Karadeniz Fen Bilimleri Dergisi, 12(1), 461-478, 2022. DOI: 10.31466/kfbd.1093994

KFBD

Karadeniz Fen Bilimleri Dergisi
The Black Sea Journal of Sciences
ISSN (Online): 2564-7377

Araştırma Makalesi / Research Article

Tea Purchase Center and Factory Matching with Fuzzy Logic Approach in Tea Production

Fatma Önay KOÇOĞLU[1*]

Abstract

Although countries are focused on the production and export of advanced technologies, defense and other industries, such as petroleum natural gas and metal products, they must maintain both economically and at least self-sufficient agricultural production. If the case will be examined in terms of Turkey, Turkey has a large and suitable area for agricultural activities. Turkey is a country where agricultural activities are carried out widely and effectively. Tea is one of the agricultural products produced in Turkey. An important point to be considered during the transportation of wet tea is that wet tea is a plant that burns very quickly and becomes unusable. Within the scope of this study, two provinces (Artvin and Rize), which are permitted by the government for planting tea, were taken into consideration to match factory-tea purchase unit location by fuzzy c-means clustering method. The use of clustering approach reduced the size of the problem and provided an easier solution. As a result of the analyses, more tea purchasing centers were assigned to some factories. The study shows that in addition to agricultural production, a correct structuring is required for the processing of agricultural products, such as the distribution of production areas and the location of processing facilities.

Keywords: Fuzzy clustering, tea production, tea factory.

Çay Üretiminde Bulanık Mantık Yaklaşımıyla Çay Alım Merkezi ve Fabrika Eşleştirmesi

Öz

Ülkeler her ne kadar gelişmiş teknoloji, savunma ve diğer endüstri, petrol doğalgaz ve maden ürünlerinin üretimi ve ihracatı üzerine yoğunlaşmış olsa da hem ekonomik açıdan hem de en az kendi kendine yetecek düzeyde tarımsal üretimi de devam ettirmek durumdadır. Türkiye açısından durum incelenecek olursa, ülkemiz tarım faaliyetleri için oldukça uygun ve geniş alanlara sahip, kuruluşundan bugüne kadar yaygın ve etkin şekilde tarım faaliyetlerinin yürütüldüğü bir ülkedir. Türkiye'de üretilen tarım ürünlerinden birisi çaydır. Bu çalışma kapsamında, hükümet tarafından çay ekimi için izin verilen 2 il için (Artvin ve Rize) tüm ilçe ve köyleri göz önünde bulundurularak bulanık kümeleme yöntemi ile uzaklığa dayalı fabrika ve yaş çay alım yeri eşlemesi yapılmıştır. Kümeleme yaklaşımının kullanılması problemin boyutunu küçülterek daha kolay çözüm üretilmesini sağlamıştır. Analizler sonucunda bazı fabrikalara daha fazla sayıda çay alım merkezi atanmıştır. Çalışma tarımsal üretimin yanı sıra tarım ürünlerinin işlenebilmesi için de gerek üretim alanlarının dağılımı, gerek işleme tesislerinin konumlanması gibi konularda doğru bir yapılanmaya gereksinim olduğunu göstermektedir.

Anahtar Kelimeler: Bulanık kümeleme, çay üretimi, çay fabrikası.

[1]Muğla Sıtkı Koçman University, Faculty of Engineering, Department of Software Engineering, Muğla, Turkey, fonaykocoglu@mu.edu.tr

[1]https://orcid.org/0000-0002-1096-9865

[*]**Sorumlu Yazar/Corresponding Author**

Geliş/Received: 27.03.2022 **Kabul/Accepted:** 13.06.2022

1. Introduction

With globalization, the competitive environment around the world has become more challenging. In this period, technological products are seen as products with high added-value and profit rate. So, production-oriented activities are dominant in this field. Although production is focused on the production and export of the products on technology, defense, industry, oil, natural gas and mineral, the importance and continuation of agricultural production is undeniably high. Agriculture plays an important role in economic growth, increasing food security, reducing poverty, and rural improvement (Mwangi ve Kariuki, 2015). The importance of agricultural production is obvious, especially considering the rapidly increasing population, decreasing cultivation areas and changing consumption habits throughout the world. On the other hand, sustainable practices are needed in the agricultural field for different reasons (Nicolopoulou-Stamati ve diğ., 2016). Therefore, countries continue their agricultural production at least at a self-sufficient level and try different applications with various innovative approaches such as the use of technological tools, organic agriculture, container agriculture.

