Chapter 28

Application of Geographical Information System to the Analysis of Urban Green Areas in Urban Development Plans – A Case Study of Zonguldak, Turkey

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1. Introduction

One of the most rapidly growing applications of remotely sensed data is the derivation of landscape pattern metrics for the assessment of land use condition and landscape dynamics (Betts et al., 2003; Colombo et al., 2004; Egbert et al., 2002; Griffith et al., 2003; Hansen et al., 2001; Imbernon and Branthomme, 2001; Ji et al., 2008; Millington et al., 2003; Santiago et al., 2007; Yu and Ng, 2006). The characteristics of green areas are generally analyzed with raster data by many scholars. In contrast with common practice, this study used vector data instead of raster data in the analysis of urban green areas in the study area. The fact that study analyzed urban development plans was the underlying reason that vector data was primarily used for this research. Geographical Information System (GIS) is one of the most useful methods for analyzing land use. All land uses for an urban development plan were considered and comparisons were made based on relative percentage of whole area. The data was derived from digitized data from an urban development. Urban green area proportion in the current city development condition was determined. Active and passive green areas were determined from an urban development plan and were prepared for analysis of trends of land use condition in the city. GIS was used as an analytical tool for this approach.

GIS data has significant utility in analysis of urban green areas in city development (Ji et al., 2008). Land use offers critical guidance to identify current landscape characteristics in urban areas. The study explored urban green areas associated with landscape features in urban areas and effectively supported an analysis of urban green area characteristics. Urban green areas can prove to be valid and useful characteristics for general landscape analysis of an urban environment.

The fact that urban green areas improve the livability of cities has made them the focus of a great deal of attention. Urban areas completely transform the landscape into which they spread, leading to the development of entirely new land uses (Busck et al., 2006). Identification of urban green areas and developed areas are essential for monitoring and assessment of ecological consequences of changes in land use (Shi et al., 2008). The defined characteristics of urban green areas put emphasis on approaches to urban development that take urban land use patterns into consideration.

The spatial characteristics of urban areas are the most important elements of urban green areas analysis. There are many reasons to analyze urban green areas in urban development. The most important reason is to understand long-term interactions between humans and nature (Bi et al, 2011). The natural environment is under pressure from the human impacts involved in urban development processes. Urban development decisions have considerable impact in shaping current urban green areas in cities. There is no need to prove that land use is one of the important elements for analyzing urban green areas in urban development plans.

This research intended to investigate the development direction of land use with regards to urban green areas in cities. GIS technologies and analysis of proportional land use were used in this study (Bi et al, 2011). These methods were implemented on Zonguldak city as a case study. Urban green areas were determined for Zonguldak city in the urban development plan in an effort to understand current land use conditions in the city.

Consequently, the study emphasized urban landscape characteristics through the analysis of urban green areas in urban development plans. The study focused on ecological characteristics of urban areas and provided a potential approach for analyzing landscape features. The study will lead to identification land use trends and aid land use management in these areas (Bi et al, 2011).

2. Area description[1]

Located in the Western Black Sea region of Turkey, Zonguldak has an area of 8625 km^2, covering 1.1% of Turkey's total land area (Figure-1) (ANONYMOUS, 2006). Zonguldak generally consists of inclined terrain due to its natural topography. Mountains in the Western Black Sea region run parallel to the coast in Zonguldak, rising sharply from the sea to elevations of up to 1976 meters (ANONYMOUS, 2006). This high mountain system provides a block between the sea and the Central Anatolian Plateaus (ANONYMOUS, 2006).

The discovery of coal in Zonguldak led to a population explosion in the region. Zonguldak was transformed from a village to a city on account of the resulting rapid economic development. In 1899, the Zonguldak coal harbor (Figure-2) was built as the hub of coal transportation in the city (ANONYMOUS, 2006). New coal washers, new employee houses and power plants steadily increased industrial productivity in Zonguldak. Zonguldak has suffered from the effects of this rapid urbanization.

