SETSCI Conference Proceedings,
4 (3): 372-382, 2019

ISAS 2019
3rd International Symposium on Innovative Approaches in Scientific Studies
Section: Fine Arts, Design and Architecture
April 19 – 21, 2019, Ankara, Turkey

Surface Flow Potential Analysis and Design Recommendations of Kastamonu Karaçomak Basin

Yekta Köse[1*+], Şükran Şahin[2]

[1]Forestry Department, Manisa Celal Bayar University, Manisa, Turkey
[2]Department of Landscape Architecture, Ankara University, Ankara, Turkey
*Corresponding author: yekta.kose@cbu.edu.tr
+Speaker: yekta.kose@cbu.edu.tr
Presentation/Paper Type: Oral and Full Paper

Özet – Son yıllarda yağış rejimlerinin değişimi ile suyun değeri, su kaynakları özellikle yüzey akışı ve kaynakla beslenen akarsular için önemli duruma gelmiştir. Bu önem, kantitatif değerler üzerinden bakıldığında; Türkiye'nin yaşadığı su sorunu ile düşünüldüğünde ise daha fazla olmaktadır.

Türkiye su kaynaklarının kıt olduğu Akdeniz ve Ortadoğu bölgesinde yer almaktadır. Türkiye'nin yıllık kullanılabilir yer altı ve yerüstü su potansiyeli toplamı 107,3 km^3'tür. Bu değer yenilenebilir su potansiyelinin %45,85'ine denktir. Günümüze dek kullanılabilir potansiyelin sadece %37,74'ü geliştirilerek kullanıma sunulmuştur [1]. Ülkemizde kullanılabilir su potansiyelini geliştirmek için su yönetimini iyi planlamak gerekmektedir. Gelecek yıllarda su açığının oluşmaması adına yağış ile elde edilen suların özellikle yüzey akışa geçen suyun iyi planlanmasına ihtiyaç duyulmaktadır. Bu çalışma ile yüzey akış miktarı elde edilerek akışa geçen kullanılabilecek su potansiyeli tahmini amaçlanmıştır.

Yağış miktarı, yüzey akışı ve kuraklık üzerinde nüfuzlu bir değişkenlik oluşturmaktadır. Yağışın birçok özellikten etkileniyor olması tahminini zorlaştırmaktadır. Yağış ile ortaya çıkan yüzey akışı elde edilirse suyun toplam ne kadar bir akıma sahip olduğu tahmin edilebilmektedir. Bu amaçla bu çalışmada Coğrafi Bilgi Sistemleri (CBS) ile ve yağış-akış modeli olarak belirlenen SCS (Soil Conservation Service, ABD) Curve Number yöntemi kullanılmıştır. Bu yöntem için toprak verilerinden CBS ortamında oluşturulan Hidrolojik Toprak Grupları (HTG) verisi, arazi örtüsü Corine Land Cover (CLC (Coordination of Information on the Environment)) 2012 yılına ait veriler ve yağış verileri kullanılmıştır. Dünyada birçok ülkede kullanılmakta olan su yönetimleri incelenmiş ve Kastamonu Havzası'na uygun olan tasarım yaklaşımları önerilmiştir.

Anahtar Kelimeler– Peyzaj planlama, yüzey akışı, Thorntwaite, su tutma potansiyeli, su yönetimi.

Abstract – In recent years, with the change of precipitation regimes, the value of water has become important for water sources, especially surface flow and streams fed by the source. Considering this importance, quantitative values; Considering that Turkey's water problem is the more experienced.

Turkey is located in the Mediterranean region and the Middle East where water resources are scarce. Turkey's annual available groundwater and surface water potential total of 107.3 km^3. This value is equivalent to 45.85% of the renewable water potential. Only 37.74% of the available potential has been developed and made available to date [1]. Water management should be planned well in order to improve the water potential in our country. In order to prevent water shortage in the coming years, it is necessary to plan the water obtained by rainfall, especially the water flowing to the surface flow. In this study, it is aimed to estimate the water potential that can be used by flowing through flow.

The amount of precipitation has a considerable variation on surface flow and drought. It is difficult to predict that precipitation is affected by many features. If the resulting surface flow is obtained by precipitation, it can be estimated how much water has a total flow. For this purpose, SCS (Soil Conservation Service, USA) Curve Number method, which is determined by Geographical Information Systems (GIS) and precipitation-flow model, was used in this study. For this method, hydrological soil groups (HTG), land cover Corine Land Cover (CLC) data and rainfall data were used. Water management which is used in many countries around the world has been examined and design approaches which are suitable for Kastamonu Basin have been proposed.

Keywords– Landscape planning, surface flow, Thorntwaite, water retention potential, water management.

I. Introduction

It is aimed to determine the surface flow potential of Kastamonu Karaçomak Basin. The current planning in the basin will be evaluated with the surface flow potential and it is aimed to provide support for the plans to be realized in the next years. For this purpose, sub-scale design suggestions that can be applied on the basin are presented.

According to Özyurt 2016; a portion of the rain falling on the surface of the surface of some of the flow through the floor flow. The surface flow is the part of the stream that flows into the basin after the evaporation and seepage. Sub-surface flow (internal or intermediate flow), flowing water flows to the surface in the upper part of the ground, usually in a short time. The underground flow, the draining water advances deeper into the ground and flows into the stream [2].

In the study, monthly meteorological data belonging to the stations operated by the General Directorate of Meteorology on different climatic zones were used. Climate data from the worldclim are also supplemented with missing data. Monthly maximum rainfall, average number of rainy days, monthly total precipitation, monthly maximum relative humidity and monthly average relative humidity were used in this study. In addition, Thorntwaite method was used to interpret the surface flow analysis. For this method, mean temperature data is used in the method formula. According to the results of analysis, surface flow amounts and climate data of the areas were mapped.

Materials and Method

A. Materials

The study area is Karaçomak Havza border located in Kastamonu province. Climate and surface flow maps of the region covering the Karaçomak Basin boundary have been established.

