International Journal of Engineering and Geosciences (IJEG),
Vol; 2; , Issue; 02, pp. 41-51, June, 2017, ISSN 2548-0960, Turkey,
DOI: 10.26833/ijeg.297271

PREFERENCE CHANGES DEPENDING ON AGE GROUPS OF CRITERIA AFFECTING THE REAL ESTATE VALUE

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ABSTRACT: In this study, whether or not the criteria affecting plot value changes depending on age was investigated in Ankara, Konya and Kayseri, which are three major cities of The Central Anatolian Region in Turkey, through survey method. 2,531 respondents, who were 18 and older, were included in the survey based on a technical viewpoint. Respondents consisted of 559 experts and 1,915 citizens. Fifty seven survey forms were considered invalid for several reasons and excluded from evaluation. The experts were selected from among people who worked on real estate valuation by using The Purposeful Sampling Method. The citizens were chosen from among people who could as well be agents in purchase and sale of the real estate by using The Simple Random Sampling Method. The survey questions were prepared on a Five-Point Likert Scale. These were made up of a total 82 questions and two main titles as locational (64 criteria) and neighbourhood (18 criteria) features (except for demographic questions). The age of the respondents was classified into six different groups. Whether or not averages of criteria were significantly different depending on the age groups was tested by ANOVA. Differences between the age groups were determined through several criteria.

Keywords: *Real Estate Valuation, Plot, Criteria, Survey, Age.*

1. INTRODUCTION

Real estate is patches or pieces of land essentially belonging to a country and reserved for public or private use. Real estates are used for shelter, trade, production and as public areas. Besides, they change the velocity of the economy through project designing, credit arrangement and tax imposing. Real estate valuation is the process of determining the purchase and sale value of real estates on the market under certain conditions for a certain period of time. The acceleration in global population and development has increased the variety and amount of the human requirements. Particularly with the growth in communication, logistics and transportation, a rapid change and progress is witnessed chiefly in trade. This commercial and social globalization has made real estate valuation more crucial. Therefore, the values of real estates are important and the reasons for the valuation of real estates in Europe and on a global scale are more or less the same; however, the tools and methods used in the process of valuation are not so (Köktürk 2009). The work of valuation is an extensive field of expertise which needs to be handled with its technical, economical and legal aspects (Açlar et al., 2003). Determination of the values of real estates accurately, objectively and reliably by experts is an issue on which all the countries dwell, particularly from an economical perspective.

The real estates valuable for national and international investors are parts of the economy. Acquisition of a real estate requires making crucial decisions in every aspect in a person's life for the purpose of shelter or trade in terms of personal and domestic economy. In parallel with global changes, the regulations concerning real estates may be faced with constant changes through reforms. For instance, imposing tax on urban rent and protection laws for agricultural fields are the most obvious among them. In addition, real estate certificate is also one of them so that the real estate can be divided into shares and it can be sold or bought easily. However, legislation that is coherent and strong in terms of sanctions is required for these purposes to be realized. The value given to the real estate in Turkey may sometimes not have any material equivalent. A spiritual value may be attached to some real estates inherited from ancestor(s) due to the past experiences. Historical and very special real estates in terms of their location are within these exceptions. Because they are not in consideration for sale, they are not valued for a price. But the values of the real estates must be known so that they can be taxed. Thus, a valuation process of real estates that is easily modeled transparently is required. A move in valuation from reality in terms of price/benefit would give rise to new problems. All these problems and uncertainties could as well lead to a new economic crisis in time.

The value of the real estates exhibits less change in countries with a stable economy. Further, they maintain their values in the face of inflation even in harsh economic conditions. Thus, the acquisition of a real estate has become more common both because of a necessity and with a view to investment. The increase in the need for real estates in the social and economic sense has brought out the credit system called mortgage. As the volume of the real estates has grown in the economy, their contribution to the economy in such aspects as credit and tax has also increased. Mortgage history has its roots in ancient civilizations. The rise of the United States' mortgage market occurred between 1949 and the turn of the 21st century. The mortgage debt to income ratio rose from 20 to 73 percent during this time. However, the economic crisis that took place in 2008 because mortgage credits could not be paid back escalated into a Global Economic Crisis (Mortgage Calculator, 2016). Mortgage system was introduced into Turkey in 2007. A lot of regulations were made in the legislation concerning the system. It is necessary to establish the value of the real estate close to the actual value on the market in accordance with the legislation in order for other crises not to occur. Investment in real estate in Turkey has increased more with the mortgage system. Mortgage system has lowered average age of the real estate buyers. Before the mortgage system, the people with a low income could only buy a real estate after the retirement. After the mortgage system, the real estate ready for use is financed by banks and the repayment is arranged in installments to continue for years. Along with the mortgage system, people of all ages can now buy a real estate, which is prompted by an increase in the income level of the household. This makes it possible to learn the criteria people consider while buying a real estate for every age group.

The surveys conducted in the literature were generally conducted to value real estates and to rank the criteria after weighting them (Yomralıoğlu, 1993; Bender et al., 2000; Kryvobokov, 2005; Nişancı, 2005; Yalpir, 2007; Çakır and Sesli, 2013). A survey was carried out in several countries by The United Nations Economic Commission for Europe Working Party on Land Administration (UNECE WPLA) between 2000-2001 and 2011 (UNECE WPLA, 2001; 2014). In addition, there are studies based on specific criteria such as large urban parks (Hammer et al., 1974), traffic noise (El-Gohary, 2004; Szczepanska et al., 2015), air pollution (Ridker and Henning, 1967; Zheng et al., 2014), view value (Jim and Chen, 2009; Damigos and Anyfantis, 2011), İstanbul Finance Center Project (Teker et al., 2012), shale gas (Lipscomb et al., 2012; Muehlenbachs et al., 2015) and zebra mussels (Henry, 2013). Hurma et al., 2012 determined criteria affecting the value of agricultural land. Also, there are applications with modern methods such as artificial intelligence in real estate valuation (Selim, 2009; Kuşan et al., 2010; Bulut et al., 2011; Yalpir et al., 2014). Yet, there are no studies that research whether the criteria for real estates changes with age groups of people.

In this study, plot was taken into account as a sort of real estate. The purpose of this study is to establish whether there are any significant differences in the criteria affecting the value of the plot depending on the age. Survey questions were asked to experts working on real estate valuation and to citizens interested in this field. The age, one of the demographic questions, was asked as an open-ended question. Age factor was grouped as "no answer", "18-29", "30-39", "40-49", "50-59" and "60+". The criteria affecting the value of the plot were grouped into two main titles that are locational and neighbourhood features. ANOVA analysis test was used to see if there were any significant

differences between the averages (av.) of the criteria according to the age groups.

2. MATERIAL AND METHODS

2.1. Study Areas

It is investigated by taking into account population, the number of voters, population increase speed and net speed of migration, the number of sales, housing mortgage and the number of processes in zoning applications relative to all city located in the Central Anatolian Region. For this reason, Ankara, Konya and Kayseri are determined as study areas (Figure 1).

Figure 1. Study areas

2.2. Plot

In a general sense, real estates vary, depending on the purpose of use. In Turkey, they are classified as plot, land and building (Real Estate Tax Law, 1970, Article 1-12). The buildings are further divided into housing (buildings in residential areas), commercial (Shopping Centers, restaurants, etc.), public buildings (schools, hospitals, etc.) and industrial buildings (factories, thermal power plants, etc.) (Yomralıoğlu, 1997; Yalpir, 2007; USPAP, 2013). Zoning parcel, defined as plot, is the form of cadastral parcels designed according to the Zoning Law, the zoning plan and directives (Zoning Law, 1985, Article 5).

For this reason, licensed buildings can only be constructed on the real estate qualified as a plot. However, for the purpose of shelter, multi-storey (>2) and licensed buildings cannot be constructed on the land. The real estates used for agricultural purposes, such as fields, vineyards and orchards, are defined as land. This important distinction between plot and land is also reflected on their economical value.

2.3. The Criteria Affecting the Value of the Plot

The criteria affecting the value of the plot were laid down after the directives related to real estate evaluation and academic studies were examined. The literature contains post-graduate/doctorate theses, national and international papers, international standards, reports by valuation experts and valuators, laws, regulations, circulars and notifications. The criteria affecting the value of a real estate are sorted as locational, neighbourhood, legal and physical ones. In this study, the choices regarding the criteria, which are under two main titles, “locational features” and “neighbourhood features” were examined in accordance with the age distribution.

Locational features involve social facilities that could be present around the plot (especially walking distance). These are composed of the subtitles of health-care organizations, educational institutions, public agencies and security units, attraction, shopping, cultural and entertainment centers, green areas, transportation networks, insanitary areas, industrial areas, cemeteries, worship places, business centers, parking areas and view. Neighbourhood features constitute the situation of the neighbourhood in which the plot is located. These are given under the subtitles of population, environmental perspective of the neighbourhood and underground, ground, over-ground features. Under most of the subtitles are the criteria (Figure 2). Survey questions were formed with the arrangement of this hierarchical structure.

Survey questions were prepared through five-point Likert Scale (Table 1). Five-point Likert Scale was arranged as not important (1), a little important (2), moderately important (3), important (4) and very important (5). The criteria have increasing/decreasing effects on the value of the plot. Therefore, the positive effect (+) and the negative effect (-) were also added to the survey questions. The respondents were asked to answer the questions by considering the effects of the criteria on the value of the plot and comparing them with each other. Demographic questions are related to the place of residence, the age, the gender, the level of education and the job. Of them, we considered the feature of age and studied whether there was a significant difference between the average values of the criteria.

Table 1 Explanations Survey Questions

Question Group	Question Type	The Scale
Locational Features	Open-ended questions	Five-point likert scale
Neighbourhood Features	Open-ended questions	Five-point likert scale
General Situation	Open-ended questions	The total-fixed scale
Demographic Questions	Open- and closed-ended questions	A mixed scale (multiple choice, script writing, etc.)

Based on this situation, Null (H_0) and alternative (H_A) hypotheses were formed as follows:
H_0= There are no differences between the average values belonging to age groups.
H_A= There is a difference between the average values belonging to at least two age groups.

2.4. One Way Variance Analysis (ANOVA)

In practice, the test required to study the differences and to compare more than two groups is one way variance analysis (Analysis of Variance-ANOVA) (Altunışık et al., 2010). ANOVA is the process of testing whether the difference between two or more related samples is significantly different from null in any way.

The following assumptions must be fulfilled for this analysis to be conducted (Gulnar, 2007):

1. The measuring level of the dependent variable must be at the least spacing scale.

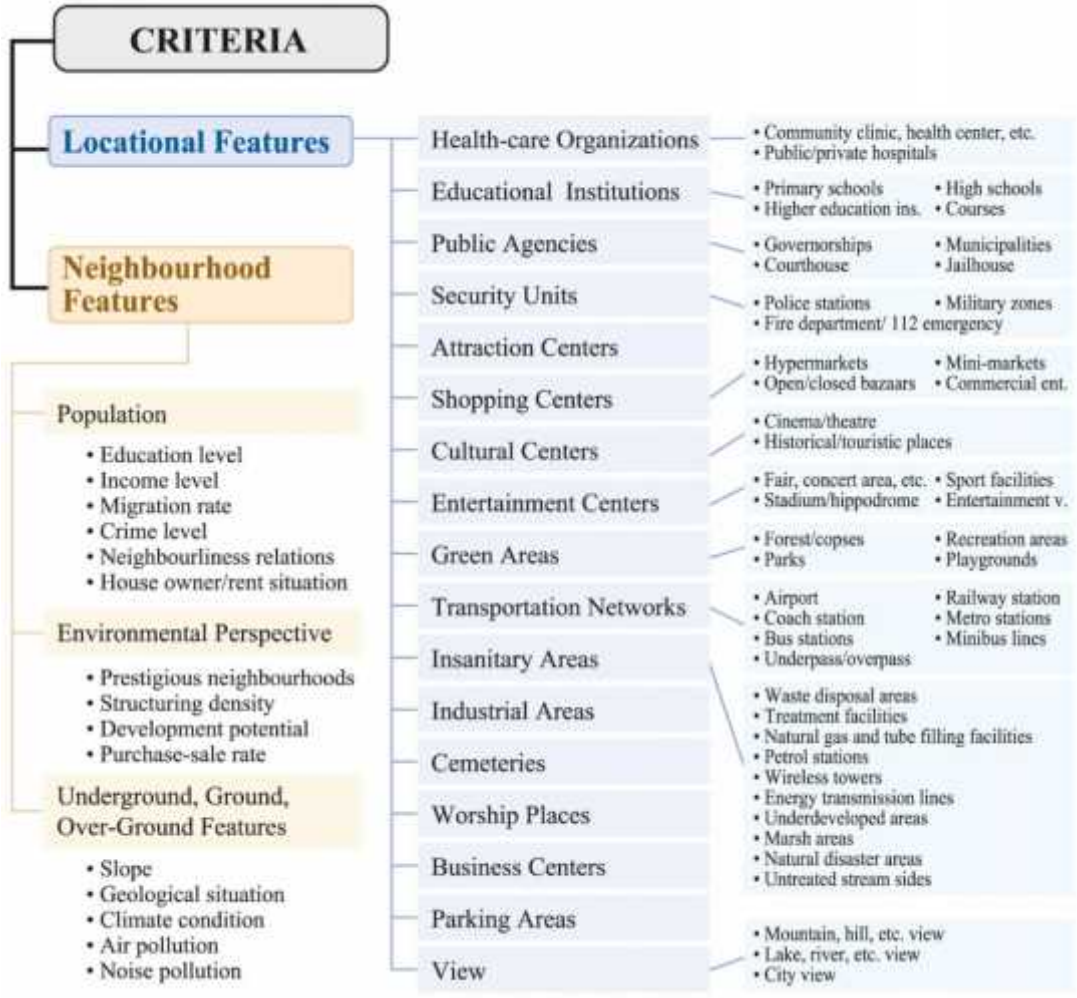

Figure 2. The Subtitles of Locational and Neighbourhood Feature and the Criteria

2. The points are normally distributed at each level of the factor whose effect on the dependent variable is studied.

3. The samples for which points of average will be compared are unrelated.

4. Variances of the samples are equal.

The fact that the significance level in ANOVA test (F test) is under 0.05 suggests that there are differences between the groups. If otherwise, there are no differences between them (Altunışık et al., 2010). When there is a difference, "Post Hoc Multiple Comparative Methods" are used to determine in which group there is a difference. Post Hoc Comparative Methods, which vary depending on whether variances are equal or not are as follows (Kayri, 2009; IBM, 2015):