[1] This part of article is developed from Mustafa ERGEN`s PhD dissertation

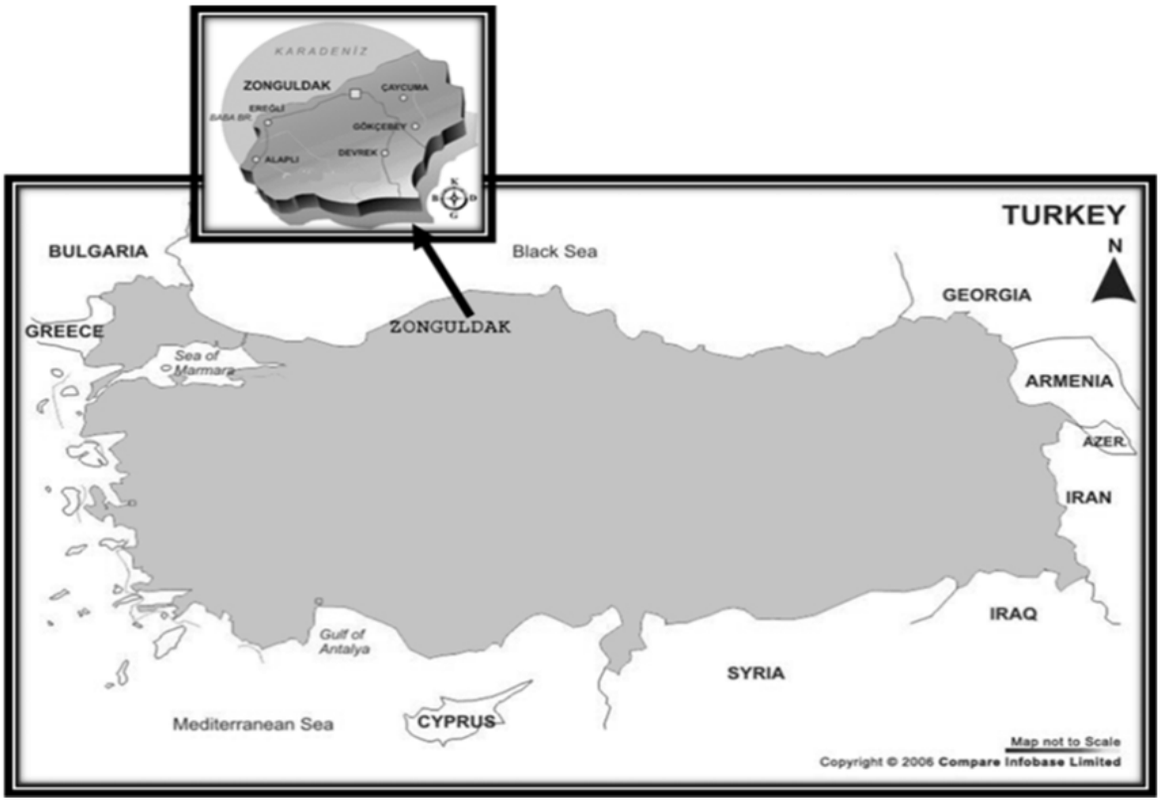

Figure 1. Location of Zonguldak City in Turkey, (The Figure is prepared by Mustafa ERGEN, 2009)
Source: http://www.loadtr.com/397588- zonguldak_haritas%C4%B1_6.htm and
http://www.mapsofworld.com/turkey/maps/turkey-outline-map.jpg,

Figure 2. Zonuguldak Port Area, Source: Mustafa Ergen, 2007 (Author`s own image)

The form and structure of Zonguldak is shaped by the coal mining industry. After the onset coal mining in the city, additional exploration accelerated the process of Zonguldak`s urbanization (Figure-3). This rapid development has had an influence on natural areas and

Figure 3. The View of Zonuguldak City, Source: Mustafa ERGEN, 2007 (Author`s own image)

