# Two Men and Nine Years: Contribution of Karsten Jacobsen and Gürcan Büyüksalih to Photogrammetry and Remote Sensing Activities of Department of Geomatics Engineering at Zonguldak Bülent Ecevit University

Hüseyin Topan<sup>1</sup>, Hakan Akçın<sup>1</sup>, Murat Oruç<sup>1</sup>, Aycan Murat Marangoz<sup>1</sup>, Can Atalay<sup>1</sup>, Çağlar Bayık<sup>1</sup>

<sup>1</sup> Dept. of Geomatics Engineering, Faculty of Engineering, Zonguldak Bülent Ecevit University, 67100, Zonguldak, Türkiye (topan, akcinh, orucmurat, aycanmarangoz, canatalay, caglarbayik)@beun.edu.tr

**Keywords:** Karsten Jacobsen, Gürcan Büyüksalih, Photogrammetry, Remote Sensing, Geospatial Information, Education, Research, Geomatics Engineering, Zonguldak Bülent Ecevit University.

#### Abstract

The millennium witnessed the development of high resolution remote sensing technology and its role in the geospatial information extraction. These developments required the photogrammetric evaluation of these images. Thanks to Dr. Gürcan Büyüksalih's attending to the Department of Geomatics Engineering at Zonguldak Bülent Ecevit University at the beginning of 1998, the education and research studies were started initiated under the guidance of a full-faculty member of the Department. After three years of preparation, a bilateral international project leading in its field was started in cooperation with Dr. Karsten Jacobsen. This paper reviews the contribution of two men to a wide range of photogrammetry and remote sensing activities in the Department of Geomatics Engineering at Zonguldak Bülent Ecevit University between 1998 and 2007. These studies involved not only the high resolution remote sensing images such as SPOT-5, IRS-1C, IKONOS, QuickBird, OrbView-3, Kompsat-1, Landsat but also the optical analogue images such as TK-350, KVR-1000 and MOMS-2P, and microwave data such as SRTM and JERS in terms of geometric analysis, georeferencing accuracy assessment, DSM/DEM generation and validation, and information content for topographic mapping. Thanks to this bilateral co-operation, the concept of mapping from space was developed and supported by many international scientists, making a very important contribution to the development of advanced remote sensing. These research activities were extended by bilateral Erasmus agreements, bilateral academic visits, two training courses which were the first in Türkiye, participation in various national and international scientific events, organisation of an ISPRS workshop and official duties in ISPRS working group.

# 1. Introduction

The success and sustainability of academic studies depend on various factors. Among them, the researcher is one of the most important factors. The research activities on photogrammetry and remote sensing in the Department of Geomatics Engineering at Zonguldak Bülent Ecevit University (BEUN, formerly Zonguldak Karaelmas University) accelerated with Dr. Gürcan Büyüksalih's participation in 1998. Following his collaboration with Dr.-Ing Karsten Jacobsen from IPI (Institute of Photogrammetry and GeoInformation, Leibniz University Hannover, Germany), the Department started the leading research on geospatial information generation and validation. This paper presents the achievements in the sections that i) the first period (1998-2001), ii) the second period (2001-2006), ii) the last period (2007-present), iii) participation to the scientific meetings, iv) organisational activities, and v) educational activities. Finally, the overall contribution of those activities will be concluded.

### 2. The First Period (1998-2001)

The Republic of Türkiye supports the master and doctorate students who would like to complete their educations in foreign countries. The friendship between Prof. Halil Erdal Koçak, the founder of the Department, and Prof. Gordon Petrie in Glasgow University was an opportunity for Dr. Büyüksalih's doctorate stage (Figure 1). He completed his thesis within this program under the supervision of Prof. Petrie at the end of 1997 (Büyüksalih, 1997), on the topic of geometric and radiometric calibration of video infrared imagers for photogrammetric applications. Following his joining to the Dept. of Geomatics Engineering in BEUN, he was responsible of the photogrammetry and the remote sensing courses both in the undergraduate and master programs. The article derived from his thesis were published by Büyüksalih (1999a), Büyüksalih and Akçın (2000), and Büyüksalih (2003). His other publications

reviewed the remote sensing equipments for geospatial applications (Büyüksalih, 1999c; Büyüksalih, 1999d; Büyüksalih, 1999e; Büyüksalih, 2000, 2001), and sub-pixel image matching for photogrammetric applications (Büyüksalih, 1999b).

Following his first experiences in those years, Dr. Büyüksalih realized that studying about his doctorate thesis was difficult with the available research environment. Prof. Petrie suggested him to meet with Dr. Karsten Jacobsen. Then, he contacted and started to study with him, and their first publication subjected the MOMS-2P (Modular Optoelectronic Multispectral Scanner) (Büyüksalih and Jacobsen, 2000). Both Dr. Büyüksalih and Dr. Jacobsen received an international-collaborate project on the geospatial application of remote sensing images in Zonguldak test field, supported by TÜBİTAK (The Scientific and Technological Research Council of Türkiye) and JRC (Jülich Research Centre of Germany). Considering the number of research projects supported by TÜBİTAK run in BEUN and other Turkish research institutions, this was very important milestone, bringing research opportunity for the Department, and turning the research direction to the evaluation of high resolution remote sensing images with respect to various kinds of geospatial information (Büyüksalih, 2001-2005; Jacobsen and Büyüksalih, 2006).



Figure 1. Prof. Halil Erdal Koçak (right), and Prof. Gordon Petrie (left, © ISPRS Bulletin 2020/2).

### 3. The Second Period (2001-2006)

This period began with the two research projects initiated under Dr. Büyüksalih's directorship in 2001. One of them focused on the 3D photogrammetric modelling of traditional Turkish houses in Safranbolu (Karabük), a member city of UNESCO World Heritage. This small scale project was supported by the BEUN Research Fund (Büyüksalih, 2001-2004). Although some publications were recorded by Marangoz et al. (2006b) within this project, the most outcomes were supplied by the second one in this period. The importance of TÜBİTAK&JRC project lay in the opportunities such as various remote sensing images (Figure 2), a budget for field campaigns and travel costs, the hardware and software etc.



Zonguldak was chosen as the test area with its suitable and extreme characteristics for geospatial information extraction, such as mountainous topography, dense urbanised areas, open pit mining facilities, dense forest, various hydrographic bodies (sea, dam, river etc.), and cliffs along the seaside.

