 Gdynia, Poland, e-mail: ocemk@ug.edu.gda
[5] Faculty of Navigation, Maritime University, Wały Chrobrego 1-2,70-500 Szczecin, Poland, e-mail: l.kasyk@am.szczecin.pl
[6] Faculty of Civil and Environmental Engineering, Gdańsk University of Technology, G. Narutowicza 11/12,80-233 Gdańsk, Poland, e-mail: jerpyrch@pg.gda.pl

of the current sea, the direction and speed of the surface current.

The idea is to build a directed graph with weights (i.e., a network) using data of sea current from 0.2 m depth. The vertices of the graph correspond to nodes of the discretisation grid net. Each vertex of the graph is incident with at most eight outgoing edges and at most eight incoming edges. Each edge has assigned a weight as a value of a weight function. The basis for determining the weight function is the direction of the surface current in the nodes of discretisation grid determined by the hydrodynamical model.

The research results can support coastal states with the requirements laid down in the European Water Framework Directive. Our methods give new possibilities in the field of hydrodynamical research, but this is only an introduction to further studies. Another challenge is to turn on more elements to describe the phenomena as best possible. Other promising results encourage us towards further research. Moreover, the methodology used here is universal, and can be used in other ports and coastal areas.

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Key words: Graph theory, Numerical models, Hydrodynamics

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STUDY ON 3D POINT CLOUDS ACCURACY OF CLOSE RANGE OBJECT RECONSTRUCTION (0021)

Grzegorz Gabara*[1], Piotr Sawicki[2]

The paper presents the results of photogrammetric 3D reconstruction of the close range test building using the image based point clouds. 32 signalised points and additionally defined 18 natural points were uniformly located on the building elevations. The geodetic and photogrammetric network points were measured by means of Leica TS30 total station. DSLR Nikon D5100 camera 16 MPix, equipped with CMOS sensor and the zoom lens with the optical stability, focused (focal f = 18 mm) on the imaging distance approx. Y_F = 10.0 m, was used to acquire the block of 28 terrestrial multiple convergent photos. To create the photogrammetric benchmark data set, the digital images automatic measurement using the LSM (Least Squares Matching) method and classical bundle block adjustment with simultaneous camera calibration in the Pictran software package was performed. Automatic determination of inner orientation parameters for the Nikon D5100 camera, the elements of the exterior orientation of photos and generation of dense point clouds for the 3D scene geometry reconstruction were performed using three tested software: RealityCapture, Photoscan and Pix4D. Image matching and adjustment were based on 24 control points. Software comparison was performed in CloudCompare application using 3D mesh models. The analysis was concerned: the comparison of processing parameters, the comparison of shapes, completeness, noises of 3D meshes (checking the visual quality of the outputs) and the evaluation of the 3D models geometrical accuracy. The tested software produced satisfactory results, but each application had some problems in different areas. The study proved the highest usefulness of the RealityCapture software which faster generated high quality, more precise and robust 3D model. The tested software allowed the point matching on the control points with the subpixel accuracy. The mean standard deviation $s_{x'y'}$ < 0.5 pixel (RealityCapture $s_{x'y'}$ = 0.36 pixel) and the mean adjustment RMS deviation $RMS_{\Delta XYZ}$ < 3 mm (RealityCapure $RMS\Delta_{XYZ}$ = 1.82 mm) were obtained. The tests proved that the dense point clouds generated from multi-view convergent imagery enable, in the case of a medium size close range object, the as-built geometric 3D reconstruction with the high accuracy (average position error m_{XYZ} < 4 mm).

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Key words: image matching, point clouds, mesh, software testing, geometry

[1] Department of Photogrammetry and Remote Sensing, University of Warmia and Mazury in Olsztyn, Oczapowskiego 1, 10–719 Olsztyn, Poland, e-mail:grzegorz.gabara@uwm.edu.pl
[2] Department of Photogrammetry and Remote Sensing, University of Warmia and Mazury in Olsztyn, Oczapowskiego 1, 10–719 Olsztyn, Poland, e-mail:piotr.sawicki@uwm.edu.pl

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TECHNICAL CONDITION OF THE BUILDINGS MANAGED BY THE AGRICULTURAL PROPERTY AGENCY - DIAGNOSIS AND ASSESSMENT (0105)

Jacek Zabielski*[1], Izabela Zabielska[2]

Buildings must be used in accordance with their intended use and environmental protection requirements. They must be kept in good technical condition and aesthetic, not allowing excessive deterioration of their technical performance and efficiency. Evaluation of technical conditions of buildings is regulated by the Polish Building Low Section 6 - Maintenance of buildings. It states the types of controls, which should be subjected to building structures and the circumstances of the various inspections. Condition check are mandatory for all buildings except single-family houses, on-farm buildings, cottages and buildings that do not require a building permit. Following a review of the technical condition, the authorized person shall prepare a record of the inspection. The protocol of the technical conditions of the building are described in detail. Building recommendations executions and the time at which they should be performed. The evaluation of the technical condition of the building is recorded in the book of a building. The building book is a document containing all the records of inspections carried out and reconstruction or renovation of a building during use. The transformation of the economy, liquidation of state farms and the transition in the management of construction resources Agricultural Property Agency (APA) are responsible for ensuring safety of buildings users. Many years of neglect, lack of maintenance, and helplessness of life tenants also cause the progressive deterioration of technical conditions. As a result - many buildings are in inadequate technical condition and require a major renovation owing to the high risk of construction disaster. Proper maintenance management in APA aims to prevent excessive wear and tear of buildings, regardless of lack of attention paid by tenants. The main objective consideration is the assessment of the technical condition of buildings. The analysis is conducted based on surveys of buildings by the local branch of APA Olsztyn. Research shows that the assessment of the technical condition of buildings is an important element affecting the safety of construction work. It is important to perform this precisely and adhere to the recommendations contained in the interpretation, in order to prevent potential threats. In addition, in order to improve a buildings technical condition, recommended repairs and upgrades should be made. The improvement of the technical condition of buildings shall improve the standard of living, reduce the operating building costs. In extreme situations so as to avoid building disaster.

Key words: evaluation of technical condition, Management by the Agricultural Property Agency, the safety of construction works

[1] Faculty of Geodesy, Geospatial and Civil Engineering, UWM, Poland, e-mail: zabiel@uwm.edu.pl
[2] Faculty of Economic Sciences, UWM, Poland, e-mail: izus@uwm.edu.pl

TESTING OF GEODETIC LASER INSTRUMENTS UNDER CONDITIONS OF AIR TURBULENCE (0109)

Janusz Kwiecień[1]

The main aim of this paper was to test the usefulness of a laser station and laser tracker to industrial metrology indoors under turbulent air conditions and to estimate the accuracy of this devices with the values declared by the manufacturer. In this work, only the analysis of the impact of air turbulence to determine the angle of laser wave propagation is discussed, and other meteorological parameters (pressure, humidity) and particles of pollutants (dust, smoke) are ignored. The influence of perturbations such as air turbulence on measurement precision by these devices is analyzed. As a result of the theoretical analysis own formula for predicting the size of the spatial variation of the laser beam has been derived. In addition, the effect of dynamically changing atmospheric parameters in realistic indoor conditions on 3D point positioning is presented. Finally, an experimental setup and method for measuring the turbulence structure coefficient Cn are described.