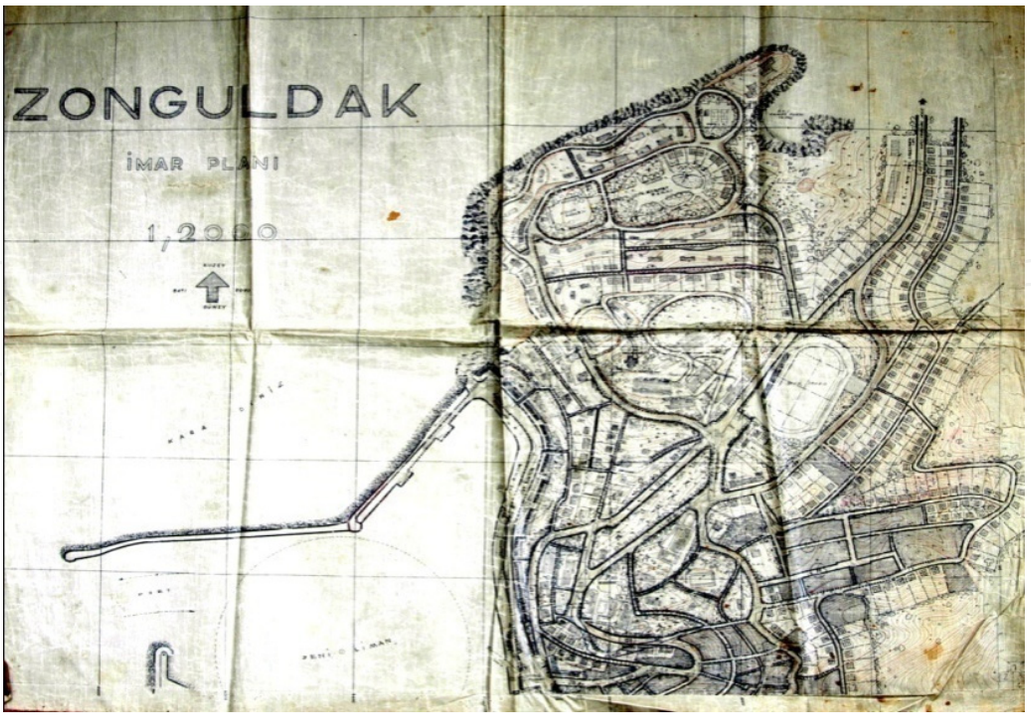

Figure 4. Development Planning Map, Source: Zonguldak Municipality, 2006

every part of the urban area. In its history of urbanization, Zonguldak reached its greatest development during this period. There have been many regulations to attempt mitigate this unhealthy and fast urbanization. However, there was no effective approach to urban green area and land use planning during the growth of the city.

The first settlements during this growth period were formed around the port of Zonguldak, and Uzulmez, Kozlu, Asma mines in the city (ANONYMOUS, 2006). The problem of settlement areas in the city has grown in parallel with the increasing coal mining activity (Figure-4). This has had far-reaching effects on planning and urban green areas structure.

As Zonguldak city is located between the sea and mountains, its topographical properties put obstacles in the way of is development in the city. Urbanization began on flat terrain in the basin. Because attempts have been made to construct primarily on the flat terrain of Zonguldak, urban development has been concentrated in certain areas (Figure-5). This led to a problematic and unhealthy development in the early stages of urbanization in Zonguldak.

Figure 5. General View of City Center and Port Area in Zonguldak, Source: Mustafa ERGEN, 2007 (Author`s own images)

3. Research method

GIS is an important tool for analyzing urban green areas (Irwin, 2003). Urban green areas are currently a crucial issue in city development, now more than ever. GIS can be used to define the proportion of urban green areas in a city. These urban green areas analyses can be compared among each other and to other land uses such that an analysis can show how urban green areas can be designed and improved in urban developments.

The inclusion of urban green areas is crucial for creating livable places in cities. GIS measures various aspects of land use patterns, including topography, shapes of land use areas and future direction of development of the cities (Irwin, 2003). This study used percentage of areas calculation and arithmetic mean calculation for analyzing green areas that gives us a broad picture of green areas condition in a city development. Percentage of land use can make clear

explanation of land use tendencies and arithmetic means can help to determine central tendency for land uses. Arithmetic mean was calculated using the below formula:

$$AM = 1/n \sum_{i=1}^{n} ai = \frac{a_1}{a_n} + \frac{a_2}{a_n} \cdots \frac{a_n}{a_n}$$

This study used percentage of land use and arithmetic mean to analyze urban green areas in Zonguldak city. The method measured current land use condition in terms of area calculation in the cities.

The data obtained through the digitized data of the urban development plan helped to determine the state of the urban green areas and the characteristics of the whole city. One reason for choosing to analyze percentage of land uses is that the investigation considered whole area for urban green areas. The second reason is that it gives a wide range of analysis options via the arithmetic mean for Zonguldak city.

