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Research Article

Using Geographical Information Systems in Determination of Production Areas of Ornamental Plants Konya, Turkey

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ABSTRACT

The increase of dependency of people in nature, due to the gradual increase of population at cities and the effect of life conditions, causes an increase in demand for green areas and ornamental plants. This increase of demand had provided an economic sector dimension to cultivation of ornamental plants. This study had been realized in order to determine suitable areas for cultivation of ornamental plants in the province of Konya which is a significant agriculture potential of Turkey and which has an ecology suitable for cultivation of many agricultural products. In the determination of these suitable areas, Geographical Information Systems having many functions such as location determination, data storage, data analysis and spatial analysis had been used. Climate, topography and soil features required for cultivation of ornamental plants had been obtained in map environment for the research area, and the analyses required for determination of suitable areas had been made in ArcGIS module. As the result of the analyses, it had been determined that the south-east and south-west areas of the province of Konya were suitable or conditionally suitable areas for cultivation of ornamental plants. These areas will be assessed considering their proximity to market and the socio-economic features of the current producer potential, and establishment of ornamental plants cultivation facilities at the most suitable area will provide significant contributions for the province of Konya in economic, social and environmental aspects.

1. Introduction

Against the fact of urbanization developing along with the increase of world population, the green areas and city parks are being addressed as the most basic factors in preserving the natural and humanistic dimensions of world life (Esmaeeli and Latifi, 2009). In this context, improving the green areas is one of the significant factors of urban planning (Teymouri et al., 2010). Especially in large cities, the accessibility of population to nature is at limited level, and the need of people for such areas is increasing as the result of decrease of green areas in cities due to urban structuring (Sarvar et al., 2011). Green areas in cities are important in respect of enabling the accessibility of people to nature and visual attraction (Herzele and Wiedemann 2003). Moreover, the green areas have a significant share in decreased the environmental problems of the cities (Sarvar et al., 2011). The rate of green areas in the cities shall be increased in order to contribute to life quality in cities, health and happiness of people encountering the problems of metropolis (Hartig et al., 2003; Maller et al, 2009) and raising the children in a peaceful environment (Balram and Dragicevic, 2005). Along with the increase of demand for ornamental plants used to generate green areas in cities in the recent years, cultivation of ornamental plants had gained the dimension of an economic sector and had started to provide significant contribution to the country's economy.

Decorative plants produced with aesthetic, functional and economic purposes are being called ornamental plants (Ay, 2009). Ornamental plants are a general concept and are being examined in four sub groups as being cut flowers, indoor (vase-saloon) ornamental plants, outdoor ornamental plants, natural flower bulbs (geophytes) (Groot, 1998; Sayın and Sayın, 2004; Polat, 2011).

Turkey has various ecological areas and suitable for production of ornamental plants in respect of soil requirement. Cultivation of ornamental plants in commercial respect had started in 1940s in Turkey, and the production continues in about 20 provinces. Considering its contribution to economy, the development of ornamental plants sector in other provinces -which are

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suitable in ecological aspect- will provide significant contributions in respect of marketing and employment.

Table 1
Ornamental plants production areas in Turkey (decare)

	1999	2005	2006	2007	2008	2009
Cut Flowers	7957	13310	12 970,4	13 282,3	13 319,3	12126
Indoor Ornamental Plants	541,2	785,4	883	1 249,5	1 325,9	1135
Outdoor Ornamental Plants	5 642,9	11 809,7	15743	15 339,1	16 737,7	19680
Natural Flower Bulbs	270,04	471,5	570	651,8	750,7	649
TOTAL	14 411,5	26 376,6	30 166,6	30 522,7	32 133,6	33 590

Source: Karaguzel et. al, 2010.

Significant increase is being observed as per years in ornamental plants cultivation in Turkey (Table 1). The reason of this increase is its significant place in world markets in parallel to intense demand for ornamental plants. %59 of ornamental plants production area of Turkey had been allocated to outdoor ornamental plants, 36% of it had been allocated to cut flower cultivation, 3% to indoor ornamental plants and 2% to natural flower bulb cultivation (Table 2). It is being observed that the most area had been allocated to cultivation of outdoor ornamental plants providing most of the increase in years.

Table 2
Turkey export of ornamental plants (1000 $)

	2007	2008	2009	2010	2010 (%)
Cut Flowers	32 659	30 116	29 921	32 154	59,6
Indoor Ornamental Plants	7 385	9116	13 009	18 479	34,3
Outdoor Ornamental Plants	1 773	1 715	1775	1 488	2,7
Natural Flower Bulbs	2 918	3 012	2 541	1 810	3,4
TOTAL	44 735	43 959	47 246	53 931	100,0

Source: TSI, 2011.

Along with the increase of ornamental plants cultivation in commercial aspect in Turkey, an increase in export had also been ensured. The export of ornamental plants had been about 54 million $ by 2010, and most of the export had been obtained from cut flowers with a rate of 59%, and outdoor ornamental plants follow it with a rate of 34%. Considering the ecological and geographical position of Turkey, studies shall be made on the issue of providing more contribution to country's economy by increasing the amount of export through the increase of production areas of ornamental plants.

Table 3
The foreign trade balance of ornamental plants in Turkey (1000 $)

	2007	2008	2009	2010
Export	44 735	43 959	47 246	53 931
Import	44 788	49 426	30 348	39 728
Odd (+,-)	-53	-5 467	16 898	14 203

Source: TSI, 2011.

Significant increase is being obtained as per years in the foreign trade balance of Turkey in respect of ornamental plants (Table 3). The foreign trade balance shall be turned in favor of country's economy by enabling the increase facility export amount through extending the production at areas suitable to ornamental plants cultivation.