On those years, the number of remote sensing missions available free-of-charge were limited, and high resolution images were generally distributed commercially. The Project provided an opportunity of studying new-generation remote sensing images. For instance, IKONOS were launched in 1999, and the group had the opportunity to study it in 2002 (Büyüksalih et al., 2003a; Büyüksalih et al., 2003c). SPOT-5 was another sample, i.e. it was launched in 2002, and the group completed the field campaign between December 2003-April 2004, and the results were published by Büyüksalih et al. (2004d) and Büyüksalih et al. (2005d). ASTER has been operational since 2000, and the group could evaluate its images by Büyüksalih et al. (2004b) and Marangoz et al. (2005a). OrbView-3 images were also investigated for georeferencing accuracy by Büyüksalih et al. (2006), three years after its launch in 2003.

The main topics were the geometric accuracy assessment, DEM (Digital Elevation Model) generation and validation, and the information content analysis for topographic mapping. BLUH (Bundle Block Adjustment University Hannover) developed by Dr. Jacobsen in Fortran was the main academic software while PCI Geomatica and eCognition were used as the commercial ones. The advantages of using BLUH were that Dr. Jacobsen could modify it according to the requirements for handling of images. Table 1 presented the publications, sensor/mission, and the research topics related to this Project. Following sections summarized these three topics.

# 3.1 Geometric Correction and Georeferencing Accuracy Assessment

Among the images handled in the Project, ASTER, TK-350, SPOT 5, IRS-1C, KOMPSAT-1, IKONOS, QuickBird, KVR-1000, and OrbVie-3 images were investigated within this topic. Considering the limited number of publications for TK-350, the Büyüksalih et al. (2005b) and Büyüksalih et al. (2005c) were two journal articles of five listed by Web of Science (WoS), receiving four and ten citations, respectively. Figure 3 shows a part of image with important details. These stereo images were handled with the photogrammetric approach.



Figure 3. A part of TK-350 image with important details (Büyüksalih et al., 2005b).

Publication	Geometric correction, georeferencing accuracy	DEM generation and validation	Information content, object detection
Büyüksalih et al. (2003b), Büyüksalih et al. (2003c)	IKONOS		
Jacobsen (2003a)		ASTER, TK-350, IKONOS	
Jacobsen (2003b), Topan (2012), Topan (2013b), Büyüksalih (2004)	IKONOS		
Jacobsen (2004)		SRTM, SPOT 5, IKONOS	
Koçak et al. (2004)		ASTER, SPOT 5, SRTM, IKONOS	
Büyüksalih et al. (2004a), Sefercik (2006) Büyüksalih et al. (2004b)	ASTER, S	SRTM RTM	
Büyüksalih et al. (2004c)	IKONOS, QuickBird, IRS- 1C KVR 1000		
Büyüksalih et al. (2004d)	SPOT	5	
Marangoz et al. (2004), Akçın et al. (2004), Marangoz et al. (2005c), Alkan et al. (2010a), Alkan et al. (2010b), Alkan et al. (2011)			IKONOS
Oruç et al. (2004), Oruç et al. (2007)			Landsat 7
Şahin et al. (2004a), Şahin et al. (2004b), Şahin           et al. (2005), Akçın and Karakış (2007)			KVR 1000
Topan et al. (2004)			Landsat 7, ASTER, TK-350, IRS- 1C, SPOT 5, IKONOS, KVR-1000
Topan (2004), Topan et al. (2005b)	IRS-1C	A 70 1	
Büyüksalih et al. (2005a) Büyüksalih et al. (2005b)	KOMPSA TK-350 S	AT-I RTM	
Büyüksalih et al. (2005c)	TK-35	50	
Büyüksalih et al. (2005d)	SPOT	5	
Büyüksalih et al. (2005e)		SRTM, TK-350, ASTER, KOMPSAT- 1, SPOT 5, IKONOS	
Jacobsen et al. (2005a)	TK-350, KVR-1000, ASTEF KOMPSAT-1, SPOT 5, IRS 1C, IKONOS, QuickBird	R, -	
Jacobsen et al. (2005b)	IKONOS, QuickBird		
Karakış et al. (2005), Marangoz et al. (2005b), Alkan et al. (2006), Karakış et al. (2006), Karakış et al. (2007), Marangoz et al. (2007), Karakış			QuickBird
(2005), Alkan et al. (2008c) Karakis et al. (2005), Alkan and Can (2007)			
Alkan et al. (2008a), Alkan et al. (2008b), Marangoz and Alkis (2012)			IKONOS, QuickBird
Koçak et al. (2005)		SRTM	
Marangoz et al. (2005a)	ASTER	ſ	
Topan et al. (2005a)			TK-350, KVR-1000, ASTER, KOMPSAT-1, IRS-1C, SPOT-5, IKONOS, QuickBird
Büyüksalih and Jacobsen (2006b)	IKONOS, QuickBird, OrbView-3		
Büyüksalih et al. (2006), Büyüksalih and Jacobsen (2007)	OrbView-3		
Büyüksalih and Jacobsen (2006a)		IKONOS, QuickBird, OrbView-3	
Büyüksalih and Topan (2006), Topan et al. (2006c), Topan et al. (2009a) Topan et al. (2006d), Topan et al. (2009a)			Landsat 7, ASTER, TK-350, KOMPSAT-1, IRS-1C, SPOT-5, IKONOS, QuickBird, OrbView-3
Topan et al. (2006b), Topan et al. (2006a), (Topan et al., 2007), Alkan and Bulut (2010)			OrbView-3
Sefercik et al. (2007)		ASTER, SPOT 5, SRTM	
Topan et al. (2009b) Topan (2009), Topan and Maktav (2010b), Topan and Maktav (2010a), Topan and Maktav (2014), Terlemezoğlu (2019), Terlemezoğlu and Topan (2020)	SPOT 5		IKONOS, QuickBird, OrbView-3
Marangoz et al. (2006a)			Landsat 7, ASTER
Buyüksalıh and Jacobsen (2006b), Topan and Kutoğlu (2009), (Topan, 2013a)	IKONOS, QuickBird, OrbView-3		

Table 1. Publications, research topics and satellite/mission related to the TUBITAK&JRC Project dataset.

SPOT 5 HRG (High Resolution Geometric) panchromatic level 1A stereo images were also investigated with respect to the 3D georeferencing accuracy. Its coverage by  $60 \text{ km} \times 60 \text{ km}$  and the winter season was a challenge for the field campaign for GNSS (Global Navigation Satellite Systems) observations; however, the points were used also for IRS-1C. Figure 4 shows the point distribution for SPOT 5. Büyüksalih et al. (2005d) received 19 citations in WoS.



