Geo-Information for Disaster Management 2019

Prague, Czech Republic
3 September – 6 September 2019
National Library of Technology

BOOK OF ABSTRACTS

Gi4DM 2019 Conference

Session

Opening: Opening Ceremony

Time: *Location:* **Balling's Hall**

Wednesday, 04/Sep/2019:
10:30am - 12:00pm

Session Chair: **Orhan Altan**

Welcome and Introduction, Orhan Altan
Welcome on behalf of the ISPRS ICWG III/IVa: Disaster Assessment, Monitoring and Management, Tullio Tanzi, chair
Welcome by Christian Heipke, ISPRS President
Welcome by Paul Cannon, URSI Past President

Presentations

Machine Learning for Information Discovery from Big Earth Observation Data Archives

Begüm Demir
Technische Universität Berlin; demir@tu-berlin.de

During the last decade, a huge number of earth observation (EO) satellites with optical and Synthetic Aperture Radar sensors onboard have been launched and advances in satellite systems have increased the amount and variety of EO data. This has led to massive EO data archives with huge amount of remote sensing (RS) images, from which retrieving useful information in the framework of disaster monitoring and management is challenging. In this talk, a general overview on scientific and practical problems related to RS image characterization, indexing and search from massive archives will be initially discussed. Then, recent developments that can overcome the considered problems will be introduced by focusing on scalable and accurate remote sensing image search and retrieval systems for disaster management.

Session

TS I Parallel: Technical Session Topics: Remote Sensing and GIS as Tools of Natural and Man-Made Disaster Management & Disaster Management & Urban Analysis

Time:

Wednesday, 04/Sep/2019:
2:00pm - 3:30pm

Session Chair: **Sultan Kocaman**

Presentations

Diseases spread prediction in tropical areas by machine learning methods ensembling and spatial analysis techniques

Alexey A Kolesnikov[1], Pavel M Kikin[2], Olga S Iliasova[2], Alexey M Portnov[3]
[1]Siberian State University of Geosystems and Technologies, Russian Federation; [2]Peter the Great St.Petersburg Polytechnic University (SPbPU), Russian Federation; [3]Moscow State University of Geodesy and Cartography,Moscow, Russian Federation; alexeykw@yandex.ru

Infection with tropical parasitic diseases has a great economic and social impact and is currently one of the most pressing health problem. These diseases, according to WHO, have a huge impact on the health of more than 40 million people worldwide and are the second leading cause of immunodeficiency. Developing countries may be providers of statistical data, but need help with forecasting and preventing epidemics. The number of infections is influenced by many factors - climatic, demographic, vegetation cover, land use, geomorphology. The purpose of the research is to investigate the space-time patterns, the relationship between diseases and environmental factors, assess the degree of influence of each of the factors, compare the quality of forecasting of individual techniques of geo-information analysis and machine learning and the way they are ensembled.

Also we attempt to create a generalized mathematical model for predicting several types of diseases.

The following resources were used as a data source: International Society for Infectious Diseases, Landsat, Sentinel. The paper concludes with the summary table containing the importance of individual climatic, social and spatial aspects affecting the incidence. The most effective predictions were given by a mathematical model based on a combination of spatial analysis techniques (MGWR) and neural networks based on the LSTM architecture.

Multi-hazard risk assessment in urban development planning using AHP

Ashrika Sharma, Hiroyuki Miyazaki. Ph.D.
Asian Institute of Technology, Thailand; ashrika-sharma@ait.asia

Many cities across the world are exposed to more than one hazards. Focus on only the most prominent natural hazards, or the most recent event can be dangerous, as many potential threats to urban development are not assessed. Even when multiple hazards in a given area is assessed, there is a lot of confusion on how to utilize hazard information in making decisions for urban land-use planning. This study is aimed to develop a method to utilize hazard maps in urban land use decision making. The study has identified numerous applications of GIS-based multi-criteria decision model (MCDM) for land-use suitability evaluation. It has then tried to integrate multiple hazard maps, a product of multi-hazard risk assessment, into the model to generate suitability maps for further development. The used parameters were correlated using the Analytical Hierarchical Process (AHP), one of the MCDM tool and incorporated into the GIS environment, with the comparison between the cases with- and without-hazard considerations. The application of the proposed methodology was tested for Madang Province, Papua New Guinea for four land-uses, i.e., residential, industrial, commercial, and agricultural. The results of the model i.e., land-use suitability maps were

spatially reflective of the model user's decisions and understanding. This model gave considerable results for the urban development plan. Furthermore, comparison of the model outputs with and without hazard considerations led to notable differences. For example, almost 1% of the study area was rendered unsuitable for residential development in the assessment without hazard consideration. Besides, approximately 14% of the study area were assessed as suitable for without-hazard consideration but less suitable for with-hazard consideration. Since the hazard maps represented patterns and locations of natural hazards, our approach of incorporating them could help highlight the gaps in risk recognition with future development in hazardous areas.

Dynamics of Spatio-Temporal Urban Expansion in South West Delhi Region: A GeoSpatial Approach for Urban Disaster Management

NIPRA SHARMA[1], Amarjeet Kaur[2], Parmita Bose[3]

[1]University School of Environment Management, Guru Gobind Singh Indraprastha University, New Delhi,India; [2]University School of Environment Management, Guru Gobind Singh Indraprastha University, New Delhi,India; [3]GeoSpatial Delhi Limited, New Delhi, India; niprasharma90@gmail.com

Rise in population and economic growth leads to rapid urban expansion, developing a pressure on natural resources thereby causing land use changes in megacities. Therefore it is necessary to study the serious problems associated with rapid development such as environmental pollution, destruction of ecological structures, scarcity of natural resources and urban disasters. This paper presents an approach to address these challenges using geospatial data to study i) the land use and land cover change and ii) the patterns and processes of urban growth. Spatio-temporal changes in land-use/land-cover were assessed over the years using multi-date high resolution satellite data. The land use classification was conducted using visual image interpretation method wherein, study area was categorized into five different classes based on NRSC classification namely agricultural, built-up, forest, waste land and water bodies. Post-classification change detection technique was used for the assessment of land-cover change and transition matrices of urban expansion were developed to quantify the changes. The results show that the city has been expanding majorly in its peripheral region with the conversion of rural area into urban. An increase in the built-up category was observed at the cost of agricultural and marginal land with an approximate change of 10% in the peri-urban areas. Urban areas are becoming more densely populated and open barren lands are converted into urban areas due to over population and migration from the rural areas of Delhi and thus increasing threat towards urban disaster. Conservation and sustainable management of various natural resources is recommended in order to minimize the impact of potential urban disasters.

3D Building Data for Disaster Management: A 3D SDI Perspective

Umroh Dian Sulistyah, Jung-Hong Hong

Department of Geomatics, National Cheng Kung University, Taiwan; umrohdians@gmail.com

In recent years, the demands of 3D cyber-city have been steadily growing. With strong links to the citizens' lives, building information is considered as the most important component in the 3D urban model. To further facilitate the best usage of 3D data, the development of 3D SDI requires creative thinking to meet different application needs. While many current applications are restricted to visualization only, we argue the 3D building data in 3D SDI must at least consider the issues of feature modeling, identification, semantics, level of details, cross-domain linking and services. This paper intends to assess the use of the semantic-enriched 3D building data in the applications of disaster management. Based on CityGML, we first create 3D building data based on a hierarchy of building-storey-household representation. Identifier systems are respectively developed for each level of features for the purpose of identifying individual features and linking to other sources of data, e.g., the household registration information. By reviewing and comparing the outcomes of the past research of 3D flood simulation, we demonstrate the improved 3D building data additionally enables the direct impact analysis at the chosen level of features, as well as visually present enriched analyzed outcomes for decision making, e.g., the number of trapped people in specific floor. As the merits of the SDI is to share reliable information, encourage multiple-purpose applications and avoid duplicated spending, we thereby conclude the necessity to further examine the level of details and multiple representation of the serviced 3D building data for cost-effective application development.

Use of machine learning techniques for rapid detection, assessment and mapping the impact of disasters on transport infrastructure.

Pavel M Kikin[1], Alexey A Kolesnikov[2], Alexey M Portnov[3]

[1]Peter the Great St.Petersburg Polytechnic University, St. Petersburg, Russian Federation; [2]Siberian State University of Geosystems and Technologies, Novosibirsk, Russian Federation; [3]Moscow State University of Geodesy and Cartography, Moscow, Russian Federation; it-technologies@yandex.ru

Road traffic infrastructure plays a key role in emergency management. It allows to evacuate people from the affected area in the shortest possible time, as well as to organize rapid emergency response. However, disasters often cause the destruction of roads, railways and pedestrian routes, which can significantly affect the evacuation plan and availability of facilities for emergency services, which increases the response time and thereby increases the losses. Therefore, it is very important to quickly provide emergency services with necessary post-disaster maps, created on the principles of rapid mapping. Change detection based on geospatial data before and after damage can make rapid and automatic assessment possible with reasonable accuracy and speed. This research proposes a new approach for detecting damage and detecting the state and availability of the road network based on the satellite imagery data, unmanned aerial vehicles (UAVs) and SAR using various methods of image analysis. We also provided an assessment of the resulting combined mathematical model based on neural networks and spatial analysis approaches.

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Time: **Wednesday, 04/Sep/2019: 2:00pm - 3:30pm**

Location: **Balling's Hall**

Session Chair: **Filiz Sunar**

Presentations

Analysis of the trend of the deformation around Kanto region estimated by time series of PALSAR-2 data

Takashi Nonaka[1], Tomohito Asaka[1], Keishi Iwashita[1], Fumitaka Ogushi[2]

[1]Nihon University; [2]Harris Geospatial Solutions K.K.; nonaka.takashi@nihon-u.ac.jp

In Japan, a large quantity of natural gas is widely dissolved in brine water and widely distributed in the Kanto region. The extraction of this water containing natural gas has caused land subsidence. Since the 1930s, there have been gas production activities near Tokyo. Large-scale production of gas and iodine in the Kujyukuri area started in 1956. The production was conducted through withdrawal of groundwater from the depth of 500 to 2000 m. Land subsidence has been found since the 1960s and large-scale land subsidence surveying was initiated at the end of the 1960s. From 1970 to 2005, the maximum accumulated subsidence was 0.85 m and the subsided area was 800 km2. Recently, land subsidence has diminished in almost all areas, but land subsidence of more than 10 mm per annum has been observed in some places. Land subsidence causes discontinuities of pipelines, subsidence or tilting of buildings, and intrusion of seawater into freshwater aquifers. In addition to the destruction of urban and industrial facilities, it also causes environmental problems and geological disasters. Therefore, to maintain sustainability, especially in urban areas, it is vital to understand land deformation trends.

Remote sensing is an effective tool for monitoring large-scale ongoing subsidence at low cost, whereas traditional leveling can provide precise measurement. Differential interferometry synthetic aperture radar (DInSAR) is a well-known tool among the remote sensing techniques for measuring surface deformation. The short baseline subset (SBAS) technique is an extension of conventional DInSAR methods. It is intended for the analysis of distributed targets. The resulting product resembles the one generated by conventional DInSAR; however, a key difference is that SBAS enables analysis of large time series, whereas DInSAR is limited to 2-, 3-, and 4-pass series. With respect to the comparable persistent scatterers (PS) technique, the SBAS technique is less sensitive to the number of acquisitions because it exploits the spatially distributed coherence instead of exclusively considering single points, as in the PS technique. However, more acquisition results in a better resulting product quality, because the atmospheric component can be better estimated and reduced. Concerning the displacement, SBAS is not exclusively limited to the linear one.

In past studies, the authors developed the SBAS technique to monitor the deformation around the Kujyukuri area from 2006 to 2010 using 26 Phased Array type L-band Synthetic Aperture Radar (PALSAR) data. From the analysis, displacement of more than 10 mm/year was observed around the cities of Yachimata and Tomisato. Then, we selected 12 validation points and estimated the root mean square (RMS) errors of the displacement by comparing with GNSS Earth Observation Network System (GEONET) data. The result showed that the RMS errors were about 10 mm. PALSAR-2 on the Advanced Land Observing Satellite (ALOS)-2 was launched in 2014, and it is expected to be used for many applications, especially disaster management. The improvement of the orbit control accuracy makes it possible to estimate displacement more accurately than with PALSAR. However, knowledge of the difference of input parameters (conditions) and the features of acquired results between PALSAR-2 and PALSAR has not been gathered fully in the past studies. Therefore, the purpose of this study was to develop a method to monitor displacement using PALSAR-2 data and to reveal subsidence by applying the method to the Kujyukuri area. Additionally, we evaluated the applicability of SBAS to PALSAR-2 by comparing the acquired results with those of PALSAR.

In this study, we collected 15 PALSAR-2 scenes from January 15, 2015, to March 7, 2019, for the InSAR stacking process. All of the scenes were observed in Stripmap (3 m resolution) mode, the descending direction, and right-looking mode. For the PALSAR-2 data, we generated 45 interferograms for SBAS processing, with respect to the multi-master images. The threshold criterion for the absolute mean of the normal baselines was 182 m and that for the absolute mean of the temporal baselines was 365 days. The image acquired on March 9, 2017, was chosen as a super master image. A multi-looking factor of three in range and four in azimuth was used, producing a ground resolution of about 8 m. The topographic phase was removed using the same digital elevation model used for the PALSAR data processing. To smooth the differential phase, the Goldstein filter was applied. The minimum cost flow (MCF) network with Delaunay method was employed to unwrap the differential interferograms with an unwrapping coherence threshold of 0.30. The same reference points used in the PALSAR SBAS processing were also used for the refinement and re-flattening. The linear inversion model was used in the processing. All of the final displacement measurements were measured in the satellite line of sight (LOS) direction and were geocoded in the WGS84 reference ellipsoid with a ground resolution of 8 m.

The mean displacement rate and standard deviation were −1.4 and 3.2 mm/year, respectively. The displacement map showed that the values were obtained by nonurban areas as well as urban areas, which was caused by less decorrelation over vegetated areas and better coherence due to longer L-band wavelength. In addition, due to the higher coherence, the number of points acquired by PALSAR-2 was less than the number acquired by PALSAR. One of the factors was that the number of used scenes for PALSAR-2 was approximately half of PALSAR as many for almost the same length of duration. The accuracy of the displacement was estimated for 4 validation points using the reference GEONET data, and it was found to be 20 mm, which was twice that of PALSAR. Although the observation period differed between PALSAR-2 and PALSAR, the spatial distribution of the displacement between them was similar. Therefore, our results demonstrate the feasibility of PALSAR-2 as an alternative to ground-based measurements for land subsidence monitoring.

In conclusion, although the utilized PALSAR-2 scenes were not sufficient, this study implied that the accuracy of the displacement was about 20 mm, twice that qualitatively acquired by PALSAR. In future studies, we intend to evaluate the accuracy of the annual rate of subsidence quantitatively using in situ leveling survey data provided by Chiba Prefecture.

Evaluation of the impacts of lack of Geoinformation data in crisis management during the 2018 Kuwait flood

Nayef Fahad Alghais

Kuwait University, Kuwait; dr.ghai@gmail.com

The State of Kuwait faced a catastrophic flood on the 9th of November 2018 due to extraordinary rainfall of around 111mm in less than 6 hours. Such an extreme flood event has not been observed in Kuwait for the last 50 years. In this research, we attempt to understand the crisis management in Kuwait from a Geoinformatics perspective. Remote sensing and GIS were used to investigate the flood impacts and response

efficiency in Kuwait city, Fahaheel city and Sabah Al-Ahmad city. A comparison was carried out based on the availability of Geoinformation data and tools, the response time for each city, and the number of recorded incidents. It was found that the response to the flood event was overall lacking, mainly due to the absence of accurate geoinformation data and the lack of real-time monitoring of the drainage network. In addition, the absence of a centralized crisis management authority in Kuwait that could coordinate the various related bodies involved in flood response aggravated the issue.

A synchronized approach for integrating photos and 3D GIS in the applications of disaster management

JungHong Hong, CHIAHSUN CHEN
National Cheng Kung University, Taiwan; j3@igis.geomatics.ncku.edu.tw

Photos are an effective tool for recording the ongoing disaster situations or damages after hazards. The emergence of smartphones brings revolutionary influences to the use of photos. Since almost everyone has a smart phone, even general public can take photos, report any disaster situations they observe via mobile network and share the photos with social media. These photos may provide valuable information about the disaster information in reality. In addition to the visual inspection, how to effectively and efficiently take advantage of the available photos remains an interesting challenge. From a 3D perspective, we propose a synchronize approach for integrating the visualization and manipulation of photos and 3D GIS data. While the photos provide the newly acquired disaster situations, the 3D GIS data provides a realistic and comprehensive reference and links to other domain data for better analyzing the damages from different viewpoints. The key idea is to restore the position and orientation when the photo was taken in the system, and synchronize the visualization of both types of data with a dual-window interface. We also demonstrate that when precisely matching the common feature points between the photos and 3D GIS data, certain operations like measurement (e.g., the depth of floods or damaged area) can be readily implemented. This would be extremely useful when the before-and-after situations are being compared. With the increasing awareness of citizens' participation, the proposed approach presents a new direction by highlighting the use of photo for better decision making in the operations of disaster management.

Vulnerability Analysis for the Integrated Coastal Zone Management Plan of City of Kastela in Croatia

Martina Baucic, Majda Ivic, Natasa Jovanovic, Samanta Bacic
Faculty of Civil Engineering, Architecture and Geodesy, University of Split, Croatia; majda.ivic9@gmail.com

One of the objectives of the Integrated Coastal Zone Management (ICZM) is to prevent and reduce the effects of natural hazards, particularly ones caused by climate changes. The ICZM methodologies include use of geographic information systems, from data collection and geo-analysis to dissemination of information to the public. As a part of the Interreg MED Co-evolve project co-financed by the European regional development fund, the ICZM based action plan is being developed for the City of Kastela in Croatia. Activities include assessing coastal vulnerability to climate change, focusing on sea flooding and storm damages and related socio-economic vulnerabilities. The paper presents development of large scale vulnerability analysis, adopted from the methodologies developed for mid and small scales. Suitability of the available data is assessed, either official or open source, and data gaps are described. The analysis's results are presented in terms of the assets exposed to sea flooding and storms, and future improvements of analysis towards house level vulnerability analysis is envisaged.