Test of Leica TDRA6000 under conditions of forced air turbulence was made in laboratory, however the experiment using Leica AT402 laser tracker was performed in a manufacturing plant modernizing rail vehicles (PESA Bydgoszcz SA) in Poland.

Experiments in turbulent air conditions have shown a radical decrease in measurement accuracy. This is demonstrated by both a decrease in power and an increase in standard deviation of the laser beam, as well as a decrease of precision in angle and distance measurement. The experimental results show a high correlation between predicted and the measured values.

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Key words: optical metrology; measurement by laser beam; geodesy; atmospheric measurement

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[1] UTP University of Science and Technology, 85-796 Bydgoszcz, Kaliskiego 7, Poland, e-mail: jkw@utp.edu.pl

THE ACCURACY OF GNSS USING LOW-GRADE RECEIVER UNDER UNFAVOURABLE CONDITIONS (0117)

Krzysztof Bruniecki[1]

Today's' usage of the GNSS based positioning is not only a matter of geodesy and surveying. GNSS based services are now ubiquitous and available for everyone in almost every mobile device (e.g. Smartphone). However, the quality of the receivers and antennas are far from the survey grade ones making it incapable to obtain a high accuracy (e.g., decimetre level or better). The situation is being continuously improved. For example, some low grade receivers proved to be capable to obtain centimetre-level accuracy in a relative positioning static mode under very good conditions. In this context this article extends such results presenting the results of GNSS positioning accuracy using a relatively low cost GNSS receiver and antenna under a significantly harsh conditions. Despite unfavourable conditions the aim was to obtain the highest possible accuracy using different modes of operation including the simplest averaging of the single solutions. In order to improve the results some multipath mitigation techniques of well-known algorithms were proposed and preliminarily implemented.

The single-frequency, single-constellation (i.e., GPS) receiver was examined. The measurements were mostly conducted in the static mode. In the static measurements the placement of the antenna was chosen as a very unfavourable. It was located on the outer sill from the North side of the building at a relatively high latitude (i.e., ~18.61 E, 54.37 N). It significantly limits the number of visible satellites and the SBAS capabilities. It also introduces considerable multipath effect. The receiver itself was capable to provide the simple positioning results in a form of NMEA messages with the rate of 5 Hz. The pseudoranges and carrier phases were also available for further processing, however the quality of those is limited. The analysed measurements were collected for roughly 50 receiver-day (i.e., 25 day using two twin configuration). The amount of raw data collected from the receiver and analysed exceeded 15 GB. The analysed algorithms include Single Solution Positioning (SSP), Relative Positioning (RP) based on pseudoranges and carrier phases as well as Precise Point Positioning (PPP). The well-known open-source software package RTKLIB was used for computation of the results. RTKLIB library was also chosen as a foundation for the implementation of the proposed modifications of the analysed algorithms. Despite the usage of a relatively modest receiver (e.g., single frequency, single constellation) the results are also discussed in the context of oncoming GNSS constellations and signals.

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Key words: Navigation, Satellite navigation systems, Global Positioning System, Software algorithms, Data processing, RTKLIB, multipath mitigation,

[1] Gdansk University of Technology, Faculty of Electronics, Telecommunications and Informatics, Department of Geoinformatics, Gdańsk, Poland, e-mail: Krzysztof.Bruniecki@eti.pg.gda.pl

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THE ANALYSIS OF RESOURCE USE PLANS BASED ON SELECTED MUNICIPALITIES – TOWARDS THE REALISATION OF GOOD GOVERNANCE CONCEPT (0064)

Marta Gross[1], Ada Wolny*[2]

One of the most important municipal authorities' tasks is the effective management of real estate resources according to sustainable development principle. Resource use plans exist inter alia to realize this mission. These are the instruments, which facilitate municipalities to lead the proper real estate resources management activities. This issue is still up to date and especially important due to the process of different data bases integration, which is necessary for local authorities.

The paper presents resource use plan as a tool for effective implementation of municipal policy. The aim of the study was to assess resource use plans in terms of their usefulness as a tool to implement the good governance concept. The plans in the same or a similar time period were chosen for the purpose of the analysis (2012-2016). Most of them were prepared for three-year-period. Then it has been proved that appropriate preparation of this documents leads to good governance principles (openness, participation, accountability, effectiveness and coherence) realisation. The area of the research was the nine selected municipalities: three urban, three rural and three urban-rural. They have different population number, administrative status, land use structure and area (in km^2]).

In the particular stages of the study comparative analysis and case study analysis were used. The data was obtained, transformed and compared with the use of statistical and geostatistical methods.

As a result of the research appropriate changes to improve the implementation of the municipal policy in this regard were proposed. One of the solutions indicated by the authors is to give the resource use plans a spatial dimension within the framework of local spatial information systems. Therefore, one of the municipal systems was chosen in order to present general assumptions for the future implementation in every municipality in Poland.

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Key words: resource management, sustainable development, decision making, geographic information systems

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[1] University of Warmia and Mazury in Olsztyn, Faculty of Geodesy, Geospatial and Civil Engineering, Department of Real Estate Resources, Prawocheńskiego 15/204, 10-720 Olsztyn, Poland, e-mail: marta.gross@uwm.edu.pl
[2] University of Warmia and Mazury in Olsztyn, Faculty of Geodesy, Geospatial and Civil Engineering, Department of Real Estate Resources, Prawocheńskiego 15/204, 10-720 Olsztyn, Poland, e-mail: ada.wolny@uwm.edu.pl

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THE EMOTIONAL PHANTOM EFFECT- THE INNOVATORY METHOD OF ANALYZING FACIAL EXPRESSIONS (0007)

Magdalena Błażek[1], Katarzyna Bobkowska[2], Maria Kaźmierczak*[3], Artur Janowski[4], Marek Przyborski[5], Jakub Szulwic[6], Mark H. Davis[7], Mario Mikulincer[8]

Basic emotions are discrete, critical for survival or well-being, with neural base that is expressed, and associated with a specific feeling or motivational aspect, which serves a particular adaptive function. The presented project reflects the unique combination of the innovative technology and psychological measures aimed at analyzing the changes in specific areas of the face when mirroring emotions. The innovative approach of the proposed method lies in the preprocessing of the series images of the human face recorded when changing of the emotional state is occurring on the face. The preprocessing is based on identification of small structures on the human face (black and white image) similar to the particles in the fluid flow. We defined it as the Emotional Phantom Effect. In our studies registration of a human face took place during the short presentation of the image of anger or joy.

Sixty eight students participated in the preliminary study (46 females / 22 males). We found associations between psychological variables and changes in face expression as measured by speed camera Phantom Miro M310 at speed of 1000 frames per second in high definition. Results indicated that participants for whom close relationships were essential for their identity were more inclined to changes in face expression when mirroring emotions, especially joy. Higher empathic emotional contagion was associated with stronger changes in face expression when mirroring anger. Contextual variables were of value as well. Those participants who reported being in positive mood, reacted stronger in joy condition. Those who were more rested, displayed less changes in face expression when mirroring anger. There were no gender differences in changes in face expression as measured by the speed camera.

Among the primary social applications of the presented project is the role of the Emotional Phantom Effect for increasing of the effectiveness of interpersonal interactions.