The first 3 provinces, where the ornamental plants are being cultivated the most in Turkey, are Izmir, Sakarya and Antalya respectively, and the production area in these provinces constitutes 60% of the total production area of ornamental plants (Table 4). Studies shall be performed for extending the production in other provinces which are suitable for ornamental plants cultivation. Thus, both the income level of producers –at micro level- and the country's economy –at macro level- will be positively affected from ornamental plants cultivation.

Table 4
Ornamental plants production by province (2009)

Provinces	Production Areas (da)	Rate (%)
İzmir	8.016	24
Sakarya	7.034	21
Antalya	5.058	15
Yalova	4.541	14
Bursa	3.220	10
Isparta	1.522	5
Kocaeli	946	3
Balıkesir	468	1
Samsun	425	1
Adana	422	1
Others	1.938	6
Total	33.590	100

Source: Republic of Turkey Ministry of Food, Agriculture and Livestock, 2012.

Agriculture is one of the most important activities of natural system use. This use must be done only in suitable areas for this economic activity. Additionally, suitable areas for agricultural use are determined by an evaluation of the climate, soil and relief environment components (Ceballos-Silva and Lopez-Blanco, 2003).

In cultivation of ornamental plants, the cultivation environment shall be carefully determined in order to obtain qualified product and in order to provide production at optimum level. Thus, the suitable areas where ornamental plants will be cultivated shall be determined considering various factors and performing required analyses. The best method which may be used in the determination of suitable areas is Geographical Information Systems. Location determination and data analysis features of GIS technology are being used for determination of current and potential production areas. GIS technology plays an important role in the analysis of information based on place and location. The most significant benefit of GIS is facilitation of collection and classification of information and opening it to sharing. GIS technology is extensively being used in the selection of locations having the highest potential of cultivating agricultural products (Basayigit and Senol, 2008; Unal et al. 2010), in determination of suitable lands for agricultural use (Akinci et al., 2013), in determination of existence of plants at urban areas (Kuter and Erdogan, 2010), and in current status analysis and location selection of green areas and parks within urban planning (Comber et al., 2008; Mohammedi and Parhizgar, 2009; Poggio and Vrscaj, 2009; Lotfi et al., 2011; Sarvar et al., 2011; Fazelniya et al., 2012; Brown et al., 2014).

In the study, the areas suitable for ornamental plants cultivation in order to open a new economic activity by developing the ornamental plants sector at Konya -being one of the significant centers of Turkey- had been determined by the Geographical Information Systems technique. The potential of lands for ornamental plants cultivation can be assessed in respect of climate, soil and topographical factors.

2. Materials and Methods

In the selection of areas suitable for ornamental plants cultivation in the province of Konya, 3 main layers as being climate, soil and topography, and the factors being provided in figure 1 being under these layers had been assessed. The maps required to analyze these factors in GIS environment had been obtained from relevant institutions, and the analyses had been performed by using the ArcGIS 9.2 module.

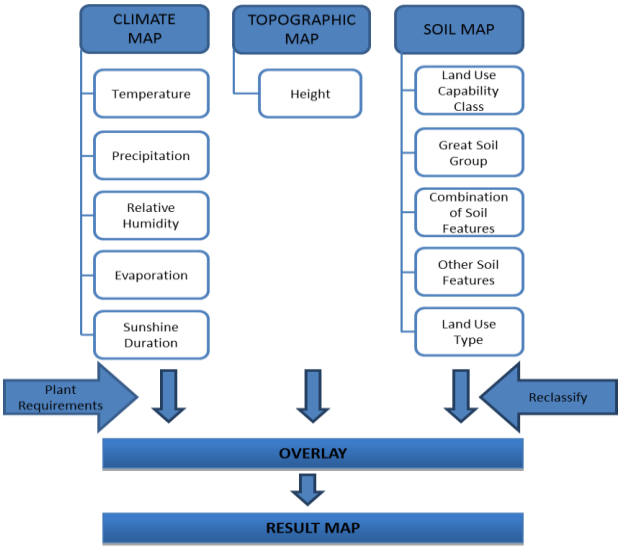


Figure 1
flow diagram in the determination of ornamental plants production

First the plant requirements had been determined in order to assess these factors. In the direction of ornamental plants requirements which may be cultivated at the province of Konya, bases had been composed for location selection by GIS technology and required analyses had been made. In the performance of these analyses at GIS, ArcInfo software and Spatial Analyst module had been used. All factors subjected to analysis had been converted to the format suitable for Grid Analysis and spatial analysis. The factors converted to Grid had been re-classified as being suitable areas, conditionally suitable areas and unsuitable areas as per the requirements of plants. Conditionally suitable areas are of a quality which can be converted to suitable areas through required improvement studies. And after this process, the most suitable areas for ornamental plants in the province of Konya had been determined in respect of the factors addressed through overlaying the data layers.

Scoring had been made as providing the highest score for criteria being suitable in re-classification of factors as per the requirements of plants. Moreover, the layers considered in the selection of areas had been weighted as per level of significance. The most significant factor in cultivation of ornamental plants is the climate layer, and the scores of the factors being at this layer had been multiplied by 1, the factors at the topographic layer –having second level of significance- had been multiplied by 0.8 and the factors at soil layer had been multiplied by 0.6 (Table 5).