FLOOD ANALYSIS WITH REMOTE SENSING DATA - A CASE STUDY: EDIRNE

Nur Yagmur, Adalet Dervisoglu, Ayse Filiz Sunar
Istanbul Technical University, Turkey; yagmurn@itu.edu.tr

A flood, one of the most devastating natural disasters in the world, occurs when water inundates land that's normally dry. Although floods can develop in many ways, river floods (i.e. overflow by rivers or river banks) are the most common. Turkey is one of the flood-affected countries with its 20 main basins in 8 regions. One of the most aggrieved basins in Turkey is the Maritsa river basin in in Eastern Balkans, which also contains the natural border regions with Greece and Bulgaria. 65% of the Maritsa River basin, which originates from the Rila Mountains and joins the Arda and Tundzha rivers, is located in Bulgaria. When the melting snow flow or precipitation in the basin increases, the Maritsa River overflows from the slopes to the Edirne Plain and from time to time exceeds the capacity of the bed, causing floods. On the other hand, since the water level in the dams and reservoirs was kept at the highest level for production purposes, the flood repeat interval increased in the region, since 2000s. Today, it is possible to monitor and evaluate the damages of flood by obtaining very reliable information with space technology. Especially, microwave SAR images that can penetrate clouds, are of great importance in flood mapping because they provide immediate information on the extent of inundation and support the evaluation of property and environmental damages. In this study, rapid flood risk assessment in the region was performed using Landsat 8 and Sentinel 2 Normalized Difference Water Index (NDWI) time series images, and calibrated Sentinel 1 SAR images produced on Google Earth Engine (GEE) platform for 2015-2018 period. GEE is a cloud-based platform that facilitates access to high-performance computing resources to handle very large geographic data sets. The results were compared and verified using meteorological data, riverbed flow data, and digital media news. The results showed that the most affected areas were consistent with the highest measured flow rates and the magnitude of flood damages caused by two main causes in the basin (i.e. opening of shutters in Bulgarian dams or local excessive rainfall) was very different (approximately 8 times larger) from each other.

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Nur Yagmur, Adalet Dervisoglu, Ayse Filiz Sunar
Istanbul Technical University, Turkey; yagmurn@itu.edu.tr

A flood, one of the most devastating natural disasters in the world, occurs when water inundates land that's normally dry. Although floods can develop in many ways, river floods (i.e. overflow by rivers or river banks) are the most common. Turkey is one of the flood-affected countries with its 20 main basins in 8 regions. One of the most aggrieved basins in Turkey is the Maritsa river basin in in Eastern Balkans, which also contains the natural border regions with Greece and Bulgaria. 65% of the Maritsa River basin, which originates from the Rila Mountains and joins the Arda and Tundzha rivers, is located in Bulgaria. When the melting snow flow or precipitation in the basin increases, the Maritsa River overflows from the slopes to the Edirne Plain and from time to time exceeds the capacity of the bed, causing floods. On the other hand, since the water level in the dams and reservoirs was kept at the highest level for production purposes, the flood repeat interval increased in the region, since 2000s. Today, it is possible to monitor and evaluate the damages of flood by obtaining very reliable information with space technology. Especially, microwave SAR images that can penetrate clouds, are of great importance in flood mapping because they provide immediate information on the extent of inundation and support the evaluation of property and environmental damages. In this study, rapid flood risk assessment in the region was performed using Landsat 8 and Sentinel 2 Normalized Difference Water Index (NDWI) time series images, and calibrated Sentinel 1 SAR images produced on Google Earth Engine (GEE) platform for 2015-2018 period. GEE is a cloud-based platform that facilitates access to high-performance computing resources to handle very large geographic data sets. The results were compared and verified using meteorological data, riverbed flow data, and digital media news. The results showed that the most affected areas were consistent with the highest measured flow rates and the magnitude of flood damages caused by two main causes in the basin (i.e. opening of shutters in Bulgarian dams or local excessive rainfall) was very different (approximately 8 times larger) from each other.

Session

Posters: Interactive Session

Time:

Wednesday, 04/Sep/2019:
4:00pm - 5:30pm

Session Chair: **Tullio Joseph Tanzi**
Session Chair: **Madhu Chandra**

Presentations

Land-cover Maps using Multiple Classifier System for Post-disaster Landscape Monitoring

Hidetake Hirayama[1], Mizuki Tomita[2], Ram C Sharma[2], Keitarou Hara[2]

[1]Graduate School of Tokyo University of Information Sciences, Japan; [2]Department of Informatics, Tokyo University of Information Sciences, Japan; h17002hh@edu.tuis.ac.jp

Recently, land cover maps created from high resolution satellite images have been used for landscape analysis, in order to understand the impact of natural disasters on biodiversity and ecosystems. Conventional land cover classification methods, however, suffer from problems with isolated pixels (salt and pepper effect). Filtering can remove the isolated pixels, but can also result in loss of accurate information. The purpose of this study is to create a land cover map for landscape analysis of large-scale disturbances caused by the Great East Japan Earthquake of 2011, utilizing a Multiple Classifier System (MCS), which allows for reduction of isolated pixels while maintaining classification accuracy. RapidEye satellite images covering the Pacific Ocean side of the Tohoku district damaged by the earthquake and subsequent tsunami were obtained for 2010, 2011, 2012 and 2016, and land cover classification was implemented using individual classifiers and the MCS method. The results showed that the MCS land cover map was able to reduce the number of isolated pixels significantly (61-71%) compared with the individual classifiers, while maintaining very high accuracy (0.976-0.986) for all four years. These results indicate that MCS land cover maps have a great potential for analyzing disturbances following infrequent large-scale natural disasters such as earthquakes and tsunami, and for monitoring the process of recovery afterwards. We expect that the results of this research will be useful in managing the recovery process in the region disturbed by the Great Eastern Japan Earthquake and Tsunami of 2011, and also for developing future Ecosystem-based Disaster Risk Reduction programs for the region.

A WEB PLATFORM FOR CRISIS MANAGEMENT BASED ON VOLUNTARY DATA AND FREE TOOLS IN CASE OF NATURAL DISASTER

Mohammed Amine HAFID, Bouhadjar Meguenni

Center of space techniques, Algeria; hafid92002@yahoo.fr

Disasters often result serious human and material damage. In the last two decades, Algeria has recorded over a dozen natural disasters between earthquakes and floods that hit the country, especially between 1994 and 2009, causing 3457 deaths and extensive damage estimated at about 211 million dollars, including Boumerdes City region following the earthquake on the May 21st, 2003.

An effective intervention of emergency based on good management of resources such as road, can limit the damage in practice. The road network can be easily damaged by a natural disaster which makes it partially or completely unusable. Also, it would be crucial to quickly map the most affected areas and associate them with a list of the necessary aids, or even indicate the places probably in danger to ensure the safety of the nearby population.

Currently, web mapping and especially voluntary web mapping (such as the famous OpenStreetMap) are presented as a key tool for the management of crisis response teams, thanks to their mobility and simplicity for the wider public, the latter can play a vital role in creating and sharing real-time data from disaster areas to better manage emergency services. A web platform will allow the contribution of anyone wishing to provide support from its location using mobile devices, and enrich the crisis cells with the largest amount of geospatial information.

Our work consists of implementing a web platform based on free tools and existing data. This platform will be accessible in case of natural disaster by everyone in order to supply its database. A global methodology for structuring and the implementing will be presented and discussed.

Modelling changes in accessibility and spatial mobility accompanying an occurrence of a natural disaster: the context of private car transport

Marta Borowska-Stefańska, Michał Kowalski, Szymon Wiśniewski

Institute of the Built Environment and Spatial Policy, University of Łódź; szymon.wisniewski@geo.uni.lodz.pl

The poster presents results of research into changes in accessibility as well as the size and spatial structure of changes in the traffic volume on the regional road network resulting from an occurrence of a flood in the water region of the Warta in Poland. An analysis of accessibility consists in showing changes in isochrone accessibility which was researched with the use of the author's independent travel speed models based, in the first place, on population density, the degree of development and the number of intersections (affecting the level of service). Secondly, the study accounted for speeds which are a result of the model of traffic distribution on the road network. The analysis of changes in traffic distribution was accomplished on the basis of macroscopic modelling (with Visum software), using the national traffic model. Both analyses are conducted on the author's independent model of the road network (comprising nearly 30 types of road sections) which was formed through superimposing information from the Open Street Map, the Database of Topographic Objects and the numerical land cover model. As it is shown by research results, analyses concerning the aforementioned phenomena should be included in the processes of flood risk management as their good recognition will contribute to an improvement in traffic control and organization as well as it will streamline the activities of rescue services and evacuated inhabitants. The work was accomplished as a result of performing the research project entitled "Changes in theoretical transport accessibility and load of the road network resulting from a flood on the territory of Poland" (ref. no. 2018/29/B/HS4/01020) financed by the National Science Centre.

Geospatial Model for large scale sea cliff rockfall susceptibility mapping

Paula Redweik[1], Rita Matildes[2], Fernando Marques[1]
[1]Faculdade de Ciências, Instituto Dom Luiz, Universidade de Lisboa; [2]Centre of History, School of Arts and Humanities, University of Lisbon; pmredweik@fc.ul.pt

Due to their relevance for the environment and the economy, coastal areas are considered national strategic segments which should be preserved. Since erosion phenomena occur intensively in those areas, it is capital to monitor them in order to identify risk zones. In addition to national and regional studies, it is also necessary to conduct local monitoring of areas prone to erosion, especially those which are often frequented by people, such as beaches limited by high cliffs. Large scale vertical mapping is necessary for these areas to model their susceptibility to mass movements, such as rock falls, in order to provide adequate prevention, protection and assistance.

Recent techniques like laserscanning or aerial photogrammetry using imagery captured from UAVs allow the definition of the status quo of a cliff wall and its situation a few years back. But to assess the susceptibility to rock mass movements in such cliff segments, inventories of past mass movements events are of primordial importance. These inventories allow applying several statistic models to better understand susceptibility together with a set of variables of internal and external nature regarding the cliff site.

We present a case study focused on the beach of Ribeira de Ilhas (Mafra, Portugal), where a workflow of terrestrial photogrammetry for present day situation and recovery of old analogue stereoscopic pairs (1999, 2000 and 2003), registry of mass movement inventory (from 1999 to 2014) by multitemporal comparison and characterization of the cliff using a GIS software, and application of the logistic regression method allowed the definition of a susceptibility map of the cliff wall towards mass movements.

Beach litter detection and monitoring using UAV image and Deep Neural Network

Suho Bak, Dohyun Hwang, Heungmin Kim, Hongjoo Yoon
Pukyong National University, Korea, Republic of (South Korea); shbak91@pukyong.ac.kr

Beach litter destroys marine ecosystems and creates aesthetic discomfort that lowers the value of the beach. In order to solve this beach litter problem, it is necessary to study the generation and distribution pattern of waste and the cause of the inflow. However, the data for the study are only sample data collected in some areas of the beach. Also, most of the data covers only the total amount of Beach litter. UAV(Unmanned Aerial Vehicle) and Deep Neural Network can be effectively used to detect and monitor beach litter. Using UAV, it is possible to easily survey the entire beach. The Deep Neural Network can also identify the type of coastal litter. Therefore, using UAV and Deep Neural Network, it is possible to acquire spatial information by type of beach litter. This paper proposes a Beach litter detection algorithm based on UAV and Deep Neural Network and a Beach litter monitoring process using it. It also offers optimal shooting altitude and film duplication to detect small beach litter such as plastic bottles and styrofoam pieces found on the beach. In this study, DJI Mavic 2 Pro was used. The camera on the UAV is a 1-inch CMOS with a resolution of 20MP. The images obtained through UAV are produced as orthoimages and input into a pre-trained neural network algorithm. The Deep Neural Network used for Beach litter detection removed the Fully Connected Layer from the Convolutional Neural Network for semantic segmentation.

The impact of flooding on the functioning of road network

Marta Borowska-Stefańska, Michał Kowalski, Szymon Wiśniewski
University of Łódź, Faculty of Geographical Sciences, Institute of the Built Environment and Spatial Policy, Poland; marta.borowska@geo.uni.lodz.pl

The poster presents results of research into assessing the impact of a flood occurrence in one of regions of Poland on transport accessibility from the time perspective in three spatial scopes of analysis: national, regional and local. In order to achieve the research aim defined in this way, the authors used methods of accessibility assessment referring to distance measurements as well as the isochrone and cumulative approach. The volume of changes to accessibility are expressed, for instance, by means of area development analysis available in the given flood-free time periods and during floods. The results are presented in the cartographic and tabular form as well as by means of histograms showing dependencies of travel time in normal conditions and its changes resulting from inundating the area by flood. The analysis points to considerable spatial differentiation of changes in time accessibility resulting from the necessity to bypass areas struck by a natural disaster both on individual spatial levels of the research and between them. The impact of flooding on travel time also clearly differs, depending on the length of theoretical journeys. This poster was created as a result of the research project No. 2018/29/B/HS4/01020 financed from the funds of the National Science Centre.

Spatial distribution of felt intensities for Portugal earthquakes

Cristina Catita[1,2], Paula Teves-Costa[1,2], Luis Matias[1,2], Josep Batlló[3]
[1]Instituto Dom Luiz, Lisbon, Portugal; [2]Faculty of Sciences of University of Lisbon, Portugal; [3]IInstitut Cartogràfic i Geològic de Catalunya, Barcelona, Spain; cmcatita@fc.ul.pt

Macroseismic intensity is a parameter of the severity of ground movement evaluated in terms of the effects that earthquakes produce on people, buildings and the environment, constituting an extremely important information source for the seismologist and engineer of structures. In recent studies, the authors of this study published a new map of maximum intensities observed for continental Portugal considering all observations of macro-seismic intensity higher than III relative to earthquakes occurred between 1344 and 2015 (Teves-Costa et al., 2019). In each parish and municipality of the continental part of the country, the maximum values of intensity were defined. A map of maximum intensities produced in this way was essentially controlled by earthquakes of greater intensity, the 1909.04.23 (near-field) and 1755.11.01 (far-field) earthquakes. In the present work, a spatial distribution of the earthquakes presents in the database (classified by their nature - near-field or far-field - intensity, and epoch) are analysed. The spatial structure, which allows the detection of spatial dependence or autocorrelation of intensity values in the administrative units of the territory is also explored in this work, in order to identify regions with similar macroseismic characteristics. The combination of the map of maximum intensities and the products generated in this work are essential for the authorities as a base of support in the definition of joint adaptation strategies for the various regions of the territory, as well as contribute to a better management of the emergency system in Portugal.

Combining social media and authoritative data for crisis mapping: a case study of a wildfire reaching Croatian city of Split

Marina Tavra[1], Ivan Racetin[2], Ana Kuveždić Divjak[3]
[1]Faculty of Civil Engineering, Architecture and Geodesy, University of Split, Croatia; [2]Faculty of Civil Engineering, Architecture and Geodesy, University of Split, Croatia; [3]Faculty of Geodesy, University of Zagreb, Croatia; mtavra@gradst.hr

Under climate changes, wildfire breakouts get more frequent and difficult to control. In the mid-July 2017, the wildfire spread from wildland to the city of Split, the second-largest city in Croatia. This unpredictable spread almost caused the collapse of rescue systems. Fortunately, a greater tragedy was avoided with the composure of the responsible services and the help of the citizens. The citizens helped in extinguishing the fire and timely publicised the significant amount of disaster-related information on different platforms and through social media.

In this paper, we address the problem of identifying useful Volunteered Geographic Information (VGI), georeferenced social media, for improving situation awareness during the wildfire reaching the Croatian city of Split. Additionally, we combine social media with other external data sources (e. g. Sentinel-2 satellite images) and authoritative data (e.g. Croatian National Protection and Rescue Directorate official data and Public Fire Department of Split data) to establish the geographical relations between the wildfire phenomena and social media messages. In this manner, we seek to leverage the existing knowledge and data about the spatiotemporal characteristics of the Split wildfire in order to improve the identification of useful information from georeferenced social media with other integrated data sources that can be valuable for improving situation awareness in wildfire events.

Effects of aerosols on the Korean Peninsula Caused by Fireworks in China during Chinese Lunar New Year

Kwanchul Kim, Jung Ok Kim
AICT(Advanced Institutes of Convergence Technology), Korea, Republic of (South Korea); fehouse@snu.ac.kr

This study investigated the effects of fireworks using aerosol optical depth (AOD) and aerosol optical properties (AOP) from Terra/Moderate Resolution Imaging Spectroradiometer (MODIS) and Sunphotometer, and PM data were observed in Gwangju, South Korea and Shanghai, China. During the Lunar New Year period in 2014, the PM2.5 concentration by fireworks in Shanghai showed the highest concentration on the day of Lunar New Year, and air pollutants of longrange transport by fireworks were affected the increase of PM10 concentration and aerosol optical depth over the Korean peninsula). These results show that the effect of fireworks, which was recognized as a local air pollution problem, can be transported to the Korean peninsula from China. The results of this study can be very useful for monitoring the atmosphere by firework effect over the Korean Peninsula.

Evaluation of selected machine learning techniques in vineyard disease detection

Jonáš Hruška[2], Telmo Adão[1,2], Luís Pádua[2], Nathalie Santos[2], Emanuel Peres[1,2], Raul Morais[1,2], Joaquim João Sousa[1,2]
[1]Institute for Systems and Computer Engineering, Technology and Science (INESC-TEC, Formerly INESC Porto), 4200-465 Porto, Portugal; [2]Department of Engineering, School of Sciences and Technology, University of Trás-os-Montes e Alto Douro, 5000-801 Vila Real, Portugal; telmoadao@utad.pt

Vine culture is influenced by many factors, such as the weather, soil or topography, which are triggers to phytosanitary issues. Among them are some diseases, that are responsible for major economic losses that can, however, be managed with timely interventions in the field, viable of leading to effective results by preventing damage propagation. While not all symptoms might present a visible evidence, hyperspectral sensors can tackle this aspect with their ability for measuring hundreds of continuously sparse bands that range beyond the eye-perceptible spectrum. Having such research line in mind in this work, a hyperspectral sensor was applied to analyse the spectral status of vine leaves samples, collected in three chronologically distinct campaigns, while costly and destructive laboratory methods were used to track Flavescence Dorée (FD) in the same samples, for a ground truth information. Regarding data processing, machine learning approaches were used, in which several classifiers were selected to detect FD in vine leaves hyperspectral images. The goal was to evaluate and find most suitable classifier for this task.

Wildfire Damage Assessment Using Multi-temporal Sentinel-2 Data

Minkyung Chung, Minyoung Jung, Yongil Kim
Seoul National University, Korea, Republic of (South Korea); mkjung4876@snu.ac.kr

Recently, the drastic climate changes have increased the importance of wildfire monitoring and damage assessment as well as the possibility of wildfire occurrence. Estimation of wildfire damage provides the information on wildfire-induced ecological changes and supports the decision-making process for post-fire treatment activities. For accurate wildfire damage assessment, the discrimination between disaster-induced and natural changes is crucial because they usually coupled together.