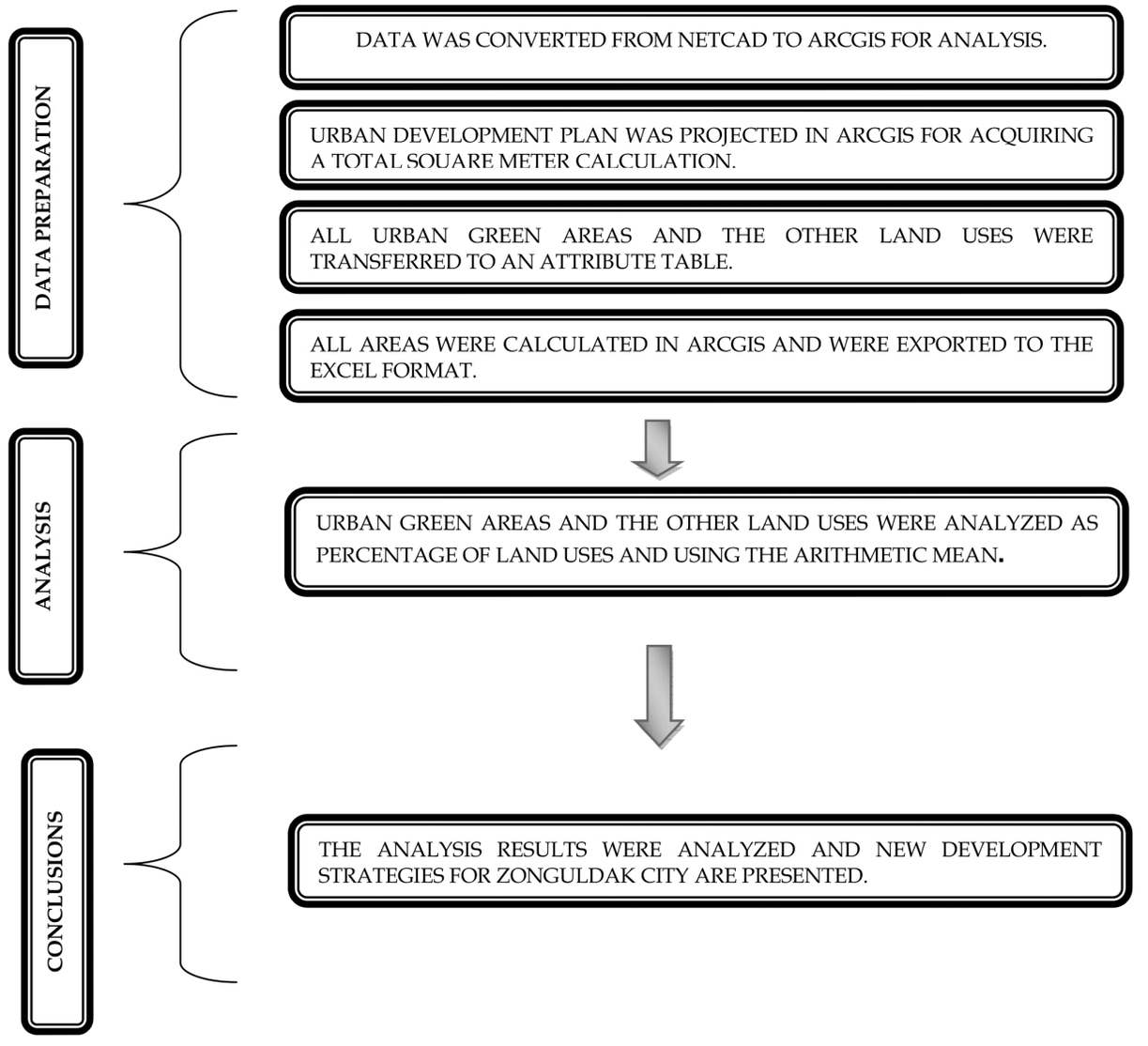

Figure 6. Flow chart of methodology

The methodology was composed of three major phases; data preparation, analysis and conclusion. Data preparation included the following steps; data was converted from another program to GIS. The plan was projected for calculation in the correct units. All land uses were determined by urban green areas analysis. The data was transmitted to an excel file. The analysis converted land use measurements to arithmetic mean and the proportion of land use was determined for each use. In the he conclusion, the results were used to formulate some development strategies for Zonguldak city. The flow chart of the methodology below details the phases step by step.

4. Results and conclusions

Urban green areas were subdivided into Garden, Copse, Park, Forest and Graveyard lands. The areas of urban green areas were obtained from area calculations in ArcGIS. It should be noted that both urban green areas and the other land uses can be analyzed for understanding current development direction in city. The active and passive green areas were compared to one another and to the other land use areas in the analysis. The method showed that the topography of Zonguldak is the main obstacle for new development in the city. It is very important that green zones should be determined for the sustainable growth. This will offer a new direction for the city's future development. The land use map was created by ArcGIS software in this study (Figure-6). The comparison data between urban green areas and the other land uses were acquired from this map.