East of Turkey's Black Sea region of Kastamonu, Sinop is located in the western part of the province, west of Bartin and Karabük, Çankırı Corum south and southeast has borders with the provinces. The entire northern part of the province constitutes a coast to the Black Sea and the length of the coastline of the province is 170 km. Kastamonu is the longest coast of the Black Sea with its length of coastline. 13 108 km² area located on Kastamonu, Turkey accounts for 1.7% of the territory. The height of the city center from the sea is 780 meters. The average height of the province is 775 m above sea level. The highest point of the province is Çatalılgaz Hill with 2,565 m. Yl mountains extend in parallel across the sea is being Turkey's covers a large portion of the projection extending towards the Black Sea [4].

B. Method

Surface flow; rainfall, rainfall distribution in the basin, stored moisture, water storage capacity, evapotranspiration, vegetation, land condition, drainage, slope, and water collection areas are affected by many factors. All of these factors should be taken into account when determining the surface flow potential. If surface flow potential is determined, the efficiency of surface water resources can also be known.There are many calculation methods used in surface flow analysis. SCS (USA) method was used in this study to determine the surface flow in Kastamonu Karaçomak Basin.

SCS (Soil Conservation Service, USA) Method: SCS CN (Curve Number) (SCS, 1956, 1964, 1972, 1993), one of these models called precipitation-flow model, is an empirical model. it is used to estimate water volumes in small basins (Mockus, 1949; McCuen, 1982; Yu, 1998; Mishra and Singh, 1999). The SCS CN method is widely used in calculation of the curve number and the surface water flowing directly from the rainfall data 5 days ago [5], [6].

The SCS CN model is a common model used in rainfall-flow models of small sub-basins worldwide [7]. Data used for this model [8];

- Land use / cover
- Hydrological soil groups (HTG)
- Daily precipitation data (1975-2003)
- Previous moisture content (AMC, Antecedent Moisture Conditions)

There is a timeout between the beginning of the rain and the time at which the surface flow appears. In this period, the pits with the plant and soil surface reach the water holding capacity and the rain flows into the soil. The amount of rain flow can be specified according to the relationship given below [9].

$$Q = \frac{(P - I_a)^2}{(P + I_a) + S}$$

Relationship;

Q = Surface flow quantity
P = Amount of rain
I_a = First retention
S = Water retention potential

The first term in the abovementioned relationship is equal to the sum of the amount of infiltration held in the pits and held on plant and soil surfaces. The first hold in the usual conditions is taken up to a maximum of the water retention amount, ie the water holding potential of 0.2. In this case, if the first hold is taken as 0.2 S, the relationship can be written as follows [9].

$$Q = \frac{(P - 0,2 \text{ x } S)^2}{P + 0,8 \text{ x } S}$$

Relationship;
Q = Surface flow quantity
P = Amount of rain
S = Water retention potential

The amount of first hold depends on plant and land use. This situation is indicated by the numbers between 0 and 100 using the relationship given below. These numbers are referred to as the Curve Number [9].

Hydrological Soil Classes	Hydrological Soil Group	Description	Code
(Class D)	Soils With High Surface Potential	When they are completely wetted, soils with a low flow rate and very low permeability show a high surface flow potential. Soils with an impermeable layer close to the surface containing a lot of clay.	4
(Class C)	Medium-High Surface Flow Potential	Where they are completely wet, soils with moderate rate of infiltration and permeability and containing very significant amounts of clay show moderate flow potential.	3
(Class B)	Soils With Medium Low Surface Flow Potential	When they are completely wet, the soil that has a moderate rate of filtration and permeability enters into this class. The soils formed by a mixture of fine and coarse grains show moderate surface flow potential.	2
(Class A)	Soils with low surface flow potential (high filtration)	In the case where they are completely wet, soils with high filtering speed and more permeability indicate low surface flow potential in hydrological terms. Generally sandy soils containing less clay and silt are included in this group.	1

$$CN = \frac{25400}{254+S} \qquad S = \frac{25400}{CN} - 254$$

Relations;
N = Surface Flow Curve number
S = Water retention potential

II. Results

The surface flow potential of Karaçomak Basin of Kastamonu was analyzed; Using the ArgMap 10.5 program, hydrological soil groups, landscape pattern, and Thornthwaite method values generated by climate data have to be obtained.

The Soil Conservation Service (SCS) in 1972 was used to determine soil permeability, and the Curve Number / SCS-CN method, which was developed for the efficient use of water and soil resources, was used in landscaping / space planning [10].

Curve Number is a parameter for finding the amount of water flowing through a rain on a land. The determination of the value of the CN determined depending on the land use pattern or cover condition, the type of sowing and the hydrological conditions is obtained completely by the planner and by the interpretation of the land soil data. The higher the CN value, the lower the flow of the surface decreases. This method is a more successful method in small and homogeneous areas, and when it is desired to apply it in larger areas, field verification and additional soil analyzes are needed. Within the scope of this study, 1 / 25.000 scaled official soil data were used. The criteria taken into consideration in classifying soils according to SCS CN method in hydrological terms are explained in Table 1 [10].

Table 1. Classification of soils according to CN in terms of hydrological [10].

The soil data of the Karaçomak Basin of Kastamonu were obtained by taking the hydrological soil groups given in Table 1 and using ArcMap 10.5 program. In 1, hydrological soil groups map of the basin was formed. Soil permeability is directly related to land cover / use. For this purpose, CORINE data is formed based on the limit of the study area. The codes given in Table 2 have been prepared and written in the explanation section via the CORINE data of the basin area. Fig. Hydrological soil groups (HTG) given in 1 were evaluated according to the field data. In Kastamonu Karaçomak Basin, there was no Class A soil group. Therefore, a class of 3 classes of soil groups, B, C and D class, were developed instead of 4 classes. According to these soil classes HTG raster map was obtained.

Table 2. Code and descriptions on the map of Corine (Orginal, 2018).