When variances are equal,

- Spaced and binary tests (Tukey, Hochberg's GT2, Gabriel and Scheffe)
- Spaced tests (Tukey's b, S-N-K (Student–Newman–Keuls), Duncan, R-E-G-W-F (Ryan-Einot-Gabriel-Welsch F test), R-E-G-W-Q (Ryan-Einot-Gabriel-Welsch range test) and Waller-Duncan)
- Binary tests (Bonferroni, Tukey, Sidak, Gabriel, Hochberg's GT2, Dunnett, Scheffe and LSD (Least Significant Difference)) are used.

When variances are not equal,

- Multiple Spaced tests (Tamhane's T2, Dunnet's T3, Games-Howell and Dunnet's C) are used.

In this study, Bonferroni test was preferred when variances were equal, and Tamhane's T2 method was preferred when variances were not equal, as they are easy to apply and use in multiple comparison tests (Doğan and Doğan 2014). Also, when the sample groups were not equal, the methods of Bonferroni (Psych Colorado 2015) and Tamhane's T2 were employed (Kayri, 2009).

3. APPLICATION

3.1. Determination of the Study Field and Sample Size

It is a prerequisite to determine the cities to be considered main-mass. For this reason, the cities in the Central Anatolian Region were examined in terms of population and the level of development. In terms of

population, such factors as population, the number of voters, population increase speed and net speed of migration were taken into account, while the number of sales, housing mortgage and the number of processes in zoning applications were considered in terms of development.

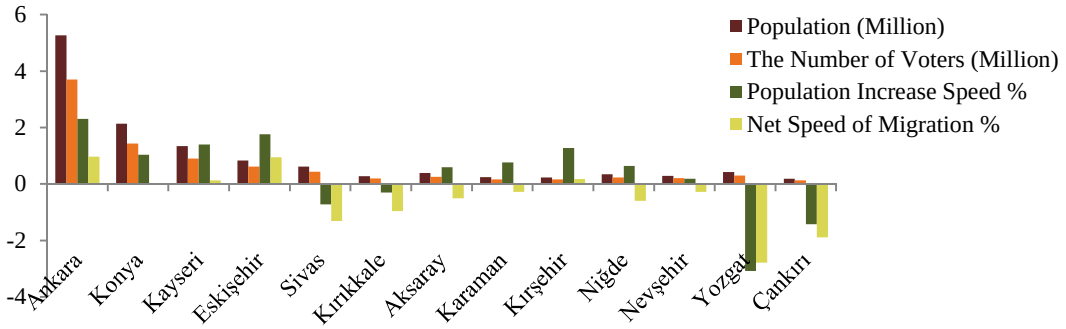

Figure 3. Graphical Demonstration of Population, the Number of Voters, Population Increase Speed and Net Speed of Migration (TUIK, 2015; YSK, 2015).

The data were obtained from the Turkish Statistical Institution (TUIK), the Supreme Election Board (YSK) and the General Directorate of Land Registry and Cadastre (TKGM). The cities of Ankara, Konya and Kayseri had the highest population and the highest the number of voters. It was revealed in Figure 3 that there were generally positive increases in Ankara, Eskişehir, Kırşehir, Kayseri and Konya. Figure 4 shows that the number of purchase and sale transactions was generally more in Ankara, Konya and Kayseri than in the other cities. Plots should be produced in places where there is a lot of population because of the shelter need. Figure 3 and Figure 4 clearly show cities where there are especially lots of population and zoning applications. For these reasons, Ankara, Konya and Kayseri were decided on as the area of the study.

As regards valuation, samples were taken from public institutions, professional organizations and private sector which were within the scope of the study. Real estate valuation concerns a number of professional groups since it is a much disciplined issue. These groups are made up of experts working on valuation, valuation specialists, valuators, constructors, real estate agents and the units that are dealt with in the literature.

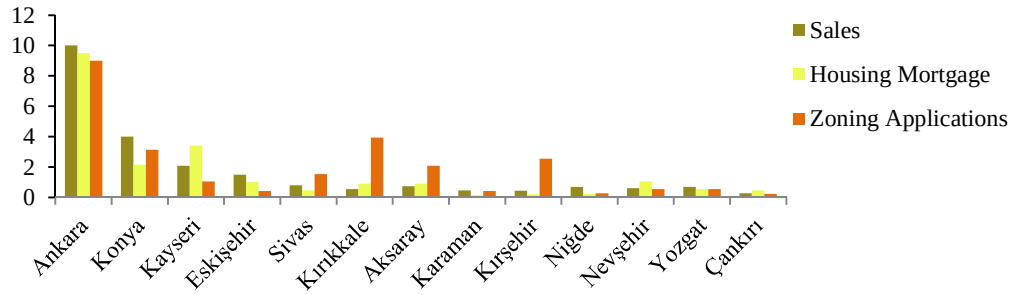

Figure 4. The Distribution of Real Estate Sales, Housing Mortgage and Zoning Applications in the Cities in the Central Anatolian Region (TKGM, 2015), (The original numbers were pulled into the spaces between 0 and 10).

The branches of professions are the branches of geometrics engineering, real estate and asset valuation, city and regional planning, agricultural engineering, civil engineering, architecture, economic and administrative sciences and the law. The majority of those in the citizen group were personally involved in buying and selling real estates. The respondents are made up of two main groups, “experts” and “citizens” (Figure 5).

5% for margin of error and 95 % confidence interval were taken into consideration while calculating the size of samples. Experts were chosen through the purposeful sampling method, and citizens were chosen via the simple random sampling method. Experts were limited in number, and the total number of samples was 375. Public institutions were universities, TKGM, municipalities and other agencies and associations, with a sample number of 57. Professional organizations were the Turkish Union of Valuation Experts, the Association of Valuation Experts, and the Union of Licensed Valuation Companies, with a sample number of 5.

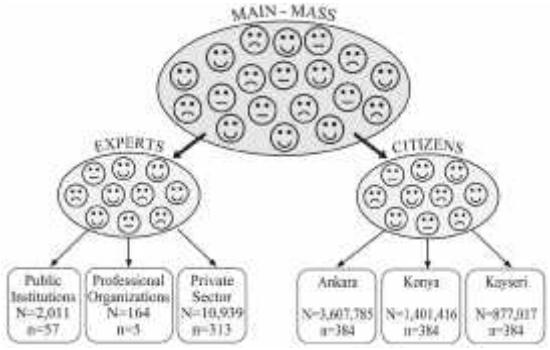

Figure 5. Main-mass of the Respondents and the Number of Samples

The private sector was composed of valuation experts employed in valuation firms, constructors and real estate agents, with a sample number of 313. As citizens, the number of voters in Ankara, Konya and Kayseri was 3,607,785; 1,401,416 and 877,017 (YSK, 2015) respectively with a sample number of 384 for each city (Figure 5). The number of experts was planned to be 500 experts and 2,000 citizens as a precaution against such setbacks as missing information in the survey forms and repetition of the same answers. Fifty seven survey forms were considered invalid for several reasons and thus excluded from evaluation. As a result, survey questions were answered by 559 respondents and 1,915 citizens (Table 2).

3.2. Classification of Ages

Age can be defined through biological and chronological criteria. World Health Organization defines the age of 60 and over as old and 80 and over as very old. Differing classifications are also suggested as a criterion for chronological aging. For instance, 45-59 is defined as middle age, 60-74 as old, 75 and over as elderly and 90 and overt very elderly (Turaman, 2001; 22-27). Several age classifications have been made by TUIK. One of these is to define 0-14 as young age, 15-64 as middle age and 65+ as old age in the population data by years, age group and sex. This study divides ages into “no answer”, “18-29”, “30-39”, “40-49”, “50-59” and “60+”, because the transactions of purchase and sales start at the age of 18.

Table 2 The Survey Data

The Survey Data	Experts	Citizens
Sampling Areas	Ankara, Konya and Kayseri	Ankara, Konya and Kayseri
Sampling Method	The Purposeful Sampling	The Simple Random Sampling
Respondents	Public institutions, professional organizations and private sector	Citizens that may take role in buying and selling of real estates
Main-Mass Number	2,011+164+10,939=13,114	3,607,785+1,401,416+877,017
Sample Number	57+5+313=375	384*3=1,152
Data Types	The Survey questions	The Survey questions
Data	The Survey data	The Survey data

The choices of purchase and sales vary with their incomes and social status. 1 % in no answer category that did not give any answers to the age question was disregarded. It is seen that the 30-39 age group had the highest number of respondents, with 32 % (Figure 6).

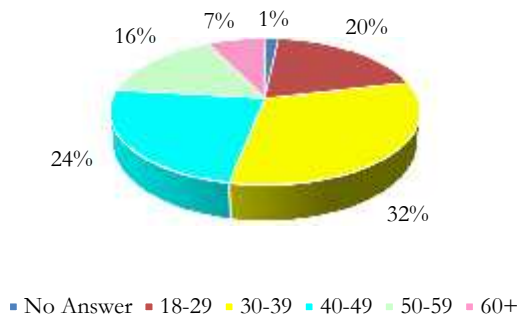

Figure 6. The Percentages of the Respondents by Age Groups

The process of aging differs in differing countries depending on nutrition, working and living conditions. It is understood from the statistics by the Turkish Statistical Institution that the number of young population is bigger than that of old population. Also, the number of old and elderly people is decreasing as life expectancy is short. The Organization for Economic Cooperation and Development (OECD) published life expectancy figures for countries in 2015. According to these figures, health spending in Turkey is under 1000 dollars per person and life expectancy is seen to remain under 77 years (OECD, 2015). Age classification was terminated with the category of 60+ as there were few respondents over 70 participating in the study.

3.3. Comparison of the Criteria Affecting the Plot Value by Age

The criteria affecting the plot value were made up of 82 questions, 64 about locational features and 18 about neighbourhood features. The average values of these questions by age groups were taken. ANOVA was used to see whether there were differences between the average values. All of the experts and citizens in the

three cities were put through analysis at the same time. ANOVA results were assessed at the significance level of 0.05. As a result of this analysis, it was established that there was not a significant difference between the average values of the criteria by age groups as seen below:

- Military zones (F=1.778/p>.05),
- Underpass/overpass (F=2.187/p>.05),
- Industrial Areas (F=1.557/p>.05),
- Parking Areas (F=2.217/p>.05),
- Population (F=0.397/p>.05),
- Migration rate (F=1.502/p>.05),
- Structuring density (F=1.503/p>.05)
- Slope (F=1.019/p>.05)

Bonferroni and Tamhane methods were used to reveal whether there were any differences between the age groups in terms of the other criteria.

The criteria of higher education institutions, Public Agencies, governorships, municipalities, Security Units, police stations, hypermarkets, mini-markets, open/closed bazaars, commercial enterprises, coach station, a mountain, hill, etc. view, income level, purchase-sale rate and geological situation had equal variances (p>.05), which was the result of Bonferroni method. Yet, no significant difference was found between the age groups.