The urban green areas were derived by urban development plans and calculated from the same map for analysis of land usage. Forest lands and copse lands border the city development, largely due to the topography of the region.

As can be seen from the table, the other land uses grow along with total area. On the contrary, park land is underrepresented. The table shows that Copse land, Garden land and Forest land are the reasons for this situation. These lands compose most green areas in the city. This shows that the city does not have many recreational opportunities. It means that urban development has not included many recreational opportunities but that has still included enough green areas in the city.

The urban land use shows that urban green areas are dominant areas in land use. That means Zonguldak is a city with high much potential for urban green areas development. The topography is the most important reason of this situation in the city. There are not many appropriate places to settle in the city and around the city. This condition makes green areas planning in the city easier. The analysis shows that urban green areas in Zonguldak are mostly passive green areas. Although the city currently has many green areas, few of those are useful. The topography allows neither settlements nor recreational opportunities.

From the figure, it is apparent that green areas are the dominant characteristic land use in Zonguldak. It is obvious that Zonguldak has much potential for urban green areas development. Copse land and garden land are the main types of green areas in Zonguldak. The figure shows that park land is one of the less frequent land uses in the city. The reason

is behind it that there are not adequate areas in which to design park land in the city because of the rough topography. Although the topography might not be amenable to the design of recreational opportunities, urban green areas could be the most important element of planning for Zonguldak. The figure also shows that garden land provides some degree of interaction with green areas to the people, but these are also not useful areas and are mostly converted from copse land and forest land. That means that the city does not have enough recreational opportunities in reality, such that while Zonguldak may maintain adequate ecological characteristics, it may not give an option for recreational uses.