In this study, Sentinel-2 images were employed to assess the damage from a wildfire, which occurred in the coniferous forest of Gangneung, Gangwon Province, South Korea on April 2019. The images were captured from both Sentinel-2A and -2B, shortening the temporal interval of available pre- and post-fire images. Multi-temporal image analysis was performed in both object and pixel-based with two commonly used spectral indices, NDVI and NBR. Additional image pair from the same period of 2018 was used to distinguish the fire-affected regions from the naturally changed area and compared with the results from using only one pair of images from 2019. The experimental results showed that the change detection performance could be affected by the number of image pairs and spectral indices used to discriminate burned region from unburned region. Thus it verified the significance of adequately employing annual multi-pair satellite images for wildfire damage assessment.

HIGHLY DISCRETE MAPPING OF THE GROWING SEASON TIME FRAMES AND TIME DYNAMICS

Ivan Rykin[1], Alyona Shagnieva[1], Evgeny Panidi[1], Valery Tsepelev[2]

[1]Saint Petersburg State University, St. Petersburg, Russia; [2]Russian State Hydrometeorological University, St. Petersburg, Russia; panidi@ya.ru

Growing season time frames can be estimated and mapped using the vegetation indexes mapping and analysis. This approach brings significant benefit consisted in the ability of detailed (highly discrete in the meaning of spatial resolution) mapping of spatial differences in growing season stage and length. In comparison with interpolation of ground air temperature (applied when using temperature to detect growing seasons), real spatial resolution raises to kilometers per pixel and higher, while nodes of ground observation network can be spaced by thousands of kilometers in some regions. Our ongoing study is devoted to design a processing chain for mapping of growing season time frames basing on vegetation indexes data with close-to-one-day time resolution. We used MOD09GA dataset as an initial data. Data processing was implemented in Google Earth Engine big geospatial data platform.

Evaluation of Water Pollution with Remote Sensing

Petr Šádek, Juraj Struhár

VSB - TU Ostrava, Czech Republic; juraj.struhar@vsb.cz

With the growing population, there is a growing demand for quality drinking water. Especially in developing parts of the world, this is a serious problem. The aim of this work is to test remote sensing methods for water quality monitoring. The presented part of the project is focused on introducing the process of water pollution assessment using vegetation indices, which are derived only using RGB images. Water quality monitoring is based on satellite imagery Landsat 8 and UAV images Phantom 3. As reference data was used in-site measurements in profiles points. In-site measurements were repeated every month in the vegetation period from April to September. Based on regression analysis, the equation for the calculation of the amount of chlorophyll and the statistical evaluation of the quality of these equations is derived for each vegetation index. The best results were achieved using the ratio aquatic vegetation index (RAVI) and ExG (Excess green) indices of 97% and 96.8% respectively.

ARTIFICIAL INTELLIGENCE AND GEOSPATIAL ANALYSIS IN DISASTER MANAGEMENT

Majda Ivić

Faculty of Civil Engineering, Architecture and Geodesy, University of Split, Croatia; mivic@gradst.hr

For quick and efficient response, as well as for recovery after any natural or artificial catastrophe, one of the most important things are accurate and reliable spatial data in real or near real-time. It is essential to know the location as well as to track and analyse passive and active threats to quickly identify the possible dangers and hazards. As technology evolves and advances, there is a broader spectrum of sensors that provide spatial data, and nowadays, decision-making processes also include non-traditional, informal sources of information. Apart from the offer, demand for new spatial data is increasing as well. For quicker and enhanced integration and analysis of data, artificial intelligence (AI) tools are increasingly used which, in addition to immediate rapid reactions, can help to make better and smarter decisions in the future. Such software algorithms that imitate human intelligence can help in generating conclusions from natural phenomena presented by spatial data. Using AI in the data analysis can identify risk areas and determine future needs. This paper presents an overview of the use of AI in geospatial analysis in disaster management.

Detection of structure defects in dark places based on the point cloud analysis by OptD method

Wioleta Błaszczak-Bąk[1], Czesław Suchocki[2], Andrzej Dumalski[1], Robert Duchnowski[1], Joanna Janicka[1]

[1]University of Warmia and Mazury in Olsztyn, Faculty of Geodesy, Geospatial and Civil Engineering, Poland; [2]Koszalin University of Technology, Faculty of Civil Engineering Environmental and Geodetic Sciences, Poland; wioleta.blaszczak@uwm.edu.pl

Data provided by Light Detection And Ranging (LiDAR) can be very useful, and their applications are very diverse. Information about the reflection, its intensity values of individual points give the possibility of a realistic visualization of the entire scanned object. This use of LiDAR is very important in improving safety and avoiding disasters. The use of LiDAR technology allows to 'look' and extract information about the structure of the object without the need for external lighting or daylight. In the paper the results of Terrestrial Laser Scanning (TLS) measurements conducted by means of the Leica C-10 scanner will be presented. The measurement will be performed in rooms without daylight: in the basement of the ruins of the medieval tower located in Dobre Miasto and in the basement of a century-old building located at the University of Warmia and Mazury in Olsztyn. Next, the obtained dataset of x, y, z and intensity will be processed using the Optimum Dataset (OptD) method. The application of the OptD allows to keep more points of interest area where surface is imperfect (e.g. cracks and cavities) and reduce more points of the low interest homogeneous surface (redundant information). The OptD algorithm was additionally modified by detecting and segmentation defects on a scale from 0 to 3 such as (0) harmless, (1) to the inventory, (2) requiring repair, (3) dangerous. The obtained survey results proved the high effectiveness of the modified OptD method in detection and segmentation wall defects.

The use of the RoadLoad application in geographical studies of flows generated by individual modes of transport

Michał Kowalski, Marta Borowska-Stefanska, Szymon Wiśniewski

University of Lodz, Poland; marta.borowska@geo.uni.lodz.pl

The purpose of this article is to present the authors' own software for predicting changes in the density and directions of traffic flows, and to compare overall results of research on transport accessibility with the results returned in the study of transport accessibility conducted with the software (isochronic accessibility). Additionally, initial specifications entered into the application were stress tested and solutions to break the methodological impasse were indicated. Developed for research purposes, the authors' application is based on Dijkstra's algorithm, which is classified as one of the greedy ones and does not always return optimum results, even though it is considered to be generally accurate.

Nevertheless, the solution was applied since, to the best of the authors' (geographers and planners) knowledge, there has not been a more effective algorithm developed, so far, to solve problems in the graph and to serve more efficiently databases used in a broad spatial spectrum of transport studies, conducted by means of the commonly applied hardware. In the course of the research, it was stated that the implementation of Dijkstra's algorithm in the RoadLoad tool is suitable for studying and prognosing phenomena, under the assumption that there is detailed data on the point of departure and destination for each trip. The tool enables us to research a spatial (cumulated values of network load) as well as time-spatial (network load at virtually any time) dimension of the phenomenon. It cannot be applied, however, without knowledge of the transport behaviour characteristics for the users of the road system. And in the case of research based on imprecise information regarding points of departure and destinations (e.g., grounded on aggregated data on territorial units), the presented tool may reflect reality under the strict condition that the initial specifications have been properly formulated.

Assessing OpenStreetMap Urban network of Oran city

Bouhadjar MEGUENNI, Mohamed Amine Hafid

Centre des Techniques Spatiales, Arzew, Algeria; bmeguenni@cts.asal.dz

OpenStreetMap (OSM) is an open-license spatial database, it is a collaborative project that collects a rich set of vector data provided by volunteers. it is a collection of map data at global scale which can be used for many different purposes. Numerous third-party online maps are based on OpenStreetMap data. Nowadays, more and more major organizations are choosing OSM for their maps.

Furthermore, the analysis of the spatial quality of the OSM data shows that it takes special care should be taken. However, there are several methods to assess OSM data quality by comparing OSM with authoritative dataset. in this context, develop an automatic procedure for improving its spatial quality is essential.

This work proposes a quantitative method for quality comparison of OSM and an authoritative dataset Urban Network data of Oran city (Algeria). The procedure is based on python modules in GIS environment and provides measures of OSM road network spatial accuracy and completeness.

The method is applied to assess the quality of Oran OSM road network dataset through a comparison against the Algerian official dataset provided by the Algerian National Institute of Cartography and Remote Sensing (INCT).

The results show that the Algerian OSM road network has a high completeness, but a poor spatial accuracy.

In addition, the study presents the intrinsic quality of the Oran OSM street networks in terms of completeness, positional accuracy, attribute accuracy and lineage.

Pre- and Post-Storm LiDAR Surveys for Assessment of Impact on Coastal Erosion

Anne-Lise Montreuil[1], Margaret Chen[1], Esquerré Alexis[1], Houthuys Rik[2], Moelans Robrecht[2], Bogaert Patrick[3]

[1]VUB, Belgium; [2]VITO, Belgium; [3]UCL, Belgium; anne-lise.montreuil@vub.be

Sustainable management of the coastal resources requires a better understanding of the processes that drive coastline change. The coastline is a highly dynamic sea-terrestrial interface. It is affected by forcing factors such as water levels, waves, winds, and the highest and most severe changes occur during storm surges. Extreme storms are drivers responsible for rapid and sometimes dramatic changes of the coastline. The consequences of the impacts from these events entail a broad range of social, economic and natural resource considerations from threats to humans, infrastructure and habitats. This study investigates the impact of a severe storm on coastline response on a sandy multi-barred beach at the Belgian coast. Airborne LiDAR surveys acquired pre- and post-storm covering an area larger than 1 000 000m^2 were analyzed and reproducible monitoring solutions adapted to assess beach morphological change was applied. Results indicated that the coastline retreated by a maximum of 14.7m where the embryo dunes in front of the fixed dunes had vanished. Storm surge and wave attacks were probably the most energetic there. However, the coastline response was spatially variable. Based on the extracted beach features, good correlations ($r>0.73$) were found between coastline, berm and inner intertidal bar morphology, while it was weak with the most seaward bars covered in the surveys. This highlights the role of the upper features on the beach to protect the coastline from storm erosion by reducing wave energy. The findings are of critical importance in improving our knowledge and forecasting of coastline response to storms, and also in being translated into management practices.

Session

Plenary: Plenary Session

Time:
Thursday, 05/Sep/2019:
9:00am - 10:30am

Location: **Balling's Hall**

Session Chair: **Madhu Chandra**
Session Chair: **Tullio Joseph Tanzi**

Presentations

Disaster Risk Reduction Challenges for ICA and ISPRS Research Agenda – Synergy and Cooperation

Milan Konečný
Masaryk university in Brno; konecny@geogr.muni.cz

United Nations Disaster Risk Reduction Conference in Sendai, Japan (2015) defined four new necessary priorities of action for improvement management of risks and disasters in 4 points: 1:Understanding disaster risk;2:Strengthening disaster risk governance to manage disaster risk;3:Investing in disaster risk reduction for resilience;4: Enhancing disaster preparedness for effective response and to “Build Back Better” inrecovery, rehabilitation and reconstruction.

ICA and ISPRS have enormous research, scientific and as well as application potentials based on newest information and communication technologies to realize above mentioned topics and improve all process of early warning, disaster risk management and new wider concept of Disaster Risk Reduction. Both professional organizations (followed later also by FIG) developed from 2004 resp. 2005 concept and methodologies to create new smart solutions of DRR. They are also part of U.N. GGIM efforts and core activities strengtheningthe GlobalData Ecosystem. U.N. GGIM is an umbrella above all important world activities of GEO, GEOSS, COPERNICUS, INSPIRE and others. Similar intention has International Society of Digital Earth initiative Digital Belt and Road Program (DBAR).

Speaker will observe potentials of deeper cooperation of ISPRS, which is producing, elaborating and dealing with Big Data, and ICA which has knowledge and ambitions to prepare Big Data for delivering to inhabitants of all ages, decision-makers and scientists by modern and attractive visualization way. Till now, development of DRR solutions is going on more separately than combined and coordinated. The speaker will highlight some items of better cooperation and give also several practical examples.

Possible contribution of geo-information technologies to prediction of run out distances of landslides

Candan GÖKÇEOĞLU
Hacettepe Üniversitesi, Turkey; cgokce@hacettepe.edu.tr

Pressure on nature has been increasing with human population growth and climate change. One of the most typical results of this pressure is the rise in losses sourced from landslides. Although serious success on regional landslide susceptibility assessment has been achieved, the assessment of the risks remains a challenging problem. Two fundamental difficulties must be overcome to obtain a plausible regional landslide risk assessment and its map. One of these difficulties is to obtain the time of occurrence while the other one is the determination of run out distance. Prediction of time of occurrence depends on intrinsic characteristics of slope-forming material, magnitude and intensity of triggering events. Additionally, threshold values of triggering events must be known. Some empirical and analytical approaches for prediction of time of landslide occurrence have been investigated and reasonable results have been obtained. However, prediction of run out is a more complex problem because run out distance depends on not only intrinsic characteristics of slope-forming material but also topography, season, surface water bodies, land use and land cover, etc. In addition, due to large extension of displaced material, it is very difficult to describe the run out by field observations. For this reason, the use of geo-information technologies for determination of run out distance may open a great horizon for landslide risk assessments.

Considering the increasing variety and possibilities in sensor and platform technologies for Earth observation coupled with photogrammetry and geospatial analysis methods, it can be said that the complexity of the run-out distance determination problem can be improved by employing:

- geodata obtained with high spatial resolution and temporal frequency from airborne and spaceborne platforms as well as volunteer contributions;
- fusion methods for multi-temporal and multi-sensor data;
- automated feature extraction methods;
- automatic 3D reconstruction, matching, and spatiotemporal analysis of dense digital terrain and surface models;
- prediction of future risks by utilizing multi-temporal data and machine learning algorithms;
- additional human interpretation through 3D visualization environments.

Accurate determination of amount of displaced material and run out distances are extremely important for empirical and analytical solutions of this problem. Additionally, these solutions may help for producing robust regional risk assessments. Consequently, in this comprehensive review, the difficulties and uncertainties encountered during regional landslide risk assessment studies are given and possible contributions of geo-information technologies to eliminate these problems are discussed.

Next generation Radar Remote Sensing: Hype versus Reality

Madhu Chandra
Chemnitz University of Technology; madhu.chandra@etit.tu-chemnitz.de

The keynote speech is dedicated to various radar techniques in disaster and risk reduction applications of the next generation.

Session

TS II Parallel: Technical Session Topics: RS and GIS as Tools of Natural and Man-Made Disaster Management & Disaster Management & Capacity Building in Disaster Monitoring & New Approaches in Disaster Management Like Societal Science & Use of Small Satellites and Drones

Time:
Thursday, 05/Sep/2019:
11:00am - 12:30pm

Session Chair: **Orhan Altan**

Presentations

EFFICIENCY IMPROVEMENT OF BRIDGE MAINTENANCE AND INSPECTION BY AN UNMANNED AERIAL VEHICLE

Jung Ok Kim[1], Jae Kang Lee[2], Kwanchul Kim[1]
[1]AICT(Advanced Institute of Convergence Technology), Suwon, Republic of Korea (South Korea); [2]KICT (Korea Institute of Civil Engineering and Building Technology), Goyang, Republic of Korea (South Korea); jaekang.lee@kict.re.kr

The economic development and infrastructure of a nation are closely interrelated. In addition, public trust in national infrastructure facilities is closely linked to the preservation of the advantages provided by these facilities to the public. Current maintenance works face certain limitations caused by various reasons: insufficient budget, increasing number of infrastructure facilities requiring maintenance, shortage of manpower, and rapidly increasing number of aging infrastructure facilities. To overcome these limitations, a new approach is required that is different from manual inspection methods under the existing rules and regulations. In this context, this study aimed to explore the efficiency of bridge inspection and maintenance by Unmanned Aerial Vehicles (UAVs) that could observe inaccessible areas, could be conveniently and easily controlled, and could offer high economic benefits. For which, various tests were performed on elevated bridges, and suitable UAV images were obtained. The obtained UAV images were inspected by using machine vision technology, thereby excluding subjective evaluations by humans. Methods for enhancing the objectivity of the inspection were also discussed. The test results showed that both the efficiency and objectivity of the proposed UAV-based method were better efficient than those of the existing bridge maintenance and inspection methods.

Usage of Geodata and Virtual Reality in the Modern Situation Visualization

Boris Wagner
Fraunhofer IOSB, Germany; boris.wagner@iosb.fraunhofer.de

When a crisis arises, geographically referenced data is helpful in dealing with the situation. A map can provide a link between available data and stakeholders. It allows all participants to obtain an understandable model of the situation. For crisis management, hawse have developed an integrated system with an emphasis on ergonomics and data fusion. Visualization and interaction are tailored towards specific responsibilities as well as towards different devices such as smartphones, desktops and large displays.

In addition to commonly available 2D geodata, highly accurate and up-to-date 3D geodata becomes more readily available. 3D geodata displayed on normal display devices, however, naturally lacks the third dimension. In order to gain a better understanding of the situation, we have added a virtual reality variant to its crisis management system. The VR environment allows meeting as a team, connecting local and remote participants, in the VR environment for a more efficient and natural discussion. In this VR meeting, all participants can work with the same geodata and annotations, providing a consistent view of the situation. To assess the additional value of 3D geodata and virtual reality visualization in this context, a user study was conducted comparing the performance using 2D geodata, 3D geodata and visualization in VR. The study provides insights into the task-specific value of 3D geodata and VR visualization.

Crowd4EMS: Crowdsourcing platform for gathering and geolocating social media content in disaster response.

Amudha Ravi Shankar[1], Jose Luis Fernandez Marquez[1], Barbara Pernici[2], Gabriele Scalia[2]
[1]University of Geneva, Switzerland; [2]Politecnico di Milano, Italy; amudha.ravishankar@unige.ch

Increase in access to mobile phone devices and social media networks has changed the way people report and respond to disasters. Community-driven initiatives such as Stand By Task Force (SBTF) or GISCorps have shown great potential by crowdsourcing the acquisition, analysis, and geolocation of social media data for disaster responders. These initiatives face two main challenges: (1) Most of social media content such as photos and videos are not geolocated, thus preventing the information to be used by emergency responders, and (2) they lack tools to manage volunteers' contributions and aggregate them in order to ensure high quality and reliable results.