Code 12	**Explanation**
112	Discrete City Structure
211	Irrigable Area
212	Continuous Irrigated Areas
231	Pastures
242	Mixed Farm Areas
243	Agricultural Areas With Natural Vegetation
311	Broad-Leaved Forests
312	Coniferous Forests
313	Mixed Forests
321	Natural Meadows
324	Plant Exchange Areas
333	Sparse Plant Fields
512	Water Bodies
111	Continuous City Structure
121	İndustrial Or Commercial Areas
131	Mine Extraction Areas
133	Construction Areas

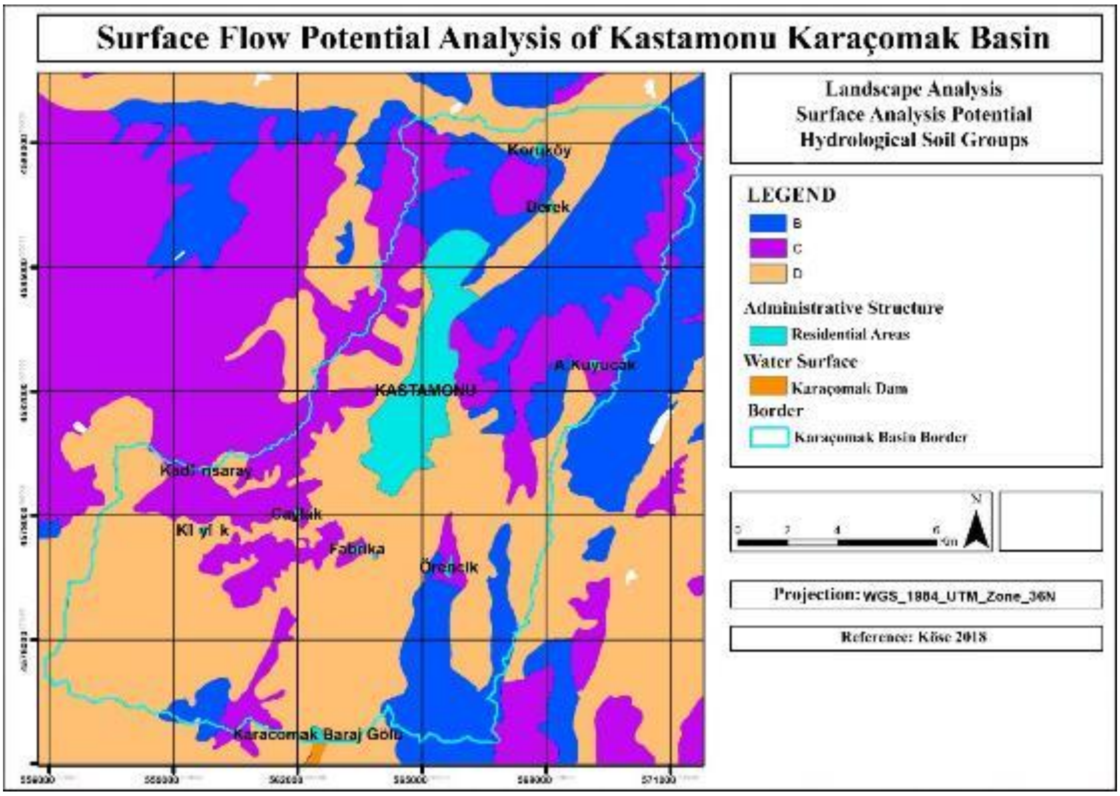

Fig. 1 Map of hydrological soil groups of Karaçomak Basin (Original, 2018).

Surface Flow Curve Number (CN) is obtained according to HTG and land use / cover information. The surface flow curve numbers given in Table 3 were entered in ArcGIS 10.5 program according to HTG and land use / cover.

Table 3. Curve number according to hydrological soil groups [11]

Land Use / Cover	Average Impermeable Area (%)	Curve Number According To Hydrologic Soil Groups			
		A	B	C	D
Residential (High Density)	65	77	85	90	92
Residential (Medium Density)	30	57	72	81	86
Residential (Low Density)	15	48	66	78	83
Commercial Areas	85	89	92	94	95
Industrial Areas	72	81	88	91	93
Gravel, Quarry Etc.	5	76	85	89	91
Farming Areas	5	67	77	83	87
Open Areas (Park, Grass Field Etc.)	5	39	61	74	80
Meadow Grassland	5	30	58	71	78
Jungle, Grove	5	30	55	70	77
Sparse Forest, Grove	5	43	65	76	82
Water / Wetlands	100	100	100	100	100

The CN (surface water flow curve number) values created in the ArcGIS program were replaced with the following formula and the maximum water retention potential (S) of the basin after surface water flow was calculated.

S = 25400 / CN - 254

From this data, a map was obtained with S (water holding potential) values (Fig.2). This time the calculation was made with the "Raster calculator" on the CN map. With this calculation, the water holding potential of the basin was calculated (Fig. 3).