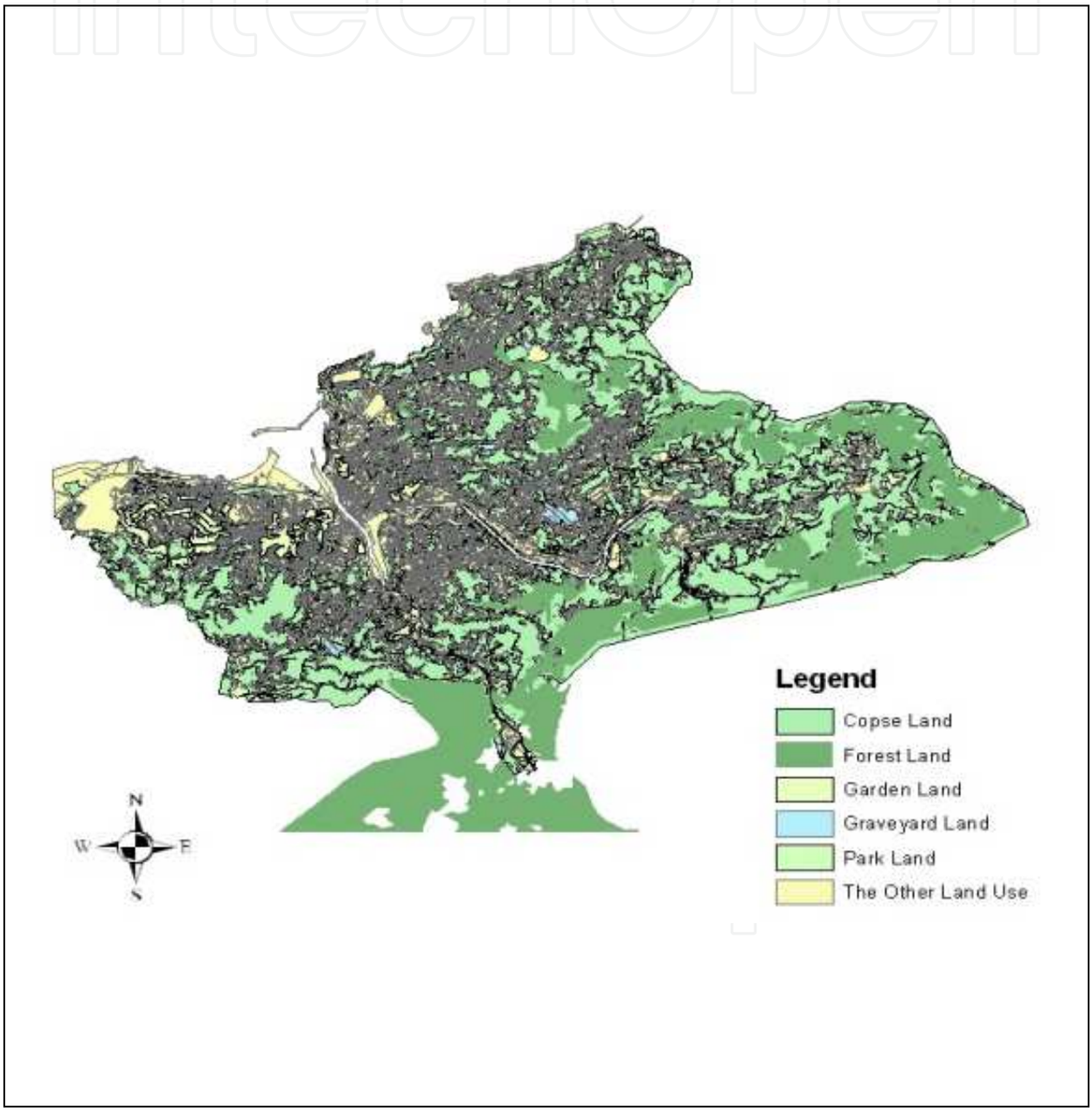

Figure 7. Zonguldak City Current Land Use Condition Depends on Urban Development Plan, Source: Anonymous, 2006 (Basic map was prepared by Modül Planlama Harita Bilgisayar İnşaat ve Ticaret Ltd. Şti with another program for Zonguldak Municipality. The map was converted and was prepared by Mustafa ERGEN for analyzing urban green areas).

Land Uses	Total Area m²
Copse Land	13125850,04
Graveyard Land	149400,47
Garden Land	8033057,98
Park Land	17373,96
Forest Land	6173642,26
The Other Land Use	5137810,08