For the criteria whose variances were not equal (p<.05), Tamhane method was used and the results are as follows:

- Community clinic, health center, etc. (F=12.072/p<.001),
- Courthouse (F=4.721/p<.001),
- Jailhouse (F=4.986/p<.001),
- Cinema/Theatre (F=6.164/p<.001),
- Historical/touristic places (F=5.674/p<.001),
- Entertainment Centers (F=12.105/p<.001),
- Fair, concert area, etc. (F=7.530/p<.001),
- Sport facilities (F=8.198/p<.001),
- Stadium/hippodrome (F=6.619/p<.001),
- Entertainment venues (F=7.984/p<.001),
- Green Areas (F=13.559/p<.001),
- Forest/copses (F=9.156/p<.001),
- Recreation areas (F=5.481/p<.001),
- Parks (F=7.281/p<.001),
- Airport (F=4.633/p<.001),
- Insanitary Areas (F=8.452/p<.001),
- Waste disposal areas (F=9.858/p<.001),
- Treatment facilities (F=10.911/p<.001),
- Natural gas and tube filling facilities (F=11.431/p<.001),
- Petrol stations (F=11.470/p<.001),
- Wireless towers (F=11.849/p<.001),
- Energy transmission lines (F=12.326/p<.001),
- Underdeveloped areas (F=8.692/p<.001),
- Marsh areas (F=11.425/p<.001),
- Natural disaster areas (F=11.470/p<.001),
- Untreated stream sides (F=13.259/p<.001),
- Worship Places (F=7.174/p<.001),
- Education level (F=10.884/p<.001),
- Neighbourliness relations (F=11.565/p<.001),
- House owner/rent situation (F=4.771/p<.001),
- Climate condition (F=3.627/p<.01),
- Air pollution (F=7.893/p<.001) and
- Noise pollution (F=8.004/p<.001).

Null hypothesis was rejected for the 33 criteria here. That is, it was established that there was a significant difference between the average values of the age groups as regards these 33 criteria. Which age group(s) paid attention to the 33 criteria was studied and the following results were found:

- Community clinic, health center, etc. was significantly more important for “60+” (av.=4.11) age group than for “18-29” (av.=3.72) age group,
- Courthouse was significantly more important for “30-39” (av.=1.93) age group than for “50-59” age group (av.=1.32),
- Jailhouse was significantly more important for “40-49” (av.= -2.41) and “50-59” (av.= -2.59) age groups than for “18-29” (av.= -1.76) age group,
- Cinema/Theatre was significantly more important for “18-29” (av.=2.88) age group than for “50-59” (av.=2.40) age group,
- Historical/touristic places was significantly more important for “18-29” (av.=2.79) age group than for “50-59” (av.=2.17) age group,
- Entertainment Centers was significantly more important for “18-29” (av.=2.71) and “30-39” (av.=2.49) age groups than for “40-49” (av.=1.97), “50-59” (av.=1.89) and “60+” (av.=1.62) age groups,
- Fair, concert area, etc. was significantly more important for “18-29” (av.=2.21) and “30-39” (av.=2.23) age groups than for “40-49” (av.=1.72) and “50-59” (av.=1.56) age groups,
- Sport facilities was significantly more important for “18-29” (av.=2.75) age group than for “30-39” (av.=2.81) age group, “50-59” (av.=2.32) and “60+” (av.=1.84) age groups,
- Stadium/hippodrome was significantly more important for “18-29” (av.=1.99) age group, “40-49” (av.=1.43) and “50-59” (av.=1.21) age group and also for “30-39” (av.=1.89) age group than for “50-59” (av.=1.21) age group,
- Entertainment venues was significantly more important for “18-29” (av.=2.26) and for “30-39” (av.=1.98) age groups than for “50-59” (av.=1.41) and “60+” (av.=1.17) age groups as well as for “18-29” (av.=2.26) age group , “40-49” (av.=1.58) age groups,
- Green Areas was significantly more important for “60+” (av.=4.00) age group than for “18-29” (av.=3.41), “40-49” (av.=3.63) and “50-59” (av.=3.55) age groups,
- Forest/copses was significantly more important for “60+” (av.=3.68) and “40-49” (av.=3.32) age groups than for “18-29” (av.=2.92) age group,
- Recreation areas was significantly more important for “60+” (av.=3.38) age group than for “50-59” (av.=2.64) age group,
- Parks was significantly more important for “60+” (av.=3.75) age group than for “18-29” (av.=3.30) age group,
- Airport was significantly more important for “30-39” (av.=1.59) age group than for “40-49” (av.=1.05) age group,
- Insanitary Areas was significantly more important for “60+” (av.= -3.95) age group than for “18-29” (av.= -3.12) and “30-39” (av.= -3.28) age groups,

- Waste disposal areas was significantly more important for "40-49" (av.= -3.89) age group than for "18-29" (av.= -3.46) age group,
- Treatment facilities was significantly more important for "40-49" (av.= -3.86) and "50-59" (av.= -3.70) age groups than for "18-29" (av.= -3.21) age group,
- Natural gas and tube filling facilities was significantly more important for "60+" (av.= -3.82), "50-59" (av.= -3.76) and "40-49" (av.= -3.84) age groups than for "18-29" (av.= -3.19) age group,
- Petrol stations was significantly more important for "60+" (av.= -3.31), "50-59" (av.= -3.15), "40-49" (av.= -3.26) and "30-39" (av.= -2.87) age groups than for "18-29" (av.= -2.27) age group,
- Wireless towers was significantly more important for "60+" (av.= -3.84), "50-59" (av.= -3.63) and "40-49" (av.= -3.70) age groups than for "18-29" (av.= -3.04) age group,
- Energy transmission lines was significantly more important for "60+" (av.= -3.74), "50-59" (av.= -3.50) and "40-49" (av.= -3.65) age groups than for "18-29" (av.= -3.00) age group,
- Underdeveloped areas was significantly more important for "40-49" (av.= -3.51) age group than for "18-29" (av.= -3.04) age group,
- Marsh areas was significantly more important for "60+" (av.= -4.07), "40-49" (av.= -3.89) and "30-39" (av.= -3.76) age groups than for "18-29" (av.= -3.34) age group,
- Natural disaster areas was significantly more important for "60+" (av.= -4.08) and "40-49" (av.= -4.00) age groups than for "18-29" (av.= -3.48) age group,
- Untreated stream sides was significantly more important for "60+" (av.= -3.77), "50-59" (av.= -3.55), "40-49" (av.= -3.70) and "30-39" (av.= -3.50) age groups than for "18-29" (av.= -3.06) age group,
- Worship Places was significantly more important for "60+" (av.=1.84) age group than for "18-29" (av.=2.92) and "30-39" (av.=1.59) age groups and additionally for "50-59" (av.=2.32) age group than for "18-29" (av.=2.92) age group,
- Education level was significantly more important for 40-49" (av.=3.65) and "50-59" (av.=3.73) age groups than for 18-29" (av.=3.18) age group,
- Neighbourliness relations was significantly more important for "40-49" (av.=3.74) and "60+" (av.=3.91) age groups than for "18-29" (av.=3.36) and "30-39" (av.=3.45) age groups,
- House owner/rent situation was significantly more important for "60+" (av.=2.58) and "50-59" (av.=2.49) age groups than for "30-39" (av.=2.00) age group,
- Climate condition was significantly more important for "50-59" (av.= -2.06) age group than for "18-29" (av.= -1.23) age group,
- Air pollution was significantly more important for "50-59" (av.= -3.79) age group than for "18-29" (av.= -3.25) age group,
- Noise pollution was significantly more important for "60+" (av.= -3.83) and "50-59" (av.= -3.76) age groups than for "18-29" (av.= -3.22) age group.

In addition, no findings were obtained through Tamhane's method concerning Health-care Organizations, public/private hospitals, Educational Institutions, primary schools, high schools, courses, fire department/112 emergency, Attraction Centers, Shopping Centers, Cultural Centers, playgrounds, Transportation Networks, railway station, metro stations, bus stations, minibus lines, Cemeteries, Business Centers, View, lake, river, etc. view, a city view, crime level, Environmental Perspective, prestigious neighbourhoods, developmental potential and Underground, Ground, Over-Ground Features.

All in all, 82 criteria were tested through ANOVA. Based on the results of ANOVA, there were not significant differences in eight criteria, whereas differences were detected between the remaining groups through Bonferroni and Tamhane methods. Bonferroni method failed to find a significant difference between the age groups of 15 criteria, while there were significant differences between the age groups in 33 criteria, but there were not significant differences in 26 criteria.

4. CONCLUSION AND SUGGESTIONS

Real estates are of importance for all age groups. As one ages, they gain more importance. Comfort and ease stand out in old age in the process of meeting any need. Besides, for these age groups, who have given up their active business lives and have now a regular income, the balance of price/benefit must be properly analyzed. For instance, evaluation of buying or renting a house for shelter is only possible with a real valuation and an analysis of price/benefit. As we look into more details, we see that the relationship of valuation of real estates with economy and social sciences becomes stronger.

Table 3 The Criteria which age groups consider important

ORDERED AGE GROUPS				
"18-29" Age Group	**"30-39" Age Group**	**"40-49" Age Group**	**"50-59" Age Group**	**"60+" Age Group**
Cinema/theatre Historical/touristic places	Courthouse Airport	Waste disposal areas Underdeveloped Areas	Climate condition Air pollution	Community clinic, health center, etc. Green Areas Recreation areas Parks Insanitary Areas

Entertainment Centers Fair, concert area, etc. Sport facilities Stadium/hippodrome Entertainment venues		Jailhouse Treatment facilities Education level		
			Worship Places House owner/rent situation Noise pollution	
		Natural gas and tube filling facilities Wireless towers Energy transmission lines		
	Petrol stations Untreated stream sides			
UNORDERED AGE GROUPS				
		"30-39" Age Group	**"40-49" Age Group**	**"60+" Age Group**
			Forest/copses Natural disaster areas Neighbourliness relations	
		Marsh areas		

In this study, we examined whether the importance of criteria varies with age groups and if it really does, which criteria actually change. It was seen that there were significant differences between young and old age groups. The "18-29" and "30-39" age groups classified as young generally enjoy being entertained and walking around. This is verified by the results of the analysis with more importance to entertainment centers. In addition, the interest taken by the "18-29" age group in cultural activities was demonstrated by the fact that they considered cultural centers important. It was seen that those in the "40-49" and "50-59" age groups considered the education level of the neighbourhood residents and proximity to jailhouse more important.

Community clinic, health center, etc. is of great importance for old and elderly people. This is confirmed in the analysis for the "60+" age group. Besides, green areas is also important for the "60+" age group. Furthermore, people at the age of 50 and over want to lead their lives in a neighbourhood far from air pollution and noise, with neighbours as homeowners and close to worship places (Table 3).

It was observed that waste disposal areas, treatment facilities, natural gas and tube filling facilities, petrol stations, wireless towers, energy transmission lines, underdeveloped areas, marsh areas, natural disaster areas and untreated stream sides from insanitary areas were of negative importance to different age groups (Table 1.3). In other words, nearly all age groups want to be away from areas harmful to health. Therefore, these criteria have the effect of reducing the value of plot.

Since young people enjoy strolling, being entertained, doing sports, joining in cultural and social activities, they wish to have entertainment and cultural centers near the house they would reside in. As people get older, they want to have a community clinic they can reach readily when they become sick, a park where they can walk around when they are bored and a sanctuary where they can worship. It is seen that people demand a more serene, peaceful, healthier and more tranquil environment when they become old. Therefore, depending on the age group, related criteria come to the fore as regards the real estate in which they will reside.

ACKNOWLEDGEMENTS

The authors would like to thank interviewers who made efforts and respondents who patiently completed the survey in the data collection phase of the survey.
This study is supported by the Scientific and Technological Research Council of Turkey (TUBITAK) with 115Y769 Projects Number.

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International Journal of Engineering and Geosciences (IJEG),
Vol; 2; , Issue; 02, pp. 52-60, June, 2017, ISSN 2548-0960, Turkey,
DOI: 10.26833/ijeg.298951

A COMPARISON OF THE CLASSIFICATION ACCURACIES IN DETERMINING THE LAND COVER OF KADİRLİ REGION OF TURKEY BY USING THE PIXEL BASED AND OBJECT BASED CLASSIFICATION ALGORITHMS

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ABSTRACT: Pixel and object-based classification methods have been used for the determination of land cover. Pixel based classification methods suffer from salt and pepper effect. So pixel based classification methods cannot reach the accuracy of the object based classification. In order to eliminate the salt and pepper effect on the remote sensing classification accuracy and improve the result maps created as a result of the classification and further improve the classification accuracy in pixel based classification, it is recommended that the sieve class, clump class and majority analyses -which are ordinarily applied to high resolution images in this study by using the pixel based classification method. So the effect of these analyzes on low and medium resolution satellite images are unknown. With the SPOT 5 satellite image, this study will investigate how much this analysis affects the accuracy of classification. The classification includes the following categories: sun flowers, corns, peanuts, trees, roads, residential areas and water resources. In this study, the object based classification method was compared with three pixel based classification methods, namely the support vector machines, maximum likelihood method and spectral angle mapper method. The following general accuracy and kappa values were obtained from the methods in question: Object based classification method (96% accuracy, kappa value of 0,949), maximum likelihood method (90.99% accuracy, kappa value of 0,67), support vector machines (92.06 accuracy, kappa value of 0.70), spectral angle mapper method (93.88% accuracy, kappa value of 0,78). Following the pixel based classification process, the total accuracy and kappa values of the classified image was improved through the application of sieve class, clump class and majority analyses. As a result of the analyses conducted on the pixel based classification methods, the following general accuracy and kappa values were obtained for the following pixel based classification methods: maximum likelihood method (92.91% accuracy, kappa value of 0,73), support vector machines (93.13% accuracy, kappa value of 0.74) and spectral angle mapper method (95.62% accuracy, kappa value of 0,88). As a result of the analyses applied to the pixel based classification method, the classification accuracy produced similar results to that of the object based classification accuracy. To the best knowledge our author this is the first study dealing with this study area. So the authors think that this paper present a different point of view for interested researchers in this study area.