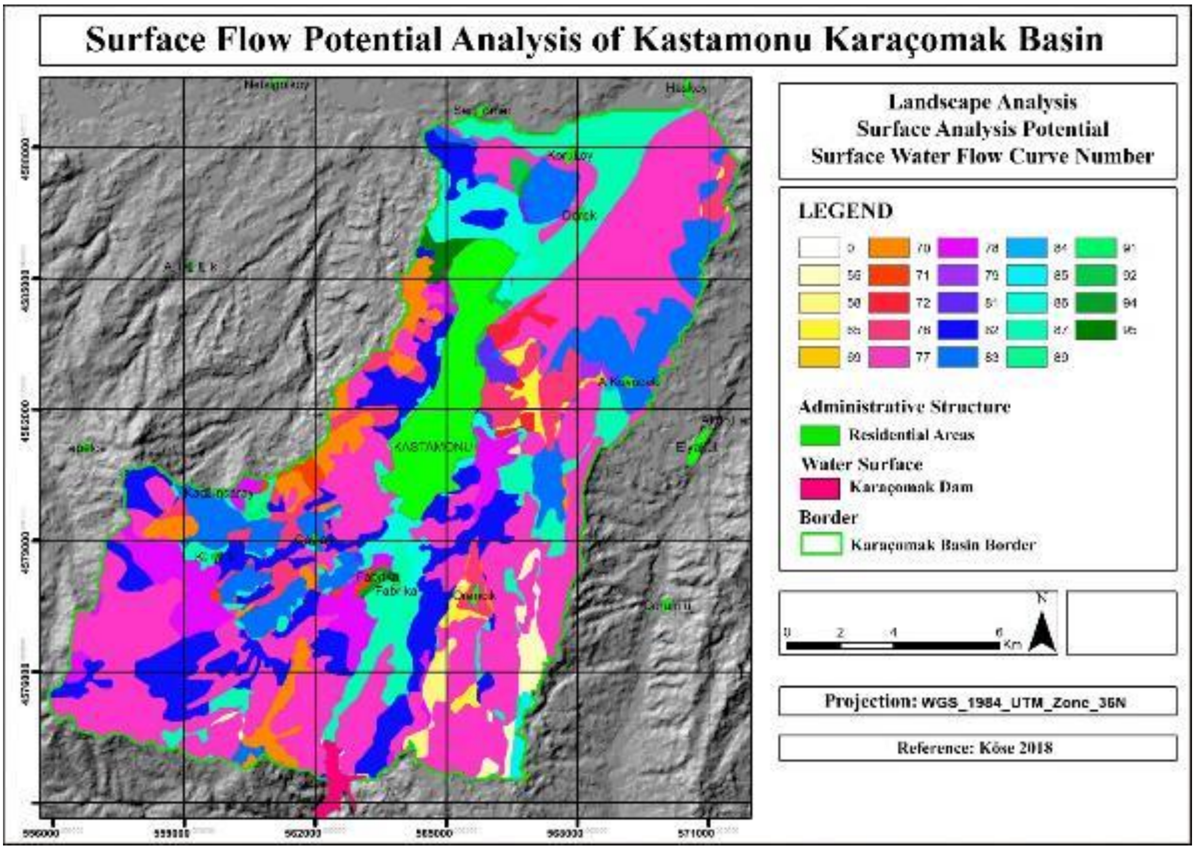

Fig. 2 Karaçomak Basin surface flow curve number map (Original, 2018).

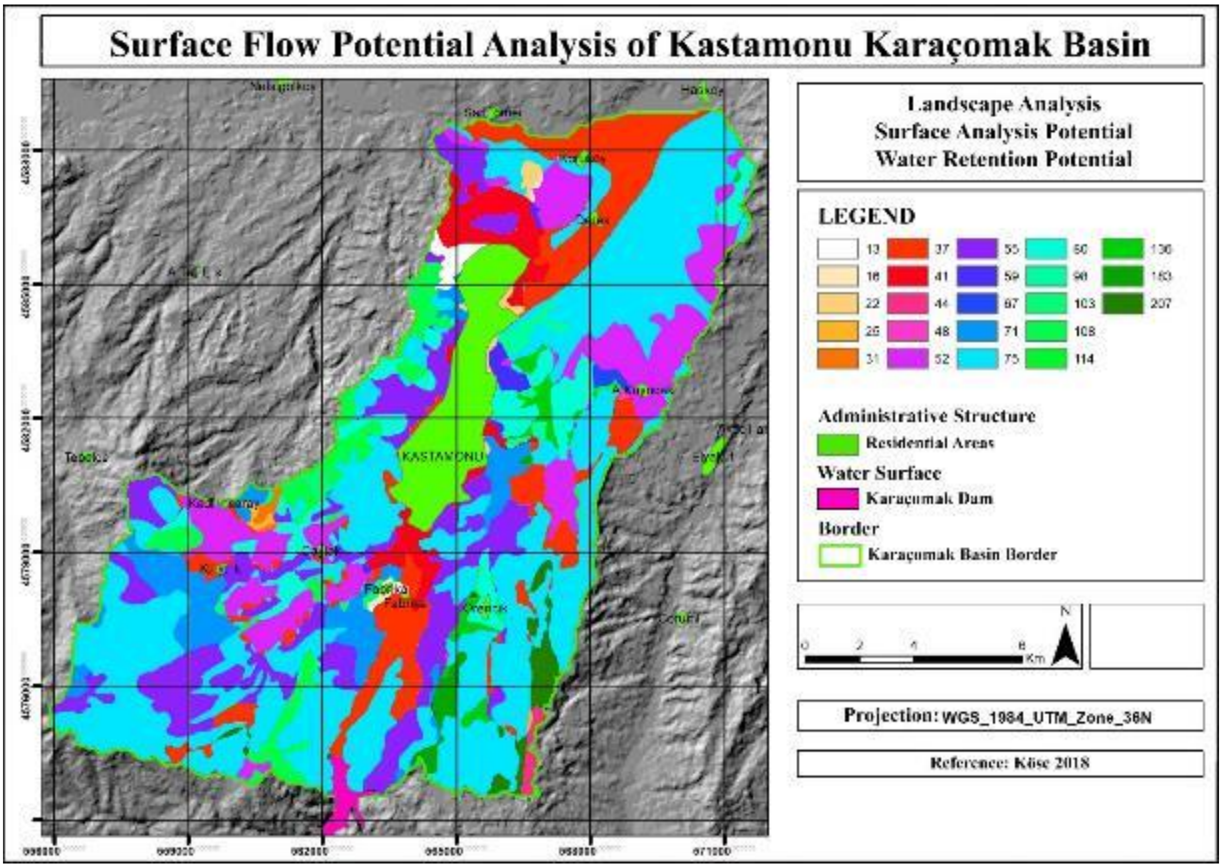

Fig. 3 Karachomak Basin water holding potential map (Original, 2018).

After this stage, climate data are needed. Climate data of the study area were taken from worldclim [3] According to monthly average temperatures of long years, the highest temperature in the region was determined as 20.3 ° C in July and the lowest in the month with 7 ° C in January and February. It was. When the average rainfall in the region was examined, the average annual precipitation was 834 mm.