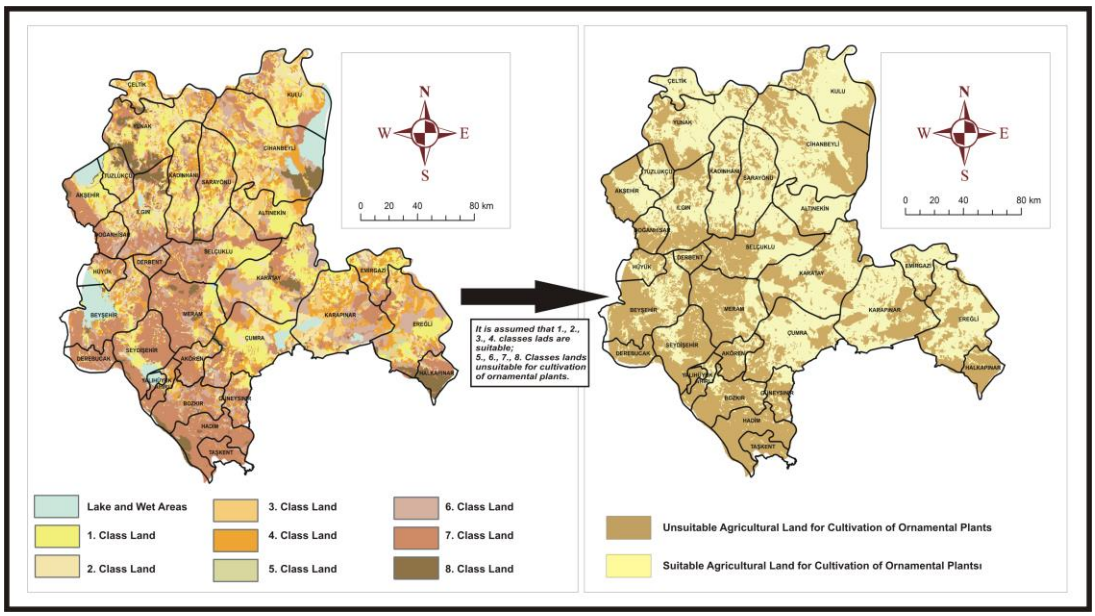
Table 5
Criteria for ornamental plants cultivation

	FACTORS	SUITABILITY	CRITERIAS	SCORE	WEIGHT
CLIMATE LAYER	Temperature	Suitable	13^0-15^0	10	1
		Conditionally Suitable	10^0-13^0	5	
		Unsuitable		1	
	Precipitation	Suitable	Min. 400 mm	10	1
		Conditionally Suitable		5	
		Unsuitable		1	
TOPOGRAPHIC LAYER	Height	Suitable	Below 1250 m	10	0.8
		Conditionally Suitable	1250-1500 m	5	
		Unsuitable	Above 1500 m	1	
SOIL LAYER	Land Use Capability Class	Suitable	I.,II.,III., IV.	10	0.6
		Conditionally Suitable		5	
		Unsuitable	V.,VI.,VII., VIII.	1	
	Great Soil Group	Suitable	Alluvial, Hydromorphic, Brown Forest, Non-calcerous Brown Forest, Reddish Mediterranean, Organic Soils	10	0.6
		Conditionally Suitable	Reddish brown, Brown	5	
		Unsuitable	Other Groups	1	
	Combination of Soil Features	Suitable	%0-6 Slope 50-+cm Depth	10	0.6
		Conditionally Suitable	%6-12 Slope 50-+cm Depth	5	
		Unsuitable	%12+ Slope 0-50 cm Depth	1	
	Other Soil Features	Suitable	Slightly salty	10	0.6
		Conditionally Suitable	Stony, Poor drainage	5	
		Unsuitable	Salty- Alkali	1	
	Current Land Use Type	Suitable	Irrigated Land, Dry Land, Orchard, Garden	10	0.6
		Conditionally Suitable	Abandoned land	5	
		Unsuitable	Others	1	

The values of relative humidity, evaporation and sunshine duration factors being within the climate layer and being valid for the province of Konya had been taken as fixed factors due to being suitable in the cultivation of ornamental plants. While having the annual average temperature in between 13^0-20^0 is suitable, the temperatures outside this range are not being deemed suitable. For suitable areas, the annual average precipitation is required to be at least 400mm and the height is required to be below 1.250m. In respect of land use capability class, revealing the suitability of soil for agricultural production and revealing the opportunities of utilization beyond agriculture, the lands of I., II., III. and IV. class had been determined as lands suitable for cultivation of ornamental plants. Alluvial, hydromorphic, brown forest, non-calcareous forest, reddish Mediterranean, organic soils are soils suitable for cultivation of ornamental plants. The cultivation environment of ornamental plants shall have a slope of at most 6% and shall be deep and mid deep (deeper than 50 cm). Moreover, the soil shall not be salty, alkali and shall not have bad drainage.