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[1] University of Gdańsk, Faculty of Social Sciences, Gdańsk, Poland,e-mail:psymb@ug.edu.pl
[2] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Gdańsk, Poland, e-mail: katarzyna.a.bobkowska@gmail.com
[3] University of Gdańsk, Faculty of Social Sciences, Gdańsk, Poland,e-mail:psymk@ug.edu.pl
[4] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Gdańsk, Poland, e-mail: artur.janowski@geodezja.pl
[5] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Gdańsk, Poland, e-mail: marek.przyborski@pg.gda.pl
[6] Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Gdańsk, Poland, e-mail: jakub.szulwic@geodezja.pl
[7] Eckerd College, Behavioral Sciences, St. Petersburg, FL, USA, e-mail: davismh@eckerd.edu
[8] IDC Herzliya, Baruch Ivcher School of Psychology, Herzliya, Israel, e-mail: mario@idc.ac.il

Key words: emotion recognition, image processing, camera

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THE INTEGRATION OF IMAGE AND NONIMAGE DATA TO OBTAIN UNDERWATER SITUATION REFINEMENT (0017)

Izabela Bodus-Olkowska[1], Janusz Uriasz[2]

The most active area of research and development in category of fusion problems is GIS, where earth imagery, maps, demographic and statistics data or facilities mapping data are combined into one common spatial referenced database [1]. The authors proposed such integrated GIS for underwater areas, where the aim is an integration of imagery and spatial referenced nonimage hydrographic data sets is a process of combining multiple pieces of hydrographic data to estimate the aspects of underwater situation. Such approach will provide complexity of the information and can be the base to infer or refine desired items on the basis of available information. The data are collected by different hydrographic sensors, which collects the data differently and gathers other information about seabed bottom.

The fusion models assumes several steps: source processing, object refinement, situation refinement, threat refinement and process refinement [2]. The integration proposed in the article is a modification of such ones and an extension of the concept of hydrographic data fusion presented in [3]. It takes place in several stages: Stage 0 – input data – assumes the processing of hydrographic data in specific hydrographic software, where final products are obtained. Stage 1 supposes spatial alignment: adjustment of the data that has lower positioning accuracy, i.e. towed systems - side scan sonar, marine magnetometer. Stage 2 initiates the feature refinement procedures, where specific seabed lying objects and buried underneath the bottom, are extracted, classified and allocated. In stage 3 extracted features are associated and the information about them are fused into one complex attributed information. Stage 4 presumes whole underwater situation refinement. Stage 5 – output – is the presentation of an integrated hydrographic information, for the needs of underwater situation refinement and assessment. For the implementation of research: high-density of bathymetric data from multibeam echosounder, high-resolution side scan sonar mosaic imagery, magnetic anomalies distribution map and the data from subbottom profiler are used.

The main result of the research is a method of image and nonimage spatial hydrographic data integration to obtain complex information about underwater area. Such integrated information provides a description of the recognized features (of the various hydrographic aspects), that lying on the seabed or underneath the bottom and make the assesments about the underwater situation around them. The advantage of integrated hydrographic information under consideration as an individual single sets of information is that, the first one is a cumulative one and is a complex summary of the area of interests. Integrated information can be easily used for comprehensive analysis

[1] Maritime University of Szczecin, Faculty of Navigation, Institute of Geoinformatics, Geodesy and Hydrograpy Department, ul. Waly Chrobrego 1-2, 72-500 Szczecin, e-mail: i.olkowska@am.szczecin.pl
[2] Maritime University of Szczecin, Faculty of Navigation, Institute of Marine Technologies, ul. Waly Chrobrego 1-2, 72-500 Szczecin, e-mail: j.uriasz@am.szczecin.pl

of subsea areas, i.e. submarine constructions, like cables or pipes: their location, placement characteristics and on-field verification.

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Key words: image fusion, data integration, geospatial analysis

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THE POTENTIAL FOR IMPROVING CARBON SEQUESTRATION THROUGH AFFORESTATION IN NIGERIA (0058)

Esther O. Makinde*[1], Michael O. Ogundeko[2], Ahmed. A. Womiloju[3]

The potential of forest as a natural sink is vast and enormous and has been well documented in several researches and reports. This project is an attempt at re-emphasizing this potential, by using geospatial technology, to quantify the amount of carbon sequestered by the Oluwa Forest Reserve.

Landsat imageries of 1984, 1991, 2002, 2010 and 2015 were obtained and used in obtaining the landuse/landcover information for those years. From this the trend in the landuse was monitored and ascertained. The fieldwork revealed two distinct tree species, and subsequently four forest strata were established. The heights and diameters at breast height (dbh) of the trees from ten randomly selected 20 m × 20 m sample points were measured. The allometric equation of Brown (1989, 1997) was used in estimating the aboveground and belowground biomass, while the Soil Organic Carbon (SOC) was obtained from the laboratory test on the soil samples, taken at 0 – 15 cm, and 15 – 30 cm from the ten sample points.

The imagery analyses revealed that in the last five years of the study period (between 2010 and 2015), the built up area/bare ground expanded by 131.53 %, while the natural forest further expanded by 88.44 %. At the same time, the *Gmelina arborea* experienced a further shrinkage of 97.65 % whereas the *Tectona grandis* shrunk by 50.37 %. This implied that the rate of forest degradation greatly accelerated. It may be attributed, as previously mentioned, to the World Bank withdrawing its support from the afforestation project in 1998, thus ending any reforestation or planting efforts. In addition, by this time, the presence of dead trees and logged woods in several places coupled with the non-stop entries of lumber vehicles into the forest and their exits from it is an evidence disproportionate exploitation of these timbers. The total above and belowground biomass was obtained to be 162,826.343 Mg/ha and 32,565.269 Mg/ha, while the total SOC was 5.7971 Mg/ha. The total carbon sequestered by the forest was estimated to be 358.565 Mt Ca. A multiple regression analysis was carried out and an adjusted r-squared value of 0.9809 with *f*-test significance of -0.000000401 was obtained. This is an attempt at developing a site specific allometric equation that could be used to predict carbon stock at any point within the study area. The result thus obtained shows the enormous potential of the Oluwa Forest as a carbon sink, which only needs to be properly harnessed and efficiently managed.

[1] Laboratory for Geospatial Research, Department of Surveying and Geoinformatics, Faculty of Engineering, University of Lagos, Akoka, Lagos State, Nigeria, e-mail: estherdanisi@gmail.com, eomakinde@unilag.edu.ng
[2] Laboratory for Geospatial Research, Department of Surveying and Geoinformatics, Faculty of Engineering, University of Lagos, Akoka, Lagos State, Nigeria, e-mail: mikel360@gmail.com
[3] Laboratory for Geospatial Research, Department of Surveying and Geoinformatics, Faculty of Engineering, University of Lagos, Akoka, Lagos State, Nigeria, e-mail: womilojuahmed78@gmail.com

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Key words: Carbon, Ecosystem, Remote Sensing

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THE SPATIAL DISTRIBUTION OF EARLY ADOPTERS OF ENERGY EFFICIENCY RENOVATIONS OF APARTMENT BUILDINGS (0025)

Lauri Lihtmaa*[1], Jürgen Vahtra[2]

It is estimated that housing stock is renewing about 1% in year which is not sufficient to achieve current climate change mitigation goals. Therefore, several incentives and special programs have been applied to foster the renovation activities. Still, current progress of energy efficiency renovation in EU is not satisfactory also [1]. There is urgent need to speed up the renovation progress. The mass effect of new technology is usually gaining momentum slowly, thus early adopters of innovation are always of special interest. By understanding what drives and motivates early adopters we might be able speed up renovation by improving support systems for housing associations. Before conducting qualitative study this paper attempts to explain the early adopters of energy efficiency renovations in quantitative way by using statistical and spatial analysis as exploratory methods.