Turkey is also a country that has suitable and fertile areas for agricultural activities, and where agricultural activities are carried out widely and effectively. The product range is just as wide, especially thanks to features such as soil structure, climatic conditions, and diversity of water resources. One of the most important agricultural products produced in Turkey is tea. Tea (Camellia sinensis, (Hamilton-Miller, 2001) is a plant that grows in humid climates and its leaves and shoots are used to produce beverages. Tea is grown in subtropical and tropical climates, especially in mountainous regions. The world's largest tea producers are China, India, Indonesia, Kenya and Sri Lanka (Tea & Herbal Infusions Europe (THIE), 2019). Turkey has been among the top 10 producer countries in the world in terms of the breadth and productivity of tea agricultural lands in recent years (Food and Agriculture Organization (FAO), 2018; Food and Agriculture Organization Corporate Statistical Database (FAOSTAT), 2019). Therefore, the tea plant has a very important place among both the consumption habits in Turkey and the agricultural products exported abroad.

According to the Agricultural Economy and Policy Development Institute (AEPDI, 2022) report, the nearly distribution of tea cultivation area in Turkey is as follows: 66% of the area is in Rize, 20% is in Trabzon, 11% is in Artvin, and 3% is in Giresun. According to the same report, the distribution of tea producers shows similar characteristics. Figure 2 shows the tea production rates by province in Turkey.

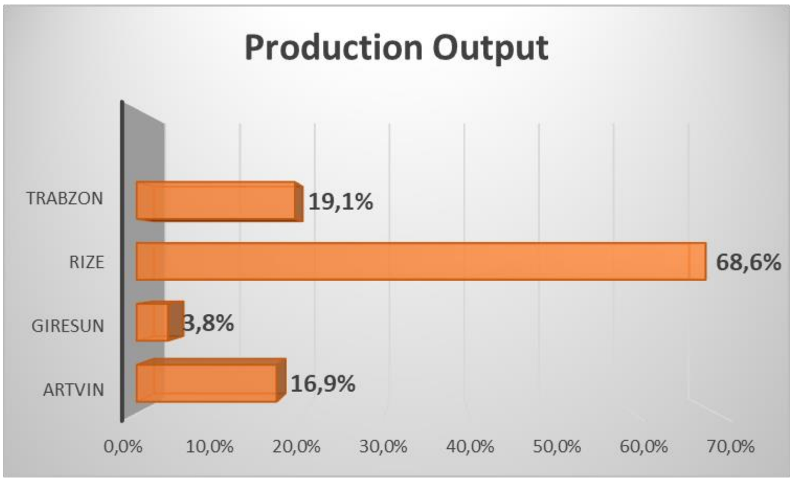

Figure 1. Distribution of tea production rates by provinces in Turkey (AEPDI, 2022).

After the tea plant is collected, it goes through a series of processes and becomes consumable. This process generally consists of the following steps:

- Gathering tea plants from the garden.
- Bringing the collected wet tea to the purchasing center.
- The purchase of fresh tea according to its quality and types, after examining it by factory experts.
- Bringing fresh tea from the purchasing center to the factory for processing.
    - Withering, rolling, fermentation and drying.
- Transfer of the obtained dry tea to the packaging unit.
    - Passing through the classification, blending and packaging stages in the packaging unit.

When the production process of tea is examined, it is seen that there is a match between each tea purchasing center and the factory. At this point, it should be determined with which factory the wet tea purchasing center should work. Because an important point to be considered during the transportation of wet tea is that wet tea is a plant that burns very quickly and becomes unusable. Therefore, the correct purchasing center-factory matching will ensure that the fresh tea is delivered to the factory from the purchasing center in the fastest way. Within the scope of this study, it is aimed to propose a Fuzzy Logic based matching proposal based on the distance between the centers where the harvested tea plant is collected (tea purchasing center) and the factories where it is processed. Although there are studies carried out with the clustering approach both on agriculture and especially on tea plants in the literature, there is no study on the matching of factory and tea purchasing center in the production process, according to our best of knowledge. The study is also important because it prepares the ground for the solution of the problem of determining the new factory locations.

The rest of this paper is as follows in “Literature Review” a literature review has been given, in “Methodology” the data, methods, and tools has been detailed, in “Results” results has been presented, and “Discussion” and “Conclusion” include assessment of results and recommendations for future studies.