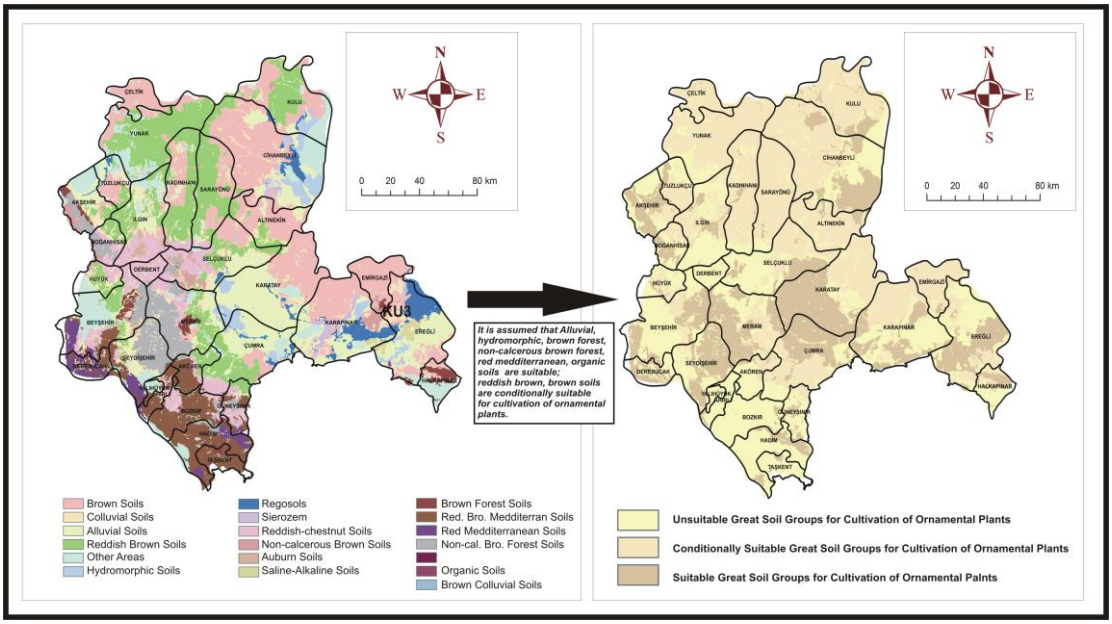
3. Results and Discussion

Province of Konya has the potential of realizing ornamental plants cultivation in economical aspect due to its ecologic and geographic position. In order for it to have a place in national and international markets and to provide significant contribution to country's economy, the most suitable cultivation areas for ornamental plants within the borders of Konya in economical and ecological aspect had been analyzed through the assistance of GIS. Maps had been provided for each of the factors included in analysis as per both factor features and re-classification features.



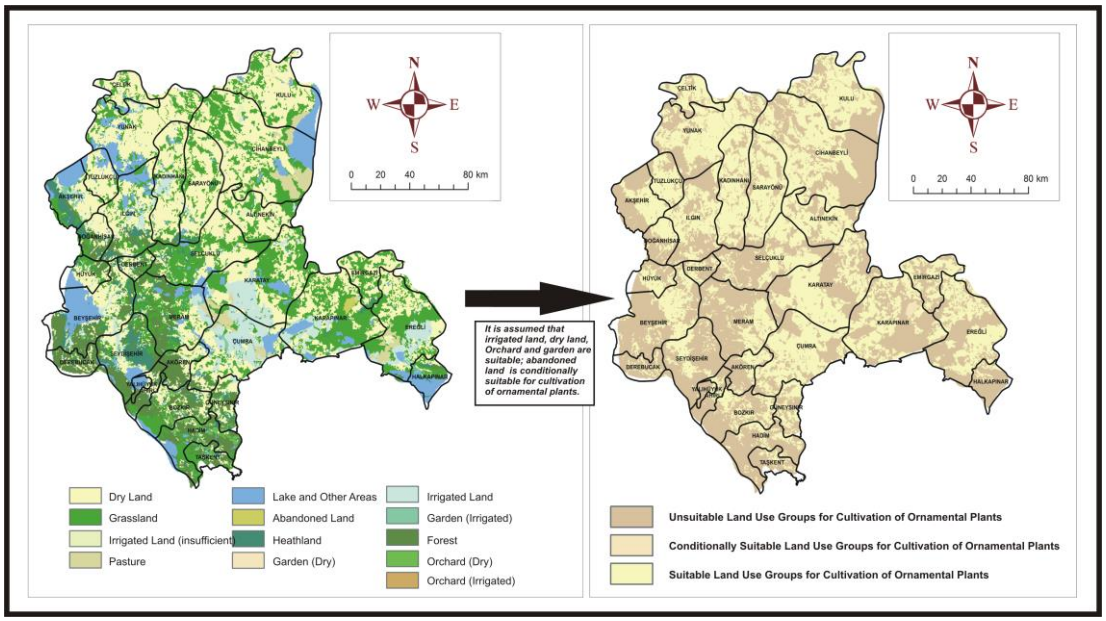
Map 1
Agricultural land map for cultivation of ornamental plants

I., II., III. and IV. classes of agricultural soils - which are allocated to eight classes as per soil ability- had been deemed as suitable for production of ornamental plants due to their features such as ease of cultivation, less slope, well drainage ability. The soil ability classes map, as per suitability for cultivation of ornamental plants, had been re-classified and made ready for analysis (Map 1).



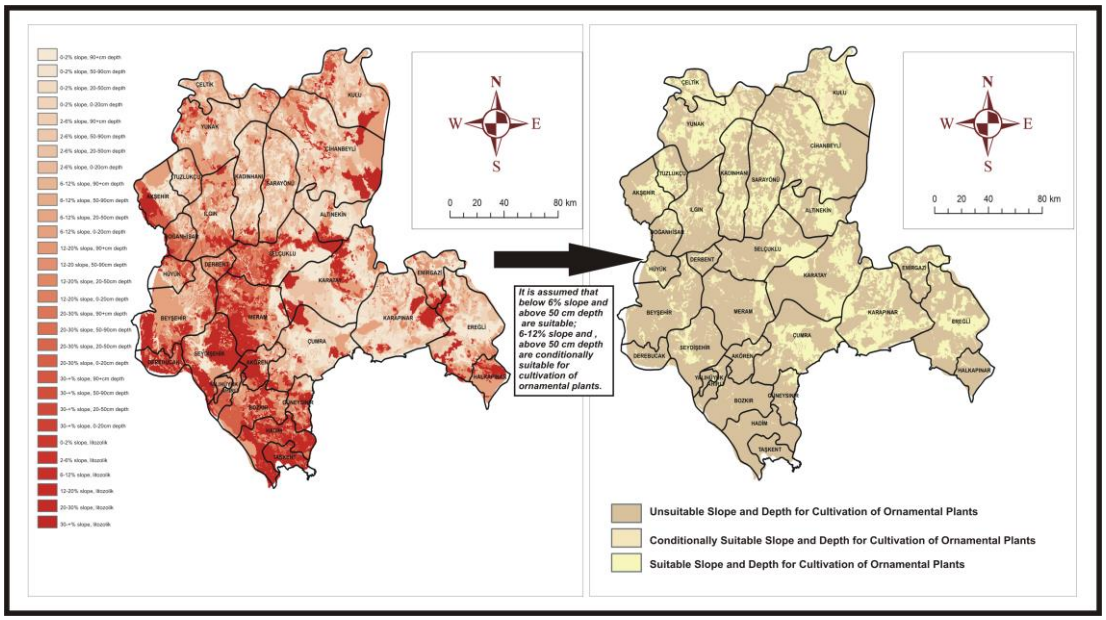
Map 2
Great soil group map for cultivation of ornamental plants