This paper illustrates the use of a crowdsourcing platform that combines automatic methods for gathering information from social media and crowdsourcing techniques, in order to manage and aggregate volunteers' contributions. High precision geolocation is achieved by combining data mining techniques for estimating the location of photos and videos from social media, and crowdsourcing for the validation and/or improvement of the estimated location.

The evaluation of the proposed approach is carried out using data related to the Amatrice Earthquake in 2016, coming from Flickr, Twitter and Youtube. A common data set is analyzed and geolocated by both the volunteers using the proposed platform and a group of experts. Data quality and data reliability is assessed by comparing volunteers versus experts results. Final results are shown in a web map service providing a global view of the information social media provided about the Amatrice Earthquake event.

Challenges of Using Drones and Virtual/Augmented Reality for Disaster Risk Management

Dimiter Velev[1], Plamena Zlateva[2], Luydmila Steshina[3], Igor Petukhov[3]
[1]University of National and World Economy, Bulgaria; [2]Institute of Robotics, Bulgarian Academy of Sciences, Bulgaria; [3]Volga State University of Technology, Russian Federation; dgvelev@unwe.bg

Natural and man-made disasters can severely destroy environments and they make conditions difficult to access the affected areas and to provide assistance. The conditions on-site could be dangerous and unstable and there is an increasing need for life-saving decisions to be taken quickly to minimize evolving hazards and to start relief operations. The accurate and timely data gathering is important to produce a full information about the calamity.

In recent disasters drones are deployed extensively to help find people quickly, provide imminent reliable imagery and data by flying closer to the ground. They are used to create disaster maps and assess damage after earthquakes, landslides, hurricanes, etc.

The fast transition into the digital age makes new technologies become available to enhance and expand drone capabilities in disaster risk management, such as Virtual Reality (VR) and Augmented Reality (AR).

The paper tries to analyze how VR can be used to plan operations in a controlled manner before deadly events strike by creating disaster simulations in digital environments, enabling the rescuers to practice as many times as necessary until they are able to achieve mastery of the life-saving techniques.

The paper also analyzes how drones, equipped with cameras, devices and AR, can be used to create different types of maps that help rescuers locate critical spots. These can also facilitate the location of people in need, and can survey constructions to find critical damages.

A Fuzzy Logic Approach for Drone Capability Analysis on Disaster Risk Assessment

Plamena Zlateva[1,2], Stefan Hristozov[2], Dimiter Velev[3]

[1]Institute of Mathematics and Informatics - Bulgarian Academy of Sciences, Bulgaria; [2]Institute of Robotics - Bulgarian Academy of Sciences, Bulgaria; [3]University of National and World Economy, Bulgaria; plamzlateva@abv.bg

In recent years, there has been an increase in the number and strength of natural and man-made disasters worldwide. Therefore, the disaster risk assessment is becoming more and more relevant. Studies have shown that the drones can be successfully used in disaster risk assessment.

The purpose of the paper is to propose a fuzzy logic approach for drone capability analysis on disaster risk assessment. In particular, a fuzzy logic model is designed as a hierarchical system with several inputs and one output.

The system inputs corresponds to the linguistic variables, describing the of levels of the external and internal input factors, which determine the capability levels of analysed drone in respect to disaster risk assessment.

As external input factors are used, for example: disaster type (flood, landslide, wildfire); weather conditions (wind speed, fog, cloud cover); operational area (urban, mountain, plain), etc.

As internal input factors are considered the drone characteristics such as drone type, flight performance (stall speed, turn radius, flight endurance), payload capabilities (camera resolution, accuracy, weight, sensors), etc.

The fuzzy logic system output gives the level of the drone capability on disaster risk assessment in defined conditions.

The model is designed in *Matlab* computer environment using Fuzzy Logic Toolbox. Several computer simulations are carried out to validate the proposed model.

The designed fuzzy logic model is part of an information system for disaster risk management using drones, which is under development.

Session

TS II: Technical Session Topics: Remote Sensing and GIS as Tools of Natural and Man-Made Disaster Management & New Approaches in Disaster Management Like Societal Science

Time:
Thursday, 05/Sep/2019:
11:00am - 12:30pm

Session Chair: **Lena Halounova**

Presentations

ASSESSMENT OF LANDSLIDE-INDUCED MORPHOLOGY CHANGES USING AN OBJECT-BASED IMAGE ANALYSIS APPROACH: A CASE STUDY OF HÍTARDALUR, ICELAND

Zahra Dabiri, Daniel Hölbling, Lorena Abad, Dirk Tiede
Interfaculty Department of Geoinformatics - Z_GIS, University of Salzburg; zahra.dabiri@sbg.ac.at

On July 7, 2018, a large landslide occurred at the eastern slope of the Fagraskógarfjall Mountain in Hítardalur valley in West Iceland. The landslide dammed the river, led to the formation of a lake and, consequently, to a change in the river course. The main focus of this research is to develop a knowledge-based expert system using an object-based image analysis (OBIA) approach for identifying morphology changes caused by the Hítardalur landslide. We use synthetic aperture radar (SAR) and optical remote sensing data, in particular from Sentinel-1/2 for detection of the landslide and its effects on the river system. We extracted and classified the landslide area, the landslide-dammed lake, other lakes and the river course using intensity information from S1 and spectral information from S2 in the object-based framework. Future research will focus on further developing this approach to support mapping and monitoring of the spatio-temporal dynamics of surface morphology in an object-based framework by combining SAR and optical data. The results can reveal details on the applicability of different remote sensing data for the spatio-temporal investigation of landslides, landslide-induced river course changes and lake formation and lead to a better understanding of the impact of large landslides on river systems.

Integrated use of GIS, remote sensing data and a set of models for operational flood forecasting

Viacheslav Zelentsov, Semyon Potriasaev, Ilya Pimanov, Maria Ponomarenko
St. Petersburg Institute for Informatics and Automation, Russian Federation; pimen@list.ru

The research is aimed at the development and testing of the system for operational river flood forecasting. The system is based on the use of a complex of hydrological and hydrodynamic models, as well as in situ and satellite data integrated processing, and implemented on the basis of a service-oriented architecture. A distinctive feature of the system is the complete automation of the entire simulation cycle - from loading initial data to interpreting results, visualizing and alerting interested parties. The theoretical basis for ensuring the coordinated functioning of all system components is the qualimetry of models and polymodel complexes. The practical implementation is carried out using open codes, free software and GIS platform «RegionView».

All the complexity associated with the use of heterogeneous geographically distributed information resources is hidden from the user. This allows the system to be used not only by specialists in GIS, IT or relevant subject area, but also by other users interested in the results of flood monitoring and forecasting - emergency services, local authorities, commercial organizations and citizens.

The described technologies and the system of operational flood forecasting were tested in the Russian Federation on the Northern Dvina River, from the city of Velikiy Ustyug to the city of Kotlas in 2014-2019.

Given test results prove that the application of such an approach ensures full implementation of the required functionality of operational flood forecasting systems, the fulfilment of the basic requirements for such systems and also indicate the possibility of a widespread use of such systems authorities and emergency services.

The research described in this paper is supported by the Russian Science Foundation (project No. 17-11-01254).

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DEEP LEARNING-BASED ANALYSIS OF THE RELATIONSHIPS BETWEEN CLIMATE CHANGE AND CROP YIELD IN CHINA

SUBIN CHO, YANGWON LEE
Pukyong National University, Korea, Republic of (South Korea); chosb401@gmail.com

Climate change is an important factor in vegetation growth, and it is very significant to understand the relationship between climate change and rice yield. China is a food-importing country whose grain consumption is higher than grain production, and which relies on imports of rice,

soybean, wheat and other grains. Therefore, in order to secure food security for 1.6 billion people in China, it is necessary to grasp the relationship between climate change and rice yield. In this study, 16 administrative districts in China were selected and designated as study area. This study used annual rice production from the USDA (United States Department of Agriculture) for each of China's major administrative regions from 1979 to 2009, as well as average climate data from July to August, which were meteorological observations collected from the CRU (Climate Research Unit). Using this data, the rice crop was increased in 10 administrative regions in China and the reduction in rice harvest in 6 administrative areas was confirmed. The relationship between selected rice production and climate change was nonlinear and modelled using a deep neural network, and the validation statistics showed that the performance of DNN was 32-33% better than that of MLR (multiple linear regression). Therefore, a more quantitative analysis of the relationship between climate change and rice yield changes has been made possible through our prediction model. This study is expected to contribute to better food self-sufficiency in China and forecast future grain yields.

Can geoinformation help to better protect informal settlements - a concept for the city of Medellin

Wolfgang Dorner, Luis Ramirez Camargo, Peter Hofmann
Technische Hochschule Deggendorf, Germany; luis.ramirez-camargo@th-deg.de

New contributions to disaster research need to address the increasing vulnerability of informal settlements in a changing climate situation. Informal settlements are frequently built in hazardous areas and are often left out of traditional disaster risk management concepts. Hence, formal and informal societal structures, as well as technical systems to warn against, handle or mitigate natural hazards, need to evolve. Within the project Inform@Risk we are addressing these issues based on a case study in Medellín (Colombia). Here, as a result of civil conflicts informal dwellings were partly constructed by people displaced from rural areas. They are mainly located in the urban peripheral areas along steep and unstable slopes, where the resettlement of all inhabitants at risk of landslides is unfeasible. This contribution presents the technical infrastructure and the concept to incorporate geodata from different sources in an integrated landslide early warning system for some selected informal settlements of Medellin. Special attention is given to possibilities on how building societal institutions, supported by information systems, increases local resilience. Using geoformation as a basis, we will combine classical participatory planning methods with digitally assisted concepts. These include combining satellite and UAS based remote sensing data with terrestrial sensor networks, crowd sourcing and citizen science to collect volunteered geographic information about the settlement and its environmental parameters, as well as distribute this information and disseminate warnings to the local population.

AN ASSESSMENT OF LAND COVER CHANGE DYNAMICS OF GAJA CYCLONE IN COASTAL TAMIL NADU, INDIA USING SENTINEL 1 SAR DATASET

Nivedita Priyadarshini K, Sivashankari V, Sulochana Shekhar
Central University of Tamil Nadu, India; nivi.darshini@yahoo.com

Land cover change is a dynamic phenomenon addressing environmental issues including natural calamities. Recent advancements in the geospatial technology and availability of remote sensor data products have fostered monitoring and mapping of land cover changes more precisely. Remote sensing is widely used for several applications where emerging research findings are focused mainly on coastal hazard studies. As one third of world's total dwelling communities live along the coast, they are extremely prone to natural disasters like cyclones, flooding, storm surge, tsunamis etc which are very destructive causing disruption to lives and properties. Tropical cyclones being an extreme weather event are more powerful and hazardous to the southern parts of the Indian subcontinent. The aftermath of the cyclone is extreme causing land cover changes like defoliation, water logging, destruction of cultivable lands, plantations and shrub vegetation, dissolving salt pans etc. The coastline of Tamil Nadu, forms a major part of the Coromandel coast at the south eastern peninsula of India that extends to a length of about 1076 Km comprising around 15% of total coastal line length of India. Monsoons are the predominant wind systems of the Indian subcontinent. The north - east monsoon gives spells of heavy rainfall accompanied by tropical cyclones that emerge from the Bay of Bengal during the months of October and November. By mid October, the low pressure is shifted to the Bay of Bengal making the south – west monsoons to blow out from the mainland towards the sea. The retreating monsoons are off-shore dry winds. As they enter over the Bay of Bengal, they gather moisture and bring considerable rainfall. The north – east monsoon on the Coromandel Coast begins with storms and pours about 48% of rainfall to Tamil Nadu. The weather becomes unsettled and heavier squalls driving intense rainfall are identified. The tropical cyclones are fierce to devastate the coastal districts of Tamil Nadu and make it a prey to these cyclones. In this paper, an attempt has been made to assess the pre and post cyclonic land cover change by utilizing the potential microwave Synthetic Aperture Radar (SAR) dataset which is a growing technology. The present study portrays the occurrence of a severe cyclonic storm named 'Gaja' that was formed over the Bay of Bengal which hit Tamil Nadu on 15th of November 2018 causing high death toll and demolition. In general, cyclones are named for better communication between forecasters and the public. Various warning centers in south – east Asia provide names to the cyclones originating in the Indian ocean region. Likewise Gaja meaning 'a mighty elephant' in Sanskrit was coined by Sri Lanka. This furious cyclone developed as a mature cyclonic storm towards the coast of Tamil Nadu with a gusting wind speed of about 115 Kmph. The Indian Meteorological Department (IMD), a nodal agency for forecasting and publicizing warning has tracked the path of Gaja cyclone from time to time with respect to wind speed and intensity of rainfall in districts of Tamil Nadu. Gaja thrashed the southern coastal tracts namely Vedaranyam of Nagapattinam district, Thiruthuraipoondi and Muthepet of Thiruvarur district, Adirampattinam and Pattukottai of Thanjavur district; Tiruchirappalli, Pudukottai and Dindigul districts of continental location. The trail of Gaja cyclone had left the terrain devoid of vegetation particularly coconut, cashew, mango and plantain grove which were the prime source of economy of the affected victims. This paper focuses on the pre and post damage assessment provoked by the Gaja cyclone. For this analysis, a methodical procedure was followed by utilizing the Sentinel 1 SAR dataset processed by the European Space Agency (ESA). Due to obscured cloud cover, manipulation of optical sensor data was difficult and hence SAR data was opted for potential outcomes as radar energy penetrates clouds to detect land cover features apparently. The level – 1 Ground Range Detected (GRD) product operated at an Interferometric Wide (IW) swath mode with High Resolution (HR) and with the polarization options HH or VV or dual HH + HV or VV + VH is used. The acquired datasets for both pre and post cyclone studies are processed using Sentinel Application Platform (SNAP) that is designed specially for processing Sentinel data products. With the passage of the cyclonic movement, there will be a rapid change in vegetative and other land cover features that are analyzed using the SAR datasets. Preliminary data processing such as radiometric calibration, speckle filtering by incorporating 3*3 Lee filter are performed for the pre and post cyclone datasets. Further, using the dual polarization ratio a profile is set for the image to obtain the original color composite in order to collect training datasets for ease of classification. Vector data samples that are homogeneous in nature are obtained for applying supervised classification algorithm. The prominent classes that are visible and well defined in the SAR dataset are clustered to attain better classification accuracy. This paper incorporated Random Forest (RF) classifier approach for mapping land cover types as it reduces the variance among

the classes thus yielding accurate predictions. Results demonstrate that classified imagery using dual polarization SAR dataset outperforms well for RF classifier thus escalating the overall accuracy. Variation in land cover features are estimated and analyzed for further processing.

Session

TS III Parallel: Technical Session Topics: Disaster Management & Desertification and Land Degradation

Time:
Thursday, 05/Sep/2019:
2:00pm - 3:30pm

Session Chair: **Lena Halounova**

Presentations

Design of Application Architecture for 3D Safety Status Information Platform

Taehoon Kim[1], Junhee Youn[2], Dusik Kim[3], Woochul Choi[4]
[1]KICT, Korea, Republic of (South Korea); [2]KICT, Korea, Republic of (South Korea); [3]KICT, Korea, Republic of (South Korea); [4]KICT, Korea, Republic of (South Korea); kth@kict.re.kr

The Korean Government has executed the research project named “The development of spatial information-based high-reality contents provision technology for disaster management”. The goal of this project is to develop and verify a Safety Index Map and a 3D safety status information platform for spatial information based customized disaster management service. This paper deals with the disign of application architecture for spatial information based 3D safety state information platform. First, we analyzes the use cases of existing disaster management platform and the needs of business users. Second, based on the analyzed results, target facilities were selected and possible service scenarios were created. Finally, we design application architecture with service development strategy and users’ requirements. The results of this research could be used for detail design of technical architectures (DA/SA/HA/NA).

Multi-purpose chestnut trees fruit detection using deep learning

Telmo Adão[1,2], Luís Pádua[2], Jonáš Hruška[2], António Sousa[1,2], Joaquim João Sousa[1,2], Raul Morais[1,2], Emanuel Peres[1,2]
[1]Institute for Systems and Computer Engineering, Technology and Science (INESC-TEC, Formerly INESC Porto), 4200-465 Porto, Portugal; [2]Department of Engineering, School of Sciences and Technology, University of Trás-os-Montes e Alto Douro, 5000-801 Vila Real, Portugal; telmoadao@utad.pt

In the early 1980’s, the European chestnut tree (Castanea sativa, Mill.) assumed an important role in the Portuguese economy. Currently, the Trás-os-Montes region (Northeast of Portugal) concentrates the highest chestnuts production in Portugal, representing the major source of income in the region (€50M-€60M). The recognition of the quality of the Portuguese chestnut varieties has increasing the international demand for both industry and consumer-grade segments. As result, chestnut cultivation intensification has been witnessed, in such a way that widely disseminated monoculture practices are currently increasing environmental disaster risks. Depending on the dynamics of the location of interest, monocultures may lead to desertification and soil degradation even if it encompasses multiple causes and a whole range of consequences or impacts. In Trás-os-Montes, despite the strong increase in the cultivation area, phytosanitary problems, such as the chestnut ink disease (Phytophthora cinnamomi) and the chestnut blight (Cryphonectria parasitica), along with other threats, e.g. chestnut gall wasp (Dryocosmus kuriphilus) and nutritional deficiencies, are responsible for a significant decline of chestnut trees, with a real impact on production. The intensification of inappropriate agricultural practices also favours the onset of phytosanitary problems. Moreover, chestnut trees management and monitoring generally rely on in-field time-consuming and laborious observation campaigns. To mitigate the associated risks, it is crucial to establish an effective management and monitoring process to ensure crop cultivation sustainability, preventing at the same time risks of desertification and land degradation.
Therefore, this study presents an automatic method that allows to perform chestnut clusters identification, a key-enabling task towards the achievement of important goals such as production estimation and multi-temporal crop evaluation. The proposed methodology consists in the use of Convolutional Neural Networks (CNNs) to classify and segment the chestnut fruits, considering a small dataset acquired based on digital terrestrial camera.