We use the city of Tartu in Estonia as the case study to present our empirical findings. The data originates form the renovation subsidy database form 2010-2014; the building registry; and census of 2011. The statistical analysis did not give us any explicit answer in explaining early adopters. There were no patterns regarding building size, type, age and residents' ethnicity, age, education, occupation etc. The statistical pattern did not emerge also on the state level. However, the spatial analysis was much more effective. While all renovations within 2010-1014 in Tartu city seemed scattered randomly, the first 15 deep energy renovations were located more in center of city while leaving out large housing estates. For further analysis, we constructed urban diversity index by combining the data of buildings' intended purpose with the accessibility to the buildings by walking distance of 600m form other buildings by utilizing UNA Toolbox [3] in ArcGIS. Our results show that early adopters of renovations are concentrated in most diverse parts of the city. Large housing estates that have largest potential for energy conservation were in places of low diversity. There were no energy efficiency renovations before the year of 2012 in those areas.

In conclusion, we can state that the spatial distribution of early adopters of energy efficiency renovations are not random and urban diversity can explain the distribution. Clearly, we are unable to explain why early adopters are segregated by the urban diversity, however, this gives a good starting point for qualitative analysis. For now, we can hypothesize that early adopters are attracted by such urban attributes like the accessibility, reduced commuting, variety of services etc. which could mean that those buildings are much more futureproof and the investment for energy efficiency is rational value added procedure. If so, we could also state that our urban diversity model can be used for urban development assessment tool.

[1] Department of Geomatics, Estonian University of Life Sciences, Tartu, Estonia, e-mail: lauri@ecobon.ee
[2] Department of Development, Municipality of Hiiu, Kärdla, Estonia, e-mail: jurgen@hiiuvald.ee

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Key words: Energy Efficiency, Urban Diversity, Early Adopters, Apartment Buildings

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THE USE OF AGGREGATED DATA TO ASSESS THE EFFECTIVENESS OF PUBLIC TRANSPORTATION IN WARSAW (0026)

Joanna Tomala*[1], Anna Wilbik[2], Albina Mościcka[3], Krzysztof Pokonieczny[4]

The organization of public transportation in the city is important for both: its users and for city management units. Areas well connected are highly attractive for potential residents, employees and even tourists. But what is more important, the special attention should be paid to areas badly communicated: the reasons of this should be analyzed, the reasonableness of the modernization of the public transport network should be determined, the future development of the infrastructure in these places could be planned or analyzed.

The aim of the research was to assess the effectiveness of the Warsaw public transportation. In the paper the trends of traveling from the entire territory of the city to different places have been analyzed and presented. So far, the authors focused on the public transport accessibility in the city in terms of travel in one specific destination. This time the research has more comprehensive character and takes into account destinations located in various parts of the city.

The authors conducted a study based on the travel time data collected automatically from the area of Warsaw, distributed in a regular grid with a mesh of 1 kilometer. Such grid size was defined in previous authors's research as the optimal for this kind of analysis. There were 398 measurement points collected throughout the city. For each measurement point the time of a journey by public transport in five different times of a day (morning and afternoon rush hours, beyond the rush hours, travel in the evening and at night) has been calculated. These times were also calculated for the three final destinations, located in various parts of Warsaw: Central Railway Station located in the heart of the city on the right side of the Vistula river, Warsaw Chopin Airport located in the south of Warsaw also on the right side of the Vistula river (about 8 km from the city center) and Municipal Office of Bialoleka District located in the north part of the city and on the left side of Vistula river (about 15 km from the city center). It takes into account all available types of public connections (trams, trains, buses), also special night bus lines. Finally 15 different travel time maps have been created. They were the base for the study on the aggregation of travel times data for various times and destinations, so it shown the public transport accessibility throughout the city in various aspects: taking into account the minimum, maximum and average travel time and the weights of final destinations or times of beginning of the journey.

The source of travel times data is a popular web service Google Maps and the data are current as of July 2016.

[1] Military University of Technology, Warsaw, Poland, e-mail: joanna.tomala@wat.edu.pl
[2] 2School of Industrial Engineering, Eindhoven University of Technology, Eindhoven, The Netherlands, e-mail: a.m.wilbik@tue.nl
[3] Military University of Technology, Warsaw, Poland, e-mail: albina.moscicka@wat.edu.pl
[4] Military University of Technology, Warsaw, Poland, e-mail: krzysztof.pokonieczny@wat.edu.pl

The results of the analysis have been visualized in the form of maps. Aggregated values were interpolated with Inverse Distance Weighted method, which is the best one for time data analysis. The final maps have revealed all the distinctive places - most importantly these badly communicated, where the journey by public transport, is very unfavorable compared to the rest of the city. In the paper the authors investigate these areas on the basis of Open Street Map data and try to find and interpret the causes of bad time accessibility.

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Key words: public transportation, travel maps, travel time, data aggregation

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THE USE OF AUGUMENTED REALITY TO VISUALIZE THE 3D GEOMETRY PARAMETERS FROM 2D INDUSTRIAL TECHNICAL DOCUMENTATION (0046)

Piotr Dronszczyk*[1]

The main aim of the study was to supplement the content of classical industry documentation with elements of augmented reality. All that for better and easier its understanding. Research and analysis are basing on the complicated piping documentation from oil and gas industry. In the experimental work there have been used modern measurement techniques, including total station surveying as well as laser scanning.

With a sophisticated classic set of documentation of industrial pipelines there have been developed their visualization in 3D CAD environment. The prepared models were adjusted in terms of texture, shape and light. It was necessary to establish an appropriate internal spatial coordinate system. Individual system for each model. The data set was then tested in Vuforia and Unity augmented reality environments. These environments allow to view and orientate the model on the most of the mobile devices like tablets and smartphones available on the market. Mutual orientation of the virtual model and the classical printed design is possible with the use of pre-defined markers. Each individual technical drawing can be a unique marker.

The obtained results confirmed that the use of augmented reality together with mobile devices allows for extremely clear and rapid identification of complex projects, their distinction and assign the appropriate geometry unerringly to the drawing. These elements previously presented mainly in the form of complex two-dimensional documentation may be presented as a understandable spatial models. The results of the studies show how useful is the use of augmented reality technology. This is particularly important in the work with complicated engineering documentation very often consisting of tens or hundreds of documents. Such spatial visualization makes easier and allows for more efficient acquisition of information and its proper interpretation.

The advantages posed by this modern technology is primarily to avoid mistakes reading the documentation as well as to get access to advanced visualization of the 3D objects from a rich database accessible on any mobile device. Augmented reality can be widely used and have positive impact on the performance and quality of work of engineers regardless of the subject environment or object.