The great soil groups map had been re-classified as per suitability for cultivation of ornamental plants and had been made ready for analysis (Map 2). It had been determined that great soil groups being suitable for ornamental plants were available at Cumra-Karatay, Seydisehir-Beysehir lines and Eregli county of the province of Konya.



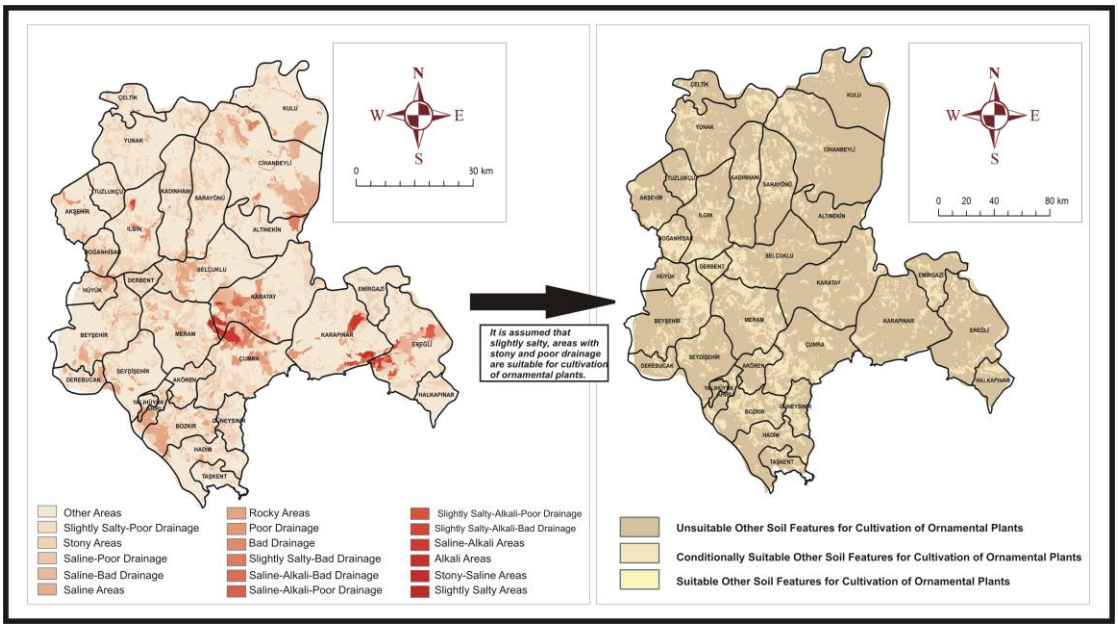
Map 3
Land use groups map for cultivation of ornamental plants

Irrigated agricultural lands, dry agricultural lands, orchard and garden areas had been deemed as suitable areas for cultivation of ornamental plants as per land utilization status. The land utilization status map had been re-classified as per suitable areas for cultivation of ornamental plants and had been made ready for analysis (Map 3).



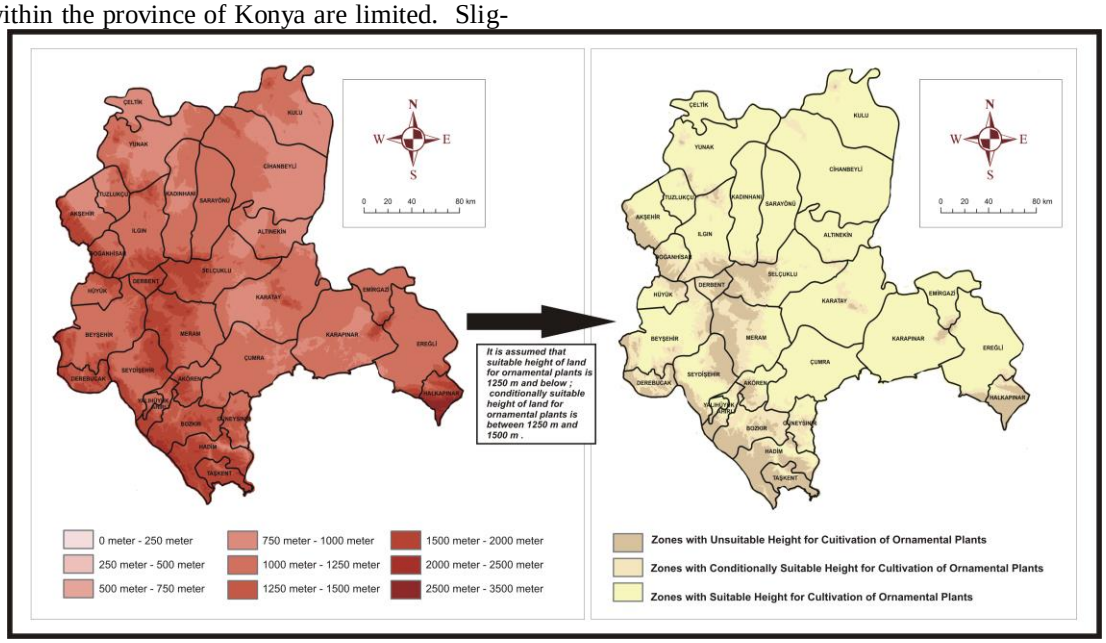
Map 4
Slope and depth map for cultivation of ornamental plants