2. Literature Review

The literature review has been examined in two main axes: the use of clustering practices in agricultural production and clustering studies based on tea plants.

2.1. Clustering Applications in Agricultural Production

Peeters et al. (2015) have developed a combined spatial and non-spatial clustering approach for splitting tree-based data in orchards. The developed clustering method is compared with the k-means clustering algorithm. The developed method has improved the results in terms of both distinguishing between feature values and representing their spatial states. It has been stated that the developed method can be used to determine the management regions for optimum precision management of tree crops. Singh and Atwal (2017) have focused on the importance of using data mining methods in estimating productivity in agriculture, and conducted a study in this context. In the study, it has been stated that in addition to the estimation, the factors affecting the yield can also be obtained by data mining methods. It has been tried to estimate the yield by using the classification and clustering methods of data mining by considering the soil properties. Majumdar et al. (2017) have stated that crops are usually selected based on their economic importance, but crop yield estimation should also be made for the agricultural planning process. Within the scope of the study, this estimation process has been tried to be made with various data mining methods. Partitioning around medoids (PAM), clustering large applications (CLARA), modified density based spatial clustering of applications with noise (DBSCAN) and multiple regression methods have been used. The modified DBSCAN method has been used to cluster data based on regions with similar temperature, rainfall and soil type, while PAM and CLARA have been used to cluster data based on counties with maximum crop production. As a result of the study, the necessary parameters for the production of wheat crop have been determined. In the estimation phase, annual crop yield has been estimated. In the study carried out by Servadio and Verotti (2018) based on the soil texture of three regions belonging to a farm located in the center of Italy, the crop yield and various soil parameters of this region have been monitored both physically and mechanically. Data has been collected over three periods with a combine harvester with a sensitive land management system. After collecting all the data, the regions have been obtained by clustering the data with the Fuzzy c-Means clustering approach. Spatial and temporal changes in the results obtained are noticeable.

2.2. Clustering Applications Based on Tea Plants

Sun et al. (2003) have carried out clustering of the tea plant grown in the Shandong region of China, according to 10 different cities and towns, 6 meteorological characteristics. The analyzes have showed that the tea plant grown in the Shandong region is divided into 4 different ecological regions. In addition to clustering analysis, variation and correlation analyzes have been also performed. It has been concluded that meteorological factors are in a positive relationship with the structure of the tea leaf. Thambipillai (2013) has conducted the study on 6 different tea planting regions in Sri Lanka. It is stated that the effects of different factors on tea planting regions should be considered in order to model remedial activities. These factors have been determined as market stability, human resources, technological capacity, finance, infrastructure, security, management and environment. These factors have been examined for each region. Tozlu et al. (2015) have developed a study to measure the quality of fermented tea. In addition to chemical analyzes and previous studies, this study performed an online electronic measurement on the fermentation line of a tea production plant. Bhatt et al. (2018) have proposed a solution for unsupervised image classification and labeling by utilizing high-level features obtained with a pre-trained Convolutional Neural Network (CNN). Accordingly, images as a data set have been first collected via a mobile application used by the farmers. Images have been clustered and labeled by clustering method according to the attributes obtained from a CNN trained with the data obtained from the ImageNet database. Then, it has been aimed to determine the classes of new images with a model using Support Vector Machines (SVM). The results have showed that 93.75% of the tea leaves was classified correctly with the established model. Tie et al. (2018) have stated that tea blending, which plays an important role in the production process of tea, provides an advantage in increasing the quality of tea, expanding the source of tea and making more profit. Manual blending methods are difficult to optimize blending programs as well as time and energy loss. Multidimensional hierarchical space-based spatial clustering has been used for the tea blending problem. Features such as herbal properties of tea, production region, processing method have been used. A similarity-based measure has been also developed in the study. Based on this similarity measure, two clustering algorithms have been proposed, namely Agglomerating Spatial Clustering Algorithm and Divisive Spatial Clustering Algorithm. Algorithm performances have been evaluated according to accuracy and processing time. Wu et al. (2018) have proposed the Allied Gustafson-Kessel (AGK) clustering model to cluster the Fourier Transform Infrared Reflection (FTIR) spectra of tea samples for the classification of tea varieties. After the FTIR spectra were collected with the FTIR-7600 infrared spectrometer, they have been preprocessed with Multiple Scatter Correction (MSC). Principal component analysis (PCA) and linear separation analysis (LDA) have been used to process the FTIR spectrum to reduce the size of the FTIR spectrum and facilitate the classification of data. Fuzzy c-Means, Probabilistic c-Means, AGK, and Allied FCM have been applied on the dataset, respectively. The highest accuracy value of 93.9% has been obtained with AGK. The results have showed that AGK combined with FTIR spectroscopy is an effective method for successful classification of tea varieties.