Keywords: *Object based classification, maximum likelihood method, support vector machine, spectral angle mapper, post classification.*

1. INTRODUCTION

Image classification methods are commonly used in determining the land cover due to their synoptic point of view and ability to operate in larger areas. Image classification involves the categorization of each pixel in an image. General image classification is done in two general approaches, namely the pixel based classification method and object based classification method. Despite the general view that the object based classification produces better results (Willhauck et al.,2000; Jensen et al., 2006; Yan et al., 2006; Hong et al., 2007; Platt and Rapoza, 2008; Weih and Riggan 2010; Whiteside et al., 2011; Myint et al., 2011; Meneguzzo et al.,2013; Varela et al.,2008; Michez,2016), there have nevertheless been studies conducted with a view to achieving high accuracy out of the pixel based methods in a classification. Support vector machines and the artificial neural networks method were found to have produced more accurate results compared to the maximum likelihood method (Foody and Mathur, 2004; Pal and Mather, 2005; Oommen et al., 2008; Naguib et al., 2009; Sakieh et al. 2016). When the pixel based and supervised classification algorithms -namely the maximum likelihood method, neural networks method and decision tree methods were compared, it was established that the support vector machines produced the highest accuracies (Huang et al., 2002). When the support vector machine was compared to the Conditional Random Fields (CRF) method, the conditional random fields method was found to have produced more accurate results (Hoberg and Müller, 2011). When the support vector machines were compared with the supervised pixel based classification methods -including minimum distance, Mahalanobis distance, maximum likelihood and spectral angle mapper (SAM) methods, it was found that the maximum likelihood method and support vector machines delivered a better performance (Yang et al., 2011). The crop index, maximum likelihood and Spectral Angle Mapper (SAM) supervised classification methods have been compared in terms of determining the weeds in legumes and grains, as a result of which the spectral angle mapper (SAM) method was found to be less accurate (Castro et al., 2012). By employing the LISS IV data, the support vector machines, spectral angle mapper and artificial neural networks methods have been used in the crop classification. The support vector machines and artificial neural networks have provided more accurate results (Kumar et al., 2015).

In remote sensing studies, the concept of accuracy -which is known as the consistency between the real class and the class label assigned to a pixel- and real class can be identified by actually going out on the field or by viewing an aerial photograph, satellite image. The classification accuracy can be improved for single images or time sequenced images by combining the multi-sourced data (Lunetta and Balogh,1999) and by establishing different spectral features (Wilson and Sader, 2002) and by developing new methods (Murai and Omatu,1997; Maxwell et al.,2004; Sun and Schulz, 2015). In remote sensing, assigning pixels to a class other than their designated class is called the salt and pepper effect. Despite the fact that Castillejo-Gonzalez et al. (2009) has talked about the significance of the salt and pepper effect on the high resolution satellite images and suggested that the classified maps should be improved to mitigate such errors and that a 5*5 majority filter be applied to be able to achieve higher accuracies, it is not known to what extent the analyses conducted following the low and mid resolution classifications actually influence the classification results. Considering the costs in agricultural studies, it is observed that the studies are mostly conducted with mid and low resolution satellite images (Yang et al.,2011;Hoberg and Müller, 2011; Huang et al.,2002; Faria et al.,2012).

In this study, the mid resolution SPOT 5 satellite image has been subjected to sieve, clump and majority analyses -after having been initially classified through maximum likelihood, support vector machines, spectral angle mapper methods-, the effects of the classification results discussed and their accuracies have been compared with the object based classification methods. To the best knowledge author this is the first study dealing with this study area. So the authors think that this paper provide a different point of view for interested researchers in this area. Because of this area has previously unstudied very fertile farm lands.

2. METHODS

2.1 Study Area

The study area is located in the fertile lands of the Eastern Mediterranean Region of Turkey, covering the areas of Ceyhan, Osmaniye, Kadirli and Kozan, on the east bank of the Ceyhan River, east of Çukurova. Osmaniye is located between 35 52’ - 36 42’ East Longitude and between 36 57’ - 37 45’ North Latitude. Osmaniye is surrounded by Gaziantep in the east, Hatay in the south, Adana in the west and Kahramanmaraş in the north. The province is approximately 7-8 km. away from the Gulf of İskenderun in the southwest.

Osmaniye is a province that agriculture has dominant structure. City of the total land area (376.70 ha), 97.419 hectares of farm land, 130 hectares of fallow land, 4.535 hectares of vegetable gardens, 13.284 ha of fruit-bond, are the sum of 115.368 agricultural land. When epiphora situation analysis of agricultural land examined, total agricultural land (124.800) of %69.3 (86.523) irrigated. %72.4 of these irrigated land irrigate.

The area is a complex mosaic of several land cover types including corn, sunflower, peanut, trees, road, residential and water resource. This spatially complex area was chosen to highlight the differences between the image classification approaches. This area has very fertile soil. It is an area untouched in terms of remote sensing studies.

2.2 Material

SPOT 5 satellite image has 10m. spatial resolution with 4 spectral band (Red, Green, Blue, NIR). The satellite has two HRG sensors that are capable of capturing high resolution data. Through those sensors, it is possible to obtain 2.5 to 5 meter resolution data in panchromatic detection mode, and 10 meter resolution or better data in multi-spectral detection mode. Moreover, the satellite also has a HRS sensor that can detect data in panchromatic mode. The HRS is capable of obtaining stereo image pairs that can identify the surface printing through forward and backward sights.

Stereo image pairs are used to establish Numerical Elevation Models that provide data regarding the elevation from the earth surface (İTU-UHUZAM). It has a synchronous near polar orbit. Its orbital altitude is around 822 km (in Ecuador). Its orbital period is 26 days. Its scan area is 60 km*60 km. Its radiometric resolution is 8 bits and spatial resolution Pan: 2.5m (production from a 2 * 5m resolution framework) Pan: 5m (rare) MS: 10m (rare) SWI: 20m (rare).

The SPOT 5 satellite image was taken on May 5, 2013, at 08:13:12 am. Multispectral image was used in study. Image was taken with ortho geometric processing level. Image incidence angle was 5.465347, sun azimuth was 135.108586 and sun elevation was 62.354325.

Sun flower and corn are planted in early March in our study area. Corn and sun flower are very green in May. So date of acquisition is convenient for our study. Comprehensive field survey data were obtained directly from farmers and village headman by interviews. 50 training data (number of fields) selected for classifier training. Another 50 field data set used for validation. Test and verification data were randomly selected.

The reference spectra can either be taken from laboratory measurement or field measurements or extracted directly from the image. We are taken spectra values field measurement on July 1, 2013 for spectral angle mapper classification method.

2.3 Image Preprocessing

Because study area became range of two middle slices, coordinates transformed geographic coordinates with geometric correction. Geometric correction of the satellite image has been done using the ENVI software. Geometric transformation of the image was obtained with 0.32 pixels RMSE (Root Mean Square Estimation) by means of second degree polynomial transformation by the help of 16 land control points acquired by RTK-GPS and the nearest neighbor resampling method (Orhan et al. 2014; Dymond and Shepherd 2004).

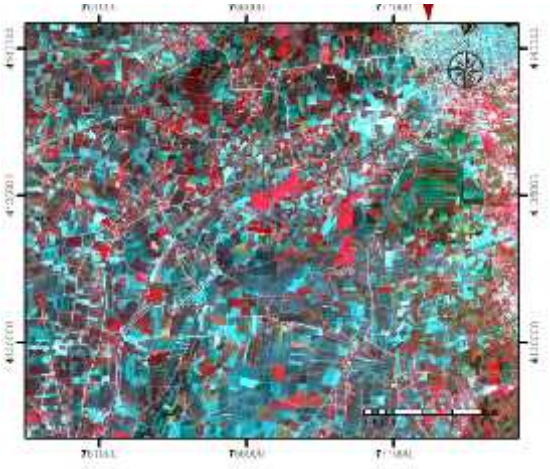

Figure 1. The study area that covers the provinces of Kadirli, Ceyhan and Osmaniye, Turkey.

2.4 Pixel-Based Classification

Being a traditional classification method, the pixel based classification takes pixel as its primary unit. In the pixel based method, where each pixel is compared in terms of its spectral proximity to the class to which it will be assigned (Casals-Carrasco et al., 2000). The pixel based classification method is divided into two categories, namely supervised classification and unsupervised classification methods.

The unsupervised classification does not contain any data with respect to the area to be classified. It uses the algorithms that classify such elements based on natural groupings or aggregation that are presently available in the digital values of the image. Since it uses the classification of natural groupings, the classes created as a result of the classification are those of the spectral classes that have been identified prior to the process (Ekercin, 2007). The most commonly used unsupervised classification methods include the k-means clustering, Euclidean distance, mahalanobis distance, sequential clustering, statistical clustering, repeated successive clustering (ISODATA) and RGB clustering.

In the supervised classification method, however, the spectral features of each object to be classified are defined based on the sample areas representing the earth, and thus the feature files are created. The feature file sampling the test area is then applied to the image data, thereby including each image data into the class that it resembles the most (Ekercin, 2007). The most commonly used supervised classification methods include the Maximum Likelihood Classification, the minimum Distance classification and the Parallelpiped Classification methods.

2.4.1. Maximum Likelihood Classification

A pixel has the highest probability value assigned to the class in the maximum likelihood method. A probability distribution model is needed to calculate these probabilities. The normal distribution model is usually used in practice. Accordingly, each class is considered to have a normal distribution of training data. In reality, this acceptance is not very correct. But the normal distribution in the modeling of optical remote sensing data is found to be appropriate. Normal distribution is determined by mean and variance parameters for single variable, mean vector and covariance vector for multivariate data (Sunar et al.,2016). The multidimensional normal distribution probability density function is as follows (Eq.1).

$$f(x) = \frac{1}{(2\pi)^{\frac{n}{2}}\sqrt{|\Sigma|}} e^{\frac{-1}{2}(X-\mu)^{t}\Sigma/(x-\mu)} \quad (1)$$

μ mean vector,
Σ covariance matrix,
$|\Sigma|$ Determinism of the covariance matrix

The distribution of each class is determined by the mean vector and the covariance matrix calculated from the training patterns. The probabilities of unknown pixels belonging to the categories can be calculated based on the distribution models calculated from the training data for all classes. As a result, the pixels are most likely assigned to the classes to which they belong (Sunar et al.,2016).

2.4.2. Support Vector Machines

The use of support vector machines (SVM) as image classification in remote sensing has first been suggested by Gualtieri and Cromp (1998). The idea has been put forward in more detail by Burges,(1998); Huang et al.,(2002); Richards and Jia, (2006). SVM classification is a controlled classification algorithm that is based on statistical learning theory. At first, the mathematical algorithms of the SVM were designed for the classification of the two class linear data, but they were later generalized for the classification of the multi class and non linear data. The working principle of the SVM is based on estimating the most suitable decision function that is capable of separating the two classes from each other, in other words identifying the sub-platform that can separate the two classes in the most appropriate way (Vapnik, 1995; Vapnik, 2000). Being successfully used in a number of fields, the recent years have seen many studies conducted for the use of SVMs in the field of remote sensing (Foody et al., 2004, Melgani et al., 2004, Pal et al., 2005).

2.4.3. Spectral Angle Mapping (SAM)

In the Spectral Angle Mapper (SAM) method that allows the performance of Object Based Reference Spectra summation (endmember) analysis, the angle between the reference vector created based on the spectral reflectance data that is used as reference- and the vector which has been created out of the satellite image pixel values whose class has not yet been assigned is calculated. If the calculated angle is less than or equal to the likelihood value that has been previously designated for the reference spectra class, the pixel with unknown class is assigned to the relevant reference spectra class (Gürsoy et al., 2013).