The areas with a slope of at less than 6% and with a depth of more than 50cm (deep, mid deep) had been deemed as suitable for cultivation of ornamental plants. The slope-depth combination map of the Konya province had been re-classified considering the areas suitable for cultivation of ornamental plants and had been made ready for analysis (Map 4).



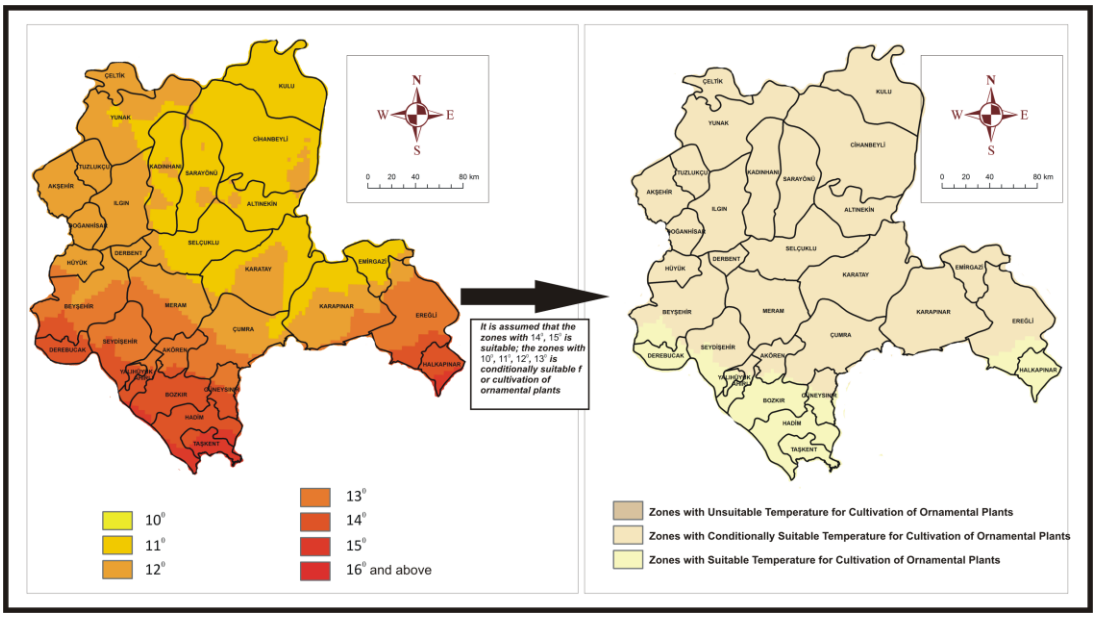
Map 5
Other soil features map for cultivation of ornamental plants

The soil at the province of Konya generally has high pH (pH: 7.5-8.5), high lime (> 15%) and insufficient drainage. When it is assessed only in respect of criteria of saltiness and drainage, it is being observed in map 5 that areas suitable for cultivation of ornamental plants within the province of Konya are limited. Slightly salty, stony and well drained areas had been deemed as areas suitable for cultivation of ornamental plants, and other soil features map had been re-classified as per suitability and had been made ready for analysis (Map 5).



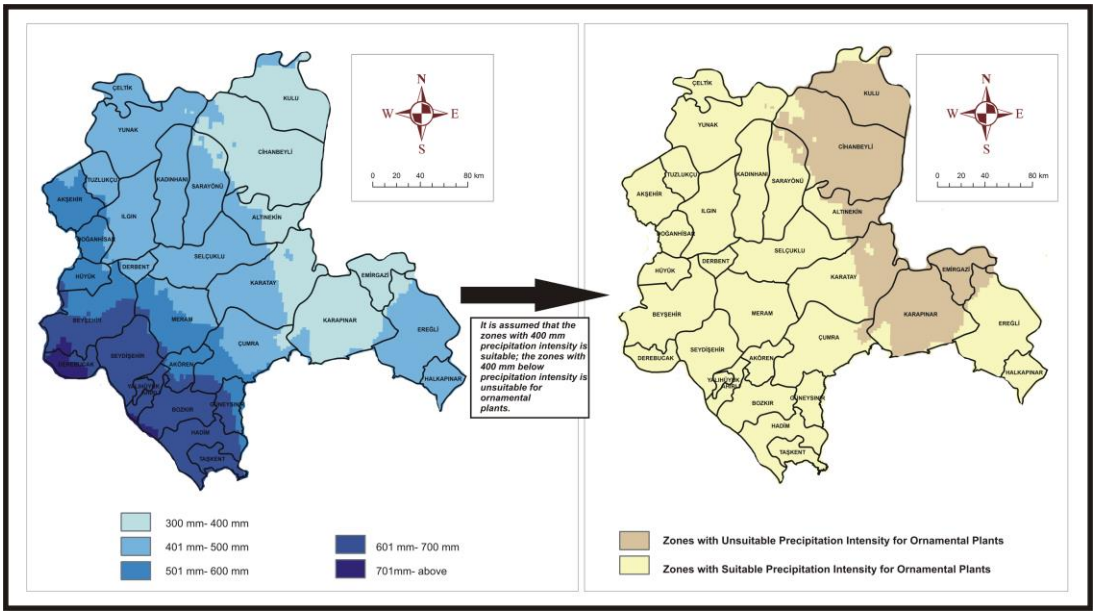
Map 6
Height map for cultivation of ornamental plants

The height of land shall be below 1.250 m for cultivation of ornamental plants. The land height within the province of Konya is in between 0-3500 m, and the height map had been re-classified as per suitability for cultivation of ornamental plants and had been made ready for analysis (Map 6).