3. Materials and Methods

Within the scope of this study, all the villages belonging to the production districts of Artvin and Rize provinces have been taken into consideration, and tea purchasing center-tea processing factory mapping has been made using Fuzzy c-Means clustering method (FCM). Considering the distances between the coordinates of the cluster centers obtained by FCM and the factory coordinates, the mapping has been performed in a way that minimizes the sum of the distances.

In the study, the districts where tea is produced have been obtained from the Turkish Statistical Institute (TUIK), the addresses for the tea factories to be matched have been obtained from the General Directorate of Tea Enterprises (ÇAYKUR), and the villages and factory locations have been obtained via Google Maps. The 29 factories whose data were used in the study have been listed in Table 1.

Table 1. Factories located in Rize and Artvin.

RİZE			ARTVİN
Factory Name			Factory Name
Ambarlık	Kirazlık	Kalkandere	Arhavi
Ardeşen	Melyat	Kendirli	Kemalpaşa
Aşıklar	Musadağı	Işıklı	Muratlı
Azaklı	Pazar	Gündoğdu	
Büyükköy	Pazarköy	Güneysu-Ulucami	
Camidağ	Salarha	Veliköy	
Cumhuriyet	Selimiye	Zihniderin	
Çayeli	Taşçılar	Derepazarı	
Çiflik	Tersane		
Total Number of Factory=26			Total Number of Factory =3

Within the scope of the study, first of all, 431 tea purchasing centers located in Rize and Artvin provinces have been clustered with the FCM method by using the vertical linear distance measure according (Euclidean distance) to the coordinates and 29 cluster centers have been obtained. Each cluster center obtained must be paired with a factory so that the tea purchasing center and factory pairing is achieved. At this point, this matching is found using the distances between cluster centers determined by FCM and factories. Which cluster center should be represented by which factory was calculated by using genetic algorithm so as to minimize the total distance between cluster centers and factories.

In the clustering process, the number of clusters has been determined as 29 and the number of iterations has been determined as 1000. In the GA, the population size has been determined as 10, the crossover method has been determined as "gaperm_oxCrossover", and the number of iterations has been determined as 100. All necessary processes for the solution of the problem have been carried out with Microsoft Excel and RStudio editor (R Core Team, 2018, RStudio Team, 2020). The packages used for the analyzes have been given below.

- Reading and writing data: xlsx (Dragulescu and Arendt, 2020)
- Clusering: e1071 (Meyer et al., 2021)
- Genetic Algorithm: GA (Scrucca, 2013)
- Visualization of data: factoextra (Kassambara and Mundt, 2020)

3.1. Fuzzy c-Means (FCM) Algorithm

As a result of basing the k-Means algorithm on the basis of fuzzy logic, the Fuzzy c-Means algorithm has been obtained. In the FCM algorithm, as in the k-Means algorithm, clustering is based on distance. However, in accordance with the fuzzy logic approach, instead of accepting that an object definitely belongs to a single cluster, belonging to different clusters is considered. The membership degrees expressing this situation are calculated and the belonging status of each data point to the clusters is expressed with these degrees. The algorithm has been formulated by Dunn (1974) for optimum fuzzy clustering of the data set and developed by James C. Bezdek et al. (1981). If the membership degree for an observation is greater for a cluster, the assignment of the observation is made to that cluster. The FCM algorithm is formulated as follows:

$$J(X;U;V) = \sum_{i=1}^{N} \sum_{k=1}^{c} (\mu_{ik})^m \|x_i - v_k\|_A{}^2 \tag{1}$$

$$\mu_{ik} \in [0,1], \forall i = 1,2,,\dots,N;\ \forall k = 1,2,\dots,c \tag{2}$$

$$\sum_{k=1}^{c} \mu_{ik} = 1 \tag{3}$$

$$0 < \sum_{i=1}^{N} \mu_{ik} < N \tag{4}$$

Here A_k is data points (observations) in the cluster k, $V = [v_1, v_2, \dots, v_c]$ being the vector consisting of the centers of c clusters, v_k is the center of the cluster k, $\|x_i - v_k\|_A{}^2 = (x_i - v_k)^T A(x_i - v_k)$ is the square of the inner product distance norm, $\mu_{ik}$is the data point i of cluster k. The Nxc-dimensional matrix $U = [\mu_{ik}]$ represents fuzzy partitioning. As it can be understood from the constraints, while the membership values change in the range of [0,1], the sum of the membership degrees of a data point (observation) should be 1.