By using the SAM algorithm, the spectral angle between the unknown spectrum (t) and the reference spectrum (r) is calculated for each pixel in radians (Kruse et al., 2003). The spectral angle is calculated by using the following equation. The unknown pixel is assigned to the reference spectrum (class) that has the least spectral angle value with itself (Eq. 2) .

$$\alpha = cos^{-1}\left[\frac{\sum_{i=1}^{n} t_i r_i}{\sqrt{\sum_{i=1}^{n} t_i^2} * \sqrt{\sum_{i=1}^{n} r_i^2}}\right] \quad (2)$$

n = Number of bands

t_i = Test spectrum

r_i = Reference spectrum

α = Spectral angle

2.5. Post Classification (Sieve-Clump-Majority/Minortiy Analysis)

Classified images often have a salt and pepper effect. Post classification processes were applied over a classified image to eliminate salt and pepper effect, and to generate an apparently less noisy image (Al-Ahmadi and Hames, 2009). Sieve, clump and majority/minority analysis have been usually applied to classified images. Sieve analyses are applied first to remove isolated classified pixel. For this, if a pixel is included with pixels of the same class, the method search the neighboring 4 or 8 pixels. If the number of pixels in a class is less than a specified threshold value, those pixels are removed from the class. (Buddenbaum et al.,2005; Al-Ahmadi and Hames, 2009). Clump analysis is used to clump adjacent similarly classified areas with morphological operators. Low pass filtering could be used to smooth images that have speckle or holes in classified areas. Clumping classes solves a problem that the class information would be contaminated by adjacent class codes (Al-Ahmadi and Hames, 2009). Determining classes are clumped together. It called dilate operation. Another operation is erode operation. A kernel of size determines in this operation. The clump algorithm fills holes smaller than a given kernel. Then 'islands' of pixels smaller than the kernel removes (Buddenbaum et al.,2005; Al-Ahmadi and Hames, 2009). Majority/Minority analysis is applied after sieve and clump analysis to classified images. Majority analyses are used to change false pixels in a large single class. Minority analysis is used to replace center pixel in the kernel with the class value that the minority of the pixels in the kernel (URL-1).

Above mentioned these three post classification processes were applied on the images that are classified by maximum likelihood, support vector machine, spectral angle mapper and object based classification methods.

2.6. Object-Based Classification

Being a traditional classification method, pixel based classification takes pixel as its primary unit. However, the heterogeneity of pixels and the variability of crops in the study area has led to an increase in the use of object based methods in the remote sensing studies (Blaschke, 2010).

Analyzing the remote sensing data with the traditional pixel based method has presented a problem in identifying some of the crops due to the variability of the crop patterns, spectral similarity, mixed up pixels and pixel heterogeneity. In order to overcome this problem, spectral, textural and hierarchical features are added to the object based image analysis following the segmentation of the image (Pena-Barragan et al., 2011).

The object based classification involves segmentation and classification stages. The segmentation stage is the most important stage that directly determines the classification accuracy. The image segmentation algorithms are aggregated in two categories, namely the area based and boundary based categories. In the boundary based segmentation algorithms, boundaries are determined by checking whether the objects are continuous. In area based methods, however, the areas are determined based on their similarity (Zhang, 1997).

The homogeneous objects obtained as a result of the segmentation process are used as classification units.

The objects representing the spectrally varying land cover type at pixel level are formed through segmentation. This way, the 'salt and pepper' effect, resulting from the pixel based classification, is eliminated. Another advantage of this unit is that, instead of using random units such as pixels, it uses the objects that represent the real world features better than pixels. Moreover, it has the extra advantages that include the shape features, the hierarchical structures of classes and objects and the topological structures of objects. The object based analyses allow the creation of a set of rules that can utilize the scenes that are capable of producing a repetitive method. One of the disadvantages of this method is that it requires the preliminary data of the land cover type that cannot be found at all times. Another disadvantage associated with this method is the segmentation between the objects that can utilize mainframe computer memory and the resulting topological relationships. The lack of definite algorithms and parameters in creating image objects is yet another disadvantage of this method. Despite the fact that the local variances are used in recent years to determine the appropriate segmentation scales, the appropriateness of the segmentation is mostly evaluated through visual inspections (Whiteside et al., 2011; Draguţ et al., 2010).

Image segmentation as the initial stage of object based classification has an important role in the performance of object based classification. The more accurate segmentation increases the results of classification. There are a lot of techniques for image segmentation (Dey, 2011). Multi-resolution segmentation, which was proposed by Baatz and Schape (2000), is one of the most powerful region based segmentation algorithms that have been implemented in commercial software, eCognition (Definiens Imaging, 2009). However, this algorithm needs a set of optimum parameters which usually obtained by trial and error method. This technique relies on the user's experience. The multi resolution segmentation is a bottom-up region merging step starting with one pixel. The method performs based on two heterogeneity criteria, geometrical and spectral. Smaller image objects are merged into bigger ones. The bigger image objects form segmentation with object on different scales. The created objects undergo an optimization process. The optimization process tries to minimize the internal weighted heterogeneity of each object. The smallest possible growth is calculated for each object. If the object properties exceed the heterogeneity threshold, the growth of this object stops. Heterogeneity is defined as the color and shape of the object. Shape, compactness/smoothness and scale parameters are user-defined parameters. Scale parameter determines the average image object size. An appropriate value of scale parameter determine with trial and error method (Dragut et al.,2010). Compactness criterion minimizes the deviation from the ideal compact form. If the shape factor is weighted with high values, the influence of color values is lower. Shape factor is also necessary to calibrate a compactness and smoothness value influencing the object generation. If the compactness is weighted low values, the smoothness factor is increased. An object with a more linear shape is obtained (Dragut et al., 2010; Definiens, Developer 7 User Guide).

3. RESULTS

The pixel based classification processes have been realized by using the ENVI software, and the object based classification processes by using the Definiens eCognition Developer.

The first stage of the object based classification process involves segmentation (Figure 2). Here, a multi resolution segmentation process was implemented in the eCognition software. In this particular segmentation algorithm, the parameters that determine the classification accuracy are that of the scale, shape and integrity parameters. For this study, scale has been chosen as 70, shape as 0,2 and the compactness as 0,6. Such parameters are the ones that most realistically represent the test farms.

Figure 2. Segments in the segmentation stage of the object based classification

7 classes have been identified in the classification stage, representing water resources, sun flowers, corns, peanuts, residential areas, roads and trees. In the classification stage, classification was performed based on the nearest neighbor method (Figure 3).

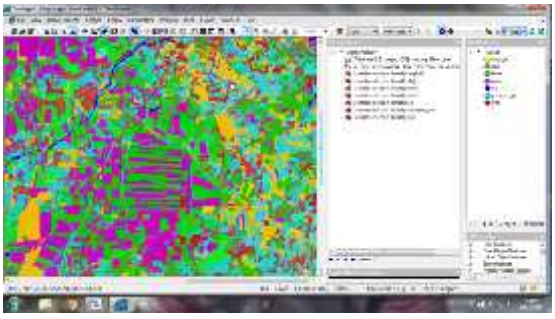

Figure 3. Results of the object based classification

In order to avoid a subjective estimation in remote sensing, a confusion matrix, which determines the accuracy of the method by comparing the confirmed land data with the classified pixel percentage, is used (Congalton, 1991). General accuracy in the confusion matrix reveals the percentage of the classified pixels in

an accurate manner. Producer accuracy and omission error presents the likelihood of the classified pixel being actually represented in that class. The acceptable general accuracy is 85% (Foody, 2002). User accuracy and omission error shows how well the pixels in training set have been classified (Rogan et al., 2002). It is reported that a classification is strong when the Kappa coefficient is over 0.8 (Landis and Kock 1977). In their study, Montserud and Leamans (1992) have suggested that the kappa value cannot be over 0.75 by chance.

The accuracy analysis of the classification results have been performed based on the 'Error Matrix based TTA Mask'. The classified image has been compared with the sample areas –chosen as test data through the segmented image- and the error matrices have been obtained. The error matrix achieved from the satellite image is presented in the Table 1. It has been observed that the classification method between the classes of roads and residential areas has been somewhat problematic (Table 1).

Table 1. Error matrix for the object based classification

User/ Reference	**Sun flower**	**Peanut**	**Corn**	**Road**
Confusion matrix				
Sunflowers	13605			
Peanuts		11595	226	
Corns			12853	
Roads				1465
Water resources				
Residential areas				236
Trees				
Total	13605	11595	13079	1701
Producer accuracy (%)	100	100	98.27	86.12
User accuracy (%)	100	98.09	100	100
General accuracy (%)	96			
Kappa (%)	0.949			
	Water resource	**Residential area**	**Tree**	**Total**
Confusion matrix				
Sunflowers				1365
Peanuts				11821
Corns				12853
Roads				1465
Water resources	5330	1556		6886
Residential areas		2821		3057
Trees			672	672
Total	5330	4377	672	
Producer accuracy (%)	100	64.45	100	
User accuracy (%)	77.4	92.28	100	
General accuracy (%)				
Kappa (%)				

The pixel-based classification employed the maximum likelihood, support vector machines, spectral angle mapping and spectral data difference methods. 7 classes have been identified in the classification stage, representing water resources, sun flowers, corns, peanuts, residential areas, roads and trees. ROIs have been identified for the classification and control, containing two different data sets. In order to improve the classification accuracy, the images obtained as a result of the classification have been subject to the sieve class, clump class and majority analyses.

Table 2. The classification accuracies obtained as a result of pixel based classification

	General accuracy	Kappa
Maximum likelihood (%)	90.99	0.67
Maximum likelihood + sieve+clump+majority Analysis (%)	92.91	0.73
Support vector machines (%)	92.06	0.70
Support vector machines + sieve+clump+majority Analysis (%)	93.13	0.74
Spectral angle mapping (%)	93.88	0.78
Spectral angle mapping + sieve+clump+majority Analysis (%)	95.62	0.88

Since most of the roads in the area are unpaved roads, the classes of roads and unpaved roads have been combined into a single class under 'roads'. The fact that the pixels were mixed up in the predominantly urbanized areas has caused heterogeneity. For this reason, the classes of roads and residential areas could not be separated from each other in most cases. In general, however, the accuracy analyses of both classifications yielded fairly similar results.

4. CONCLUSION and DISCUSSION

In this study, the object based classification method has been compared with the pixel based classification methods and the effect of sieve, clump, majority analysis applied to the pixel based classifications (maximum likelihood classification, support vector machine and spectral angle mapper classification) on the medium resolution SPOT 5 satellite image was investigated. The SPOT 5 satellite image of Osmaniye region, taken in May 2013, has been used for making such comparison in this study. The maximum likelihood method (90.99% accuracy, kappa value of 0,67), support vector machines method (92,06% accuracy, kappa value of 0,70) and the spectral angle mapping method (93.88% accuracy, kappa value of 0,78) have been used as pixel based classification methods in this study area. In order to improve the classification accuracy, the images classified by pixel based methods have been subject to the sieve class, clump class and majority analyses. As a result of those analyses, the accuracy of the maximum likelihood method (92,91% accuracy, kappa value of 0,73), support vector machines method (93,13% accuracy, kappa value of 0,74) and the spectral angle mapping method (95,62% accuracy, kappa value of 0,88) have improved and the overall classification accuracy has come closer to the accuracy of the object based methods (96% accuracy, kappa value of 0,95)in this study area. The kappa values, in particular, considerably increased as a result of those analyses. It is

believed that the reason for such an improvement in the pixel based classification accuracy is due to the selection of the test and control farms that best represent the land cover and having taken the satellite image when the selected crops had the best reflection values. This way, fairly accurate classification results have been obtained by using a specific-dated mid-resolution satellite image in this study area. It was observed that the satellite image in question was inadequate in terms of distinguishing the buildings therein. Due to the resolution of the satellite image, the classes of residential areas and roads could not be separated from each other by using the object based classification method. Despite the fact that the support vector machines method seems to produce more accurate results according to the literature, we have obtained more accurate results from the SAM method in the present study. It is believed that high accuracy obtained as a result of this study has been due to the selection of the projection values that best represent the crop types. Considering the cost and accessibility issues of the crop type determination studies in the literature, it is observed that such studies usually use low and mid resolution satellite images. It has been established that the application of sieve class, clump class and majority analyses to the pixel based classification results – achieved through low and mid resolution satellite images- in the literature has produced classification results, and particularly the kappa values, that are considerably close to that of the object based classification results. Results show that object-based classification results is more accurate than the other methods. Object-based classification accuracy results have not been achieved even when the pixel-based classification accuracy results are increased with various analyses.

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International Journal of Engineering and Geosciences (IJEG),
Vol; 2; , Issue; 02, pp. 63-67, June, 2017, ISSN 2548-0960, Turkey,
DOI: 10.26833/ijeg.297223

EVALUATION OF LAND REFORM POLICIES IN TURKEY

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ABSTRACT:

Turkeys agricultural policies of the European Union, World Bank, International Monetary Fund on a global scale, such as areas of activity by the organizations and groups, referral is made. Since the beganning of the Republic of Turkey, land reform has been different application. "On June the 11th 1945, a Law to Provide Farmers with Land enumerated 4753, Land and Agrarian Reform Law dated 1973 and Enumerated 1757, Agrarian Reform Law Regarding Land Regulations in Irrigation Areas, Land Protection & Land Use Law enumerated as 5403/5578" applications have handled in within Turkey land reform. In region of the land reform applied, had been a lot of problem for example, lack of credit, absence of qualified personnel for giving information, etc. and had not gotten efficiency to expected performance and successed expectancy.