A Comparative Assessment of Cartographic Symbol Sets for Crisis Mapping

Ana Kuveždić Divjak, Boško Pribičević, Almin Đapo
Faculty of Geodesy, University of Zagreb, Croatia; akuvezdic@geof.hr

Cartographic symbols on crisis maps serve as the means of depicting information about the position, properties, and/or numerical values of objects, phenomena or actions specific to crisis mapping. The aim of symbology for many crisis cartographic visualisations are simple, clear, aesthetically pleasing symbols that can be easily used and understood by a wide range of crisis map users. If they are incomprehensible, illegible, ambiguous, unclassified, and random, if they lack hierarchical organisation and other characteristics which are important when designing a cartographic symbol set, they can fail to deliver the intended message. In addition to effective graphic design, cartographic symbol sets for crisis mapping are facing additional challenges, including consideration of their availability (sharing and promotion, dissemination and promulgation) and standardisation (ensuring the general and repeatable use of map symbols). To determine the extent of these challenges and to assess the current state of the cartographic symbology for crisis mapping we have compiled and compared the prominent examples of symbol sets that were promoted in the cartographic scientific and crisis mapping community in recent years. We pay particular attention to those sets that have gone through a new, reviewed or extended edition. We research whether the latest changes incorporated follow the recognised challenges posed to the crisis mapping symbology.

EVALUATION OF SPATIAL DISTRIBUTION OF EVACUATION CENTERS IN METRO MANILA, PHILIPPINES

Edward P Cajucom[1,2], George Y Chao Jr[1,3], Gemma A Constatino[1,4], Jay A Ejares[1], Sofia Joy G Quillope[1,5], Haydee M Solomon[1,6], Cherry Lagason Ringor[1]
[1]Institute of Environmental Science and Meteorology, University of the Philippines Diliman, Quezon City 1101 Philippines; [2]Department of Science and Technology-Philippine Atmospheric, Geophysical & Astronomical Services Administration (DOST-PAGASA), BIR Road,

Quezon City, 1100 Philippines; [3]University of Santo Tomas - Department of Chemical Engineering, España Boulevard, Sampaloc, Manila 1008 Philippines; [4]Sultan Kudarat State University, Tacurong City, Sultan Kudarat, 9800 Philippines; [5]Department of Agriculture - Agricultural Training Institute, Elliptical Road, Diliman, Quezon City, 1101 Philippines; [6]Department of Science and Technology-Philippine Nuclear Research Institute (DOST-PNRI), Commonwealth Avenue, Diliman, Quezon CIty, 1101 Philippines; gychao@up.edu.ph

In a densely-populated and hazard-prone megalopolis like Metro Manila (MM), the ability to execute a rapid evacuation protocol is crucial in saving lives and minimizing the damage during disastrous events. However, there is no centralized database on the location of evacuation centers (ECs) in MM and the available lists are not up-to-date. This study geo-tagged the current list of ECs in MM obtained from different government agencies to evaluate the spatial distribution using Geospatial Information System (GIS). This is important since the immediate evacuation of residents depends on the proximity and safe location of the ECs. A total of 873 ECs were geo-tagged and validated using the street view of Google EarthTM. EC-to-population ratios were calculated for each of the 16 cities and one municipality of MM. Values range from ~3,000 to 81,000 persons per EC. Distance analysis using Thiessen Polygon shows that the ECs are not evenly distributed with proximity areas ranging from 0.0009 to 9.5 km2. Out of the total number of ECs, 577 (66%) are situated in flood-prone areas while 109 (12%) are within the 1-km buffer hazard zone of an active faultline. Re-evaluation of the locations and the number of ECs per city or municipality is highly recommended to facilitate prompt evacuation when disasters strike.

Assessment for a road condition using the terrestrial LiDAR data

Je-Sung Park, Kyung-Su Lee, Seong Sam Kim

National Disaster Management Research Institute, Korea, Republic of (South Korea); jesung0225@korea.kr

The pothole is called a road breakage where the surface of road is locally recessed. The conventional vehicle-mounted pothole detection sensor acquires data only when the vehicle directly contacts the pothole and moreover, the acquired data is limited to show the position information of the pothole based on the low-precision GPS. We have, therefore, studied the assessment methods for the road condition using the terrestrial LiDAR data to complement and improve the current methodology. In this study we subtract the low-resolution raster data from the high-resolution raster one that are taken from the terrestrial LiDAR, which is similar to the Trend Analysis. We found that the model we proposed well detected manholes, which we assumed as potholes. It also showed that our model can improve a variety of perspectives such as time consuming, space extension and quantitative interpretation. As a result, we could expect the proposed method will be effectively used in the field of road management.

Session

TS III: Technical Session Topics: Remote Sensing and GIS as Tools of Natural and Man-Made Disaster Management & Disaster Management

Time:
Thursday, 05/Sep/2019:
2:00pm - 3:30pm

Session Chair: **Filiz Sunar**

Presentations

Flood detection in Norway based on Sentinel-1 SAR imagery

Jarle Hamar Reksten, Arnt-Børre Salberg, Rune Solberg
Norwegian Computing Center, Norway; jarle.reksten@nr.no

After large flood incidents in Norway, The Norwegian Water Resources and Energy Directorate (NVE), has the responsibility for documenting the flooded areas. This has so far mainly been performed by utilising aerial images and visual interpretation. Satellite images are a valuable source of additional information as they are able to cover vast areas in each satellite pass. In the Sentinel-1 Synthetic Aperture Radar (SAR) images wet areas and water bodies usually show lower backscatter than dry areas. There are currently two Sentinel-1 satellites in operation, A and B, which passes a location in Norway about two times a day. Each satellite has a repeat cycle of six days, meaning they acquire images with the same coverage and geometry every 6th day. This makes comparison between images with the same acquisition geometry convenient. By comparing an image captured during a flood event with a reference image, it is possible to detect flooded areas in most cases.

Obtaining relevant training data is difficult and time consuming. Both because flood incidents are relatively rare (usually 1 or 2 a year in Norway), a satellite passage is not covering the whole country (about 50% of the area in southern Norway) and because the flood incidents have to be manually verified both in location and extent. However, a training dataset has been obtained from three flood cases, with Sentinel-1 coverage, which were manually annotated by NVE. This training set has been used to train a random forest (RF) classifier, which outputs a score for each pixel in the SAR image. This score image is thresholded in order to obtain a crude flood detection.

When comparing a reference image and an event image, the floods stands out due to the difference in backscatter for water and land. However, there are other events that may trigger such a change in backscatter between the reference image and the event image. For instance, a field of crops which has been harvested between the event and the reference image, may yield a similar difference. Another typical "lookalike" is wet snow, which reduces the backscattered signal compared to dry snow or bare ground, and thereby be a source of false positives. To mitigate this, several techniques have been implemented and tested to reduce the amount of lookalikes returned by the algorithm. This includes masking flood objects less than 4 pixels (1600 m2), objects with larger than 15° slope and a masking based on "height above nearest drainage" (HAND).

The Norwegian Computing Center (NR) has implemented this algorithm in an automated processing chain for flood detection and mapping, which is now used operationally by NVE. The system is automatically triggered by the daily flood warnings issued by NVE, it downloads the satellite images, preprocesses (geocode and georeference) them and performs change detection for regions which have a flood warning for that particular date. For areas without any flood warning, the images are downloaded, preprocessed (geocoded and georeferenced) and stored for usage as reference images.

The performance of the algorithms for detecting and delineating flooded areas in Norway was in general very good. From the flood events, we were able to detect 168 of 179 labelled flood objects. In addition a substantially amount of non-annotated objects were detected as floods by the algorithm. However, many of these detections are expected to correspond to flooded areas which have not been manually verified and thus not included in the labelled dataset.

DEVELOPMENT OF GEOSPATIAL TECHNIQUES FOR NATURAL HAZARD RISK ASSESSMENT IN THAILAND

Surassawadee Phoompanich, Stuart Barr, Rachel Gaulton
Newcastle University, United Kingdom; s.phoompanich2@ncl.ac.uk

In order to mitigate environmental risk in Thailand it is essential to understand where and when specific geographic areas will be exposed to individual and multiple natural hazards. However, existing national scale approaches to natural hazard risk assessment are poorly adapted to deal with multiple hazards where significant uncertainties are associated with input variables and prior knowledge of the spatiotemporal nature of hazards is poor. To overcome these limitations, a geospatial approach has been developed that integrates machine learning within a GIS environment. Four hazards were investigated by Naïve Bayes while multiple hazards and their causalities were analysed via a Bayesian Network. Geospatial and Earth observation data representing past hazard events and their trigger variables were used input to the models to calculate the probability of a hazard and subsequent conditional probabilities. Results revealed that lowland areas covering 22,868 and 139,193 km^2, or 9% and 52% of total lowland areas were at-risk at a 90% probability-level of floods in rainy-seasons and droughts in the summer. Upland areas were exposed to landslides with a 90% probability in rainy season, and forest fires in summer with a 60% probability, covering 37,727 and 40,069 km^2, respectively. Within the Bayesian Network four relations of multiple hazards represented by a directed acyclic graph and the conditional probabilities were investigated. At a 90% significance level approximately 176,576 km^2 was at risk from a combination of forest fires and droughts. At over 80% probability, 185,824, 123,823, and 95,262 km^2 of land were at risk from a combination of 1) floods and landslides, 2) forest fires, floods, and landslides, and 3) all four hazards, respectively. The results were then used to produce the first fine-spatial scale multi-hazard risk assessment for Thailand, to support national policies on risk mitigation and adaption.

Flood impact-based forecasting for early warning and early action in Tana River basin, Kenya

Osunga Michael Otieno[1], Halima Saado Abdillahi[1], Ted Bolton Edward[2], Emmah Mwangi Wambui[1], Kenei Steve Kiprono[1]
[1]International Center for Humanitarian Affairs, Kenya; [2]Netherlands Red Cross; osunga.michael@redcross.or.ke

Kenya is mostly affected by floods during the March-April-May (MAM) and October-November-December (OND) rainfall. This often occurs along river basins such as the Tana river basin, leading to disruption of people's livelihoods, loss of lives, infrastructure destruction and interruption of economic activities. This study used openly available data on flood exposure, vulnerability, lack of coping capacity, flood impacts

and observed satellite rainfall to analyse and predict forecast-based impacts in Tana river. Earth observation satellites including LANDSAT, sentinel 1 and 2 were acquired based on credible flood event dates to validate flood exposure and flood events. The community risk assessment (CRA) approach was used to delineate communities at high risk of floods using combination of data on vulnerability, flood exposure and lack of coping capacity. Using an ordinary least squares (OLS) predictive model, observed satellite rainfall was used as a covariate in order to predict flood impacts on communities with high flood risk scores in Tana river. Weighted scores from the CRA dimensions were summed up with forecasted hazards from the OLS model in order to derive a flood impact-based forecast. The flood impact information is to be used in forecast-based action through early warning, early action protocols thereby reducing impacts of potential floods in communities living in high flood risk areas based on the flood risk map.

Decision making on disaster management in agriculture with Sentinel applications

Georgia Doxani[1], Sofia Siachalou[1], Zina Mitraka[2], Petros Patias[1]

[1]Aristotle University of Thessaloniki, Greece; [2]Foundation for Research and Technology Hellas, Heraklion, Greece; gdoxani@auth.gr

Considering the high importance of the agricultural sector, the European Union (EU) implements a set of regulations under the Common Agricultural Policy (CAP), aiming at the sustainable development and management of natural resources. In particular, in case of a natural disaster, EU and each state member offer recovery assistance to disaster-affected farmers to mitigate the impact of the problems caused. The successful implementation of CAP and insurance coverage though requires precise detecting and monitoring of natural disasters' effects by carrying out timely and accurate controls. Until now, in Greece for instance, these controls are mainly performed by in-situ visits resulting in very high administrative costs. This procedure is not only time-consuming itself, but certain difficulties, i.e. adverse weather conditions, inaccessible areas, etc., can further delay the compensations. Copernicus Emergency Management Service provides operationally today mapping information for disaster-affected areas upon request of authorised users at regional, national, European and international level. The service though is activated under certain circumstances, i.e. extent, damages, duration, etc. and does not cover all the disaster events.

Free and open access policy to Copernicus Sentinel data offers a big volume of data to the users on a consistent and complete basis. Due to their various features and the frequent revisit time, Sentinels support efficiently many environmental applications, including monitoring of large agricultural fields and mapping floods and fire extent. The effective handling of the available long time series though is still at an early stage and the development of accurate automated techniques is limited. To this end, the DiAS (Disaster and Agriculture Sentinel Applications) project revises the existing knowledge on remote sensing methods for mapping the extent of natural and/or man-made disaster over agricultural areas and proposes improvements. The goal is to assist the responsible Greek services to take decisions on farmers' compensations.

One of the main goals of this project is to provide a detailed mapping product showing the extent of floods and fires and their effects in agricultural land. The flooded areas are mapped using Sentinel-1 and Sentinel-2 (when the cloud coverage permits) data, following a comparison procedure of the images acquired pre- and post- flood event. Filtering and thresholding are implemented on the Sentinel-1 difference image of the two dates, with the aim to highlight the areas cover with water. In order to improve this detection, water and vegetation indices are calculated based on the corresponding Sentinel-2 data providing this way ancillary information for more accurate mapping. Similarly, several vegetation, water and burn area indices are considered to map the affected agricultural areas in case of a fire event. The developed methodology is implemented in a Decision Support System (DSS), which will be freely available and easy-to-use by non-experts. DiAS is expected to improve the efficiency of the decision-making process on agricultural aid and reimbursement. Exploiting free satellite data will reduce the number of in-situ visits, minimizing costs and delays of controls. The automation of the satellite image processing will contribute to the immediate decision making and to the sustainability of agriculture not only for Greece, but also potentially in an international level.

Analysis of urban planning documents with the use of DTM in terms of their optimization to improve air quality

Lukasz Kulesza

Kielce University of Technology, Poland; l.kulesza@tu.kielce.pl

In recent years, the problem of air pollution in cities has significantly increased. According to the latest ranking published by the World Health Organization (WHO), there are 36 Polish urban centres among 50 European cities with the highest concentration of PM2.5 particulate matter. In order to improve the situation, corrective and preventive actions can be taken. The first of these mainly include the shift towards more ecological fuels and increasing the biologically active area. The second group includes, among others optimizing existing planning documents. From the point of view of the location of buildings, in particular industrial plants, the most favourable are the highest areas, where the dust generated as a result of fuel combustion can be dispersed much faster. Unfortunately, the applicable provisions of Polish law do not impose an obligation to include terrain elevation in spatial planning. The growing problem of smog has stimulated the analysis of planning documents for selected Polish cities from the list published by the WHO taking DTM into consideration. First of all, on the basis of DTM, three zones (unfavourable, advantageous and very favourable) were determined for each of the test areas from the point of view of the location of buildings. Then an index was established, which was called the Elevation Planning Potential that allows to determine whether and to what extent there are possibilities to make beneficial changes from the point of view of air quality in planning documents taking into account the terrain shape. It takes into consideration both information from DTM and data determined on the basis of urban planning documents covering the existing development and land-use as well as planned spatial development directions. The solutions developed can significantly improve the air quality in cities by optimizing the location of new buildings.

Session

TS IV Parallel: Technical Session Topics: RS and GIS as Tools of Natural and Man-Made Disaster Management & Disaster Management & Forest Fire Control & Guiding Rescue Teams by GI-Technology

Time:

Thursday, 05/Sep/2019:
4:00pm - 5:30pm

Session Chair: **Pieter-Jan Baeck**

Presentations

Post-fire forestry recovery monitoring using high-resolution multispectral imagery from unmanned aerial vehicles

Luís Pádua[1], Telmo Adão[1,2], Nathalie Santos[1], António Sousa[1,2], Emanuel Peres[1,2], Joaquim João Sousa[1,2]

[1]Department of Engineering, School of Sciences and Technology, University of Trás-os-Montes e Alto Douro, 5000-801 Vila Real, Portugal; [2]Institute for Systems and Computer Engineering, Technology and Science (INESC-TEC, Formerly INESC Porto), 4200-465 Porto, Portugal; telmoadao@utad.pt

In recent years unmanned aerial vehicles (UAVs) have been used in several applications and research studies related to environmental monitoring. The works performed have demonstrated the suitability of UAVs to be employed in different scenarios, taking advantage of its capacity to acquire high-resolution data from different sensing payloads, in a timely and flexible manner. In forestry ecosystems, UAVs can be used with accuracies comparable with traditional methods to retrieve different forest properties, to monitor forest disturbances and to support disaster monitoring in fire and post-fire scenarios. In this study an area recently affected by a wildfire was surveyed using two UAVs to acquire multi-spectral data and RGB imagery at different resolutions. By analysing the surveyed area, it was possible to detect trees, that were able to survive to the fire. By comparing the ground-truth data and the measurements estimated from the UAV-imagery, it was found a positive correlation between burned height and a high correlation for tree height. The mean NDVI value was extracted used to create a three classes map. Higher NDVI values were mostly located in trees that survived that were not/barely affected by the fire. The results achieved by this study reiterate the effectiveness of UAVs to be used as a timely, efficient and cost-effective data acquisition tool, helping for forestry management planning and for monitoring forest rehabilitation in post-fire scenarios.

Using virtual scenarios to produce machine learnable environments for wildfire detection and segmentation

Telmo Adão[1,2], Luís Pádua[2], Nathalie Santos[2], António Sousa[1,2], Joaquim João Sousa[1,2], Emanuel Peres[1,2]

[1]Institute for Systems and Computer Engineering, Technology and Science (INESC-TEC, Formerly INESC Porto), 4200-465 Porto, Portugal; [2]Department of Engineering, School of Sciences and Technology, University of Trás-os-Montes e Alto Douro, 5000-801 Vila Real, Portugal; telmoadao@utad.pt

Today's climatic proneness to extreme conditions together with human activity have been triggering a series of wildfire-related events that put at risk ecosystems, as well as animal and vegetal patrimony, while threatening dwellers nearby rural or urban areas. When intervention teams - firefighters, civil protection, police - acknowledge these events, usually they have already escalated to proportions hardly controllable mainly due wind gusts, fuel-like solo conditions, among other conditions that propitiate fire spreading.

Currently, there is a wide range of camera-capable sensing systems that can be complemented with useful location data - for example, unmanned aerial systems (UAS) integrated cameras and IMU/GPS sensors, stationary surveillance systems - and processing components capable of fostering wildfire events detection and monitoring, thus providing accurate and faithful data for decision support. Precisely in what concerns to detection and monitoring, Deep Learning (DL) has been successfully applied to perform tasks involving classification and/or segmentation of objects of interest in several fields, such as Agriculture, Forestry and other similar areas. Usually, for an effective DL application, more specifically, based on imagery, datasets must rely on heavy and burdensome logistics to gather a representative problem formulation. What if putting together a dataset could be supported in customizable virtual environments, representing faithful situations to train machines, as it already occurs for human training in what regards some particular tasks (rescue operations, surgeries, industry assembling, etc.)?