Figure 4. Point distribution for SPOT 5 (left) and KOMPSAT-1 (right).

Büyüksalih et al. (2005a) was one of limited number of publications out of Korea, subjecting the geometry of KOMPSAT-1 images (Figure 4). The high resolution images such as IKONOS, QuickBird, and OrbView-3 were also handled using RFM (Rational Function Model) and other kinds of sensor independent models (Table 1).

#### 3.2 DEM Generation and Validation

This topic was naturally related to georeferencing accuracy as evidenced by some publications in the Table 1. The DSM (Digital Surface Model) from stereoimages of ASTER, TK-350, SPOT 5, KOMPSAT-1, IKONOS, QuickBird, and OrbVie-3 images were mostly generated by BLUH or PCI Geomatica, and were filtered from DSM to DTM (Digital Terrain Model) using BLUH. These DTMs were typically compared with the SRTM and the height model generated for the 1:25000 topographic maps. The group published the first research from Türkiye by Büyüksalih et al. (2004a) (Figure 5). The advantages using BLUH for assessing the height accuracy were that the generated and reference DEMs were shifted in planimetry at the first stage by DEMSHIFT, and then, the analysis was performed by DEMANAL, which accounted for the inclination of topography, establishing a function between the height accuracy and the inclination.



Figure 5. SRTM X-band DEM (Büyüksalih et al., 2004a).

As an example, Büyüksalih et al. (2004b) estimated the following formulation as a function of the standard deviation of height ( $S_z$ ) and terrain inclination ( $\alpha$ ) for TK-350:

$$S_z = 20.0m + 23.9 * tan \alpha \text{ for open areas}$$
(1)  

$$S_z = 49.0m + 11.4 * tan \alpha \text{ for forest areas}$$
(2)

Considering the point-based evaluation of height models is still preferred by the researchers, those two steps (shift in planimetry and surface based evaluation with a sample formulation by (1) and (2)) were in an advanced level.

# 3.3 Information Content Analysis and Object Detection

The high resolution satellite images such as IKONOS, QuickBird and OrbView-3 started a discussion on their potential of vectoral map generation. There was a belief that, for instance, if the georeferencing accuracy of IKONOS image is  $\pm 1$  GSD (i.e. 1 m), this means this image could be used to generate 1:5000 scale vectoral maps (considering the precision of human eye as 0.2 mm, a line on those maps could be estimated as 5000mm \* 0.2 = 1m). Nevertheless, the georeferencing accuracy and information content for vectoral map are different metrics. The real scale generated by IKONOS image with 1 m GSD was between 1:5000 and 1:10000. The following formulation presents the required GSD of image for a target map scale

$$GSD = (0.2 - 0.5) \cdot 0.25mm \cdot (1:scale)$$
(3)

Effective GSD analysis were another approach to discover the real GSD of images. Among all optical images, TK-350, KVR-1000 and IRS-1C had the effective GSD larger than nominal one. This was caused by the reason of that TK-350 and KVR-1000 images were acquired on the photograph films and scanned to be digitized. IRS-1C had originally 5.6 m GSD, and was distributed in 5.0 m GSD resampled. Nevertheless its 6 bit radiometric resolution caused a blurring effect, and its effective GSD was 6.0 m in our case.

All images, but especially the high geometric resolution images such as IKONOS, QuickBird and OrbView-3 were handled in this topic. The multispectral bands (red, green, blue and near infrared) for IKONOS and QuickBird images were available, and they were also investigated with their pansharpened images generated by BLUH and PCI Geomatica. Figure 6 presents the samples of manual vectorisation of these images. The group published many publications on this topic, and a commercial software, eCognition, were used for object oriented segmentation.



Figure 6. Two samples of manual vectorisation.

The TÜBİTAK&JRC Project officially concluded in 2005. However, its outcomes continued with the group in the following years. This second period was completed at the end of 2006, because Dr. Büyüksalih resigned from the University, and moved

to BİMTAŞ, an İBB (İstanbul Metropolitan Municipality) company. However, the relationship was continued between the group in BEUN, Dr. Büyüksalih and Dr. Jacobsen. The scientific collaboration and research direction were continued, as presented in the last period.

### 4. The Last Period (2007-Present)

This period consisted of the ongoing collaboration between the group, Dr. Büyüksalih and Dr. Jacobsen. As presented in Table 1, the publications were also published after 2006. Dr. Hüseyin Topan, Dr. Umut Güneş Sefercik and Dr. Aycan Murat Marangoz from the group were completed their doctorate studies following their experience gained in the second period. Still, they continue the research, courses and supervisions on their topics. Besides, the participation of national and international scientific events, the bilateral visits, organizing the scientific events etc. were continued, as presented in the following sections.

#### 5. Participation to the Scientific Meetings

The group were advised by the Dr. Büyüksalih and Dr. Jacobsen to participate the national and international scientific meetings. As seen by Table 2, EARSeL (European Association of Remote Sensing Laboratories) and ISPRS (International Society of Photogrammetry and Remote Sensing) were the organisers of most attended meetings by the group.

Publication	Organiser	Location
Büyüksalih and Jacobsen (2000)	RSS	Leicester, UK
Jacobsen (2003a), Jacobsen (2003b)	EARSeL	Ghent, B
Büyüksalih et al. (2003b), Büyüksalih et al. (2004b), Büyüksalih et al. (2004b), Büyüksalih et al. (2005c), Lacobsen et al. (2005b)	ISPRS	Hannover, DE
Büyüksalih et al. (2004a), (Büyüksalih et al., 2004d), Şahin et al. (2004a)	EARSeL	Cairo, EG
Jacobsen (2004)	EARSeL	Dubrovnik, HR
Büyüksalih et al. (2004c), Marangoz et al. (2004), Oruç et al. (2004), Topan et al. (2004), , Şahin et al. (2004b), Koçak et al. (2004), Akçın et al. (2004)	ISPRS	Istanbul, TR
Büyüksalih et al. (2005a), (Topan et al., 2005a)	EARSeL	Porto, PT
Jacobsen et al. (2005a), Karakis et al. (2005), Marangoz et al. (2005a)	RAST	Istanbul, TR
Karakış et al. (2005), Marangoz et al. (2005c), Topan et al. (2005b), Şahin et al. (2005)	НКМО	Ankara, TR
Alkan et al. (2006), Büyüksalih et al. (2006), Karakış et al. (2006), Topan et al. (2006b), Marangoz et al. (2006a)	ISPRS	Ankara, TR
Büyüksalih and Jacobsen (2006a)	EARSeL	Warsaw, PL
Büyüksalih and Topan (2006)	BEUN	Zonguldak, TR
Marangoz et al. (2006b)	EARSeL	Berlin, DE
Topan et al. (2006c)	ITU	Istanbul, TR
Topan et al. (2006d)	ISPRS	Haifa, IL
Büyüksalih and Jacobsen (2006b)	ASPRS	Reno, US

Table 2. The participated scientific meeting between 2000-2006.