The data obtained for the province of Kastamonu in the Thornthwaite method; The method of precipitation is formulated using the formula = l (100s-60d) / n [12].

In the formula;

Im = Precipitation efficiency index.

s = Annual water surplus (mm)

d = Annual water deficit (mm)

n = Annual Evapotranspiration.

According to Thornthwaite method, water balance values of Kastamonu province are given in Table 4 and results of precipitation efficiency formula according to Thornthwaite method are given in Table 5.

Table 4. Water balance values of Kastamonu province according to Thornthwaite method [13]

Balance Sheet Elements	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Toplam**
Temperature	**7**	**7**	**11**	**16**	**20**	**23**	**26**	**27**	**23**	**19**	**13**	**8**	**16,7**
Temperature Index	1,66	1,66	3,3	5,82	8,16	10,08	12,13	12,85	10,08	7,55	4,25	2,04	79,58
Uncorrected PE	11,7	11,7	26,5	52,2	78,1	100,5	125,5	139,0	100,5	71,2	35,8	14,9	767,6
Adjusted PE	9,8	9,7	26,9	56,8	94,7	122,8	155,4	161,0	102,6	67,6	29,7	12,1	848,9
Precipitation	**48**	**53**	**69**	**107**	**133**	**100**	**41**	**31**	**61**	**72**	**58**	**61**	**834**
Warehouse Change	18,3	0,0	0,0	0,0	0,0	22,8	77,2	0,0	0,0	4,4	28,3	48,9	200,0
Storage	100,0	100,0	100,0	100,0	100,0	77,2	0,0	0,0	0,0	4,4	32,7	81,7	696,1
Real Evapotranspiration	9,8	9,7	26,9	56,8	94,7	122,8	118,2	31,0	61,0	67,6	29,7	12,1	640,1
Water deficiency	0,0	0,0	0,0	0,0	0,0	0,0	37,1	130,0	41,6	0,0	0,0	0,0	208,8
Water surplus	19,9	43,3	42,1	50,2	38,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	193,9
Surface flow	9,9	31,6	42,7	46,2	44,3	19,2	0,0	0,0	0,0	0,0	0,0	0,0	193,9
Humidity ratio	3,9	4,5	1,6	0,9	0,4	-0,2	-0,7	-0,8	-0,4	0,1	1,0	4,1	14,2

Table 5. Precipitation efficiency formula results according to Thornthwaite.

S=	193,89
D=	208,78
N=	848,89
Im=	8,08
Etp=	848,89
Ia=	24,59

Temperature Regime =	51,73

When the water balance sheet graph of Kastamonu region is examined, there is surplus of water due to the excess of precipitation which is relatively high in the period of 5 months starting from January. But in the following 3 months, the surplus water is lost and a decrease in the amount of water stored is observed. Subsequently, as a result of the increase in potential evapotranspiration and decreasing rainfall since July, drought period is entered and a dry period of 3 months is experienced. After that, again water is being stored in parallel with the increase in precipitation and decrease of potential evapotranspiration.

According to the Thornthwaite method, climates were collected in two main classes as moist and arid climates depending on the relationship between precipitation and evapotranspiration. The humid climates are 6 (C2, B1, B2, B3, B4, A), and the arid climates are divided into 3 (E, D, C1) climates and a total of 9 climate classes have been formed (Table 6). This classification uses the formula (Im) of precipitation efficiency index. The formula, classification system and symbols are given below [14].

Table 6. Climatic classes according to precipitation index

Precipitation Activity Index (Im)	Precipitation Efficiency	Climate Type	Symbol
Less than -40	Arid (Desert)	Arid Climates	E
(-40)-(-20)	Semi-arid	Arid Climates	D
(-20)-0	Arid-Less efficient	Arid Climates	C1
0-20	Semi-moist	Moist Climates	C2
20-40	Damp	Moist Climates	B1
40-60	Damp	Moist Climates	B2
60-80	Damp	Moist Climates	B3
80-100	Damp	Moist Climates	B4
More than 100	Very moist	Moist Climates	A

The precipitation effect of Kastamonu was found to be 8.08% at IM (precipitation index) in Table 5. Therefore, this value in the climate type diagram (Table 6) shows that the "C2" symbol, that is, the "humid climates" of the region corresponds to the climate class.

Temperature and rainfall data covering Kastamonu area from Turkey's general climate data were also created in the ArcMap 10.5 environment and the results obtained by thornthwaite method were compared. (Fig.4 , fig. 5).