This work intends to propose not only a system to produce faithful virtual environments to complement and/or even supplant the need for dataset gathering logistics while eventually dealing with hypothetical proposals considering climate change events, but also to create tools for synthesizing wildfire environments for DL application. It will therefore enable to extend existing fire datasets with new data generated by human interaction and supervision, viable for training a computational entity. To that end, a study is presented to assess at which extent data virtually generated data can contribute to an effective DL system aiming to identify and segment fire, bearing in mind future developments of active monitoring systems to timely detect fire events and hopefully provide decision support systems to operational teams.

Mapping of Burned Area Using Presence and Background Learning Framework on the Google Earth Engine Platform

Dalila Attaf[1,2], Khelifa Djerriri[1], Djamel Mansour[1], Djamila Hamdadou[2]

[1]Centre des Techniques Spatiales, Arzew, Algeria; [2]University of Oran 1 Ahmed Benbella, Oran, Algeria; dalila.attaf@gmail.com

Mapping of burned area caused by forest fire was always a main concern to researchers in the field of remote sensing. Thus, various spectral indices and classification techniques have been proposed in the literature. In such a problem, only one specific class is of real interest and could be referred to as a one-class classification problem.

One-class classification methods are highly desirable for quick mapping of classes of interest. A common used solution to deal with one-class classification problem is based on one-class support vector machine (OCSVM). This method has proved useful in classification of remote sensing images. However, over-fitting problem and difficulty in tuning parameters have become the major obstacles for this method.

The new Presence and Background Learning (PBL) framework does not require complicated model selection and can generate very high accuracy results. On the other hand the Google Earth Engine (GEE) portal provides access to satellite and other ancillary data, cloud

computing, and algorithms for processing large amounts of data with relative ease. Therefore, this study mainly aims to investigate the possibility of using the PBL framework within the GEE platform to extract burned areas from freely available Landsat and Sentinel-2 archive.

In this work, the Principal Component Analysis (PCA) was applied to extract the best possible features form the original multispectral image and calculated spectral indices (Normalized Burn Ratio (NBR), NormalizedVegetation Index (NDVI), Burned Area Index (BAI)). Then the resulting subset of features was applied to different classifiers.

The quality of the results obtained using PBL framework was assessed using ground truth digitized by qualified technicians and compared to other classification techniques:Binary Support Vector Machine and OCSVM classifiers. Experimental results demonstrate that even though the PBLframework for mapping the burned areas does not showed the higher classification accuracy than SVM, but it shows the suitability for the cases with few positive labelled samples available, which facilitates the tedious work of manual digitizing.

Aerial Firefighting of Forest Fires - Spatial Data Support

Pavel Špulák

General Directorate of Fire Rescue Service of the Czech Republic, Czech Republic; pavel.spulak@grh.izscr.cz

Forest fires represent a serious danger to the population. Due to the climate change, they become common in the area, where they were very rear in the past. The aerial firefighting is the most effective way of the extinguishing of the large forest fires. Because of that, the article deals with the usage of various spatial data support for Aerial Firefighting Service in the Czech Republic.

At the beginning, the article deals with the usage of statistical data, related to the forest fires, stored in the databases on the operational centers of Fire and Rescue Service of the Czech Republic, to support a strategical planning of the aerial firefighting. The article follows with the usage of spatial data to support for public procurement, focused on strengthening of current assets for the aerial firefighting. Finally, the support for aerial firefighting usage on daily basis is shown.

The article tries to demonstrate some kind of methodology, how to use the spatial data to support the aerial firefighting of forest fires. It demonstrates the usage of spatial data, starting from a strategic decision, through public procurement, to the support for running public service, protection of life, health and property of citizens and environment against fire.

Drone based near real-time human detection with geographic localization

Pieter-Jan Baeck, Nicolas Lewyckyj, Bart Beusen, Walter Horsten, Klaas Pauly

VITO, Belgium; pieter-jan.baeck@vito.be

Detection of humans, e.g. for search and rescue operations has been enabled by the availability of compact, easy to use cameras and drones. On the other hand, aerial photogrammetry techniques for inspection applications allow for precise geographic localization and the generation of an overview orthomosaic and 3D terrain model. The proposed solution is based on nadir drone imagery and combines both deep learning and photogrammetric algorithms to detect people and position them with geographical coordinates on an overview orthomosaic and 3D terrain map. The drone image processing chain is fully automated near real-time and therefore allows search and rescue teams to operate more efficiently in difficult to reach areas.

Session

TS IV: Technical Session Topics: Remote Sensing and GIS as Tools of Natural and Man-Made Disaster Management & Disaster Management

Time:
Thursday, 05/Sep/2019:
4:00pm - 5:30pm

Session Chair: **Ludwig Mohr**

Presentations

Extracting Dimensions and Locations of Doors, Windows and Door Thresholds out of Mobile LiDAR Data using Object Detection to Estimate the Impact of Floods

Samuel Van Ackere, Jeffrey Verbeurgt, Lars De Sloover, Alain De Wulf, Nico Van de Weghe, Philippe De Maeyer
Ghent University, Belgium; samuel.vanackere@ugent.be

Increasing urbanisation, changes in land use (e.g., more impervious area) and climate change have all led to an increasing frequency and severity of flood events and increased socio-economic impact. In order to deploy an urban flood disaster and risk management system, it is necessary to know what the consequences of a specific urban flood event are to adapt to a potential event and prepare for its impact. Therefore, an accurate socio-economic impact assessment must be conducted. Unfortunately, until now, there has been a lack of data regarding the design and construction of flood-prone building structures (e.g., locations and dimensions of doors and door thresholds and presence and dimensions of basement ventilation holes) to consider when calculating the flood impact on buildings. We propose a pipeline to detect the dimension and location of doors and windows based on mobile LiDAR data and 360° images. This paper reports on the current state of research in the domain of object detection and instance segmentation of images to detect doors and windows in mobile LiDAR data. The use and improvement of this algorithm can greatly enhance the accuracy of socio-economic impact of urban flood events and, therefore, can be of great importance for flood disaster management.

Detection and delineation of subsurface coal mine fire from spaceborne thermal infrared data in Jharia coalfield, Dhanbad, India

Shanti Swarup Biswal, Amit Kumar Gorai
National Institute of Technology, Rourkela, India; shantiswarup@live.in

Coal fire has been found to be a major problem worldwide in coal mining areas. The surrounding areas get hugely affected and a lot of reserves is wasted due to the burning of coal. This severely affects the environment condition, which leads to a rise in temperature of the region which is a major reason for climate change. Greenhouse gases like CO_2 SO_2 NO CH_4 are also emitted from the cracks and fissures. Large masses of the burning of coal also causes land subsidence and collapse. Underground coal fires ignited by natural causes or human error leads to atmospheric pollution, acid rain, land subsidence, and increased coronary and respiratory diseases. They consume a valuable energy resource, destroy floral and faunal habitats, and promote human suffering because of heat, subsidence, and pollution. Jharia Coalfield, Jharkhand, India, is well known for being the storehouse of prime coking coal and for accommodating the maximum number of coal fires among all the coalfields in the country. In this paper, some of the important issues of coal fire mapping from satellite thermal infrared data have been addressed in particular reference to Jharia Coalfield. Namely, these are: retrieval of spectral radiance from raw digital satellite data using scene-specific calibration coefficients of the detectors from metadata, thermal emissivity of surface to obtain kinetic temperature at each ground resolution cell of satellite data, field-based modelling of pixel-integrated temperature for differentiating surface and subsurface fire pixels in Landsat 8 thermal IR data, identification of surface coal fire locations from infrared data and lateral propagation of coal fire.

Damage Estimation of Explosions in Urban Environments by Simulation

Ludwig Mohr[1], Richard Benauer[2], Peter Leitl[2], Friedrich Fraundorfer[1]
[1]Graz University of Technology, Austria; [2]Bionic Surface Technologies, Austria; ludwig.mohr@icg.tugraz.at

Precise models of the impact of explosions in urban environments provide novel and valuable information in disaster management for developing precautionary, preventive and mitigating measures. Yet to date, no methods enabling accurate predictions of the process and effect of detonations at particular locations exist.

We propose a novel approach mitigating this gap by combining state-of-the-art methods from photogrammetric 3D reconstruction, semantic segmentation and computational based numerical sim-ulations. In a first step, we create an accurate urban 3D reconstruction from georeferenced aerial images. The resulting city model is then enriched with semantic information obtained from the original source images as well as from registered terrestrial images using deep neural networks. This allows for an efficient automatic preparation of a 3D model suitable for the use as a geometry for the numerical investigations. Using this approach, we are able to provide recent and precise models of an area of interest in an automated fashion.

Within the model, we are now able to define the explosive charge size and location and simulate the resulting blast wave propagation using CFD simulation. This provides a full estimation for the expected pressure propagation of a defined charge size. From these results, arising damages and their extent, as well as possible access routes or countermeasures, can be estimated. Using georeferenced sources allows for the integration and utilization of simulation results into existing geoinformation systems of disaster management units, providing novel inputs for training, preparation and prevention.

We demonstrate our proposed approach by evaluating expected glass breakage and expected damages impairing the structural integrity of buildings depending on the charge size using a 3D reconstruction from aerial images of an area in the inner city of Graz, Austria.

UAV-based structural damage mapping – results from 6 years of research in two European projects

Norman Kerle, Francesco Nex, Diogo Duarte, Anand Vetrivel
University of Twente, Faculty ITC, Netherlands, The; n.kerle@utwente.nl

Structural disaster damage detection and characterisation is one of the oldest remote sensing challenges, and the utility of virtually every type of active and passive sensor deployed on various air- and spaceborne platforms has been assessed. The proliferation and growing sophistication of UAV in recent years has opened up many new opportunities for damage mapping, due to the high spatial resolution, the resulting stereo images and derivatives, and the flexibility of the platform. We have addressed the problem in the context of two European research projects, RECONASS and INACHUS. In this paper we synthesize and evaluate the progress of 6 years of research focused on advanced image analysis that was driven by progress in computer vision, photogrammetry and machine learning, but also by constraints imposed by the needs of first responder and other civil protection end users. The projects focused on damage to individual buildings caused by seismic activity but also explosions, and our work centred on the processing of 3D point cloud information acquired from stereo imagery. Initially focusing on the development of both supervised and unsupervised damage detection methods built on advanced texture features and basic classifier such as Support Vector Machine and Random Forest, the work moved on to the use of deep learning. In particular the coupling of image-derived features and 3D point cloud information in a Convolutional Neural Network (CNN) proved successful in detecting also subtle damage features. In addition to the detection of standard rubble and debris, CNN-based methods were developed to detect typical façade damage indicators, such as cracks and spalling, including with a focus on multi-temporal and multi-scale feature fusion. We further developed a processing pipeline and mobile app to facilitate near-real time damage mapping. The solutions were tested in a number of pilot experiments and evaluated by a variety of stakeholders.

Frequency ratio landslide susceptibility estimation in a tropical mountain archipelago

Dymphna Nolasco Javier[1], Lalit Kumar[2]
[1]University of the Philippines Baguio, Baguio City, Philippines; [2]University of New England, Armidale, New South Wales, Australia; dnjavier@up.edu.ph

In a high-rainfall, landslide-prone region in this tropical mountain region, a landslide database was constructed from high resolution satellite imagery (HRSI), local reports and field observations. The landslide data was divided into training (80%) and validation sets (20%). From the digital elevation model (DEM), scanned maps and HRSI, twelve landslide conditioning factors were derived and analysed in a GIS environment: elevation, slope angle, slope aspect, plan curvature, profile curvature, distance to drainage, soil type, lithology, distance to fault/lineament, land use/land cover, distance to road and normalized difference vegetation index (NDVI). Landslide susceptibility was then estimated using the frequency ratio method as applied on the training data. The detailed procedure is explained herein. The landslide model generated was then evaluated using the validation data set. Results demonstrate that the very high, high, moderate, low and very low susceptibility classes included an average of 86%, 7%, 4%, 3% and 1% of the training cells, and 84%, 7%, 5%, 3% and 1% of the validation cells, respectively. Success and prediction rates obtained were 90% and 89%, respectively. The sound output has discriminated well the landslide prone areas and thus may be used in landslide hazard mitigation for local planning.

Session

TS V Parallel: Technical Session Topics: Landslide Monitoring and Data Processing & Earthquake and Geo-Hazards & Use of Small Satellites and Drones for Disaster Management

Time:
Friday, 06/Sep/2019:
9:00am - 10:30am

Session Chair: **Nevin Betul Avsar**

Presentations

CAPACITY BUILDING FOR GEOINFORMATION-DRIVEN EMERGENCY RESPONSE IN CHINA

Zhongxiang Wang[1], Hao Wu[1], Jie Zhu[1], Ronghui Zhang[1], Hao Song[2], Junwei Wang[3], Zihao He[4]

[1]National Geomatics Center of China, China; [2]HeiLongjiang Geomatics Center of MNR, China; [3]Sichuan Surveying and Mapping Geographic Information Bureau Surveying and Mapping Technology Service Center, China; [4]The First Geodetic Surveying Brigade of MNR, China; wuhao@ngcc.cn

Natural disasters occurred frequently in China and have caused serious losses to people's lives and property. Taking Sichuan province in where Wenchuan earthquake has occurred in 2008 as an example, there are more than 40,000 potential geological disasters points been confirmed and about 1,650,000 people are still being affected by them.

Surveying and mapping technology, which could be used to obtain the image of disaster areas and further analyse the damage, has made powerful contributions to former emergency response activities. While, due to the scattered distribution of disasters, the current equipment and methods are lack of capacity in fill the requirements of quick response. The gaps demonstrated as 4 aspects: 1) the speed of image obtaining is not quick enough for decision making; 2) the equipment for gathering multiple geoinformation in frontline is not effective enough to fill the needs of disaster monitoring; 3) the software used for conventional 4D product are not appropriate for the automatically processing of disaster geoinformation; 4) the transmission and sharing of disaster geoinformation are still restricted by missing of interconnected network and uniform platforms.

In the other hand, the surveying and mapping and other related technologies have made great progress in last decade. For example, there are more and more satellites could be selected to obtain image of disaster area. Industrial grades UAVs, with longer endurance and heavier mission payload, have been applied into aerial photogrammetry area. With the improvement of variety and accurate of aerial sensors, the size and weight of them are becoming more lightweight. The development of deep learning, big data and knowledge service technologies have made it possible to realize automatic and collaborative processing of disaster geoinformation.

Therefore, make use of the new technologies to improve the current capacity for geoinformation-driven emergency response is imperative. But former researches mainly focused on one aspect of emergency response, such as the image acquisition, data processing, emergency analysis or thematic mapping. Not much is known about geoinformation-driven emergency response system, especially for a huge country like China.

Taking the capacity building project of national emergency response in China as background, the aim of this research is establishing a collaborative and dynamic geoinformation-driven national emergency response system. The structure of this paper could be organised as follows. Firstly, the requirements of different stages of geoinformation-driven emergency response were discussed in Section 1. Secondly, recent researches on image acquisition, automatic processing, data sharing and service platforms were analysed in Section 2. Thirdly, the business and data transformation processes were introduced and then the architecture consisted of UAV based aerial photography, field surveying, data integration and smart service was approved in Section 3. Based on the above, the collaborative relations of different parts in the geoinformation-driven national emergency response system were designed in Section 4. Finally, the preliminary progress and prospective achievement were discussed in Section 5.

Long term changes in flooding risk around Gifu city

Kojima Toshiharu[1], Chantsal Narantsetseg[2]

[1]River basin research center, Gifu university, Japan; [2]Graduate school of Engineering, Gifu university, Japan; nrntstsg@gmail.com

Heavy rainfall within a short period and consequent high river discharge are results in floods which subsequently creates huge infrastructure problems for areas, such huge economic deficits in production as well as damages to existing property and goods, even loss of human lives. The flat-land around the Kiso Three Rivers system (the catchment areas of the Kiso River, Nagara River, and Ibi River are called “Kiso Three River system”) included Gifu City, Gifu Prefecture of Japan, was frequently damaged by inundation after heavy rainfall within a short period about hundred years ago.
Our research aims to evaluate whether people and property have protected by river improvement such river infrastructures are constructing in Kiso Three River system from the downstream to the upstream in the past hundred years.
For that reason, we simulated in several times on the peak flow rate of inundation in the urban area of Gifu city in the large, medium and low scale case, then compared the maximum flooding depth on these simulations.
The results, it can be seen that the damage to small scale flood damage in the urban area of Gifu City dramatically reduced from 3.82 km² to 0.48 km² and the depth of flooding also decreased from 735 cm to 558 cm.

Relative Sea Level Change along the Black Sea Coast from Tide Gauge Observations

Nevin Betul Avsar, Senol Hakan Kutoglu

Zonguldak Bulent Ecevit University, Turkey; nb_avsar@beun.edu.tr

Rising sea levels can affect human activities in coastal regions. It causes to inundate low-lying land, contributes to coastal storms and flooding, induces shoreline erosion, and increases salt water intrusion into estuaries and nearby groundwater aquifers. Moreover, coastal infrastructure would be more vulnerable to damage from extreme sea level events.

When sea level is referred to the Earth's centre of mass, it is defined as "absolute sea level" whereas when it is referred to a fixed point that is used as a reference on the solid Earth, it represents "relative sea level". Thus, if considering coastal impacts of sea level change, relative sea level is the more relevant quantity, and it has been measured using tide-gauges for the past few centuries. In this context, this study focus on relative sea level trends in the Black Sea coast. For this aim, the sea level observations from 12 tide gauge stations along the Black Sea coast were analyzed. The available stations from the Permanent Service for Mean Sea Level (PSMSL) (Batumi, Poti, Tuapse, Sevastopol, Constantza, Varna, Bourgas) and the Turkish National Sea Level Monitoring System (TUDES) (Igneada, Sile, Amasra, Sinop, Trabzon) are unevenly distributed circum the Black Sea. Each station has a different data length. Moreover, most of the records suffer from data gaps and/or short data period. The tide gauge observations also contain some geophysical (i.e., non-oceanographic) signals, as tide gauges measure sea level relatively to the ground. Poor knowledge of vertical ground motion can distort the sea level rise estimates, which in turn causes assessment of the coastal impacts deficiently. Therefore, for this study, in order to determine ground motions' contribution to relative sea level changes, the continuous Global Navigation Satellite System (GNSS) data were provided from nearly co-located GNSS stations at the available locations.