MSU (Milli Savunma Üniversitesi, National Defence University) and HKMO (Harita ve Kadastro Mühendisleri Odası, Turkish Chamber of Survey and Cadastre Engineers) were the local organizers of the domestic meetings. Especially the ISPRS XX. Congress in Istanbul (Türkiye) was an opportunity for the group since all members could join one of the most important congress of the community. ISPRS Hannover meetings has an importance place for the group since these meetings were chaired by Prof. Christian Heipke and Dr. Karsten Jacobsen between 2005 and 2017, and the group continued to participate there, not only up to 2007, but also following years. RAST (Recent Advances in Space Technologies) meetings were another most participated international meetings domestically host, and the HKMO Congress series were the most attended national one.

#### 6. Organisational Activities

Dr. Büyüksalih and Dr.-Ing Jacobsen played leading roles or served as members many scientific organisations. Dr.-Ing Jacobsen served one of the directors of the ISPRS Hannover meetings between 2005 and 2017. Additionally, he organised many workshops within EARSeL Symposiums as the chair of SIG (Spacial Interest Group) 3D Remote Sensing (now 3D Mapping). He and Dr. Büyüksalih helped the organisation of ISPRS Ankara Workshop, as the chair and secretary of ISPRS WG-I/5 working group (Figure 7), and Dr. Büyüksalih was local member, and Dr. Jacobsen were international member of ISPRS XXth Congress in Istanbul (Türkiye) in 2004.



a) The group in ISPRS Ankara Workshop (from left: Murat Oruç, Mehmet Güven Koçak\*, Hakan Şahin, Hakan Akçın, Eray Can, Aycan Murat Marangoz, Hüseyin Topan, Kasten Jacobsen, Gürcan Büyüksalih\*, Mehmet Alkan, Serkan Karakış\*) \*: Manually added.



b) An iconic photo under the plate of "We already exceeded our borders." (Safranbolu, 2005).Figure 7. Some photographs from the group.

Considering the unavailability of virtual attendance in those years, these in-situ participations were more challenging and noteworthy than in recent years.

The 1<sup>st</sup> and 2<sup>nd</sup> Educational Course on Mapping from Space, in 2005 and in 2006, respectively, were hosted by BEUN in Zonguldak (Figure 8). These courses reflected the responsibility of the group since they would like to inform the Turkish community about the research topics. Prof. Gottfried Konecny, Prof. Christian Heipke, Prof. Uwe Sörgel, Dr. Kian Pakzad, Dr. Peter Lohmann, and Dr.-Ing. Karsten Jacobsen were the lecturers from IPI, while Dr. Gürcan Büyüksalih, Dr. Hakan Akçın, Dr. Mehmet Alkan and Dr. Mehmet Güven Koçak were from BEUN. The courses were supported by the practical applications using BLUH. Figure 9 presents the Prof. Christian Heipke and Prof. Gottfried Konecny during their speeches.



Figure 8. Course participants (upper: 2005, bottom: 2006).



Figure 9. Prof. Christian Heipke (left), Dr. Büyüksalih and Prof. Konecny (right) during the courses.

The 61th birthday of Dr.-Ing Jacobsen were also celebrated in February 11, 2005, by the Department in Zonguldak, as a grateful of the group (Figure 10).

# 7. Educational Activities

The research atmosphere was naturally an opportunity by the group. By the bilateral visits between Hannover and Zonguldak, the participating the scientific meetings, active studying in field and laboratory, the practice with the broad vary of images using BLUH, PCI Geomatica and eCognition, and scientific discussions (Figure 11).

Hüseyin Topan, Serkan Karakış and Umut Güneş Sefercik completed their master thesis in 2004, 2005 and 2006, respectively. Hüseyin Topan continued the topic of georeferencing accuracy of linear array optical images, and Umut Güneş Sefercik completed his doctorate with the TUBITAK scholarship in Hannover on the topic of DEM generation and validation of microwave images. Besides, Aycan Murat Marangoz studied on the object based segmentation in his doctorate thesis. Umut Güneş Sefercik was one of first two Erasmus student of BEUN history. Dr. Naci Yastıklı from the Dept. of Geomatics Engineering in Yıldız Technical University was the academic visitor during Dr. Jacobsen's visits in Zonguldak. Another researcher was Dr. Ayhan Ateşoglu from the Dept. of Forestry in Bartın University. As mentioned in the 6<sup>th</sup> section, two educational courses were organised for the national researchers in Zonguldak. The Erasmus agreement was available between IPI and the Department between 2005 and 2021.



Figure 10. Dr. Büyüksalih's opening speech for the celebration of the 61th birthday of Dr.-Ing. Karsten Jacobsen.



Figure 11. The group is looking the anaglyph scene generated by Dr. Jacobsen while he tooked the photo in the Photogramemtry and Remote Sensing Laboratory (February 7, 2005, Zonguldak).

# 8. Conclusion

This paper presented two men's scientific contribution on the photogrammetry and remote sensing activities of Department of Geomatics Engineering in BEUN (Zonguldak, Türkiye). 2000s were the milestone of using very high resolution remote sensing images, and the community witnessed the publications on the geospatial information extraction using this kind of images. Among them, the cooperative studies supported by the TÜBİTAK&JRC project garnered significant attention not only in the nation-wide, but also in the international community, with the journal papers, presentations in the scientific meetings, courses etc. As an example of this educational ISPRS&EARSeL&DGPF joint event dedicated to Dr. Jacobsen's 80<sup>th</sup> birthday, the group did not end the deep collaboration with Dr. Jacobsen, continuing with the various projects and academic visits within various programs such as TUBITAK or Erasmus program. The Department organised the third and last educational course with the special emphasis on the geospatial information extraction of remote sensing images and data in 2016, with the support of Dr. Jacobsen, and the effect of scientific direction through georeferencing accuracy assessment and image segmentation for object detection using the optical images were continued by the group members in the Department. Dr. Jacobsen served as an advisor for the Pléiades 1A projects supported by Airbus Defence and Space, BEUN and TUBITAK run in BEUN between 2013-2015.