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Key words: Augmented reality, Industry applications, Distance measurements, Electromagnetic measurements, Petroleum industry, Graphical models

[1] Apply Capnor Poland Sp z o.o., al. gen. Bora-Komorowskiego 25b, Krakow 31-684, Poland,
e-mail: piotrdronszczyk@gmail.com

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THE USE OF MULTI-CRITERIA GIS ANALYSIS IN REVITALISATION OF SPACE (0040)

Marek Ogryzek*[1] , Krzysztof Rząsa[2]

Revitalisation means the process of spatial, technical, social and economic changes taken in the public interest. The aim of that process is to extract an area from a crisis situation, to restore its old features and create conditions for its further development through the use of endogenous features. The Polish law introduced the obligation to prepare municipal revitalisation programs. The Municipal Council accepts the revitalisation program by resolution. It includes among other things, a detailed diagnosis of the revitalisation area including analysis of negative phenomena and local potentials occurring on the area. Multi-criteria GIS analysis is a method that can have different uses. It can be used for example for typing areas that meet certain criteria. So it can be used in revitalisation of space. If the criteria are indicators of urban revitalisation, used to create municipal revitalisation programs, the use of the method can greatly facilitate and improve typing areas for revitalisation. For example the GIS tool ArcMap (the main component of Esri's ArcGIS suite of geospatial processing programs, and is used primarily to view, edit, create, and analyze geospatial data) can be used. An additional attribute of the GIS software is the ability to visualize the results. It can be useful for example at the stage of public consultation or check the variant solution. Much easier is also processing the results obtained for the following specialized analysis. The authors in an article present the results of studies on example of a local revitalization program of the City of Olsztyn.

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Key words: geographic information systems, geospatial analysis, revitalisation

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[1] University of Warmia and Mazury, Faculty of Geodesy, Geospatial and Civil Engineering, Department of Planning and Spatial Engineering, Prawochenskiego Street 15, 10-720 Olsztyn, tel. +48 895233473 Poland, e-mail: krzysztof.rzasa@uwm.edu.pl
[2] University of Warmia and Mazury, Faculty of Geodesy, Geospatial and Civil Engineering, Department of Planning and Spatial Engineering, Prawochenskiego Street 15, 10-720 Olsztyn, tel. +48 895233473 Poland, e-mail: marek.ogryzek@uwm.edu.pl

THE USE OF PUBLIC REAL ESTATE RESOURCES FOR TRANSPORTATION DEVELOPMENT IN FUNCTIONAL URBAN AREAS (0038)

Ada Wolny[1]

Functional urban areas are sub-regions emerged from the strong impact that cities have on their hinterlands, with temporary transformation processes in land use, settlement, labour market and most of all population. As travel-to-work flows are used to identify the hinterlands as the "worker catchment area", outside the densely inhabited core, the main determinants and ways of daily commuting in a sub-regional scale should be investigated. In order to avoid the adverse effects of urbanization, like urban sprawl and increasing traffic, local authorities use public area to create opportunities for the development of public transport.

For the purpose of the article, a comparative analysis for selected Polish functional urban areas was conducted. The main criteria for the selection was the size of functional urban area according to the number of population. That is why both small and medium functional urban areas were taken into consideration, while the large and metropolitan were omitted. There were chosen areas with the less developed transportation system and with the most important for these particular areas transport investments in progress.

The article includes statistical and spatial analyses developed using GIS software based on selected and processed data. The study contains, in particular, the analysis of road density, optimal path and range of public transport in selected areas. Moreover the main activities of public authorities like repurposing in land use plan, division and consolidation are shown. Furthermore the transportation investments in the implementation process as well as development plans in this field for the perspective of 2014 – 2020 are visualized.

Due to inter-municipal cooperation within delimited functional urban areas links between the activities of the various administrative units have been identified with the aim of their connection with the recently introduced integrated territorial investments. Finally, determinants for sustainable transportation development in selected areas have been examined. As a result the significant limitations, connections and the recently introduced improvements have been depicted.

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Key words: resource management, public transportation, sustainable development

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[1] University of Warmia and Mazury in Olsztyn, Faculty of Geodesy, Geospatial and Civil Engineering, Department of Real Estate Resources, Prawocheńskiego 15/204, 10-720 Olsztyn, Poland, ada.wolny@uwm.edu.pl

TIMBER FRAME HOUSES WITH DIFFERENT INSULATION MATERIALS - SEISMIC ANALYSIS (0045)

Marcin Szczepański*[1], Wojciech Migda[2], Robert Jankowski[3]

The aim of this article is to present results of a seismic analysis that two real-sized timber frame building structures were subjected to. The first model was insulated with mineral wool, the second one with polyurethane foam. Technology and specifications involved in both models construction is based on the previously conducted experimental research on timber frame houses upon which their numerical models, which precisely reflected results of the research, were proposed.

During the seismic analysis 1 extreme, external node on each model construction was specified. Each selected nodes displacement values were measured and compared between two analyzed models. Results of the analysis clearly prove the thesis placed during the experimental and numerical research in the form of a modal analysis concerning, a growth in damping and stiffness of the timber-frame objects by the usage of polyurethane foam insulation instead of a mineral wool insulation.

The dynamic numerical analysis focused on the response of timber-frame house under seismic excitation has been presented. Based on the results of the numerical seismic analysis for both models, a positive outcome of using polyurethane foam insulation instead of mineral wool in timber frame structures is visible. There is a substantial difference in peak displacements of the analysed node in all three directions.

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Key words: dynamics, numerical analysis, numerical simulation, earthquakes

[1] Gdansk University Of Technology, Narutowicza 11/12, 80-233 Gdańsk Department of Civil and Environmental Engineering; e-mail: marszcze@pg.gda.pl
[2] Gdansk University Of Technology, Narutowicza 11/12, 80-233 Gdańsk Department of Civil and Environmental Engineering; e-mail: wmigda@pg.gda.pl
[3] Gdansk University Of Technology, Narutowicza 11/12, 80-233 Gdańsk Department of Civil and Environmental Engineering; e-mail: jankowr@pg.gda.pl