In this study, the least-squares method were used to fit the time series of sea level change for each station, and estimate the relative sea level change trends. Consequently, nearly all the tide gauge stations indicated the rising sea level. However, the Sinop and Sile stations showed no significant sea level change. The non-significant results may be related to the short records (from June 2005 to December 2014 for Sinop, from July 2008 to December 2014 for Sile). On the other hand, at the Poti station a highly sea level trend of 6.66 ± 0.07 mm/y were calculated. This relative sea level rise may be resulted from the subsidence at the Poti coast. Unfortunately, in order to monitor ground motions at the tide gauge stations along the Black Sea coast, the number of the GNSS receivers/stations attached directly to the tide gauge or located nearby are very sparse. So, we have the vertical rates of only 6 GNSS stations. These GNSS stations and related tide gauge stations with their distances are as follows: TUAP-Tuapse (0.05 km), VARN-Varna (2.1 km), BUR3-Bourgas (1.5 km), SLEE-Sile (1.2 km), SINP-Sinop (0.8 km), TRBN-Trabzon (2.8 km). The vertical rates analysis of these stations show that the land subsidence motions were observed at the Tuapse, Varna, Bourgas, Sile and Trabzon tide gauge locations, whereas the land uplift motion was appeared at the Sinop tide gauge location. Eventually, the obtained sea level changes at the tide gauge stations are affected by the ground motions along the Black Sea coast.

Assessing tidal flood upon solar salt farming area in north part of Java using hydrodynamic model

Anang Widhi Nirwansyah[1], Boris Braun[2]

[1]Institute of Geography, University of Cologne, Germany; [2]Institute of Geography, University of Cologne, Germany;
a.nirwansyah@smail.uni-koeln.de

This study aims to assess the impact of high tide upon salt production areas in north part of Java, Indonesia. Single case in June 2016 was applied using MIKE 21. The inputs are tidal height records, bathymetry, digital elevation model from Geospatial Information Agency (GIA), and wind data from OGIMET. Peak water level from tidal constituent is extracted from the simulation. This study also value of GIS for the spatial analysis of tidal flood distribution upon solar salt area as part of marginal non-built up area. The maps that were generated from one-month simulation showed that tidal event has led to 82.9% of salt production area being inundated. West and east part are recorded as the most affected location due to this extreme event. The maximum water level has reached about 38 cm and covered more than 6,489.38 ha during the tide. Whilst the accurate identification will provide valuable information for salt sufficiency program, coastal disaster planning, and management in Indonesia.

FLOOD HAZARD MAPPING AT LONG XUYEN QUADRANGLE IN 2015 USING GEOGRAPHIC INFORMATION AND REMOTE SENSING

Diep Thi Hong Nguyen

Cantho University, Vietnam; nthdiep@ctu.edu.vn

In recent year, the flooding has been occurred with higher frequency at Long Xuyen Quadrangle areas of Mekong Delta, Vietnam. It was considered as a major natural disaster which effects on the physical and spiritual in people's life in this area. This research aims to generate a flood hazard map and assess the flood situation at Long Xuyen quadrangle in 2015. The MNDWI (Modification of Normalized Difference Water Index) extracting from Sentinel 2 image was used to map the flood extent at Long Xuyen quadrangle during rainy season in 2015. The statistics method was estimated corelation coefficient between flooding spatial distribution and hydrologcal stations on SPSS software. The results showed that the severe flood occurred from August to December in 2015. There were about 47.6% and 28.2% of the total area were inundated in October and August, respectively. The correlation between inundated areas and water level at Ha Tien and Chau Doc hydrological stations was 0.73 and 0.65 ($p < 0.01$), respectively. The derived information was very essential and valuable for local managers in making decision on responding and mitigating to the flood disaster.

Session

TS V: Technical Session Topics: Remote Sensing and GIS as Tools of Natural and Man-Made Disaster Management & Landslide Monitoring and Data Processing

Time: **Friday, 06/Sep/2019: 9:00am - 10:30am**

Location: **Balling's Hall**

Session Chair: **Candan GÖKÇEOĞLU**

Presentations

GIS assessment of population exposure to landslide hazard in Sukabumi, Indonesia in two growth scenarios

Sesa Wiguna, Jay Gao

University of Auckland, New Zealand; jg.gao@auckland.ac.nz

As a kind of natural hazard, landslides can do damage to properties and infrastructure, and even cause loss of human lives. So far landslides have been mapped from various remotely sensed data using different image classification methods. However, few have assessed human exposure to landslide hazard. In particular, nobody has studied how land cover change in the future can potentially affect the exposure of an evolving population to landslide hazard. This study attempts to overcome these deficiencies by developing a method of assessing people's exposure to the modelled landslide hazard in the Sukabumi district in the West Java Province of Indonesia. As one of the top five highest landslide-prone areas in the province, it has suffered repeated landsliding in the past. There have been 128 landslide events causing 71 casualties and displacing 5,772 people over the last decade. Featured prominently in the assessment is the temporal variation of landslide risk caused by changes in land use pattern. Two land cover/land use change scenarios are studied: A-the same unchecked growth as in the past, and B-restricted growth imposed by land use zoning. In addition, this assessment also takes into consideration projected population growth, the spatial distribution of settlements, and landslide susceptibility based on past landslide distribution. The assessment is implemented in four steps. First, land cover in 2030 was modelled based on land cover changes from 1993 and 2013, and validated against the actual land cover in 2017. A high overall accuracy of 98.8% and a Kappa coefficient of 0.96 were achieved in the modelling in both growth scenarios. Second, quantitative relationships between landslide determinants and past landslide events were establsihed using the Weights-of-Evidence method to identify the contribution of different factors to landslide risk. Third, landslide susceptibility was modelled from all the important determinants in ArcGIS. Finally, the spatial distribution of population was estimated via a dasymetric map of settlements. The results demonstrate that land cover change exerts an impact on landslide susceptibility zoning, hence the exposure to landslide hazard. In both scenarios of land use change, landslide susceptibility and exposures are predicted to increase in 2030. In 2017 a total of 1.09 million people (39.3%) face a high and very high risk of landslide hazard. This percentage is projected to rise to 1.15 million (39.2%) inscenario A and 1.14 million (39.0%) in scenario B. While the proportion of people facing a high risk will not change over the projected period, the absolute number of people will increase by at least 53,069. In the restricted growth scenario B, the extent of high and very high landsliding susceptability zones (147,790 ha) is only slightly lower than in scenario A (149,858 ha), both being higher than 146,957 ha (35.0%) in 2017. It is concluded that exposure to landslide hazards in 2030 will worsen and the worsened landslide susceptibility will make more people exposed to a (very) high level of landslide hazard in the future. Perper planning of settlements can reduce both the area of hazardous landsliding zones and the number of people exposed to landsliding hazard by 1.9%.

Multi-temporal high-resolution landslide monitoring based on UAS photogrammetry and UAS LiDAR Geoinformation

Chen-Ling J. Hung[2], Chun-Wei Tseng[1,2], Mei-Jen Huang[1], Chih-Ming Tseng[3], Kuo-Jen Chang[1]

[1]National Taipei University of Technology, Taiwan; [2]Taiwan Forestry Research Institute, Taiwan; [3]Chang Jung Christian University, Taiwan; epidote@ntut.edu.tw

Due to the high seismicity and high annual rainfall, numerous landslides occurred and caused severe impact in Taiwan. Typhoon Morakot in 2009 brought extreme and long-time rainfall, and caused severe disasters. After 2009, numerous large scale deep-seated landslides may still creeping, however not necessary easily to inspect the activity. In recent years, the remote sensing technology improves rapidly, providing a wide range of image, essential and precious geoinformation. Accordingly, the Small unmanned aircraft system (sUAS) has been widely used in landslide monitoring and geomorphic change detection. This study used UAS to continuously monitor a landslide area in Baolai Village in southern Taiwan, which had a catastrophic landslide event triggered by heavy rainfall caused by Typhoon Morakot in 2009. In order accesses the potential hazards, this study integrates UAS, field geomatic survey, terrestrial laser scanner (ground LiDAR), and UAS LiDAR for data acquisition. Based on the methods we are able to construct multi-temporal and high resolution DTMs, so as to access the activity and to monitoring the creeping landslides. The data set are qualified from 21 ground control points (GCPs) and 11 check points (CPs) based on real-time kinematic-global positioning system (RTK-GPS) and VBS RTK-GPS (e-GNSS). More than 10 UAS flight missions for the study areas dated since 2015, for an area large than 5Km^2 with 8-12 cm spatial resolution. Then, the datasets was compared with the airborne LiDAR data, to evaluate the quality and the interpretability of the dataset. Recently, we integrate UAS LiDAR technology to scanning part of the study area, to re-evaluate the data precision by dense point cloud, higher than 250 and 100 pts/m^2 for the total and ground point, respectively. The spatial distributions of geomorphologic changes were quantified and the disaster potential was evaluated at different times, and reveals that most of the changes were on the eastern side of the landslide. Significant changes in elevation were detected before the middle of 2017, however reactivated again since middle of 2018. The results of this study provide not only geoinfomatic datasets of the hazardous area, but also for essential geomorphologic information for other study, and for hazard mitigation and planning, as well.

ON THE USE OF SENTINEL-2 IMAGES AND HIGH RESOLUTION DTM FOR LANDSLIDE SUSCEPTIBILITY MAPPING IN A DEVELOPING URBAN SETTLEMENT (MAMAK, ANKARA, TURKEY)

Tugce Yanar[1], Sultan Kocaman[1], Candan Gokceoglu[2]

[1]Hacettepe University, Department of Geomatics Engineering, 06800 Ankara, Turkey; [2]Hacettepe University, Department of Geological Engineering, 06800 Ankara, Turkey; sultankocaman@hacettepe.edu.tr

Urban planning starts with the selection of suitable sites. The main factors and components for site selection are the geological-geotechnical parameters that directly affect the natural hazards, such as landslide and flood, construction costs and the location and distribution of the existing infrastructure. The presence and accuracy of up-to-date maps in planning are very important. With the increase of satellite technologies and high resolution Earth observation satellites, the required data can be obtained with high temporal frequency and spatial availability. From these data, the base parameters for planning can be extracted semi- or fully automatically. Among the Earth observation satellites, the Sentinel-2 mission of ESA provides high resolution optical images and the data are freely available also at different processing levels such as orthorectified images.

In this study, the possibilities of the production of landslide susceptibility maps which should be one of the base maps in urban planning by using Sentinel-2 satellite images has been investigated in Mamak District of Ankara City, Turkey. The land cover and land use data have been produced from Sentinel-2 images by supervised classification in SNAP Tool of ESA. The lithological definitions have been received from the General Directorate of Mineral Research And Explorations. The topography related parameters such as slope, aspect, topographic wetness index, etc. have been extracted from a high resolution digital terrain model of the area. The logistic regression method has been applied to the derived parameters to obtain the landslide susceptibility map and the results will be presented here.

LANDSLIDE INVESTIGATION USING DIFFERENTIAL SYNTHETIC APERTURE RADAR INTERFEROMETRY: A CASE STUDY OF BALLORAN DAM AREA IN SYRIA

Muhannad Hammad, László Mucsi, Boudewijn Van Leeuwen

University of Szeged, Hungary; muhannad@geo.u-szeged.hu

Landslides are one of the main geological hazards that can cause critical damage to the infrastructure in an area and can result in serious risks to the people's safety there. Landslides can be investigated and monitored using field survey, aerial mapping and high resolution optical satellite data analysis. However, these methods are relatively time-consuming. Interferometric synthetic aperture radar (InSAR) can investigate and monitor landslides and provide sub-centimeter accuracy for ground-surface deformation when time series analysis techniques are employed. In this research, differential synthetic aperture radar interferometry was applied on Sentinel-1 data of two Single Look Complex (SLC) images from 16 October 2018 and 21 March 2019 in the Interferometric Wide (IW) swath mode using the Sentinel application platform (SNAP) to determine the extreme ground-surface deformations, as a prelude to landslides occurrence in Balloran dam area in the north-west of Syria, where the ophiolite complex deposits of the Maastrichtian are exposed causing, due to the heavy rains, several landslides affecting the road network in this area every year. The results reveal ground-surface deformations during the study period along the satellite line of sight near to the main road in Balloran dam area with a maximum value reaches to around 20 cm. The D-InSAR results were compared to the D-GPS results of 10 validation points along the main road in the study area, where the RMS difference value was 20 cm.

NDEI-based mapping of land surface changes

Victor Daniel Angulo Morales[1], Jorge Luis Rodriguez Galvis[2], Elvis Eduardo Gaona Garcia[1], Ivan Alberto Lizarazo Salcedo[2]

[1]Universidad Distrital Francisco Jose de Caldas, Colombia; [2]Universidad Nacional de Colombia; vdangulom@correo.udistrital.edu.co

Topography measurements of land surface elevation changes are essential for geomorphological studies and research on natural hazards. However, conventional topography and remote sensing methods pose several challenges. Fieldwork in remote areas could be insecure or be hard to conduct due to physical barriers. Remote sensing satellite images, in turn, may lack the temporal resolution for monitoring topography changes or be covered by clouds and shadows that reduce their usefulness.

Unmanned Aerial Vehicles (UAV) provide high-resolution imagery from remote areas and may give a greater insight into land surface changes. Previous studies have demonstrated the potential of the normalized difference elevation index (NDEI), derived from UAV surveys, to map changes in topography in different environments, including a quarry zone of sand mines in Colombia, and in the North Pole Ice Cap. As the NDEI is a metric capable to reveal topography disturbances, it could be exploited for rapid assessments of mass movements occurrence.

For this research, a fine temporal resolution dataset of monthly NDEI values were used to explore their utility as a mass wasting identification technique. NDEI was used to map changes in the land surface in a quarry zone affected by landslides and mudflows. NDEI values were obtained from the multi-temporal analysis of digital surface models generated from UAV images and processed using Structure from motion (SfM) techniques.

Main components of the proposed method are: (i)UAV-based imagery data capture, (ii)data processing using SfM techniques, (iii)NDEI calculation, and (iv)mass movement identification. Results illustrate the feasibility of using UAV-based imagery data to increase the accuracy of land changes information and produce rapid assessments of mass movements occurrence. Results show that the NDEI approach may increase the accuracy of land surface changes assessment and mapping, as well as enable the design of new methodologies to identify natural hazards and risks.

Session

TS VI Parallel: Technical Session Topics: Remote Sensing and GIS as Tools of Natural and Man-Made Disaster Management & Disaster Management & Capacity Building in Disaster Monitoring, Assessment, and Management & Flood Analysis, Drought Monitoring

Time:
Friday, 06/Sep/2019:
11:00am - 1:00pm

Session Chair: **Seongsam Kim**

Presentations

AN OBJECT-BASED APPROACH FOR MONITORING THE EVOLUTION OF LANDSLIDE-DAMMED LAKES AND DETECTING TRIGGERING LANDSLIDES IN TAIWAN

Zahra Dabiri[1], Daniel Hölbling[1], Lorena Abad[1], Günther Prasicek[2,3], Anne-Laure Argentin[2], Tsai-Tsung Tsai[4]

[1]Interfaculty Department of Geoinformatics - Z_GIS, University of Salzburg; [2]Department of Geography and Geology, University of Salzburg; [3]Center for Interdisciplinary Mountain Research, University of Lausanne; [4]Disaster Prevention Education Center, National Cheng Kung University; zahra.dabiri@sbg.ac.at

In August 2009, Typhoon Morakot caused a record-breaking rainfall in Taiwan. The heavy rainfall triggered thousands of landslides, in particular in the central-southern part of the island. Large landslides can block rivers and can lead to the formation of landslide-dammed lakes. Cascading hazards like floods and debris flows after landslide dam breaches pose a high risk for people and infrastructure downstream. Thus, better knowledge about landslides that significantly impact the channel system and about the resulting landslide-dammed lakes are key elements for assessing the direct and indirect hazards caused by the moving mass. The main objectives of this study are 1) to develop an object-based image analysis (OBIA) approach for semi-automated detection of landslides that caused the formation of landslide-dammed lakes and 2) to monitor the evolution of landslide-dammed lakes based on Landsat imagery. For landslide and lake mapping, primarily spectral indices and contextual information were used. By integrating morphological and hydrological parameters derived from a digital elevation model (DEM) into the OBIA framework, we automatically identified landslide-dammed lakes, and the landslides that likely caused the formation of those lakes, due to the input of large amounts of debris into the channel system. The proposed approach can be adapted to other remote sensing platforms and can be used to monitor the evolution of landslide-dammed lakes and triggering landslides at regional scale after typhoon and heavy rainstorm events within an efficient time range after suitable remote sensing data has been provided.

A multi parametric micro-level vulnerability assessment model for mountain habitat: A case example from Bhilangana Block, Uttarakhand Himalaya, India

Sakshi Naithani[1,2], Prashant Kumar Champati ray[1], Ramesh Chandra Joshi[2]

[1]Indian Institute of Remote Sensing; [2]Kumaun University; naithanisakshi@gmail.com

Although vulnerability is a relatively simple concept reflecting the degree of harm or adverse impacts on an individual, group or a system due to hazards, its implementation is rather complex due to underlying social, economic and physical dimensions of vulnerability along with coping capacity. This complex problem is addressed through a multi hazard vulnerability assessment model at a smallest human habitat i.e., village level in Himalayan state of Uttarakhand, India. The model can be effectively upscaled to higher administrative levels to present a multi-scalar view of the state of vulnerability in one of the worst disaster affected regions in India. It was tested for Bhilangana block of Uttarakhand state (India) set in multi-hazard prone North-west Himalaya. The analysis included elements of population, buildings and road infrastructure measured across dimensions of physical, social and economic conditions. A total of 32 factors were used to define vulnerability; data was normalized and aggregated to obtain a single index value for each village. Each component and overall comparative vulnerability were estimated using k-means clustering, where natural clusters of villages with similar vulnerability emerged as one class. Results show that remotely located villages like Pinswar, Gainwali, Banoli and Gangi exhibit highest vulnerability to multi-hazards. Least vulnerable villages are clustered around local business or tourist centres. The results highlight the spatial variation of vulnerability and its causative factors which are crucial for introducing appropriate policy measures to strengthen villages that are high on vulnerability parameters.

Application of the steep slope risk assessment using three dimensional spatial information data

Dong Yoon Shin, Jun-Seok Sim, Kyung Su Lee

Disaster Scientific Investigation Division, National Disaster Management Research Institute, Republic of Korea; sdy718@korea.kr

A collapse of steep slopes is one of the natural disasters that often occur during the thaw and rainy season. In order to prevent this kind of disaster, safety monitoring is carried out through risk assessment. This assessment consists of various items such as inclination angle and height, and inspectors evaluate the score using the compass, the laser range finder, and so on. This approach is, however, consumed a lot of the manpower and the time. Therefore, in order to solve these problems, this study aims to evaluate the rapid and accurate steep slope risk by using the terrestrial LiDAR which acquired 3D spatial information data.