Map 7
Temperature map for cultivation of ornamental plants

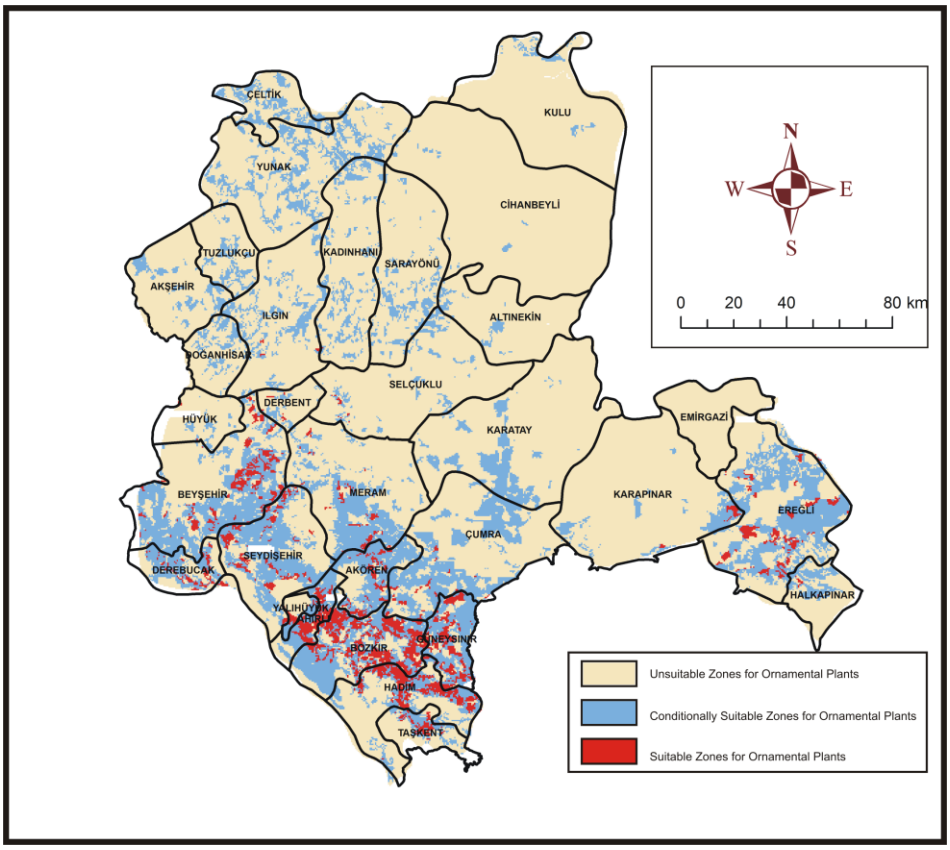
The most significant factors for cultivation of ornamental plants are climate features. The annual average temperature is in the range of 10^0-16^0 within the province of Konya. The annual average temperature requirement of ornamental plants is 14^0-15^0, and the temperature map had been re-classified as per suitability of temperature and had been made ready for analysis (Map 7).



Map 8
Precipitation map for cultivation of ornamental plants

Annual average precipitation amount of the province of Konya is in between 300-800 mm. Precipitation of over 400 mm is being required for cultivation of ornamental plants, areas other than the east of Konya province are suitable areas for cultivation of ornamental plants as per precipitation criterion (Map 8).

The result map indicating the areas suitable for cultivation of ornamental plants within the province of Konya had been constituted by using the layers constituted after conversion of all factors as per cultivation conditions of ornamental plants and by using the ArcInfo software, Spatial Analyst module and Overlay analysis.



Map 9
Suitable zones map for cultivation of ornamental plants

As per the obtained results, the area in between Ahırlı-Bozkır-Hadim-Taşkent-Güneysınır (S1), east of Beysehir Lake (S2), North-East and South-West Axis of Eregli (S3) had been determined as areas suitable for cultivation of ornamental plants within the province of Konya. And the conditionally suitable areas had been determined as the area in between south-west of Derbent and province border of Antalya (CS1), area in between the borders of Çumra-Karatay (CS2), Eregli and its surrounding (CS3), east-west axis of Sarayönü-Kadınhanı-Ilgın-Akşehir (CS4), Yunak and its surrounding, and Cihanbeyli İnsuyu area (Map 9). The general features of suitable and conditionally suitable areas have been provided in Table 6 and Table 7.

For the determination of the most suitable area within the suitable areas, the criteria such as marketing opportunities, transportation opportunities, determination of area of suitable size for the establishment of required facilities as well as cultivation areas, adoption level of a new production area by the producers and determination of areas requiring alternative product cultivation shall be considered.