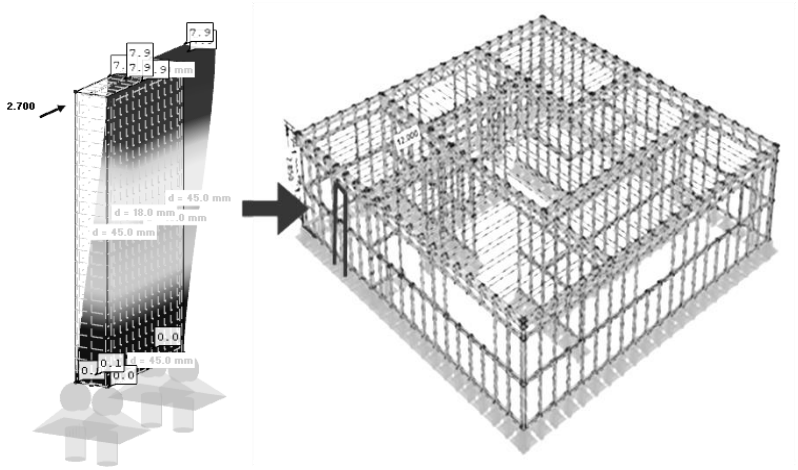

Fig. 1. Numerical model of wall and building

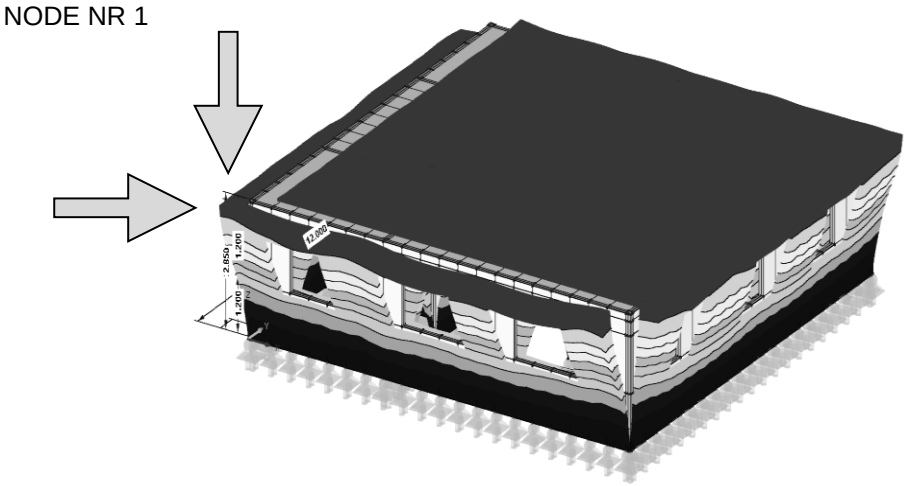

Fig. 2 Numerical model with polyurethane foam – extreme displacements visualisation

TIME ACCESSIBILITY OF EUROPEAN AIRPORTS - POLAND CASE STUDY (0050)

Łukasz Gładysz[1], Marta Kuźma*[2], Albina Mościcka[3]

The aim of this paper is to present the research on time accessibility of Polish airports. In the research 15 Polish airports, as well as the selected airports of the Schengen Area, located near the Polish border were also taken into account. In the research, not only main important airports, as Warsaw, Gdańsk, Kraków or Poznań were taken into account. These very small airports, like e.g. Lublin, Radom, were also included into research due to the rapid development of their connections and the role they play while ensuring a smooth connections with major airports. Additionally, 16 airports from the neighboring Shengen countries have been also analyzed. According to EU standards, it is assumed that the border time travel, which determines the time accessibility of regional airport, is 90 minutes. Taking account into the roads condition and frequency of rail in Poland, time accessibility of transport should be increased to at least 120 minutes.

The analysis was conducted for a person driving by car on March 23, 2016, at 12.00. To achieve the most reliable data, omitting obstacles such a traffic jams or road works a weekday was selected - Wednesday (a midweek) and 12.00 (midday). 990 measurement points have been distributed on the entire territory of Poland. Data were obtained from the Targeo.pl website. Interpolation was held using the method IDW.

As the result of the research maps of the airports availability in two different cases have been created. The first map applies to the time reachability of the airports, taking into account only airports in Poland. The second map shows the timely availability of Polish airports together with the neighboring countries airports - Germany, the Czech Republic, Slovakia and Lithuania. The results are compared and analyzed in details to show the areas from which travel to the Polish airports is longer than to the airports located in the territory of other Shengen countries.

The results of the research allow to present people interested in air transportation how fast they can reach the nearest airport from anywhere in Poland. Moreover, this gives the opportunity to choose whether to go to Polish or abroad airport. Developed maps can be used for analyzes of the Polish aviation. Presented results and drawn conclusions can be used for Civil Aviation Authority of the Republic of Poland, public administration, to managing transport infrastructure, as well as by any potential passenger.

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Key words: air transportation, travel maps, travel time

[1] Military University of Technology, Warsaw, Poland, e-mail: lukasz.gladysz1@student.wat.edu.pl
[2] Military University of Technology, Warsaw, Poland, e-mail: marta.kuzma@wat.edu.pl
[3] Military University of Technology, Warsaw, Poland, e-mail: albina.moscicka@wat.edu.pl

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TOWARDS PRECISE UAV VISUAL NAVIGATION AND DIRECT GEOREFERENCING USING ORB-SLAM2 (0047)

Pawel Burdziakowski[1]

A low accuracy of positioning using GPS are not meet geodetic requirements for direct images georeferencing for UAV photogrammetry [1]. A majority of UAVs are equipped with a monocular non-metric camera for either visual data gathering or live operators video feed. A cheap positioning techniques used on board commercial UAV are not that precise as geodetic community requires. Moreover, a traditional satellite navigation suffers from a multipath GPS signal in an industrial environment and cities or during operation in operating in poor GPS space segment geometry [5]. In that cases, the UAV position can be enhanced by a visual navigation method [2].

The paper presents a result of implementation of recently developed monocular SLAM method (ORB-SLAM 2 [4]) for a low cost hexacopter platforms [3] navigation system augmentation in order to support a precise and robust direct images georeferencing.

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Key words: geographic information systems, geospatial analysis, revitalisation

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[1] Faculty of Civil and Environmental Engineering, Gdansk University of Technology, Gabriela Narutowicza Str. 11/12, Gdansk 80-233, Poland, e-mail: pawel.burdziakowski@pg.gda.pl

TROPOSPHERE DELAY MODELING WITH HORIZONTAL GRADIENTS FOR SATELLITE LASER RANGING SOLUTIONS (0098)

Mateusz Drożdżewski*[1], Krzysztof Sośnica[2]

Satellite Laser Ranging (SLR) observations have a significant impact on the determination of precise satellite orbits, the definition of the origin of the reference frame, the global scale and the gravitational constant [1]. The present accuracy of SLR solutions is limited by deprivations in the background models which are applied when processing SLR data. One of the most important factors limiting the accuracy of SLR is the modeling of the troposphere delay [2], especially the unmodeled horizontal gradients of the troposphere delay [3].

The SLR observation technique is based on very short and precise laser pulses, whose accuracy corresponds to a level of few millimetres. The observations are carried out to dedicated passive geodetic satellites, active remote sensing satellites and also to satellites of the Global Navigational Satellite Systems (GNSS) equipped with retroreflectors. In contrast to other space techniques based on microwaves, the SLR observations are limited by weather conditions, and thus, the number of SLR observations is typically small compared to, e.g., GNSS microwave observations. Any additionally estimated parameters may deteriorate the stability of SLR solutions, in particular the repeatability of the vertical component of SLR station coordinates. As opposed to the GNSS solutions, the possibility of the simultaneous estimation of horizontal gradients of the troposphere delay in SLR solutions is very restricted and may lead to unrealistic results when the number of SLR observations is insufficient.