3.2. Genetic Algorithm

Various soft computing and evolutionary algorithms have been developed for complex and difficult-to-solve problems. One of these algorithms is the Genetic Algorithm, which is the most common and most used branch of evolutionary programming. Genetic algorithm is a search and optimization method based on natural selection principles. Its basic principles have been put forward by John Holland (John, 1992; Emel and Taşkın, 2002). Genetic algorithm is used in workshop scheduling, artificial neural networks and design, image control, electronic circuit design, optimization, expert systems, packaging problems, machine and robot learning, traveling salesman problem, economic modeling problems (Mitchell and Forest, 1994).

The first step of the genetic algorithm is to determine the chromosome structure for the solution of the problem. After determining the chromosome type, an initial population is created. This population is referred to as the initial candidate solutions. Crossover and mutation operations are performed between pairs determined according to various selection functions. These processes will ensure the acquisition of new individuals. At this point, the fitness values of the new individuals are calculated. It is aimed to obtain a better fitness value in each iteration. Considering an evolutionary process, individuals with higher fitness values at each step can move on to the next step. This process is continued until the number of new generations reaches a certain number or until the fitness value in the population does not change.

4. Findings

As a result of this study, factory-tea purchasing center matching has been carried out. The results obtained in this direction have been shared below.

Table 2. Obtained cluster centers.

Cluster Centers					
Cluster	X-Coordinate	Y- Coordinate	Cluster	X- Coordinate	Y- Coordinate
1	41.039935	40.714586	16	40.642940	40.552210
2	40.959840	40.633923	17	40.983170	40.472833
3	40.985672	40.400036	18	41.378631	41.620433
4	41.453517	41.667188	19	40.735200	40.596202
5	41.030371	40.911196	20	41.140965	41.018933
6	41.468534	41.925029	21	41.319713	41.720444
7	41.385549	41.752098	22	41.385249	41.476942
8	40.966004	40.552672	23	41.307801	41.316586
9	40.886509	40.478967	24	40.818319	40.924997
10	41.114190	41.077562	25	41.083800	40.796083
11	41.239308	41.217063	26	41.317902	41.376138
12	41.138822	40.856832	27	41.213534	41.152844
13	41.023107	40.616224	28	40.933251	40.789530
14	41.474079	41.524386	29	41.292365	41.423003
15	41.130727	40.929332			

The distribution of tea purchasing centers according to the cluster centers obtained has been given in Figure 2. In the figure, 29 clusters are seen in different colors, and the numbers in the clusters represent the tea purchasing centers.