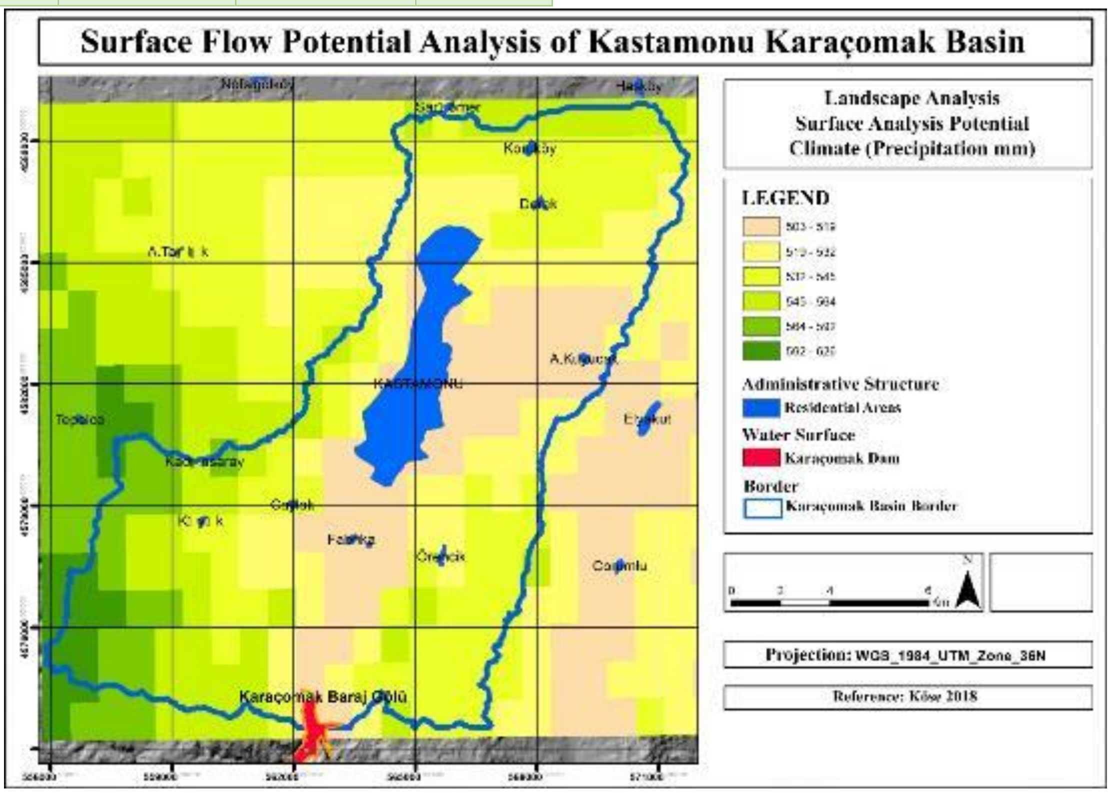

Fig. 4 Climate-precipitation data map of Kastamonu Karaçomak Basin

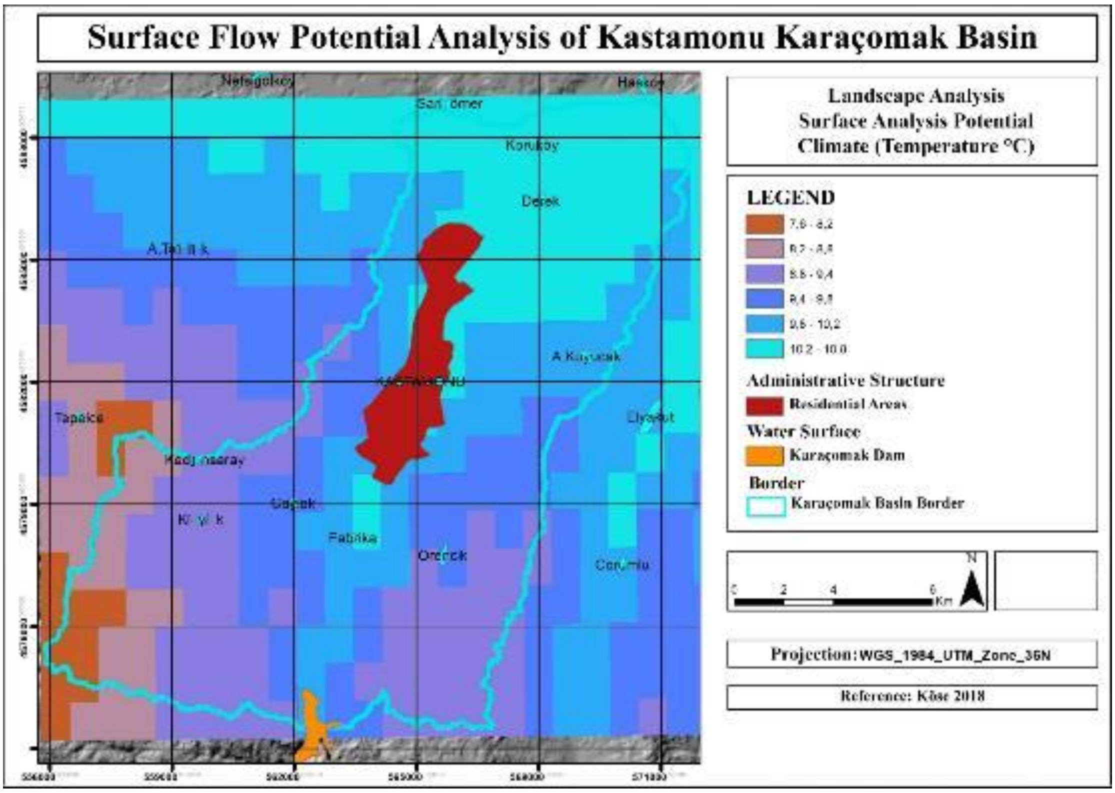

Fig. 5 Climate temperature data map for Kastamonu Karaçomak Basin

The next step is to calculate surface flow quantities according to the water retention potential. S values vary between 13 and 207 mm. Okman 1994; The formula is used.

Q=(P-02xS)2 / (P+08xS)

Q = Surface water flow rate (mm)

P = Rain water (mm)

According to Thornthwaite method with S value determined in ArcMap 10.5; The surface flow map was obtained by taking the P value of 133 mm which is the maximum rainfall in May and the calculation by the raster calculator command (Q values are shown in Fig.6).