In this paper, we examine three dedicated approaches of the horizontal gradient modeling for SLR. In the first case, we use horizontal gradients derived from the European Centre for Medium-Range Weather Forecasts (ECMWF) [4]. In the second approach, we use horizontal gradients estimated by the enhanced number of estimated parameters from SLR observation. In the last case, we apply GNSS-derived horizontal gradients from the GNSS solutions provided by the Center for Orbit Determination in Europe (CODE) reprocessing campaign (repro2), which was generated in the framework of the preparation for the International Terrestrial Reference Frame 2014 (ITRF 2014). We analyze the troposphere delay series using up to 20 years of GNSS products from the IGS campaign repro2 for SLR-GNSS co-located stations. The fundamental period of the repeatability of the GPS constellation with respect to the position of the Sun is named the “draconitic” year, whose interval is about 351.2 day. The draconitic period is strongly aliased to the annual and semi-annual periods, which are associated with the seasonal variations in the troposphere delays and are of special interest for every co-located GNSS-SLR station. We approximate the horizontal gradients for GNSS stations

[1] Wroclaw University of Environmental and Life Sciences, Institute of Geodesy and Geoinformatics, ul. Grunwaldzka 53, 50-357 Wrocław, mateusz.drozdzewski@igig.up.wroc.pl
[2] Wroclaw University of Environmental and Life Sciences, Institute of Geodesy and Geoinformatics, ul. Grunwaldzka 53, 50-357 Wrocław, krzysztof.sosnica@igig.up.wroc.pl

by fitting a function consisting of an offset, linear drift and the annual and semi-annual signals for the East-West and North-South components. The offsets are at a submillimeter level with the maximum value for the north-south (NS) offset of 0.5 mm for the station Arequipa in South America, and a minimum value of NS = - 0.7 mm. The maximum value for East-West (EW) offset amounts to 0.7 mm for the station Wuhan in China. The minimum EW offset has the value of -1.18 mm for the station Komsomolsk in Russia. The mean offset is equal to -0.2 mm for the NS component and -0.25 mm for the EW component. The offsets are much larger when the station is near the ocean. The majority of stations in the northern hemisphere achieve smaller values of horizontal gradients, as compared to the stations in the southern hemisphere. The value of NS offset in the south hemisphere is positive nearly for all station. The NS gradient is larger than the EW gradient for major stations. The median value of NS component amounts to -0.20 mm while the EW median component is significantly smaller -0.02 mm. The values of linear drift depend on local conditions and predominate for the NS component. The maximum value for NS drift amounts to 0.1 mm/year for the station Wuhan in China. All values of linear drifts are at the submilimetre level, however, this parameter should not be neglected, because they reflect a change of the environmental conditions around the GNSS stations. Further, we introduce these empirical functions of the horizontal components of the tropospheric delays to the SLR solutions for the SLR-GNSS co-located stations.

We compare the estimated SLR station coordinates, geocenter coordinates, Earth rotation parameters and range biases from the solutions using three different ways of handling horizontal gradients in the reprocessed 13 years of SLR observation to LAGEOS-1 and LAGEOS-2. The data are reprocessed using a modified version of Bernese GNSS Software dedicated for SLR data. First results of horizontal gradients derived from SLR-GNSS co-located give corrections at the sub-millimetre level in the zenith, however after applying the Chen–Herring mapping function [5], the corrections for the elevation angles at 10 degrees achieve values up to 20 mm. Therefore, applying the horizontal gradients of the troposphere delay in SLR solutions is indispensable in order to fulfil the challenging requirements of the Global Geodetic Observing System (GGOS) asking for the station coordinate accuracy of 1 mm.

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Key words: Laser Ranging, Troposphere delay modelling, mapping functions

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USE OF A POTENTIAL MODEL TO ANALYSE POPULATION DISTRIBUTION STRUCTURE (0012)

Bogdan Wolak[1]

A map, as a visual model of spatial phenomena, enables conducting analyses to understand the characteristics of a space as well as the relationships and dependencies occurring in it. Cartographic research methods are used to analyze fluctuations in the distribution and intensity of phenomena, dependencies and correlations, to distinguish trends in spatial relationships and to forecast changes in time and space [1].

The potential model assumes that the total size of the body interaction potential is the function of the mass of separate bodies and the distance between the bodies. J.Q. Stewart, who formulated the laws of demographic gravitation based on the theory of Newton's physics, is the author of the potential model concept for research related to population distribution. J.Q. Stewart presumed that the interaction in space between population centres corresponds with the relations concerning the interaction between physical masses. The method suggested by J.Q. Stewart is being applied to many issues involving thematic maps, e.g. population, regions, industrial plants and income, which are treated as the size of the mass (M) of centres or regions. The distance (d) between centres may be defined as the actual (terrain) distance, which relates to the measurement of a line connecting two points, or as a distance in time, calculated as travel time [3, 4].

Potential maps are developed on the basis of the calculated values of the total population potential of benchmarks. Potential maps are most often developed using isarithms. A potential line layout reflects the potential topography. On a potential surface, forms can be distinguished which are analogous with forms on a topographic surface, including ridges, slopes, summits, depressions and synclines. An understanding of the shapes and characteristic points of equipotential lines allows for a comprehensive analysis of surfaces and studying the correlation between the size of the potential (and other) objects of a geographical space.

Population distribution can be examined by distinguishing two aspects, i.e. global (physical) distribution and specific (social) distribution. The global approach refers to where a given person or a social group resides physically. From the social perspective, there are relations considered between a population and its quality characteristics, including its qualifications, structure and beliefs. Population distribution depends on environmental, economic, cultural, demographic and historical factors. Natural conditions, i.e. the lie of the land, climate, water conditions and soils, are a crucial factor in determining population distribution [2].

In this work, a potential model was used to develop a map of the population distribution of Olsztyn and the towns and villages from six neighbouring communes, i.e. Barczewo, Dywity, Gietrzwałd, Jonkowo, Purda and Stawiguda, from a global perspective. The research findings were based on 2011 data for 120 towns and villages from the region of Olsztyn, obtained from the Central Statistical Office

[1] University of Warmia and Mazury in Olsztyn, ul.Oczapowskiego 1, 10-719 Olsztyn, Poland, e-mail: wolak@uwm.edu.pl

of Poland (GUS). The developed map illustrates the strength of the interactions between particular towns and villages and presents the morphology of the potential field of the region of Olsztyn. The article shows the possibility of using the potential of the model in the study of spatial recognition locally. The results of the analysis can be used for both the current interpretation of the results and to formulate predictions in the study of geography.

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Key words: geography, geographic information systems, geospatial analysis

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USING GIS IN PUBLIC HEALTH: RISK ASSESSMENT OF CUTANEOUS LEISHMANIASIS IN SOUTHERN IRAN (0003)

Ahmad Ali Hanafi-Bojd*[1], Homa Nasseh[2]

Leishmaniasis is one of the most important vector-borne diseases in Iran, with thousands of cases of cutaneous and visceral forms. The spatial distribution of CL is highly dependent to the environmental variables as well as poverty and knowledge of community about transmission and its' prevention methods. The prevalence of the cutaneous form of the disease had has an increasing trend and now it is endemic in 17 out of the 31 provinces of the country. Jask County is an endemic area for the disease in the southeast of the country. This study analyses the situation of cutaneous leishmaniasis during 2006-2014 and tries to find the high risk areas, based on the current geographical distribution of CL, with due attention to biotic and environmental factors affecting the transmission process. Characteristic features of the cases of cutaneous leishmaniasis which have been referred to the appropriate health division for treatment were documented in special forms designed by the ministry of health. In this descriptive-analytical study, necessary data were passively extracted from the above-mentioned forms. The study period span between the years of 2006-2014. The got data were later transferred onto an excel spreadsheet and the related charts and tables were computed using this software. ArcGIS 10.3 used for spatial analysis. Co-kriging analysis was used to predict the risk of CL across Jask County using the disease data as dependent variables and total precipitation and average of mean monthly temperature as independents. During the study period 874 cases were registered in the district health center, mean an averaged incidence of 162.5 per 100000. Over 90 percent of the cases were inhabitants of the rural areas. Co-kriging analysis involving altitude, mean monthly temperature and total annual precipitation variables showed a positive autocorrelation between the disease and the total precipitation and altitude. The prediction map indicated the eastern parts of Jask County, together with some northern areas of the county, are more susceptible in maintaining CL transmission. Totally, 61 rural/urban areas are categorized as high-risk areas for CL transmission, with a total population of closely 18,000. Conversely, more than a third of Jask County inhabitants are living in high-risk areas, while the risk of CL transmission is medium in more than 50 rural/urban areas. In conclusion, GIS-based spatial study on a vector-borne disease helped us to find the hot spots and population at risk to plan and do a targeted prevention and control program.