Finally, this paper was written to present the gratefulness of the authors, and to inform the community summarized the research outcomes initiated in the 2000s and continuing to this day. We wish happy and healthy life to both of them.

#### References

Akçın, H., Karakış, S., 2007. Rus Uydu Görüntüsü KVR-1000'in Topoğrafik Harita Yapımındaki Potansiyeli Üzerine Bir İnceleme, TUFUAB IV. Teknik Sempozyumu, İstanbul, Türkiye, pp. 1-6.

Akçın, H., Karakış, S., Büyüksalih, G., Oruç, M., 2004. GIS Based Analysis of the Detection of Landcoverage Changes Arising From Coal Production Wastes in Zonguldak Metropolitan Area-Turkey, in: Altan, O. (Ed.), ISPRS 2004 Congress. ISPRS, İstanbul, pp. 509-514.

Alkan, M., Arca, D., Bayık, Ç., Marangoz, A.M., 2011. Updating Object For GIS Database Information Using High Resolution Satellite Images: A Case Study Zonguldak, Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., Almanya.

Alkan, M., Bulut, G., 2010. Kent Bilgi Sistemlerinde Yüksek Çözebilirlikli Uydu Görüntülerinin Kullanımı: Kozlu-Zonguldak Örneği, III. Uzaktan Algılama ve Coğrafi Bilgi Sistemleri Sempozyumu.

Alkan, M., Can, E., 2007. Yüksek Çözünürlüklü Uydu Görüntülerinden Otomatik Ve Yarı-Otomatik Yol Obje Çıkarım Metotları ve CBS'de Kullanımı, 11. Türkiye Harita Bilimsel ve Teknik Kurultayı, Ankara.

Alkan, M., Marangoz, A., Karakış, S., 2008a. Feature Extractions from High Resolution Imagery and Using For City Information System, 4th Workshop on Remote Sensing for Developing Countries / GISDECO 8, İstanbul. Alkan, M., Marangoz, A., Karakış, S., Büyüksalih, G., 2006. Verification of Automatic and Manual Road Extraction Methods Using QuickBird Imagery, ISPRS Ankara Workshop 2006, WG I/5 & I/6 Workshop on Topographic Mapping from Space (with Special Emphasis on Small Satellites), Ankara.

Alkan, M., Marangoz, A.M., Karakış, S., 2008b. Feature Extractions from High Resolution Imagery and Using For City Information System, 4th Workshop on Remote Sensing for Developing Countries.

Alkan, M., Sefercik, U., Marangoz, A., Karakis, S., 2010a. Updating Objects for Topographic Map Information Using High Resolution Satellite Images of Zonguldak Testfield, 30th EARSeL Symposium, Remote Sensing for Science, Education and Culture, Paris, France, pp. 1-7.

Alkan, M., Sefercik, U.G., Oruç, M., 2008c. Integration of High Resolution Quickbird Images to GoogleEarth, XXIst ISPRS Congress: Technical Commission I.

Alkan, M., Yıldırım, Y., Oruç, M., 2010b. Düzensiz Katı Atık Depolama Alanı İle Deniz Kıyı Çizgisi Arasındaki Zamansal Değişimlerin Yüksek Çözünürlüklü Uydu Görüntüleri İle Belirlenmesi, III. Uzaktan Algılama ve Coğrafi Bilgi Sistemleri Sempozyumu, Kocaeli.

Büyüksalih, G., 1997. Geometric and Radiometric Calibration of Video Infrared Imagers for Photogrammetric Applications, Faculty of Science. Glasgow University, Glasgow, UK, p. 500. Büyüksalih, G., 1999a. Kızılötesi CCD Kameralar ve Teknik Özellikleri. Harita Dergisi 66, 28-40.

Büyüksalih, G., 1999b. Piksel-altı Doğruluklu Digital Görüntü Eşleştirme Teknikleri ve Fotogrametrik Aplikasyonları, 7. Türkiye Harita Bilimsel ve Teknik Kurultayı, Ankara, Turkey, pp. 73-89.

Büyüksalih, G., 1999c. Son Teknoloji Uzaktan Algılama Sistemleri ve Harita Yapım Amaçlı Yeterlilik Düzeylerinin Değerlendirilmesi, in: Yomralıoğlu, T. (Ed.), Yerel Yönetimlerde Kent Bilgi Sistemi Uygulamaları Sempozyumu. KTÜ, Trabzon, Turkey.

Büyüksalih, G., 1999d. Topoğrafik Harita Üretimi İçin Geliştirilmiş Uzaktan Algılama Donanımları. Harita ve Kadastro Mühendisleri Odası Dergisi.

Büyüksalih, G., 1999e. Uydu Görüntüleme Sistemleri ve Harita Üretimi Açısından Eksiklikleri. Yıldız Teknik Üniversitesi Dergisi 1999-4, 66-75.

Büyüksalih, G., 2000. Doğrusal Dizin (Pushbroom) Görüntüleme Sistemleri. Pamukkale Üniversitesi Mühendislik Fakültesi Mühendislik Bilimleri Dergisi 6, 219-229.

Büyüksalih, G., 2001. Yüksek Çözünürlüklü Uydu Görüntülerinin Özellikleri ve Aplikasyonları. HKM Jeodezi, Jeoinformasyon ve Arazi Yönetimi Dergisi 87, 48-60.

Büyüksalih, G., 2001-2004. Safranbolu'nun Tarihi ve Kültürel Varlıklarının Kalıcı Kaydının Dijital Fotogrametrik Yöntemlerle Oluşturulması, in: Akçın, H., Marangoz, A.M., Oruç, M., Şahin, H., Köksal, E. (Eds.), Zonguldak.

Büyüksalih, G., 2001-2005. Türkiye'deki Bir Test Alanında Topoğrafik Harita Yapımı Amaçlı Uydu Görüntülerinin

Geometrik ve Semantik Analizi Projesi, in: Akçın, H., Koçak, M.G., Şahin, H., Topan, H., Karakış, S., Oruç, M., Marangoz, A.M. (Eds.), Zonguldak.