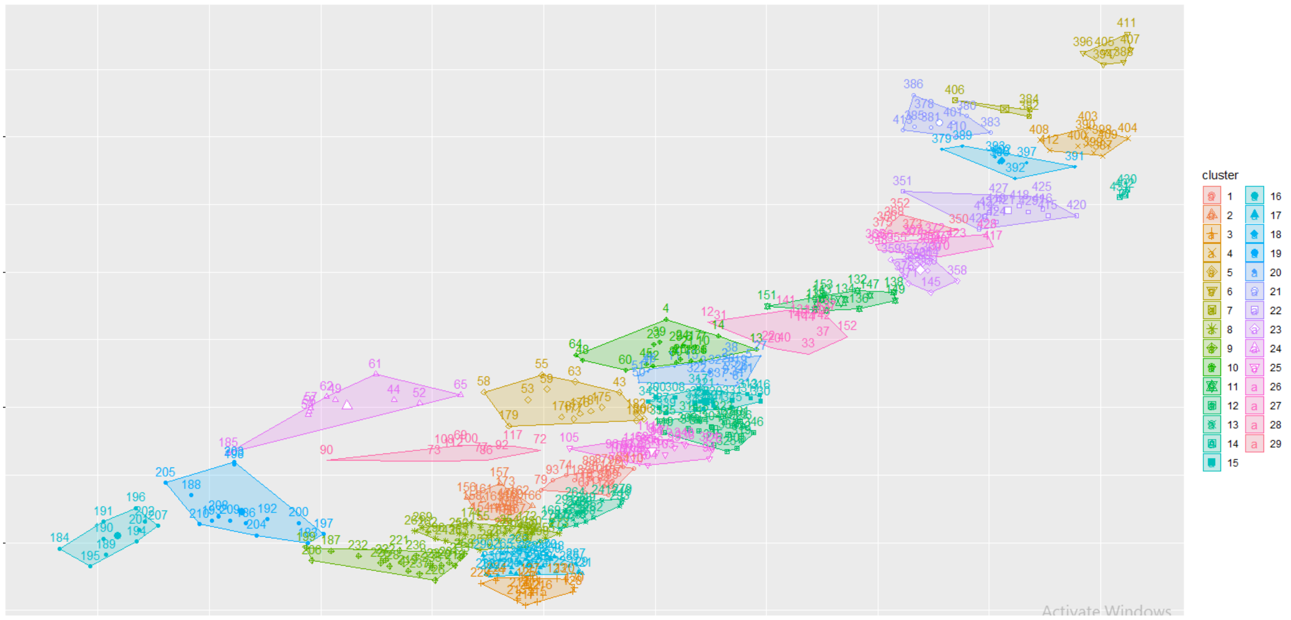

Figure 2. Cluster centers obtained as a result of the analyzes.

The factory corresponding to each cluster center is given in Table 3. Accordingly, while the first cluster center was matched with the "Cumhuriyet" factory, the 10th cluster center was matched with the "Çayeli" factory.

Table 3. Cluster center factory mapping.

Cluster	Factory	Cluster	Factory	Cluster	Factory
1	Cumhuriyet	11	Gundogdu	21	Muratli
2	Azakli	12	Asiklar	22	Musadagi
3	Derepazari	13	Selimiye	23	Kendirli
4	Arhavi	14	Kirazlik	24	Camidag
5	Guneysu-Ulucami	15	Ambarlik	25	Zihniderin
6	Tascilar	16	Kalkandere	26	Kemalpasa
7	Isikli	17	Salarha	27	Ardesen
8	Pazarkoy	18	ciflik	28	Velikoy
9	Buyukkoy	19	Melyat	29	Tersane
10	Çayeli	20	Pazar		

The table in Appendix 2 has been prepared in order to indicate exactly which factories are matched with tea purchasing centers. According to this table, the tea purchasing center in each row is matched with the tea factory indicated opposite. In other words, the tea plant that comes out of this tea purchasing center should be taken to the specified factory. The first 10 rows of the obtained result have been given in Table 4. All matches have been given in Appendix 1.

Table 4. Tea purchase center and factory match (first 10 lines).

Tea Purchase Center	Factory
Akdere Village	Pazar
Akkaya Village	Pazar
Arıcılar Village	Çayeli
Armağan Village	Pazar
Aşağıdurak Village	Çayeli
Bayırcık Village	Çayeli
Beyazkaya Village	Pazar
Çıraklar Village	Pazar
Doğanay Village	Çayeli
Duygulu Village	Pazar

The number of tea purchasing centers assigned to each factory is given in Table 5. When the table is examined, Veliköy is the factory with the most assigned with 28 centers, while Melvat is the factory with the least assigned with 3 purchasing centers.

Table 5. Number of tea purchasing centers assigned to factories.

Factory Name	Number of Assigned Center	Factory Name	Number of Assigned Center
Pazar	22	Işıklı	3
Ambarlık	20	Kalkandere	10

Ardeşen	16	Kemalpaşa	15
Arhavi	10	Kendirli	12
Aşıklar	22	Kirazlık	3
Azaklı	17	Melyat	14
Büyükköy	19	Muratlı	9
Camidağ	10	Musadağı	14
Çayeli	21	Pazarköy	25
Çiflik	9	Salarha	28
Cumhuriyet	21	Selimiye	18
Derepazarı	17	Taşçılar	6
Gündoğdu	12	Tersane	6
Güneysu-Ulucami	15	Veliköy	11
		Zihniderin	26
		Total	431

5. Conclusions and Discussion

Due to the rapid burning of the tea leaf, the tea plant at the tea purchase center must be delivered to the factories as quickly as possible. In the study, matching has been carried out between tea purchasing centers and factories so that the sum of the distances was minimum.