In this study, land reform, according to the particular application in the world have studied the similarities and differences. A viable model for our country's land reform was formed.

Keywords: *Land Reform, Land Regulation, Land Use, Use of Rural Land.*

1. INTRODUCTION

An integrated reformist approach to regulate relation of man and soil is necessary to develop and improve rural areas. In Turkey, an agricultural structure with a feudal or semi feudal population, lack of sufficient land in many of the agricultural companies, and the presence of many farming families who do not have any fields but maintain their living through sharecropping and agricultural labor, is evident. Many farmer families with sufficient soil are engaged in an agricultural production which is not economic and ergonomic due to fragmentized fields, tilt, and false product selection.

Nowadays, we are in times in which policies are determined globally. Agricultural policies in Turkey are not an exception to this rule and are determined with the impact of organizations and groups operating on a global basis such as the European Union (EU), World Bank, and International Monetary Found. As a country trying to resettle on the one hand man-earth relations domestically and on the other hand trying to come to terms with the Common Agricultural Policies of the EU, a long term policy of Turkey to become a member state, and fulfill the demands regarding agriculture will make a revision of land, person, and property relations in rural areas inevitable.

Today one of the big biggest problems in the World is the comparison of assets and poverty. There are currently 350 billionaires in the world. According to David C. Korten, the annual income of 45 % of the world's poorest population is equivalent to these billionaire's yearly income. This contrast is a result of the injustice in land ownership, lack of access to farmland, and distribution of goods.

According to Susan George's book "How the Other Half Die'', in a world where millions of poor live , among all the land owners in the world only 2.5 % have fields of 100 decare and all over the world about three quarters of all land are in the control of this 0.23 % (Stibbe 1997). Land tenure research is itself a vast and complex area due to the large variation and complexity of land tenure systems, which has contributed to the specialization of land tenure researchers (Stein and Hosaena, 2016). There is little solid empirical evidence of the long-run impact of tenancy reforms, and limited understanding of whether economic actors use land markets to reduce or amplify the intended impact of these regulations (Besley et al.,2016).

If the factors necessitating and influencing land reform are to be investigated, concerns about permanent settlement efforts, land problem existence, development of villagers, industrialization and modern urbanization demands, ideological perspectives of the executives, and the consideration of the peasantry without land as a potential source of conflict can be mentioned. Hartvigsen (2014) presented an overview of land reform approaches and fragmentation issues in a Central and Eastern European context (for 25 countries), focusing on the causality between the chosen land reform approach and the resulting land fragmentation.

The use of land, among the key elements of agricultural production, as a tool of exploitation has increased the social pressure and thus the political pressure on land. Therefore "land reform" is constantly on the agenda. In the present study, land reform policies from Ottoman Times until today in Turkey, criteria leading to changes in these policies, and land reform policies, global agricultural polices, are analyzed.

2. LAND & AGRARIAN REFORM POLICIES OF THE REPUBLICAN PERIOD

The initial approach of the Turkish Republic to the land issue can be summarized under three main headings (Toklu, 2010):

1. Efforts to restrict property acquisition by foreigners,

2. Efforts to reduce pressure on land to achieve industrialization together with modern urbanization,

3. Improving agriculture and abandoning peasantry with a feudal structure through democracy. In the early years of the republic, industrialization, modern urbanization, land reform efforts and attempts to solve the problems of agriculture were conducted in unison.

Article 87 of the Village Law enumerated as 442 and dated 18th March 1924 prohibits the acquisition of land by foreign nationals within village boundaries. Furthermore, within the general restrictions introduced by item 35 of the Land Registry Law dated 22nd December 1934 and enumerated 2644; foreign nationalities may have land ownership if they comply to the laws and regulations and fulfill the conditions of reciprocity. Item 36 of the same law stipulated that foreign nationalities may purchase independent farms out of the village boundaries up to 30 decare; yet, beyond that portion only if the government allows them to do so. Thus limitations were brought into this issue.

With approval of the Amendment in the Land Registry Law enumerated 5782 and dated 3rd July 2008 by the Constitutional Court, all obstacles in land ownership by foreigners were resolved. Henceforth, all foreign nationalities as well as foreign companies having a legal personality established according to their laws in their countries can be titleholders in Turkey.

Use at most three levels of headings that correspond to chapters, sections and subsections. The first level headings for chapter titles should be in 10pt, bold, justified, and upper case font. Leave one-blank line before and after the first level headings, respectively.

2.1 The Second Level Headings

On June the 11th 1945, a Law to Provide Farmers with Land (Çiftçiyi Topraklandırma Kanunu (ÇTK)) enumerated 4753 and Land Festival enumerated 4760 was passed. The purpose of this law is determined

as to provide land to farmers without or with insufficient land. Among the aims of the law was also to donate the farmers who were lacking the means of production with the necessary equipment. Furthermore, applications such as founding capital, business capital supply were brought to the agenda. The purpose of these laws were not only to eliminate structural problems in land ownership by dividing large estates into smaller pieces, but also providing the necessary support and help to improve agriculture and to take measures for constant taming of the soil for continuing production.

According to item 7 of the law, any piece of land not cultivated, cared for, and used economically according to local conditions for three consequent years without an acceptable excuse, will be considered by the Ministry of Agriculture as unprocessed and will be expropriated.

Land to be distributed primarily was public land, public property in the villages, and land to be acquired from dried lakes and marshy grounds. In the areas where these were insufficient, it was stipulated that private land was to be expropriated and then distributed. In general 5000 decare, in areas with scarce land above 2000 decare was to expropriated and then distributed. The most debated item of this law was item 17. According to this item, agricultural laborers, sharecroppers, and tenants without or with little land, could become owners of the land they have been working on. In a country like Turkey where sharecropping was practiced widely, this item would enable the confiscation the field of many large land owners.

A group of large landowners lead by Adnan Menderes, Emin Sazak and Cavit Oral, claimed the following about ÇTK: There is not a land scarcity problem in Turkey, if desired, arable land can be increased up to 3 times in Turkey. The current problem in Turkey arises from the fact that the goods of the farmers are sold cheaply and their necessitties purchased expensively. The greatest needs of the farmer are equipment with necessarry tools, increase of their credits, and the use of scientific methods in agriculture (Suicmez ve Güler 2005).

At the end of these political reactions, although there were other important reasons as well, The Democratic Party (DP) was founded under the leadership of large landowners separated from the CHP along with "Quarted Proposal" on the 12th of June in 1945.

In 1950, the limit of land expropriation was increased from 500 decar to 5000 decar in the in Law to Provide Farmers with Land (ÇTK). During the time in wihich the law was practised, the provisions especially related to the expropriation were put out of commission, out of the 2.225.428 decar land distiributed to 446.825 families in the 8116 villages,1540 decare of land was obtained through exproriation and only 540 decare within 1540 decare land was dispossesioned from private individuals.

As Law to Provide Farmers with Land (ÇTK) could not lead to the division of large pieces of land, the land distributed was moslty public porperty and in places where land is scarce and where there is no public land property suchas the Black Sea Region, distribution of land was minimal. In Southeastern Anatolia Region; however, large landowners prevented small commodity farming by passing to capitalist agriculture and maintained thus their political strength.

The most important reason why the Law to Provide Farmers with Land (ÇTK) did not yield the expected results was the the inability to organize farmers and the lack of cooperatives supporting them in every aspect.

2.1.1 Land and Agrarian Reform Law dated 1973 and Enumerated 1757

Within the scope of the Law to Provide Farmers with Land (ÇTK), public property land was distributed and hence the current land structure more deranged.

Land and Agrarian Reform Law dated 1973 and enumerated 1757 is the one regulating best the relation between man and land. It was only effective for five years until it was abolished five years later by the Constituinal Court of Turkey in terms of form. Unlike Law to Provide Farmers with Land (ÇTK), this law aimed to prevent further fraction of land not only distributed from public property but also land in the posession of private individuals, and it included interesting items limiting the use of grazing land and other lands for non agricultural activities. As this law was not reformulated within a year after it was cancelled by the Constituinal Court of Turkey, it was completely abolished on the 10th of May in 1978.

Land and Agrar Reform Law was in effect between the July, 19^{th,} 1973 and 10th of May 1978 and Şanlıurfa had been chosen as a pilot area during this period. The underlying reasons for the selection of Şanlıurfa were; land distribution in that area was quite unjust and by resolving the injustice in land distribution and hence preventing migration to major cities, quite on top of agenda in those days, to contribute to the development of East and Southeast Anatolian Region. Resulting from the implementation of the law:

The results of the reform implementation in Şanlıurfa province were as follows:

Out of the 697 villages in total, expropriation was conducted in 329 villages

Expropriated land: 1.616 km^2

Number of villages land was ditributed to: 47

Number of families land was ditributed to: 1.218

Amount of land distirbuted: 231 km^2

According to this data ,231 squarekilometer land was distributed to 1.218 families. 1.616 km² land was expropriated (URL1).

To implement the Land and Agrar Reform law enumerated as 1757, the undersecratariat for Land and AgrarReform was established in 1973.

During the period in which this law was effective, the Land and Agrarian Reform Undersecretary transferring subventions to the relevant instituions and organizations has made several social investments such as 45 health centers for social purposes,3 high schools ,7 regional primary boarding schools, 1 feed plant, 190 irrigation wells,132 miles village road, 80 bridges, drinking water pipes to 364 villages ,227 miles (km)provincial roads ,power transmission lines, and transformer stations possible (Anonymous 1995).

In order to realize objectives of Land and Agrar Reform Law enumerated as 1757, to maintain the living of a family of five at provincial level throghout Turkey, 79-337 decare land for dryland agriculture and 32-106 decare for irrigated farming were determined as necessary. Although granting land to farmers was not realized due to the cancellation of the Law enumerated as 1757, when the law enumerated as 3083 came into force in 1984 , 101-103 decare public property land was distributed to 754 farmers families in 36 villages who were defined according to law no.1757 as potential farmers (Anonymous 1995).

2.3. Agrarian Reform Law Regarding Land Regulations in Irrigation Areas (Law dated 1984 and enumerated 3083)

Land and Agrarian reform law was repealed in 1978. On December the 1st, 1984 enumerated 3083 the "Agrarian Reform Law Regarding Land Regulations in Irregation Areas" came into force. In order to realise the objectives of this law "General Directorate for Agrarian Reform (TRGM)" was established in line with the law defining the role and function of Agrarian Reform General Directorate as published in the official Gazette No.18685 and dated March 5th 1985 and enumerated 3155.

The scope of this law is determined according to the decisions taken by the Council of Ministers and proposals made by the relevant ministry.

"Agrarian Reform Law Regarding Land Regulations in Irrigation Areas" includes land reform within its form. This law also foresees land expropriation from land owners with vast lands above the determined norm and provision to the farmers with no or insufficient land. For this purpose, expropriation will be conducted on areas ten times above the foreseen provision amounts and the facilites on them with the exception of vineyard, garden, forested land, and model businesses belonging to legal entities.

In line with the article 44 of the current 1982 constituiton in force stating: "The state takes necessary cautions for protecting and developing the cultivation land, avoids its loss by erosion and provides land to peasant who are agriculturists without or insuficient land" item b of the law enumerated 3083 land is to be distributed. In the areas where this law was applied, 11399 agriculturist farmer families in 147 villages were distributed 735741 decar public land between 1987 and 2006. Until 2013, additionally 88 442 decar public land was distributed to 13734 agriculturist farmer families in 176 villages. Land is still distributed in areas where this law is applied. Within this framework, in the application areas during the 2005-2006 rental period 319 farmers without or insufficient land were rented 431 687 decar land. During 2000-2012; however, to 143391 agricultural farmers 683163 hectar land for an amount of 66221637 TL (1 $= 1,80 TL) was rented (URL 2).

According to the law enumerated 3083 " General Directorate fo Agrarian Reform (TRGM)" continues, either with or without the consent of the legal entities, land consolidation in the areas where the law is put into practice. Until so far (between 2003-2012 land consolidation has been conducted for 2503 602 hectar land by TRGM. Land consolidation will be conducted in the coming 5 years in an area of 2 million hectar (Anonymous, 2012).

2.4. Land Protection & Land Use Law enumerated as 5403/5578

In Turkey, legal regulations about land protection have only been items, statetments, and regulations until 2005. In 2005 for the first time a code solely for "Land Protection and Land Use " enumerated 5403 was put into force (Ulger and Cay 2012).

The aim of this law is; saving land by preventing the loss of its features by natural or artificial ways and developing and determining planned land use based on principles of sustainable development.

This law generally determines correct use of land by determining soil type and land presence, classification of agricultural areas, determining land parcel sizes, protection and usage of land, use of agricultural lands for cultivation purposes, land consolidation, and distribution.