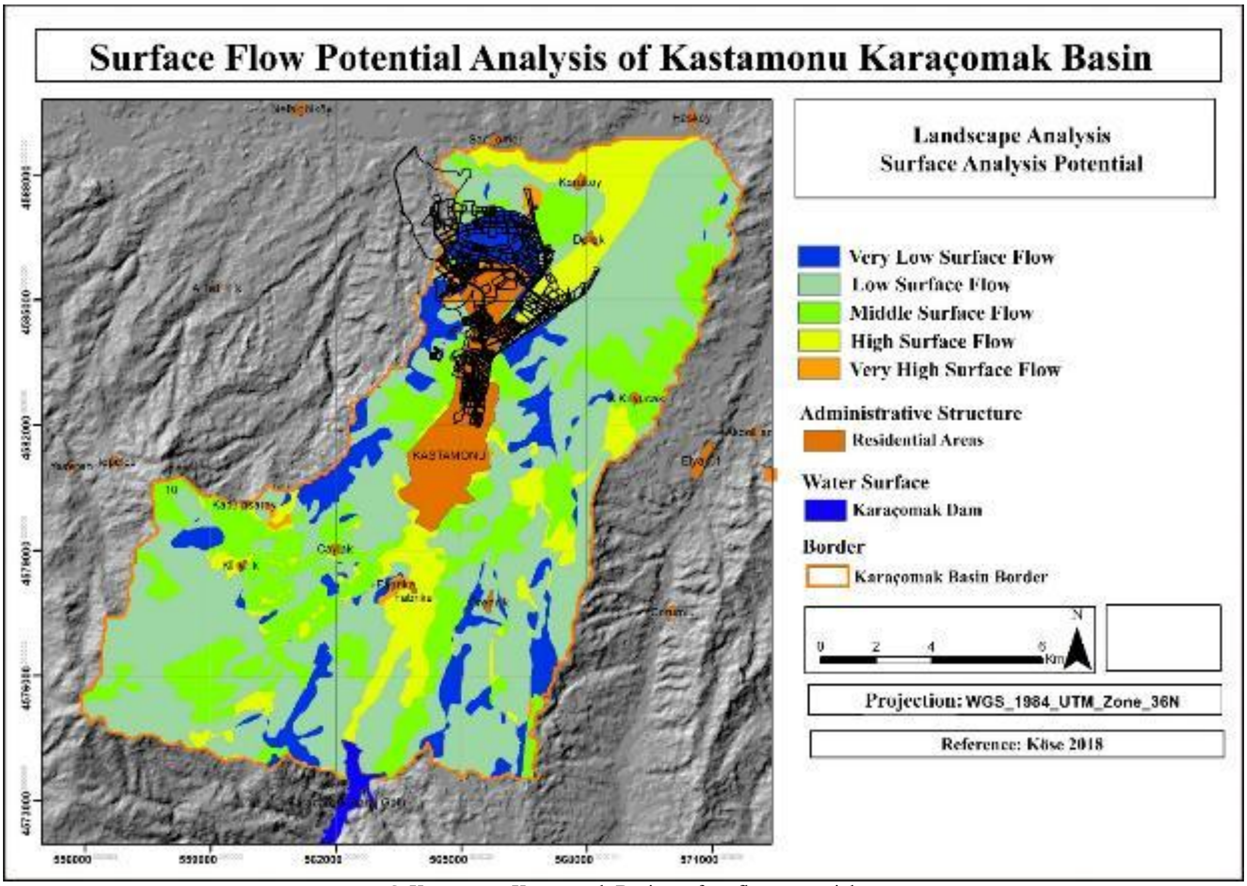

Fig. 6 Kastamonu Karaçomak Basin surface flow potential map

As a result of the analysis completed with ArcMap 10.5 program, surface flow values are divided into 5 classes. Surface water flow was analyzed in 5 grades in MM. These values range from 0-34. Analysis of Kastamonu Karachomak basin according to this 5 class;

- 1311 ha low surface flow area,
- 75 ha high surface flow area,
- 6164 ha low surface area,
- 4139 ha medium surface flow area

It is calculated as an area with 105 ha high surface flow.

After the surface flow analysis and map were created, Kastamonu's zoning map was built on the ArcMap and the effect of urbanization on surface flow was observed in the basin. After urbanization, soil permeability on that area will decrease because of the surface flow will increase. Therefore, the permeability of soil data has been recalculated by determining the area of urbanization. After this calculation, changes in surface surface area were observed.

III. DISCUSSION/CONCLUSION

The amount of surface flow on Kastamonu Karaçomak basin was determined at 5 different levels and shown on the map (fig 6). After urbanization, the soil permeability will change in the areas within the urban boundaries as the areas covered with hard soil will increase. In the regions where the city comes, the soil permeability class was accepted as Class D soil with a layer of soil that shows low water flow rate and has a very low surface flow potential, contains a lot of clay and has an impermeable layer close to the surface. It is observed that the surface flow rate of the re-evaluated areas as Class D within the city border is increasing (Fig 7). The reduction of green areas in cities will result in the rapid removal of water from the surface stream, but also in the reduction of soil absorption and transpiration. With this result, the increase in the amount of surface flow will adversely affect the water cycle and will increase the water pollution. In these areas, in order to minimize the losses on hydrology, the amount of green areas should be increased, and planning and design that contribute to sustainable and ecologic management should be carried out within the urban settlement.