Büyüksalih, G., 2003. Geometric calibration models of infrared cameras and scanners for photogrammetric and remote sensing applications. Optical Engineering 42, 1923-1934.

Büyüksalih, G., 2004. Generation and Validation of High Resolution Space Image DEMs, ASPRS 2004 Annual Conference "Mountains of Data -Peak Decisions", Colorado, USA, pp. 1-11.

Büyüksalih, G., Akçın, H., 2000. Fotogrametri ve Uzaktan Algılama Uygulamalarında Kullanılan Video Sistemleri ve Teknik Özellikleri. Harita Dergisi 67, 41-55.

Büyüksalih, G., Akçın, H., Jacobsen, K., 2006. Geometry of OrbView-3 Images, ISPRS Topographic Mapping From Space (with Special Emphasis on Small Satellites), Ankara, Turkey.

Büyüksalih, G., Akçın, H., Marangoz, A., Jacobsen, K., 2005a. Potential of KOMPSAT-1 for Mapping Purposes, 25th EARSEL Symposium, Porto.

Büyüksalih, G., Jacobsen, K., 2000. Geometric Aspects of MOMS-2P Three-Line Imagery for Mapping Applications, Annual Meeting of the Remote Sensing Society, Leicester, UK.

Büyüksalih, G., Jacobsen, K., 2006a. Comparison of DEM generation by very high resolution optical satellites, 26th EARSeL Symposium on New Developments and Challenges in Remote Sensing, Warsaw, Poland, pp. 627-637.

Büyüksalih, G., Jacobsen, K., 2006b. Comparison of Very High Resolution Space Images, Annual Conference of the American Society for Photogrammetry and Remote Sensing 2006: Prospecting for Geospatial Information Integration, Reno, USA, pp. 197-204.

Büyüksalih, G., Jacobsen, K., 2007. Digital Surface Models in Build Up Areas based on Very High Resolution Space Images, ASPRS Annual Conference 2007: Identifying Geospatial Solutions, Tampa, US, pp. 118-125.

Büyüksalih, G., Koçak, G., Jacobsen, K., 2004a. Quality Assessment of DEM derived from the SRTM X- and C-band Data: A Case Study for Rolling Topography and Dense Forest Cover, EARSeL Workshop on Remote Sensing for Developing Countries, Cairo, Eygpt.

Büyüksalih, G., Koçak, G., Oruç, M., 2005b. Geometric Accuracy Evaluation of the DEM Generated by Russian TK-350 Stereo Scenes Using the SRTM X- and C-Band Interferometric DEMs. Photogrammetric Engineering & Remote Sensing 71, 1295-1301.

Büyüksalih, G., Koçak, G., Oruç, M., Akçın, H., Jacobsen, K., 2003a. Handling of Ikonos Images from Orientation up to DEM Generation, Proc. of Joint ISPRS Workshop "High Resolution Mapping from Space 2003", Hannover.

Büyüksalih, G., Koçak, G., Oruç, M., Akçın, H., Jacobsen, K., 2004b. DEM Generation by Aster and TK-350, Joint ISPRS Workshop "High Resolution Mapping from Space 2003", Hannover.

Büyüksalih, G., Koçak, G., Oruç, M., Akçın, H., Jacobsen, K., 2005c. Accuracy Analysis, DEM Generation and Validation Using Russian TK-350 Stereo-Images. The Photogrammetric Record 19, 200-218.

Büyüksalih, G., Koçak, G., Topan, H., Oruç, M., Marangoz, A., 2005d. SPOT Revisited: Accuracy Assessment, DEM Generation and Validation from Stereo SPOT 5 HRG Images. Photogrammetric Record 20, 130-146.

Büyüksalih, G., Koçak, M., Oruç, M., Akçın, H., Jacobsen, K., 2003b. Handling of Ikonos Images from Orientation up to DEM Generation, Proc. of Joint ISPRS Workshop "High Resolution Mapping from Space 2003", Hannover.

Büyüksalih, G., Marangoz, A., Jacobsen, K., 2005e. Generation and Analysis of Height Models based on Satellite Information, ISPRS Hannover Workshop 2005: High-Resolution Earth Imaging for Geospatial Information, Hannover, 17 – 20 May, 2005, Hannover.

Büyüksalih, G., Oruç, M., Jacobsen, K., 2004c. Precise Georeferencing of Rectified High Resolution Space Images, Int. Arch. of Photogrammetry & Remote Sensing, Istanbul.

Büyüksalih, G., Oruç, M., Koçak, G., 2003c. Geometric Accuracy Testing of Ikonos Geo-Product Mono Imagery Using Different Sensor Orientation Models. Turkish Journal of Engineering and Environmental Sciencies 27, 347-360.

Büyüksalih, G., Oruç, M., Topan, H., Jacobsen, K., 2004d. Geometric Accuracy Evaluation, DEM Generation and Validation for SPOT-5 Level 1B Stereo Scene EARSeL Workshop, Remote Sensing for Developing Countries, Cairo (Egypt).

Büyüksalih, G., Topan, H., 2006. Uzaydan Harita Yapımı, II. Ulusal Mühendislik Kongresi, Zonguldak, Türkiye. Jacobsen, K., 2003a. DEM Generation from Satellite Data. EARSeL, Ghent, Belgium, p. 14.

Jacobsen, K., 2003b. Orthoimages and DEMs by QuickBird and IKONOS, EARSeL Symposium, Ghent, Belgium.

Jacobsen, K., 2004. Analysis of Digital Elevation Models Based on Space Information, 24th EARSeL Symposium, Dubrovnik, Crotia.

Jacobsen, K., Büyüksalih, G., 2006. Mapping From Space-A Cooperation of Zonguldak Karaelmas University and University of Hannover, Fifth International Symposium" Turkish-German Joint Geodetic Days, pp. 28-31.

Jacobsen, K., Büyüksalih, G., Marangoz, A., Sefercik, U., Büyüksalih, İ., 2005a. Geometric Conditions of Space Imagery for Mapping, 2nd International Conference on Recent Advances in Space Technologies Space in the Service of Society RAST 2005, İstanbul.

Jacobsen, K., Büyüksalih, G., Topan, H., 2005b. Geometric Models for the Orientation of High Resolution Optical Satellite Sensors, ISPRS Hannover Workshop 2005: High-Resolution Earth Imaging for Geospatial Information, Hannover.

Karakis, S., Topan, H., Buyuksalih, G., Marangoz, A., Jacobsen, K., 2005. Semantic analysis of space imagery for mapping purposes, Proceedings of 2nd International Conference on

Recent Advances in Space Technologies, 2005. RAST 2005., pp. 500-504.