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Key words: Cutaneous Leishmaniasis, Risk assessment, Geographical information Systems

[1] Department of Medical Entomology & Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran, E-mail: aahanafibojd@tums.ac.ir
[2] Pooyesh Clinic, Shahid Beheshti Blvd., Karaj, Iran, E-mail: nasseh2002@yahoo.com

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VIDEO IMAGERY ORIENTATION ACQUIRED USING A LOW COST MOBILE MAPPING SYSTEM (0043)

Paulina Deliś*[1], Michalina Wojtkowska[2], Aleksandra Grochala[3], Magda Zacharek[4]

Dynamic developments in the field of measuring equipment such as: GPS receivers, reflectorless total stations, laser scanners together with digital video cameras, as well as associated software, allow for a much greater ease in geodata gathering. One of types of systems used for acquiring and processing geospatial data is a mobile mapping system. Mobile mapping systems play an important role in collecting street and road data for mapping and GIS purposes. Imagery data acquired by the mobile mapping system are a perfect addition to information provided by satellite images, aerial images, LIDAR and low altitude imagery from UAV.

A Mobile Mapping System (MMS) typically consists of video cameras, GPS, inertial navigation and a high-resolution lidar. Measurement devices are usually mounted on a car or train.

The aim of the study was to verify the possibility of registering video imagery acquired using a low-cost mobile platform mounted on a car. The platform consisted of an RTK GPS receiver, a laser rangefinder and a video camera. The first step of the algorithm is the video sequence acquisition by a video camera mounted on a car platform. The next stage relies on the automatic selection of video frames from video sequences on the assumption that the base ratio is 0.8. In order to determine linear exterior orientation elements X_0, Y_0, Z_0, GPS RTK surveys had been used. In the bundle adjustment process, interior orientation elements had been taken into account.

The calculated values of the video frames exterior orientation elements X_0, Y_0, Z_0 have been verified using coordinates from the geodetic network. In order to perform an accuracy assessment of the absolute orientation elements of the video images which had been acquired using the proposed methodology, a comparison was made of the video images orientation results from two variants. Variant I - absolute orientation of video frames based on data from a GPS RTK; Variant II - absolute orientation of video frames based on control points.

It was found, that the more accurate method of video frames' orientation is the GPS/RTK data (variant 1). This method is more accurate by 13 % compared to the video frames orientation based

[1] Department of Remote Sensing, Photogrammetry and Imagery Intelligence, Geodesy Institute, Faculty of Civil Engineering and Geodesy, Military University of Technology, 00-908 Warsaw, S. Kaliskiego 2, Poland, e-mail: paulina.delis@wat.edu.pl
[2] Department of Remote Sensing, Photogrammetry and Imagery Intelligence, Geodesy Institute, Faculty of Civil Engineering and Geodesy, Military University of Technology, 00-908 Warsaw, S. Kaliskiego 2, Poland, e-mail: michalina.wojtkowska@wat.edu.pl
[3] Department of Remote Sensing, Photogrammetry and Imagery Intelligence, Geodesy Institute, Faculty of Civil Engineering and Geodesy, Military University of Technology, 00-908 Warsaw, S. Kaliskiego 2, Poland, e-mail: aleksandra.grochala@wat.edu.pl
[4] Department of Remote Sensing, Photogrammetry and Imagery Intelligence, Geodesy Institute, Faculty of Civil Engineering and Geodesy, Military University of Technology, 00-908 Warsaw, S. Kaliskiego 2, Poland, e-mail: magda.zacharek@wat.edu.pl

only on control points (variant 2). The study showed that the accuracy of video images orientation using the proposed formula of automatic video frames selection and using GPS RTK measurement to calculate the coordinates of projections centers, is about 1-2 pixels.

To obtain the expected results when performing of this type of video imagery orientation, using a single car mobile platform the following conditions must be met. The proposed method of mobile imaging is useful for areas of low-rise buildings. The allowable height of buildings is determined by the FOV angle of the camera lens. The second condition is associated with adjusting the appropriate vehicle speed, so that the image is not characterized by blur. These two conditions have a large impact on the accuracy of orientation and also on the quality of any further research.

Because the proposed method does not require any prior information about the coordinates of control points, it allows for the orientation of video frames in near real-time.

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Key words: Image capture, Image sequence analysis, Image registration, Global Positioning System

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ZENITH TROPOSPHERIC DELAY ESTIMATES USING ABSOLUTE AND RELATIVE APPROACHES TO GNSS DATA PROCESSING – PRELIMINARY RESULTS (0023)

Pawel Golaszewski*[1], Pawel Wielgosz[2], Katarzyna Stepniak[3]

GNSS is a well-established technique used for obtaining the data for meteorological purposes. Basically, there are two main methods for estimation of tropospheric delays based on GNSS data. The first one is the relative technique, relying on creating double-differences (DD) of the observations and processing baselines connecting GNSS stations. The second method that allows for tropospheric delay estimation form undifferenced measurements is the Precise Point Positioning (PPP). These techniques differ in terms of processing complexity, handling of error sources and required geodetic products.

In this research, GNSS-derived tropospheric parameters were computed for selected EUREF stations located in Poland and Europe using both approaches. For DD approach the Bernese v.5.2 software was applied, while the PPP solution was executed with the G-Nut/Tefnut software and with the Bernese v.5.2 software as well. For the PPP solution the IGS final products (satellite orbit and clock corrections parameters) were used The data was obtained and compared in one hour interval. The resulting time series were compared in terms of quality and accuracy (e.g. # of outliers). In addition, both solutions were compared to the final EUREF solution. It was concluded that both approaches allow generation high-quality tropospheric delay estimates.

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Key words: Global navigation satellite system, Global Positioning System, Electromagnetic refraction, Delay effects, Time series analysis, Meteorology

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[2] Univerity of Warmia and Mazury in Olsztyn, Institute of Geodesy, Oczapowskiego 2, 10-719 Olsztyn, Poland, e-mail: pawel.wielgosz@uwm.edu.pl

[3] Univerity of Warmia and Mazury in Olsztyn, Institute of Geodesy, Oczapowskiego 2, 10-719 Olsztyn, Poland, e-mail: katarzyna.stepniak@uwm.edu.pl

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