Table 1. Land Uses Total Areas

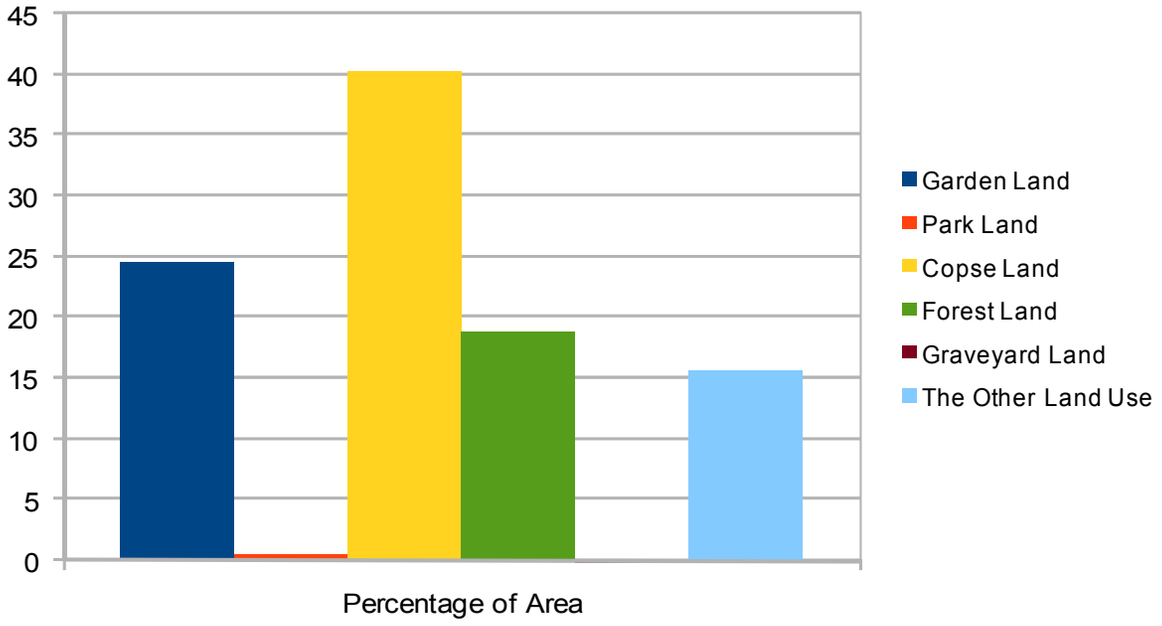

Figure 8. Proportion of Land Use Condition

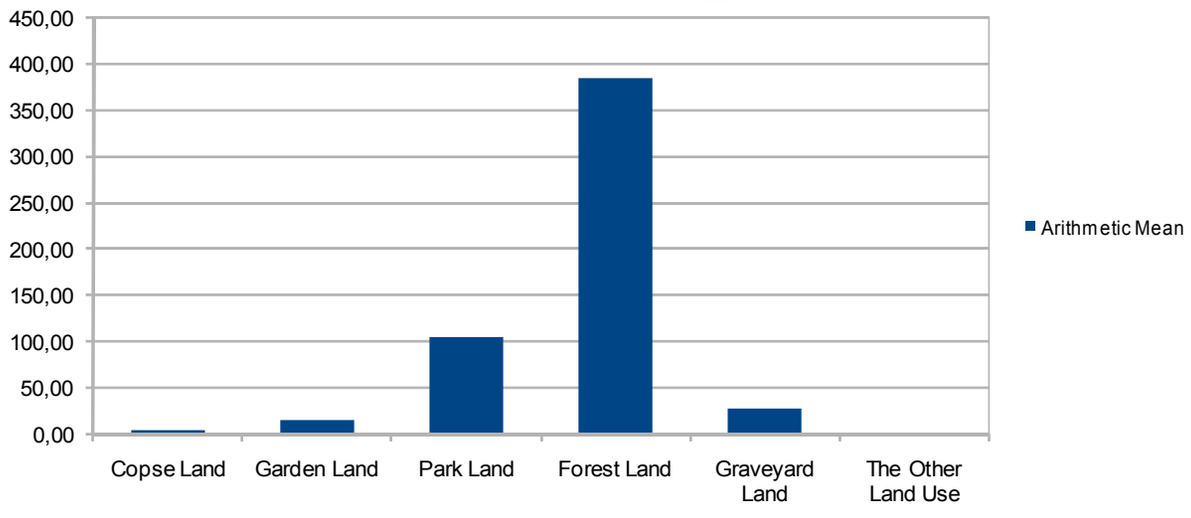

Figure 9. Arithmetic Mean of Land Uses

It can be seen from the figure that forest land dominates the other land uses. This demonstrates that the city has adequate green areas. The figure also shows that the other land uses do not have much representation in the city. There are many reasons behind this; the most important reason mentioned above is the topographic obstacle. We may claim that development costs might be another reason for this situation. The study concludes with an obvious approach to defining several strategies for the future development of Zonguldak;

- The planning development should take the difficult topography into consideration.
- The potential development option must be defined for future development goals such as Eco-tourism.
- Achieving new development emphasizes new structures and developments in the city.
- The green potential provides new opportunities for city development such as ecological development in city.
- Eco-city development elements should be taken into consideration for new development strategies.

Consequently, this study proves that green areas are the characteristic land use in Zonguldak. Other land uses use up all the flat terrain in the city. There is no way to sprawl and develop to the other places in city development. The study showed that rough topography is main obstacle for development in Zonguldak.

The forest and copse land creates a green belt condition in city, especially in the south, south-east and east parts. This is the reason that they are also obstacles for new developments in the city. There is no clear strategy for new development to suggest. However, it introduces crucial development options in regards to urban greenery. The urban green areas are the only the option for the new developments for Zonguldak. Possible basic development approaches might be eco-tourism, recreational opportunities or open air museum.

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5. References

Anonymous, 2006, "Zonguldak Belediyesi Genel Yaklaşım Raporu", Modül Planlama Harita Bilgisayar İnşaat ve Ticaret Ltd. Şti., Ankara

Betts, M. G., Franklin, S. E. and Taylor, R. G., 2003, "Interpretation of Landscape Pattern and Habitat Change for Local Indicator Species Using Satellite Imagery and Geographic Information System Data in New Brunsick, Canada, Canadian Forest Research 33 (10), p. 1821-1831

Bi, H., Gao, L., Ren, Y. and Cui, Z., 2011, "Spatial and Temporal Change of Landscape Pattern in the Hilly-Gully Region of Loss Plateau", 2011 2nd International Conference on Environmental Science and Technology, IPCBEE vol. 6 (2011) copy right IACSIT Press, Singapore, volume 2, p. 10-15, Available at www.ipcbee.com/vol6/no2/3-F10079.pdf, [Cited 7.12.2012]