Karakış, S., 2005. QuickBird Örneğinde Yüksek Çözünürlüklü Uydu Görüntüsü Üzerinden Kentsel Ayrıntıların Otomatik ve Manuel Çıkarımı Üzerine Uygulama / Automatic and Manual Extraction of Urban Features from QuickBird High Resolution Space Imagery, Geomatik Mühendisliği. ZBEÜ.

Karakış, S., Marangoz, A., Büyüksalih, G., 2005. Quickbird Pan-Sharpened Görüntüsü Üzerinden Otomatik Detay Çıkarımı ve Coğrafi Bilgi Sistemlerine Uygunluğunun Analizi, TMMOB Harita ve Kadastro Mühendisleri Odası 10. Türkiye Harita Bilimsel ve Teknik Kurultayı, Ankara.

Karakış, S., Marangoz, A., Büyüksalih, G., 2006. Analysis of Segmentation Parameters in Ecognition Software Using High Resolution Quickbird MS Imagery, ISPRS Ankara Workshop 2006, WG I/5 & I/6 Workshop on Topographic Mapping from Space (with Special Emphasis on Small Satellites), Ankara.

Karakış, S., Marangoz, A., Topan, H., Şahin, H., 2007. Pan-sharp QuickBird Görüntüsü Kullanılarak Nesne-Tabanlı Görüntü Analizi ve Ekran Üzerinden Elle Sayısallaştırma Yöntemlerinin Karşılaştırılması, 11. Türkiye Harita Bilimsel ve Teknik Kurultayı, Ankara.

Koçak, G., Büyüksalih, G., Oruç, M., 2005. Accuracy Assessment of Interferometric Digital Elevation Models Derived from the Shuttle Radar Topography Mission X- and C-Band Data in a Test Area With Rolling Topography and Moderate Forest Cover. Optical Engineering 44, 1-7.

Koçak, M.G., Büyüksalih, G., Jacobsen, K., 2004. Analysis of Digital Elevation Models Determined by High Resolution Space Images, in: Altan, O. (Ed.), 20th ISPRS Congress on Technical Commission VII, İstanbul, Türkiye, pp. 636-641.

Marangoz, A., Alkış, Z., 2012. Nesne-Tabanlı Görüntü Sınıflandırma Yöntemlerini Kullanarak Uydu Görüntülerinden Kentsel Detayların Belirlenmesi, Haritaların Güncellenmesi ve CBS'ye Entegrasyonu, IV. Uzaktan Algılama ve Coğrafi Bilgi Sistemleri Sempozyumu, Zonguldak.

Marangoz, A., Büyüksalih, G., Büyüksalih, İ., Sefercik, U., 2005a. Geometric Evaluation, Automated DEM and Orthoimage Generation from Along-Track Stereo ASTER Images, 2nd International Conference on Recent Advances in Space Technologies Space in the Service of Society (RAST 2005), İstanbul.

Marangoz, A., Karakış, S., Akçın, H., 2007. Object-Based Automatic Classification of Urban Open Green Areas Using High Resolution QuickBird Imagery and Integration to GIS, 27th EARSeL Symposium on Geoinformation in Europe, EURAC Research, Bolzano.

Marangoz, A., Karakış, S., Akçın, H., Oruç, M., 2005b. Kentsel Alanlarda Ağaçlık ve Yeşil Alanların Uydu Görüntülerinden Nesne-Tabanlı Çıkarımı Ve Coğrafi Bilgi Sistemlerine Entegrasyonu, Ege CBS Sempozyumu, Ege Üniversitesi Coğrafya Bölümü, İzmir.

Marangoz, A., Karakış, S., Oruç, M., 2006a. Analysis of Object-Oriented Classification Results Derived From Pan-sharpened LANDSAT 7 ETM+ and ASTER Images, ISPRS Ankara Workshop 2006, WG I/5 & I/6 Workshop on Topographic Mapping from Space (with Special Emphasis on Small Satellites), Ankara.

Marangoz, A., Karakış, S., Oruç, M., Büyüksalih, G., 2005c. Nesne-Tabanlı Görüntü Analizi ve Ikonos Pan-Sharpened Görüntüsünü Kullanarak Yol ve Binaların Çıkarımı, TMMOB Harita ve Kadastro Mühendisleri Odası 10. Türkiye Harita Bilimsel ve Teknik Kurultayı, Ankara.

Marangoz, A., Karakış, S., Oruç, M., Şahin, H., Sefercik, U., Topan, H., Büyüksalih, G., 2006b. 3D Cultural Heritage Documentation of Safranbolu Test Site Using High Resolution Satellite Imagery, 1st Workshop of the EARSeL Special Interest Group Urban Remote Sensing "Urban Remote Sensing Challenges & Solutions", Berlin.

Marangoz, A., Oruç, M., Büyüksalih, G., 2004. Object-oriented Image Analysis and Semantic Network for Extracting the Roads and Buildings from Ikonos Pan-sharpened Images, ISPRS XX. Kongresi, İstanbul.

Oruç, M., Marangoz, A., Büyüksalih, G., 2004. Comparison of Pixel-based and Object-oriented Classification Approaches Using Landsat-7 ETM Spectral Bands, ISPRS XX. Kongresi, İstanbul.

Oruç, M., Marangoz, A., Karakış, S., 2007. Pan-Sharp Landsat 7 ETM+ Görüntüsü Kullanılarak Piksel-Tabanlı ve Nesne-Tabanlı Sınıflandırma Yaklaşımlarının Karşılaştırılması, 11. Türkiye Harita Bilimsel ve Teknik Kurultayı, Ankara.

Sefercik, U., Jacobsen, K., Oruç, M., Marangoz, A., 2007. Comparison of SPOT, SRTM and ASTER DEMs, ISPRS Hannover Workshop 2007 – High Resolution Earth Imaging for Geospatial Information, Hannover.

Sefercik, U.G., 2006. Accuracy assessment of digital elevation models derived from shuttle radar topography mission (SRTM), Fen Bilimleri Enstitüsü. Zonguldak Karaelmas Üniversitesi, Zonguldak, p. 100.

Şahin, H., Büyüksalih, G., Akçın, H., Topan, H., Karakış, S., Marangoz, A., 2004a. Information Content Analysis of KVR-1000 Ortho-Image Based on the Available Topographic Maps in the GIS Environment, EARSeL Workshop on Remote Sensing for Developing Countries, Kahire, Mısır.