However, this law is mostly criticized for the determination of parcel sizes; whereas the minimum separable parcel size on the agricultural lands is 5000 m² by the Registry Law, by the law of Land Protection and Land Use Law, according to this law it is "the smallest area on which agricultural actions can be performed economically and agricultural area parcel size that is not be fractioned any more as determined by the ministry of agriculture according to social, economical, ecological, and technical specifications of specific regions and areas. Except the areas required for public investments, agricultural areas can not be divided into smaller parts as determined previously as agricultural land parcels. Parcelling can not be done in areas inherited if sufficient parcels can not be formed. Common use, renting or selling are the only acceptable practices. It is indicated that the parcel area can not be less than as defined by land norm value. As the land norm will have differences regarding the regions, smallest separable area has been a matter of public discussion and repudiated values by the public are defined as 2 hectars in certain agriculture lands and specific crop areas, 0,5 hectar in planted agricultural areas, 0,3 hectar in greenhouse cultivation, and at least 2 hectars in marginal agriculture lands.

3. CONCLUSION AND SUGESSTIONS

Diverse problems have been encountered during each stage of land reform by the many states that have implemented land reform long before the Republic of Turkey. Although there will be Turkey specific prblems, the problems, of the states that have implemented land reform as well as the solutions to these, will be largely similar. Thus, implementing a land reform by taking advantage of the experiences and expertise of the states that have implemented land reforms long before Turkey will be possible. Yet focusing on the specific requirements of Turkey and producing appropriate solutions to these special conditions will prepare the ground for a more successful land reform and prepare the ground for a more just and participatory democratic structure.

It is necessary to pay particular attention to the following facts regarding this topic about the practices of the countries: After the implementation of land reform, in the areas that underwent land reform, many times expected outcomes are not achieved and the success dimnished due to reasons such as insufficient loans, lack of personel to inform and lead farmers, and delays in title deed transactions of the newly distributed land. Moreover, in oreder to keep his small fields, farmers need loans, technical know-how and cooperratives. Therore, in order to educate the farmers about sustainable agriculture and relevant techniques, courses openend to educate the villagers in the areas that underwent land reform.

Following Turkey specific issues bearing the potential of making land reform practices difficult are to be considered:

- Owners of vast land will be against the implementation of land reform. These objections will lead sometimes to political pressures and other times to social pressures.
- Insufficient employment opportunities in non-agricultural sectors and fast population growth-rate will be among the challenges faced in land refom practices. Yet these are far beyond the problems that can be solved through agrarian reforms.
- Financial problems. There will be major monetary issues about meeting the expropriation costs. Therefore, before any land reform attempt, financial resources are to be considered right form the beginning.
- There will be various problems in the valuation process. The diversity in the soil structure, climatic and geographical variations if considered, means that there will be various problems.
- Political pressures, disputes, and social unrest resulting are points that will eliminate the excitement during land reform implementation.
- The bound of the peasants living in rural areas on a small piece of land will be among the problems faced during the implementation of land reform.

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International Journal of Engineering and Geosciences (IJEG),
Vol; 2; , Issue; 02, pp. 68-74, June, 2017, ISSN 2548-0960, Turkey,
DOI: 10.26833/ijeg.296835

THE EFFECT OF OBJECT SURFACE COLORS ON TERRESTRIAL LASER SCANNERS

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ABSTRACT: Terrestrial laser scanning systems are a relatively new measurement technology. With the advances in technology, these systems have gained more popularity and have been increasingly used in many different fields. With the terrestrial laser scanning technology, three- dimensional (3D) information and images of objects can be obtained in a more practical and easier manner and with higher accuracy compared to the conventional methods. Additionally, the measurement of an object is performed without being in physical contact. In this study, a test area of 2.10 meters ×2.80 meters in a vertical position was scanned at a 35 meters distance using different object colors (white, red, blue and green) with a Topcon laser scanner to determine the position accuracy of the scanner according to the colors. Then, by switching the Y and Z coordinates obtained from laser scanning, the test area was placed in a horizontal position, which resulted in a half rectangular prism. Then, the volume of this prism and the volumes obtained from laser scanning were calculated and compared. Based on the differences in this values, it was found that within a scanning distance of 35 meters, the position accuracy of the laser scanner varied between 5.7 mm and 12.2 mm. In addition, the best result was obtained by scanning the test area in white color.

Keywords: *Laser Scanning Technology, Object Color, Position Accuracy, Volume.*

1. INTRODUCTION

In recent years, three dimensional terrestrial laser scanning systems have been employed very successfully in many engineering applications. These systems allow the user to survey structural surfaces and 3D bodies. The data is then transferred to a computer where it is converted into accurate 3D models. The high quantity and precision of the measured points enable the user to generate realistic, 3D illustrations of complex structures (Shulz and Ingesand, 2004; Yılmaz at al., 2009). 3D terrestrial laser scanning techniques are an effective method of creating a complete 3D documentation of the spatial geometries of an object. They yield maximum information and have unsurpassed accuracy within a few millimeters. The recording techniques are hands-free allowing hazardous sites to be easily documented from a distance of greater than 100 m (Demir at al., 2004; Yılmaz at al., 2009). In terrestrial laser scanning, 3D coordinates are obtained as point clouds. Several 3D coordinates on an object's surface can be measured in a very short time (Ingesand at al., 2003; Yılmaz at al.,2009). Thus, terrestrial laser scanners present as a very promising alternative for various types of surveying applications. They allow acquiring a huge amount of 3D data in a fast manner and can be often profitably combined with colored high resolution digital images to provide an accurate 3D representation of the environment. Another major advantage of this technique is providing a higher level of detail with good metric accuracy which results in the representation of real objects more adequately than using a single picture or a collection of pictures. The 3D models generated with these scanners are now widely used for cultural heritage, industrial, land management and medical applications (El-Hakim, 2001; Yılmaz at al., 2009).

Today, terrestrial laser scanning technology is used more than classical measuring methods. This technology provides the users with direct 3D position information and performs measurements faster and more accurately compared to the conventional methods. Therefore, particularly studies that would be time consuming and cost intensive using classical measuring techniques can be easily performed with laser scanning techniques to overcome these disadvantages.

Terrestrial laser scanning technology has significant advantages in terms of cost, time, and convenience in a wide variety of applications. Using this technology, 3D and high-resolution data can be obtained with high precision.

As with all measurement techniques, the results of laser scanning can be misleading due to different factors such as environmental factors and the characteristics (e.g., permeability and roughness) of the object surface to be measured and roughness. Therefore, the determination of the error sources is extremely important and necessary to maintain the quality of data. It is also crucial to know the accuracy of the measurements made with this type of equipment (Karşıdağ and Alkan, 2012).

In this study, the test area surface was covered by glossy foil paper of different colors (white, red, blue, and green) and scanned using a Topcon GLS-1000 terrestrial laser scanner from a distance of 35 meters. Then, the effects of the object surface color on the accuracy of the scanner were investigated.

2. MATERIAL AND METHOD

2.1 The Test Area

For this study, a test area of 2.10 meters × 2.80 meters was constructed and placed in a vertical position. The inside of this test area was covered with steel and the outer surface was covered with hardboard. Figure 1 shows that the test area is mounted on special metal feet and is fixed.

Figure.1 The test area

To ensure that the test area was exactly vertical, level screws were placed on the feet and on the back. The hardboard surface was white because this color reflects the most light.

2.2 Topcon GLS-1000 Terrestrial Laser Scanner

In this study, a Topcon GLS-1000 terrestrial laser scanner was used as shown in Figure 2.

Figure.2 Topcon GLS-1000 terrestrial laser scanner

The Topcon terrestrial laser scanner has the ability to quickly collect and store data. It has precise scanning technology, a 2 megapixel digital camera, 3000 dots per

second scan rate, 90% reflection up to a range of 330 meters, 4 mm accuracy from 1 meter to 150 meters, 6″ angle accuracy horizontally and vertically and horizontal and vertical movement. There is less noise in the point clouds in the scans made with the Topcon terrestrial laser scanner, and even at distances above 100 meters, it possesses sufficient accuracy.

2.3. The Method

In this study, glossy foil paper in different colors of white, red, blue, and green were pasted on the test area surface. Then, by scanning the test area with a Topcon GLS-1000 terrestrial laser scanner at a distance of 35 meters, the effects of object surface colors on the terrestrial laser scanner were investigated.
To achieve this aim, the test area was scanned with different surface colors and after the test area was placed in a horizontal position with the help of the obtained point clouds, the volumes that were obtained were calculated. It is necessary to determine the most appropriate scanning color by comparing the calculated volumes with known volumes. Verticality was provided using the levels at the feet and behind the test area. The verticality was checked again using a square grid network of 10 cm created in an area of 2.70 × 2.00 meters using the Total Station in local system. The coordinates of the 588 points obtained were recorded as shown in figure 3.

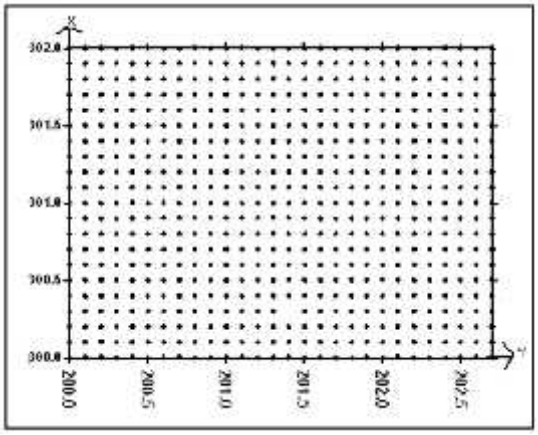

Figure.3 The grid network created on the test area.

The Y and Z coordinates were displaced to obtain a 3D image of the test area as shown in Figure 4.

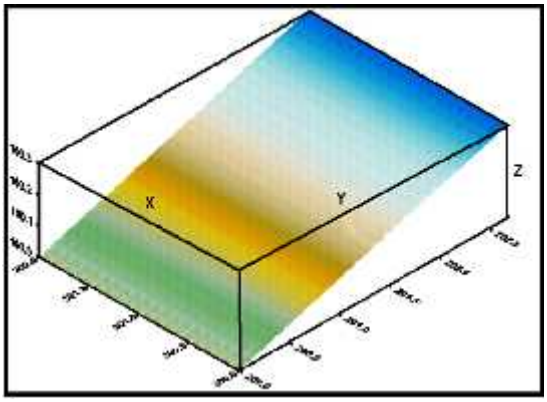

Figure.4 A 3D image of the grid network on the test area

Since the system that coordinates the grid network was not perpendicular to the test area, a surface that was a half a rectangular prism was obtained. This surface should have a volume of 0.8154 m3 and it was calculated by the obtained coordinates as 0.8165 m3 according to the volume calculation method of the rectangular prism. This very close result is numerical proof of the verticality of the test area. It is also necessary to have systematicity between the coordinates on the test area and this was visually checked for the three axes. Figures 5 to 7 show the systematicity between the X, Y and Z coordinates of the axes, respectively.

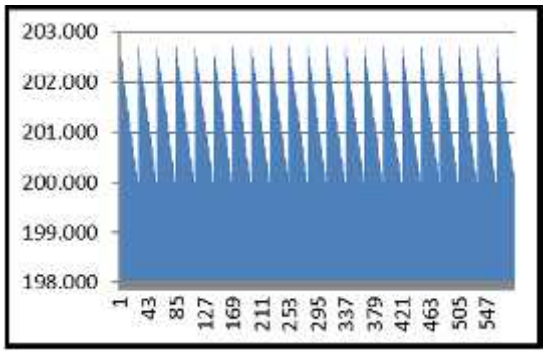

Figure.5 Systematicity between the X coordinates

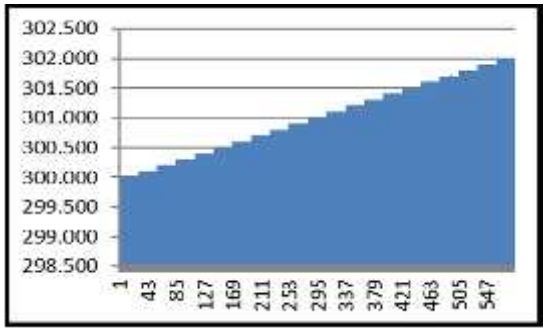

Figure.6 Systematicity between the Y coordinates

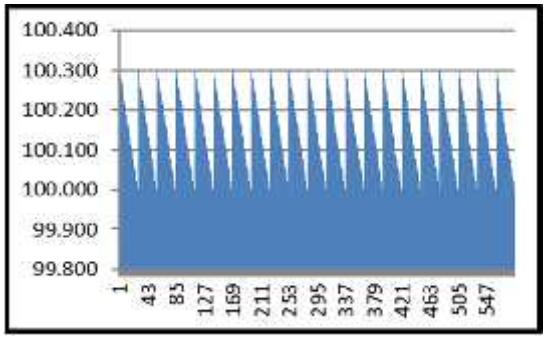

Figure.7 Systematicity between the Z coordinates

Each scan was performed at a fixed point 35 meters from the test area. The test area was first scanned in white color as shown in Figure 8.