Table 6
Suitable areas features for cultivation of ornamental plants

	Suitable Area 1 (S1)	Suitable Area 2 (S2)	Suitable Area 3 (S3)
The Region's Location	The area in between Ahırlı-Bozkır-Hadim-Taşkent-Güneysınır	East of Lake Beyşehir	Ereğli North-East and South-West Axis
Temperature	15^0	14^0	14^0
Precipitation	601mm-700mm	601mm-700mm	401mm-500mm
Height	1250m-1500m	750m-1000m	750m-1000m
Land Capability Class	7. class	1. and 7. class	1., 2., 3. class
Great Land Group	Reddish Brown Mediterranean Soils, Reddish Mediterranean Soils, Non-calcerous Brown Forest	Reddish Brown Soils, Reddish Brown Mediterranean Soils, Colluvial Soils	Alluvial Soils, Brown Soils
Combination of Soil Features	Slope %2-6 Depth 50-20 cm, Slope %12-20 Depth 50-20 cm, Slope %20- Depth 20-0 cm, Slope %20-30 Depth litozolik	Slope %0-2 Depth 90-+ cm, Slope %6-12 Depth 50-20 cm, Slope %12-20 Depth 20-0 cm	Slope %0-2 Depth 90-+ cm, Slope 0-2 Depth 20-0 cm, Slope 2-6 Depth 50-20 cm
Other Soil Features	Stony, Slightly salty, Poor drainage	Stony	Saline, Saline-alkali, Poor drainage, Bad drainage
Current Land Use Type	Forest, Dry Orchard, Dry Land	Dry Land, Forest	Irrigated Land, Grassland

Table 7
Conditionally Suitable Areas Features for Cultivation of Ornamental Plants

	Conditionally Suitable Area 1 (CS1)	Conditionally Suitable Area 2 (CS2)	Conditionally Suitable Area 3 (CS)	Conditionally Suitable Area 4 (CS4)	Conditionally Suitable Area 5 (CS5)
The Region's Location	The area in Meram-Çumra-Derbent South-West and the border of Antalya Province	Çumra and its surrounding	Ereğli and its surrounding	Sarayönü-Kadınhanı-Ilgın-Akşehir East-West Axis	Yunak and its surrounding, Cihanbeyli İnsuyu Area
Temperature	14^0 ve 15^0	11^0 ve 12^0	14^0 ve 15^0	11^0 ve 12^0	11^0 ve 12^0
Precipitation	501mm-600mm	401mm-500mm	401mm-500mm	401mm	500mm
Height	750m-1000m ve 2000m-2500m	750m-1000m	750m-1000m ve 1500m-2000m	1000m-1250m	1000m-1250m
Land Capability Class	6. and 7. class	1., 2., 3., and 4. class	3., 4. and 6. class	1., 2., 3., and 4. class	1., 2., 3., and 4. class
Great Land Group	Reddish-Chestnut Soils, Non-calcerous Brown Forest, Brown Forest Soils, Red Mediterranean Soils	Alluvial Soils, Reddish Brown Mediterranean Soils	Regosols, Brown Soils, Saline-Alkali and Saline-Alkali Mixed Soils, Brown Forest Soils	Brown Soils, Reddish Brown Soils	Brown Soils, Reddish Brown Soils
Combination of Soil Features	Slope %12-20 Depth 50-20 cm, Slope %12-20 Depth 20-0 cm, Slope %20-30 Depth 20-0 cm, Slope %20-30 Depth litozolik	Slope %0-2 Depth 90-+ cm, Slope %2-6 Depth 50-20 cm	Slope %0-2 Depth 90-+ cm, Slope %0-2 Depth 90-50 cm, Slope %6-12 Depth 50-20 cm	Slope %0-2 Depth 90-+ cm, Slope %6-12 Depth k 90-50 cm, %6-12 Depth 50-20 cm, Slope %12-20 Depth 20-0 cm	Slope %0-2 Depth 90-+ cm, Slope %6-12 Depth 90-50 cm, %6-12 Depth 50-20 cm, Slope %12-20 Depth 20-0 cm
Other Soil Features	Rocky, Slightly salty, Poor drainage	Saline bad drainage, Slightly salty -bad drainage, Saline-alkali	Slightly salty- Poor drainage, Stony	Slightly salty- Poor drainage, Stony, saline-Poor drainage	Slightly salty- Poor drainage, Stony, saline- Poor drainage
Current Land Use Type	Grassland, Forest, Heathland, Dry Land	Irrigated Land	Dry Land	Grassland, Dry Land, Irrigated Land	Grassland, Dry Land, Irrigated Land

4. Conclusions

In the globalizing world, the urbanization and environment comprehension and social requirements which change each passing day increase the demand for ornamental plants. Moreover, the approach of local authorities to take notice of environmental planning, the requirement of people to live in nature as moving away from the city life, rural areas close to the cities, increase of lodgings with gardens within the borders of villages and in metropolis had significantly increased the demand for outdoor ornamental plants being the basic argument of environmental green area planning at cities and at new living areas. The ornamental plants being a significant market product also indicates that they can be assessed in economical aspect. Thus cultivation of ornamental plants provides significant contribution in different aspects as per regions.

As specific ecological conditions are required for cultivation of ornamental plants, GIS technology had been used in the study in the determination of locations suitable to such conditions. As benefiting from the location determination and data analysis features of GIS technology, climate, topographic and soil features –being effective in cultivation of ornamental plants- had been included in the analysis, and suitable and conditionally suitable areas within the province of Konya had been determined. It had been determined as the result of analyses that the south-east and south-west areas of the province of Konya were suitable areas for the cultivation of ornamental plants. Moreover, the junction position of the province of Konya among metropolis at west and east regions provides a significant status in respect of proximity to market.

By performing analysis with GIS technique, it is being contributed to both enabling saving in respect of cost and time in feasibility studies and performance of more qualified and profitable production. Putting into practice the results obtained from this study will provide many contributions to the province of Konya –being the area of research- in economical, environmental and social aspect.

5. Acknowledgement

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