Şahin, H., Karakış, S., Topan, H., Marangoz, A., 2005. KVR-1000 Uydu Görüntüsü Üzerinden Elle Sayısallaştırma ve Nesneye Yönelik Görüntü Analizi Yöntemlerinin Karşılaştırılması, 10. Türkiye Harita Bilimsel ve Teknik Kurultayı, Ankara.

Şahin, H., Topan, H., Karakış, S., Marangoz, A., 2004b. Comparison of Object Oriented Image Analysis and Manual Digitizing for Feature Extraction, in: Altan, O. (Ed.), International Archives of Photogrammetry and Remote Sensing, İstanbul, pp. 114-118.

Terlemezoğlu, B., 2019. Optik Uydu Görüntülerinin Yöneltmesinde Oluşan Kötü Şartlı Matrislerin İyileştirilmesi (Regularization of the Ill-Conditioned Matrix Arising in Orientation of Optical Spaceborne Images), Graduate School of Science Engineering and Technology, Department of Geomatics Engineering. Zonguldak Bülent Ecevit University, Zonguldak, p. 109.

Terlemezoğlu, B., Topan, H., 2020. Eigenvalue-Based Approaches for Solving an Ill-Posed Problem Arising in Sensor Orientation. IEEE Transactions on Geoscience and Remote Sensing 58, 1920-1930.

Topan, H., 2004. Yörünge Düzeltmeli IRS-1C/1D Pankromatik Mono Görüntüsünün Geometrik Doğruluk ve Bilgi İçeriği Açısından İncelenmesi, Fen Bilimleri Enstitüsü. Zonguldak Karaelmas Üniversitesi.

Topan, H., 2009. Geometric Analysis of High Resolution Space Images Using Parametric Approaches Considering Satellite Orbital Parameters, Department of Geomatics Engineering. Istanbul Technical University, İstanbul, p. 113.

Topan, H., 2012. Yüksek Çözünürlüklü Uydu Görüntülerinin Koordinatlandırılmasında RFM Kullanımı, IV. Uzaktan Algılama ve Coğrafi Bilgi Sistemleri Sempozyumu (UZAL-CBS 2012), Zonguldak.

Topan, H., 2013a. First Experience with Figure Condition Analysis Aided Bias Compensated Rational Function Model for Georeferencing of High Resolution Satellite Images. Journal of the Indian Society of Remote Sensing 41, 807-818.

Topan, H., 2013b. Yüksek Çözünürlüklü Uydu Görüntülerinin Koordinatlandırılmasında RFM Kullanımı. Havacılık ve Uzay Teknolojileri Dergisi 6, 81-86.

Topan, H., Büyüksalih, G., Jacobsen, K., 2004. Comparison of Information Contents of High Resolution Space Images, in: Altan, O. (Ed.), International Archives of Photogrammetry and Remote Sensing, İstanbul, pp. 583-588.

Topan, H., Büyüksalih, G., Jacobsen, K., 2005a. Information Contents of High Resolution Satellite Images, EARSeL Workshop on 3D Remote Sensing, Porto.

Topan, H., Büyüksalih, G., Jacobsen, K., 2006a. Information Content of High-resolution Satellite Images: Mapping with OrbView-3 Images. GIM International 20, 14-17.

Topan, H., Büyüksalih, G., Jacobsen, K., 2006b. Information Contents of OrbView-3 for Topographic Mapping, ISPRS Ankara Workshop 2006 Topographic Mapping from Space (with Special Emphasis on Small Satellite), Ankara.

Topan, H., Büyüksalih, G., Koçak, G., 2005b. IRS-1C Düzey 1B Görüntüsünün Geometrik Analizinin Sensör Yöneltme Modelleriyle ve Değişik Referans Verileriyle İrdelenmesi, 10. Türkiye Harita Bilimsel ve Teknik Kurultayı, Ankara, pp. 895-902.

Topan, H., Büyüksalih, G., Maktav, D., 2007. Mapping Potential of Orbview-3 Panchromatic Image in Mountainous Urban Areas: Results of Zonguldak Test-Field, Urban Remote Sensing Joint Event 2007 (4th IEEE GRSS/ISPRS Joint Workshop on Remote Sensing and Data Fusion over Urban Areas & 6th International Symposium of Remote Sensing of Urban Areas), Paris, France.

Topan, H., Kutoğlu, Ş.H., 2009. Georeferencing Accuracy Assessment of High-Resolution Satellite Images Using Figure Condition Method. IEEE Transactions on Geoscience and Remote Sensing 47, 1256-1261.

Topan, H., Maktav, D., 2010a. GeoSpot: Doğrusal Dizi Uydu Görüntülerinin Uydu Yörünge Parametreleri ile Demet Dengelenmesi, III. Uzaktan Algılama ve Coğrafi Bilgi Sistemleri Sempozyumu, Kocaeli.

Topan, H., Maktav, D., 2010b. SPOT-5 HRG 1A Stereo Görüntülerinin Geometrik Doğruluğunun Uydu Yörünge Bilgilerini Kullanan Parametrik Modelle İncelenmesi. İTÜ Dergisi D 9, 59-72.

Topan, H., Maktav, D., 2014. Efficiency of Orientation Parameters on Georeferencing Accuracy of SPOT-5 HRG Level-1A Stereoimages. IEEE Transactions on Geoscience and Remote Sensing 52, 3683-3694.

Topan, H., Maktav, D., Büyüksalih, G., 2006c. Uydu Görüntülerinin Bilgi İçeriğinin Topografik Harita Yapımı Açısından İncelenmesi, I. Uzaktan Algılama – CBS Çalıştay ve Paneli, İstanbul.

Topan, H., Maktav, D., Jacobsen, K., Buyuksalih, G., 2009a. Information content of optical satellite images for topographic mapping. International Journal of Remote Sensing 30, 1819-1827.

Topan, H., Maktav, D., Jacobsen, K., Büyüksalih, G., 2006d. Mapping Potential of High Resolution Space Images in Mountainous Urban Areas, International Archives of Photogrammetry and Remote Sensing, Haifa.

Topan, H., Oruç, M., Jacobsen, K., 2009b. Potential of Manual and Automatic Feature Extraction From High Resolution Space Images in Mountainous Urban Areas, ISPRS Hannover Workshop 2009 High-Resolution Earth Imaging for Geospatial Information, Hannover.