Figure.8 Scanning of the test area in white color.

Then, the test area was scanned in red, blue, and green as shown in Figures 9 to 11, respectively.

Figure.9 Scanning of the test area covered with red foil.

Figure.10 Scanning of the test area covered with blue foil.

Figure.11 Scanning of the test area covered with green foil.

The color values of each glossy foil paper were measured and recorded as shown in Table 1. A Datacolor SF600+CT device was used for color measurement. The parameters were chosen as follows: eye size 30 mm, enlightening CIE-D65 and the observation angle 100.

Table 1. Results of color measurement (CIE color parameters)

Color Parameters	Color Name			
	White	Red	Green	Blue
CIE L*	91.05	37.81	42.49	33.15
CIE a*	-2.36	58.84	-59.45	21.52
CIE b*	-3.42	38.85	21.36	-60.57
CIE Y	78.60	9.98	12.82	7.61
CIE x	0.3040	0.6066	0.2172	0.1652
CIE y	0.3260	0.3250	0.5134	0.1302

The scans were undertaken in an indoor space to reduce the effects of the external environment. Once the scanning was complete, the data was transferred to Scanmaster software to remove any unnecessary point clouds. The remaining point clouds were recorded in Microsoft Excel to calculate the expected volumes for each scan. For the red and green foil, the raw data and the processed images (unnecessary point clouds removed) are shown in Figures 12 to 15.

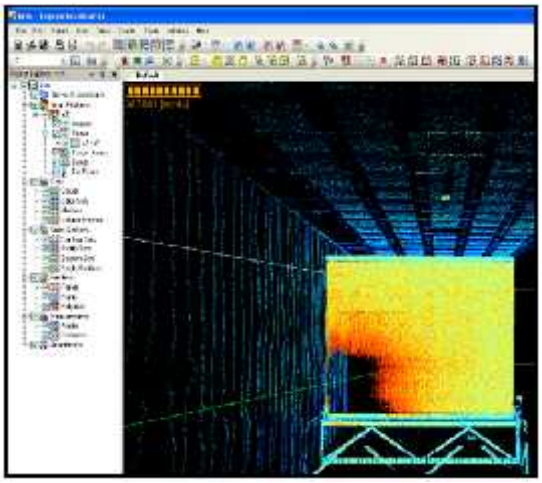

Figure.12 A Scanmaster image of the test area based on raw data from the scan of the red foil.

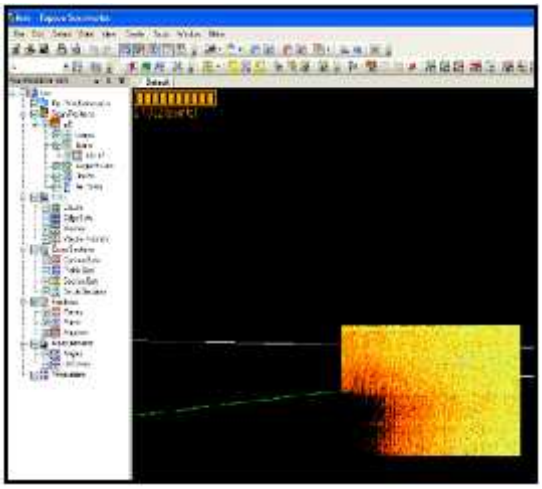

Figure.13 A Scanmaster image of the test area based on the processed data from the scan of the red foil.

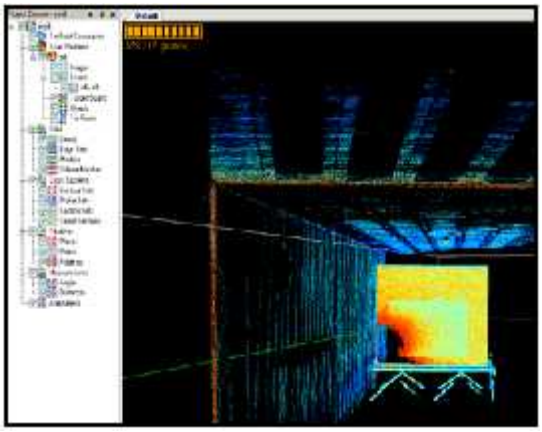

Figure.14 A Scanmaster image of the test area based on raw data from the scan of the green foil.

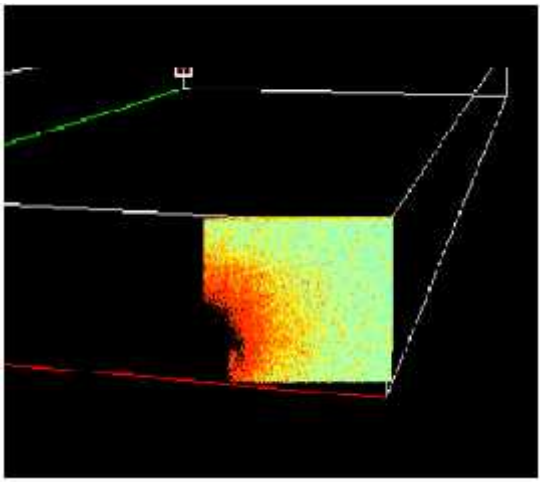

Figure.15 A Scanmaster image of the test area based on processed data from the scan of the green foil.

The minimum and maximum values of the coordinates of the required point clouds were calculated in Microsoft Excel. In order to avoid a possible conversion error, the local coordinates obtained from the scanner were used directly. From the obtained coordinates, the values of "Y" and "Z" were replaced and the test area was made horizontal. If the scans had been made exactly perpendicular to the test area, the volume of the rectangular prism would have been zero. However, since the scanner was not completely perpendicular to the object and was not leveled, this was not possible. In this case, a half rectangular prism is expected to be formed with a base which is the difference between the minimum and maximum X coordinates and the difference between the minimum and maximum Y coordinates, and the height of the rectangular prism is the difference between the minimum and maximum Z coordinates. The calculated difference values were multiplied (base area × height) and divided by two (half rectangular prism) and the expected volume values were calculated for each color. The calculation of the volume value obtained from scanning the white test area is shown in Figure 16.

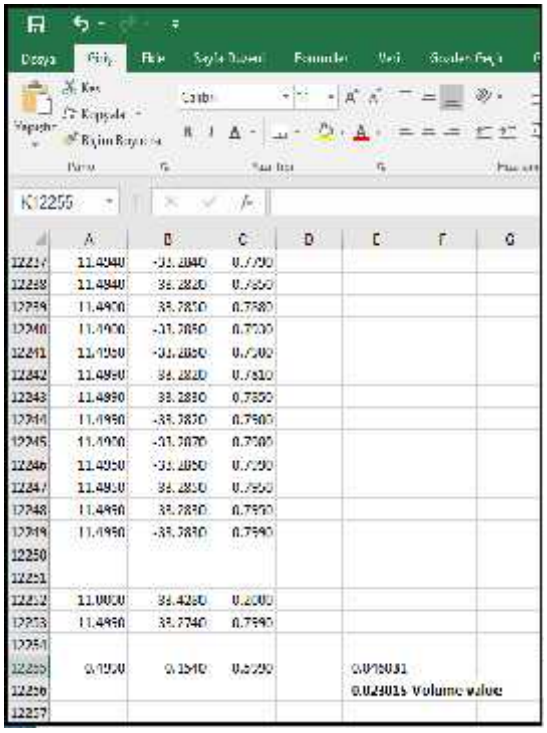

Figure. 16 The expected volume obtained by scanning the test area in white color.

After determining the difference between the minimum and maximum values of the coordinates of the four scanning stations, these values were transferred to Surfer software to calculate the volume for each station. Figure 17 shows the volume values calculated using the point clouds obtained by scanning the test area in white color.

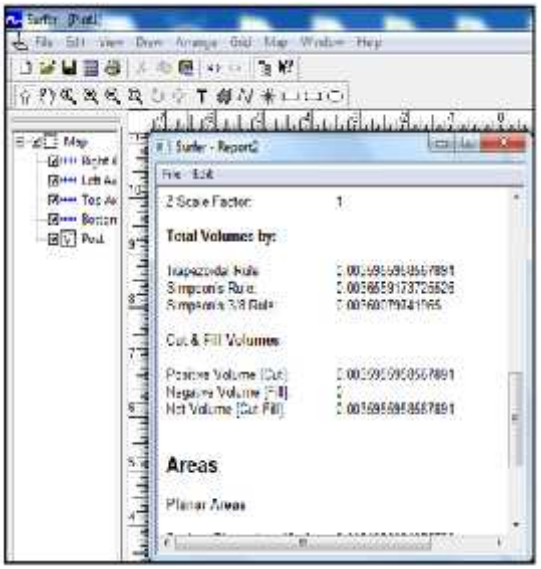

Figure.17 Volumes calculated from the point clouds obtained by scanning the test area in white color.

As the surface of the object was flat, a linear interpolation method was used in the volume calculations for the best result (Yılmaz, 2007). In addition, the volume values obtained from the coordinates for each color were calculated. This allowed determining the differences between the volumes.

2.4. Results

Table 2 presents all the calculated volumes and the differences between the values by scanning color.

Table 2. A comparison of the calculated volumes between the scanning colors.

Object Surface Color	Volumes Calculated From Point Clouds (m3)	Expected Volumes (m3)	Differences (m3)
White	0.0036	0.0230	0.0194
Red	0.0033	0.0440	0.0407
Blue	0.0027	0.0312	0.0285
Green	0.0033	0.0451	0.0418

A 1.0 meters × 2.0 meters portion of the test area was assessed in the study. The laser scanner was not completely perpendicular to the test area and there was a 30 cm slip on the Y axis. This resulted in a half rectangular prism of 2.7×2.0×0.3 meters in dimensions for each scan. The volume of this half rectangular prism was calculated as 0.810 m3. The volumes were recalculated by increasing each edge of the prism from 1 mm to 15 mm and the values obtained are shown in Table 3.

Table3. The volume values obtained by increasing each edge of the prism from 1 mm to 15 mm.

Y (m)	X (m)	Z (m)	Error (mm)	Calculated Volume (m³)	Known Volume (m³)	Differences (m³)
0.301	2.701	2.001	1	0.81341	0.81000	0.00341
0.302	2.702	2.002	2	0.81682		0.00682
0.303	2.703	2.003	3	0.82021		0.01021
0.304	2.704	2.004	4	0.82366		0.01366
0.305	2.705	2.005	5	0.82709		0.01709
0.306	2.706	2.006	6	0.83052		0.02052
0.307	2.707	2.007	7	0.83395		0.02396
0.308	2.708	2.008	8	0.83740		0.02740
0.309	2.709	2.009	9	0.84085		0.03085
0.310	2.710	2.010	10	0.84430		0.03430
0.311	2.711	2.011	11	0.84776		0.03776
0.312	2.712	2.012	12	0.85122		0.04122
0.313	2.713	2.013	13	0.85469		0.04468
0.314	2.714	2.014	14	0.85816		0.04816
0.315	2.715	2.015	15	0.86161		0.05160

The differences in the volume values shown in Tables 2 and 3 were compared. According to the data in Table 3, if the volume difference was 0.02740 m3, it was assumed that scans had been performed with an error of 8 mm. Then, the difference values given in Table 2 were compared to those in Table 3 to obtain the scanning sensitivity/precision of the four applications (Table 4).

Table 4. Scanning precisions by object surface color.

Object Surface Color	Scanning Precision (mm)
White	5.7
Red	11.8
Blue	8.3
Green	12.2

3. CONCLUSION

In recent years, the scanning precision and field of use of terrestrial laser scanners have been steadily increasing. These scanners have been successfully applied in many engineering applications. The most important factor in obtaining 3D positional data of an object is the sensitivity of this data. The acquisition of this data in the shortest time is another important factor. In addition to 3D modeling, which is one of the most common uses of terrestrial laser scanning technology, there are various applications such as deformation measurements, in which data precision is very important.
In terrestrial laser scanners, the radial resolution is defined by the scan range. In this study, the test area was covered with glossy foil papers in different colors (white, red, blue, and green) and scanned with a Topcon GLS-1000 terrestrial laser scanner from a distance of 35 m. Then, the effects of the object surface colors on the precision of scanning were investigated. The results demonstrated a scanning accuracy of 5.7 mm to 12.2 mm. As known, the 5 mm scan range for each scan somewhat varies. Accordingly, the number of points obtained for each scan was also different, which resulted in variations in the results. On the other hand, there is more reflection of a certain region on the test area than the other regions that causes the lack of data in this region. Based on the results, it can be concluded that the Topcon terrestrial laser scanner used in this study has a scanning sensitivity of 5.7 mm to 12.2 mm for the given colors at a 35 m distance and scans with minimum errors when the object has a white color.

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