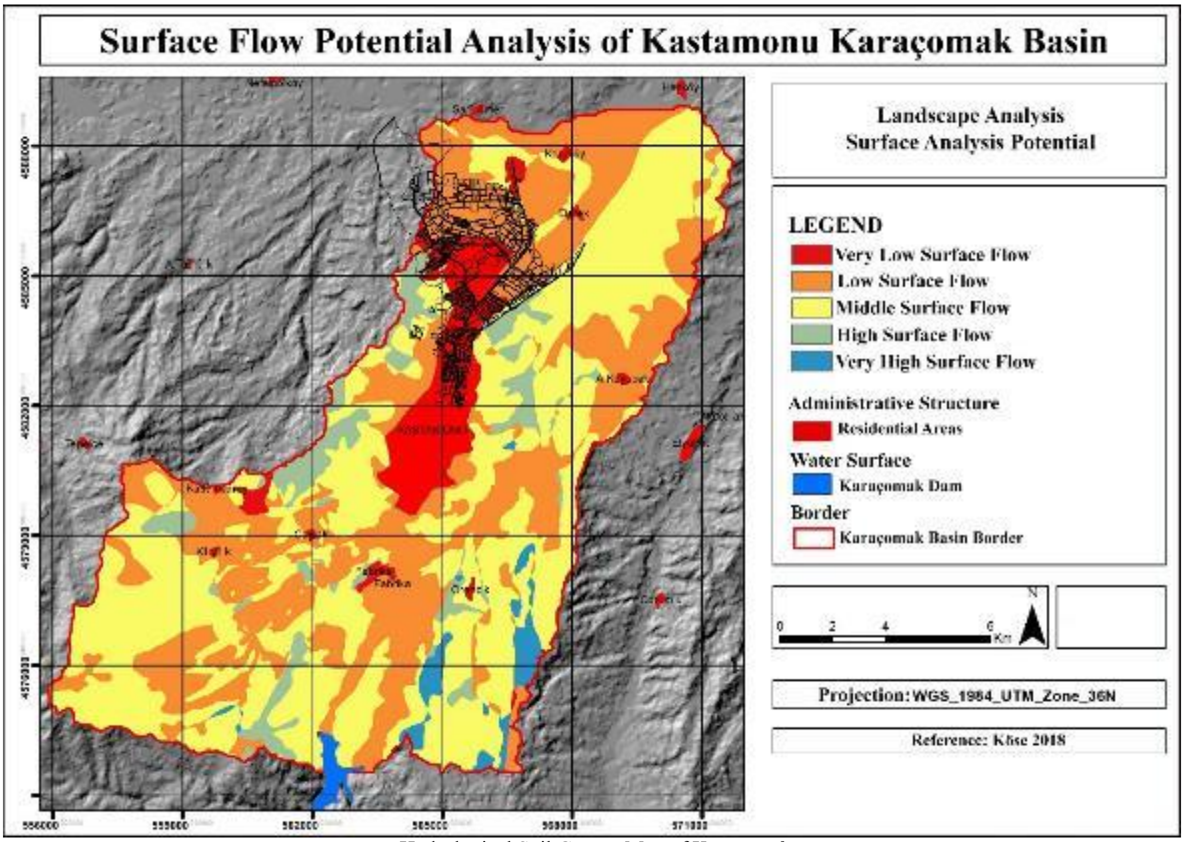

Fig. 7 Hydrological Soil Groups Map of Karaçomak Basin

In order to reduce the effects of climate change, there are many sustainable initiatives such as energy efficient planning, reuse and adaptation of materials, smart cities and climate-based designs. In these initiatives, there are methods by which landscape architects will contribute to the climate change which will contribute by taking sustainable measures. One of them, and perhaps one of the most important ones, is the planning and design for the efficient use of water. In recent years, researches emphasize that the hydrological cycle will change with the increase in temperature in the climate. It is stated that with increasing temperature, evaporation rates will increase and the amount of precipitation will decrease. As a result, groundwater feeding will slow down and droughts will begin to form. Provides water efficiency; rain gardens, permeable surface tiles, roof gardens, artificial wetlands and stormwater (bioswales) design approaches such as rain water to reach the soil should be provided. Instead of concrete canals built for river and river improvement, the use of permeable materials for stream and river roads and stormwater ditches can be considered. Plants in stormwater trenches can contribute to groundwater feeding by cleaning the water. Rain water flowing from the roofs, water flowing from impermeable surfaces and drainage water in the ground can be stored and filtered to transform the rain water.

The problems regarding water resources management in the world and in our country have been realized and it has been accepted that the targets should be determined in the sustainable protection-use balance related to water management. This acceptance is found in the laws on water management and the work of the relevant departments of the ministries. In this context, it is observed that rain water management projects have been implemented in some countries. Accelerating water management projects in our country is also important for the future.

References

[1] R. Kanber. Turkey Run in Water Resources Potential: Usage, Problems and Solutions. TMMOB Water Policies Congress, Ankara.

[2] Anonymous. 2018. Web site: http://yunus.hacettepe.edu.tr/~nozyurt/Hidrojeoloji_3.pdf. Accessed on: 10.06.2018

[3] Anonymous 2019a. https://www.worldclim.org

[4] Anonymous 2019b. https://tr.wikipedia.org/wiki/kastamonu_(il)

[5] Jain, M. K., Mishra, S. K., and Singh, V.P. (2006): Evaluation of AMC-dependent SCS-CN-based models using watershed characteristics CN, Water Resources Management, 20: 531-552.

[6] Y. Kose and S. Şahin. Soil Structure Permeability and Surface Flow Potential Analysis in. Unfounded Book section 2018. Kastamonu Municipality- Ankara University.

[7] Beven, K.J. (2001) Rainfall-Runoff Modeling, John Wiley & Sons, LTD, England.

[8] Özdemir, H. 2007. SCS CN Precipitation-Flow Model Implementation with GIS and Remote Sensing Methods: The Case of Havran Stream Basin (Balıkesir). Journal of Geographical Sciences. 5 (2), 1-12.

[9] Okman, Cengiz. 1994. Hydrology. Ankara: Ankara University Faculty of Agriculture Publications no: 1338. Textbook: 402.

[10] Şahin, Ş., Perçin, H., Kurum, E., Uzun, O. and Bilgili, BC, 2014. National Technical Manual for Landscape Character Analysis and Evaluation in the Region - Sub-Region Scale TC of Institutions Ministry of Interior, T.C. Ministry of Environment and Urbanization and T.C. Ministry of Forestry and Water Affairs, T.C. Ankara University, and the TÜBİTAK KAMAG 1007 Program 109G074 PEYZAJ-44 Project Output, 148 Pages, Ankara.

[11] Halley, M.C., White, S.O. and Watkins, E.W., 2000. ArcView GIS extension for estimating curve numbers, ESRI User Conference-2000, San Diego, California.
[12] Birsoy, Y. Ölgen, M.K. 1992. Computer use in determining water balance and climate type with Thornthwaite method. Ege Geography Magazine. 6 (1).
[13] Anonymous 2019. https://dergipark.org.tr/download/article-file/56867 (Y.Birsoy and M.K. Ölgen.
[14] Özdemir, S. 2015. Ecological characteristics of Turkish thyme (origanum onites l.) And large flowered sage (salvia tomentosa miller) in Ovacık Mountain region. Süleyman Demirel University Institute of Science and Technology. Master Thesis.
[15] Okman, C. 1994. Hydrology. Ankara: Ankara University Faculty of Agriculture Publications no: 1338. Textbook: 402.
[16] Chow, V. T., Maidment, D. R., Mays, L.R. (1988) Applied Hydrology, McGraw- Hill Inc., New York.
[17] McCuen, R.H. (1982) A Guide to Hydrologic Analysis Using SCS Methods, Prentice-Hall, Englewood Cliffs, NJ.