Busck, A. G., Kristensen, S. P., Praestholm, S., Reenberg, A. and Primdahl, J., 2006, "Land System Changes in the Context of Urbanisation: Examples from the Peri-Urban Area of Greater Copnehagen", Danish Journal of Geography 106(2), p. 21-34, Available at rdgs.dk/djg/pdfs/106/2/03.pdf, [Cited 9.12.2012]

Colombo, S., Chica-Olmo, M., Abarca, F. and Eva, H., 2004, "Variographic Analysis of Tropical Forest Cover from Multi-Scale Remotely Sensed Imagery", ISPRS Journal of Photogrammetry and Remote Sensing, 58 (5-6), p. 330-341

Egbert, S. L., Park, S., Price K. P., Lee, R. Y., Wu, J. and Nellis, M. D., 2002, "Using Conservation Reserve Program Maps Derived from Satellite Imagery to Characterize Landscape Structure, Computers and Electronics in Agriculture 37 (1-3), p. 141-156

Griffith, J. A., Stehman, S. V., Sohl, L. T. and Loveland, T. R., 2003, "Detecting Trends in Landscape Pattern Metrics over a 20-Year Period Using a Sampling-Based Monitoring Programme, International Journal of Remote Sensing 24 (1), p. 175-181

Hansen, M. J., Franklin, S. E., Woudsma, C. G. and Peterson, M., 2001, "Caribou Habitat Mapping and Fragmentation Analysis Using Landsat MSS, TM and GIS Data in the North Columbia Mountains, British Columbia, Canada, Remote Sensing of Environment 77 (1), p. 50-65

Imbernon, J., Branthomme, A., 2001, "Characterization of Landscape Pattern of Deforestation in Tropical Rain Forests", International Journal of Remote Sensing 22 (9), p. 1753-1765

Irwin, G. E., 2003, "Using GIS to Model Patterns of Urban-Rural Land Use Change", Ohio Geospatial Technology Conference for Agriculture and Natural Resources Holiday Inn Wothington, Columbus, Ohio March 24-26, 2003, Available at geospatial.osu.edu/conference/proceedings/papers/irwin_pap.pdf, [Cited 7.12.2012]

Ji, J., Yuanyuan, C., Wunian, Y. and Yanyan, K., "Analysis and Evaluation on Landscape Pattern of Songpan County with Remote Sensing and GIS", The International Archieves of the Photogrammetry, Remote Sensing and Spatial Information Science Vil. XXXVII, Part B8, Beijing, p. 1143-1148, Available at htpp://www.isprs.org/proceddings/XXXVII/congress/8_pdf/11_WG-VIII-11/25.pdf, [Cited 6.11.2011]

Millington, A. C., Velez-Liendo, X. M. and Bradely, A. V., 2003, "Scale Dependence in Multitemprol Mapping of Forest Fragmentation in Bolivia: Implacations for Explaining Temprol Trends in Landscape Ecology and Applications to Biodiversity Conservation, ISPRS Journal of Photogrammetry and Remote Sensing 57 (4), p. 289-299

Santiago, S., Sandra C., 2007, "Scaling Functions for Landscape Pattern Metrics Derived from Remotely Sensed: Are Their Subpixel Estimates Really Accurate?", ISPRS Journal of Photogrammetry and Remote Sensing 62, p. 201-216

Shi, Y., Xiao, J. and Shen, Y., 2008, "Landscape Pattern Change and Associated Environmental Implications in Haihe River Basin, China, p. 569-573, Available at http://www.isprs.org/proceedings/XXXVII/congress/6b_pdf/28.pdf, [Cited 14.10.2011]

Yu, X., Ng, C., 2006, "An Integrated Evaluation of Landscape Change Using Remote Sensing and Landscape Metrics: A Case Study of Panyu, Guangzhou", International Journal of Remote Sensing 27 (6), 1075-1092

References of images

Anonymous, 2006, "Zonguldak Belediyesi Genel Yaklaşım Raporu", Modül Planlama Harita Bilgisayar İnşaat ve Ticaret Ltd. Şti., Ankara

Zonguldak Municipality, 2006, "The Image was acquired by Zonguldak Municipality"

--------, --------, "Zonguldak Haritasi", Available at http://www.loadtr.com/397588-zonguldak_haritas%C4%B1_6.htm, [Cited 8 December 2011]

--------, --------, "Türkiye Haritasi", Available at http://www.mapsofworld.com/turkey/maps/turkey-outline-map.jpg, [Cited 8 December 2011]