3D spatial information data was acquired using the terrestrial LiDAR for steep slopes classified as very unstable slopes. Noise and vegetation of the acquired scan data were filtered to generate point cloud data with a rock or mountain model. The RMSE of the registration accuracy was 0.0156 m. From the point cloud data, the inclination angle, height, shape, valley, collapse and loss were evaluated. As a result, various risk assessment items can be checked at once. In addition, it is expected to be used as basic data for constructing steep slope DB, providing visualization data, and time series analysis in the future.

Utilization of fine resolution satellite data for landslide susceptibility modelling: A case study of Kashmir earthquake induced landslides.

Muhammad Zeeshan Ali[1], Hone Jay Chu[1], Saleem Ullah[2], Muhammad Shafique[3], Asad Ali[2]

[1]National Cheng Kung University, Tainan, Taiwan, Taiwan; [2]Institute of Space Technology, Islamabad, Pakistan.; [3]National Centre of Excellence in Geology, University of Peshawar, Peshawar, Pakistan.; zeeshanktk1992@yahoo.com

The 2005 Kashmir earthquake has triggered thousands of landslides which devastated most of the livelihood and other infrastructure in the area. Landslide inventory and subsequently landslide susceptibility mapping is one of the main prerequisite for taking mitigation measure against landslide effects. This study has focused on developing most updated and realistic landslide inventory and Susceptibility mapping. The high resolution data of Worldveiw-2 having spatial resolution of 0.4 m is used for landslide inventory. Support Vector Machine (SVM) classifier was used for landslide inventory developing. Total 51460 number of landslides were classified using semi-automatic technique with covering area of 265 Km^2, smallest landslide mapped is covering area of 2.01 m^2 and the maximum covered area of single landslide is 3.01 Km^2. Nine influential causative factors are used for landslide susceptibility mapping. Those causative factors include slope, aspect, profile curvature, elevation, distance from fault lines, distance from streams and geology. Logistic regression model was used for the Landslides susceptibility modelling. From model the highest coefficient was assigned to geology which shows that the geology has higher influence in the area. For landslide susceptibility mapping the 70 % of the data was used and 30% is used for the validation of the model. The prediction accuracy of the model in this study is 92 % using validation data. This landslide susceptibility map can be used for land use planning and also for the mitigation measure during any disaster.

Geoinformation for research of ongoing geodynamic processes in the Republic of Croatia

Ana Kuveždić Divjak[1], Marin Govorčin[1], Bojan Matoš[2], Almin Đapo[1], Boško Pribičević[1]

[1]Faculty of Geodesy, University of Zagreb, Croatia; [2]Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, Croatia; akuvezdic@geof.hr

Multidisciplinary research of surface geodynamic processes is important for understanding mechanisms that lead to sudden release of accumulated strain energy, i.e. earthquakes. It requires development of an original scientific approach which combines data from various geosciences such as geodesy, geology and seismology. This implies that each geoscience contributes to a better understanding by providing specific direct or indirect information on activity (spatial movements) and properties of seismogenic sources (faults). In recent years, new and accessible sources and types of geoinformation have greatly enhanced, enabling a more comprehensive investigation of ongoing geodynamic activity on faults and, therefore, improve our ability to develop approaches to assess and mitigate the seismic hazard and risk within the earthquake-prone areas.

In this paper, we seek to identify the geoinformation required to improve the current knowledge on regional and local geodynamic processes in the Republic of Croatia. Focusing on the complementarity of geodetic, geological and seismological data, we discuss possible sources of the diverse sets of site-specific geospatial data. Examples include: ground/surface movement observations with Global Navigational Satellite Systems (GNSS) and Satellite Radar Interferometry (InSAR); data about historical and instrumental seismicity (e.g. focal mechanism solutions, number of earthquakes, b-value, etc.); fault location, fault geometrical properties and information on their neotectonic activity, paleoseismological data, etc. Challenges regarding the integrated use of these data, such as heterogeneity of data sources, access protocols, metadata standards, data quality, up-to-dateness, and other limitations are also addressed.

Applicability Assessment of UAV Mapping for Disaster Damage Investigation in Korea

Seongsam Kim, Tai-Hoon Kim, Jun-Seok Sim

National Disaster Management Research Institute, Korea, Republic of (South Korea); sskim73@korea.kr

Natural disaster closely related to meteorological phenomena and geographic factors can reduce slightly damage extent by taking preparative and preventive measures. For effective and systematical disaster management, far-reaching researches and promising technical development have been carried out actively to minimize the damages by natural disaster using advanced observation platforms and observation sensors: satellite-based and aerial mapping platform, high-precision mobile mapping system (MMS), UAV-based LiDAR, etc.

Despite the dramatic growth of these technologies, socio-economic losses and casualties caused by natural disaster have been increased in Korea due to rapid urbanization and global climate change. The total cost of recovery by natural disaster is estimated about 400 million US dollars per a year over past decades. Most of the damage by natural disaster around the Korean Peninsula has been caused by flood and landslide such as a typhoon, a heavy rainfall for the rainy season. Occurring natural disaster in Korea, the local and the central government should investigate the damage situation promptly, analyze quantitatively the extent of damage, and establish an appropriate disaster recovery plan in accordance with Framework Act on the Management of Disasters and Safety.

The purpose of this study is to assess the applicability of UAV photogrammetry for the management of natural disaster. For that, we build up small easy-to-use UAV-based investigation procedure for natural disaster damaged area in the phase of disaster recovery in Korea.

The study sites were selected on considerable damaged areas where landslides, river floods, and reservoir collapses have occurred practically due to heavy rains and a typhoon in 2018. Before drone-based aerial surveying, we performed a field survey with DGPS RTK for GCPs setting-up around disaster site. In this paper, we generated three dimensional terrain information and high-resolution ortho-imagery and then analyzed quantitatively damage degree by natural disaster using commercial UAVs and drone mapping technique.

Finally, we evaluated the mapping accuracy and work efficiency of drone mapping for disaster investigation application through comparing with traditional investigation work process which was dependent on labor-intensive field survey. The resolution ortho-image map of within less 5cm of GSD generated by aerial photographs acquired from UAVs at the altitude of 100m ~ 250m enabled us to check damage information such as facilities destroy or the trace of soil erosion around the river flooded and reservoir collapsed area. In addition, three dimensional point cloud data of landslide-damaged areas enabled us to more accurately measure the width and the depth of outflows caused by landslides, soil runoff distance, and landslide damage area. The photogrammetry-based drone mapping technology for the disaster damage investigation is expected to be an alternative approach to support or replace the labor-intensive disaster site survey that needs to investigate the disaster site quickly and timely.

Application of Off-Nadir Satellite Imagery in Earthquake Damage Assessment Using Object-Based HOG Feature Descriptor

Shabnam Jabari, M. Krafczek

University of New Brunswick, Canada; sh.jabari@unb.ca

One of the most important applications of very high resolution (VHR) satellite images is disaster management. In disaster management, time is of great importance. Therefore, it is vital to acquire satellite images as quickly as possible and benefit from automatic change detection to speed up the process. Automatic damage map generation is performed by overlaying the co-registered before and after images of the area of interest and performing a spectral comparison to highlight the affected infrastructures. To speed up image capturing, satellites tilt their imaging sensor to take images from oblique angles. However, this kind of image acquisition causes severe geometric distortion in the images which prevents proper image co-registration in the automatic change detection processes. Using conventional change detection methods, it is not possible to effectively use off-nadir satellite images for automatic damage map generation. In this study, a Patch-Wise Co-Registration (PWCR) solution is used. PWCR utilizes nadir as well as off-nadir images for change detection and has proved to be effective in city development detection applications [2] using basic change detection methods such as Change Vector Analysis (CVA) and Multivariate Alteration Detection (MAD). In this algorithm, the *before* the image is divided into pieces, i.e. segments, and the corresponding segments are detected in the *after* image. Finally, a CVA or MAD comparison is performed between the corresponding segments to detect changed areas. However, due to the complicated structure of debris in damage detection applications, CVA and MAD cannot perform well. In this work, different image features such as spectral, textural, information-based methods are used to detect damaged areas. The algorithm is tested on images from the 2016-Equador earthquake and the 2013-Heidi earthquake, captured by DigitalGlobe, and we achieved around 90% accuracy in detecting damaged structures. This demonstrates the potential to significantly open up the remote sensing data sources for urban change detection. Thus, this method shows the potential to be used in early response systems as it speeds up the damage map generation by providing flexibility to utilize different off-nadir angle satellite images for automatic change detection.

Session

TS VI: Technical Session Topics: Remote Sensing and GIS as Tools of Natural and Man-Made Disaster Management & Flood Analysis, Drought Monitoring

Time:
Friday, 06/Sep/2019:
11:00am - 1:00pm

Session Chair: **Jürgen Schulz**

Presentations

Constructing the flood evacuation zones based on user-centric time-distance representation

Jung Ok Kim[1], Seula Park[2]
[1]AICT(Advanced Institute of Convergence Technology), Suwon, South Korea; [2]Department of Civil and Environmental Engineering, Seoul National University, Seoul, South Korea; geostar1@snu.ac.kr

This paper aims to provide an approach to flood evacuation mapping for use as an effective resource to support evacuations prompted by a sudden inundation. In particular, we propose an algorithm to generate a flood evacuation cartogram based on an actual evacuation in real-time. The suggested time-distance cartogram minimizes distortion by transforming the evacuation routes and preserves the topological characteristics as a whole. To empirically evaluate its application, we apply this method to Samcheok city in South Korea. As a result, optimal shelter and evacuation routes are derived by considering significant factors influencing the actual access to the facilities and escape routes, such as pedestrian elevation and the expected flood area. Moreover, the flood evacuation cartogram provides a more effective and intuitive visualization than classic topographic maps, by relocating shelters and reshaping the routes intended for evacuation. The suggested method is significant as it provides practical flood evacuation information effectively for people in a flood situation. Our empirical results also provide helpful insights for disaster authorities or policy makers for more efficient evacuation plans.

Airborne Technologies for Disaster Management

Jürgen Schulz
Hansa Luftbild AG, Germany; schulz@hansaluftbild.de

Currently, satellite-based systems and UAVs are very popular in the investigation of natural disasters. Both systems have their justification and advantages - but one should not forget the **airborne** remote sensing technology. The presentation shows with three examples very clearly how airborne remote sensing is still making great progress and in many cases represents the optimal method of data acquisition.

The airborne detection of forest damages (especially currently the bark beetle in spruce stands) can determine the pest attack using CIR aerial images in combination with ALS and hyperspectral systems - down to the individual tree. Large forest areas of 100 sqkm and more can be recorded from planes on one day (100 sqkm with 10cm GSD on one day).

Flood events - such as on the Elbe in 2013 - were recorded by many satellites. However, many evaluations require high-resolution data (GSD 10cm), e.g. to clarify insurance claims. Here the aircraft system, which was able to fly below the cloud cover and was constantly flying at the height level of the flood peak, proved to be unbeatable.

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Precise radionuclide localization using UAV-based LiDAR and gamma probe with real-time processing

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[1]AIT Austrian Institute of Technology GmbH, Austria; [2]RIEGL Laser Measurement Systems GmbH, Austria; stephan.schraml@ait.ac.at

In this work we propose an effective radiation source localization device employing a RIEGL VUX-1UAV laser scanner and a highly sensitive Hotzone Technologies gamma radiation probe mounted on a RiCOPTER UAV combined with real-time data processing. The on-board processing and radio communication system integrated within the UAV enables instant and continuously updated access to georeferenced 3D lidar point clouds and gamma radiation intensities. Further processing is done fully automated on the ground. We present a novel combination of both the 3D laser data and the gamma readings within an optimization algorithm that can locate the radioactive source in real-time. Furthermore, this technique can be used to estimate an on-ground radiation intensity, which also considers the actual topography as well as radiation barriers like vegetation or buildings. Results from field tests with real radioactive sources show that single sources can be located precisely, even if the source was largely covered. Outcomes are displayed to the person in charge in an intuitive and user-friendly way, e.g. on a tablet. The whole system is designed to operate in real-time and while the UAV is in the air, resulting in a highly flexible and possibly life-saving asset for first-responders in time-critical scenarios.

Assessing complex damage using pre-disaster optical and post-disaster PolSAR data

Minyoung Jung, Minkyung Chung, Yongil Kim
Seoul National University, Korea, Republic of (South Korea); worldhurrah@snu.ac.kr

Combining pre-disaster optical and post-disaster synthetic aperture radar (SAR) data is regarded as desirable for timely damage assessment, which is essential for the prompt rescue operation. Due to the extreme differences between the two data, however, this combination has not been practically used in the previous research. In this paper, a method to assess the various types of damage caused by disasters using the desirable data combination, particularly pre-disaster very high resolution optical data and post-disaster polarimetric SAR data. The propose5d

method is a rule-based classification, and uses diverse components derived from the two data such as normalized difference vegetation index, polarization orientation angle, SPAN, and entropy. The proposed method was applied to the case study of the 2011 tsunami in Japan. The experimental results demonstrated the potential of the proposed method to assesses the types of tsunami-induced damage in urban and vegetated areas. The achievement in this paper is expected to facilitate efficient and fast disaster-induced complex damage assessment.

GIS-BASED MAPPING OF ESTIMATED FLOOD INUNDATION AREA, GEOMETRICAL ASPECT

Evgeny Panidi[1], Kseniia Popova[2], Valery Tsepelev[2,3]

[1]Saint Petersburg State University, St. Petersburg, Russia; [2]ROSHYDROMET North-West Department for Hydrometeorology and Environmental Monitoring, St. Petersburg, Russia; [3]Russian State Hydrometeorological University, St. Petersburg, Russia; panidi@ya.ru

A full processing chain for inundation modelling/mapping is implemented in different specialised software like HEC-RAS or Flood Modeller. Alternatively, inundation water level can be estimated separately, and then can be mapped in desktop (universal) Geographic Information System (GIS) software. Last approach can be demanded in a complex already-formed GIS-based mapping processing chains, when inundation area mapping appears only as a step of analysis and mapping technology. This context is usual for cadastral accounting of inundation areas. However, such a processing chain have a lack of computation tools, as currently used desktop GISs (e.g., QGIS, ArcGIS, etc.) capable originally to map only a lake-type inundation areas (certainly, in the case of regular software assembly), while along-the-river inundation should have water surface sloping along the river body.

Addressing to the filling the gap of along-the-river inundation mapping in desktop GIS software, we have developed an approach to mapping of river-type inundation area, and implemented it in a test mode to support cadastral accounting of river flood inundation areas. The approach is based upon geometrical modelling of the water surface only, and is not concerned with consideration of hydrogeological conditions and ground water regime. Being simplified, this technique may be rough tool for the cases when hydrogeological aspect have to be respected, however it is simple for implementation and is useful when estimating topography impact only.

Flood Evacuation Routes Mapping Based on Derived- Flood Impact Analysis from Landsat 8 Imagery Using Network Analyst Method (Case Study: West of Surabaya)

Nur Watik, Lalu Muhamad Jaelani

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Denoted by National Disaster Response Agency of Indonesia (BPBD) as many as 94 dies, 149 injured, and more than 88 thousands homeless caused by floods in 2018. Beside bringing casualties to people and environment, the floods also affect the damages to transportation infrastructures in which vital to disaster emergency rensponse operation e.g. evacuation process that can worsen the casualties. Due to the complex impact of current disaster, the demands of providing a short-term response increases accordingly. Therefore, this research proposes a prototype of flood evacuation route utilizing network analyst method. The network analyst method particularly focus on finding alternative route based on time and distance. This research uses a flood simulation model derived from Landsat 8 imagery, slope data, and rainfall data. Subsequenty, the simulation model devides the flood severity based on the depth which consist of < 0,3 m (slight), 0,3-0,5 m (moderate), and > 0,5 m (serious) in order to generate an impact analysis regarding the estimation of damages and casualties. In order to resemble the real situation of flood, barriers (e.g. flood area) are applied into the finding evacuation route procedure. Thereby, the estimated evacuation route can be executed considering the safest and fastest way. Moreover, some comparisons between before and after flood are conducted in order to know the effectiveness of evacuation routes. By such comparison proves that network analyst enables to support disaster management operation with respect to handling the evacuation procedure.

THE USE OF MULTI-TEMPORAL SENTINEL SATELLITES IN THE ANALYSIS OF LAND COVER/LAND USE CHANGES CAUSED BY THE NUCLEAR POWER PLANT CONSTRUCTION

Emre Çolak[1], Madhu Chandra[2], Filiz Sunar[1]

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Session

TS VI: Technical Session Topics: Remote Sensing and GIS as Tools of Natural and Man-Made Disaster Management & Flood Analysis, Drought Monitoring

Time:
Friday, 06/Sep/2019:
11:00am - 1:00pm

Session Chair: **Jürgen Schulz**

Presentations

Constructing the flood evacuation zones based on user-centric time-distance representation

Jung Ok Kim[1], Seula Park[2]
[1]AICT(Advanced Institute of Convergence Technology), Suwon, South Korea; [2]Department of Civil and Environmental Engineering, Seoul National University, Seoul, South Korea; geostar1@snu.ac.kr

This paper aims to provide an approach to flood evacuation mapping for use as an effective resource to support evacuations prompted by a sudden inundation. In particular, we propose an algorithm to generate a flood evacuation cartogram based on an actual evacuation in real-time. The suggested time-distance cartogram minimizes distortion by transforming the evacuation routes and preserves the topological characteristics as a whole. To empirically evaluate its application, we apply this method to Samcheok city in South Korea. As a result, optimal shelter and evacuation routes are derived by considering significant factors influencing the actual access to the facilities and escape routes, such as pedestrian elevation and the expected flood area. Moreover, the flood evacuation cartogram provides a more effective and intuitive visualization than classic topographic maps, by relocating shelters and reshaping the routes intended for evacuation. The suggested method is significant as it provides practical flood evacuation information effectively for people in a flood situation. Our empirical results also provide helpful insights for disaster authorities or policy makers for more efficient evacuation plans.

Airborne Technologies for Disaster Management

Jürgen Schulz
Hansa Luftbild AG, Germany; schulz@hansaluftbild.de

Currently, satellite-based systems and UAVs are very popular in the investigation of natural disasters. Both systems have their justification and advantages - but one should not forget the **airborne** remote sensing technology. The presentation shows with three examples very clearly how airborne remote sensing is still making great progress and in many cases represents the optimal method of data acquisition.

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