As a result of the study, it has been seen that the tea purchasing centers in each village do not need to deliver products only to the factory located in the district to which they are affiliated. This situation shows that the factory mapping of purchasing centers should be based on a scientific method, and various advantages can be achieved accordingly. It can be said that the inclusion of cluster analysis in the model helps in minimizing the problem. If cluster analysis had not been included in the model, mapping would have to be made between 431 purchasing centers and 29 factories. However, together with the cluster analysis, this matching has been carried out between 29 cluster centers and 29 factories. Also, it has been observed that more purchasing centers were assigned to some factories. Based on these numbers, necessary capacity planning can be made.

The study is limited only to the cities of Rize and Artvin. The results can be expanded by including the cities of Trabzon and Giresun in the analysis. The matching process can be renewed considering the capacities of the factories and the amount of production in the tea purchasing centers. Some companies are trying to determine new factory locations especially for the production of organic tea (white, green, etc.). Therefore, the study can be expanded to provide a new factory location proposal. In the next study, it is aimed to produce a solution with the extended one-step FCM algorithm by including the altitude parameter in the analysis due to the altitude difference in the Black Sea Region. Therefore, the study revealed results that will form the basis for production and planning.

Authors' Contributions

All authors contributed equally to the study.

Statement of Conflicts of Interest

There is no conflict of interest between the authors.

References

Bezdek, J. C. (1981*). Pattern recognition with fuzzy objective function algorithms*. Boston, ABD: Springer.

Bhatt, P., Sarangi, S., Pappula, S. (2018). Coarse clustering and classification of images with CNN features for participatory sensing in agriculture. *The International Conference on Pattern Recognition Applications and Methods* (pp.488-495). Portugal.

Çay İşletmeleri Genel Müdürlüğü (Çaykur). (2017). İstatistik bülten, Retrieved from http://caykur.gov.tr/CMS/Design/Sources/Dosya/Yayinlar/281.pdf.

Çay İşletmeleri Genel Müdürlüğü (Çaykur). (2019). Üniteler. Retrieved from http://caykur.gov.tr/Pages/Tanitim/FotoGaleri.aspx?ItemId=222

Dragulescu, A., Arendt, C. (2020). xlsx: Read, Write, Format Excel 2007 and Excel 97/2000/XP/2003 Files. R package version 0.6.5.
https://CRAN.R-project.org/package=xlsx

Dunn, J. C. (1974). Fuzzy relative of the ISODATA process and its use in detecting compact well-seperated clusters. *Journal of Cybernetcis*, 3(3), 32–57.

Emel, G. G., Taşkın, Ç. (2002). Genetik algoritmalar ve uygulama alanları. *Uludağ Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi,* 21(1), 129-152.

Food and Agriculture Organization of the United Nations (FAO). (2018). Document CCP:TE 18/CRS1, Retrieved from http://www.invest-data.com/eWebEditor/uploadfile/2020041616145273605009.pdf.

Food and Agriculture Organization of the United Nations Statistics (FAOSTAT). Retrieved from http://www.fao.org/faostat/en/

Hamilton-Miller, J. M. T. (2001). Anti-cariogenic properties of tea (Camellia sinensis). *Journal of medical microbiology*, 50(4), 299-302.

John, H. (1992). Holland genetic algorithms. *Scientific american*, 267(1), 44-50.

Kassambara A., Mundt, F. (2020). factoextra: Extract and Visualize the Results of Multivariate Data Analyses. R package version 1.0.7. https://CRAN.R-project.org/package=factoextra

Majumdar, J., Naraseeyappa, S., Ankalaki, S. (2017). Analysis of agriculture data using data mining techniques: application of big data. *Journal of Big Data*, 4(1), 1-15.

Meyer, D., Dimitriadou, E., Hornik, K., Weingessel, A., and Leisch, F. (2021). e1071: Misc Functions of the Department of Statistics, Probability Theory Group (Formerly: E1071), TU Wien. R package version 1.7-9. https://CRAN.R-project.org/package=e1071

Mitchell, M., & Forrest, S. (1994). Genetic algorithms and artificial life. *Artificial life*, 1(3), 267-289.

Mwangi, M., & Kariuki, S. (2015). Factors determining adoption of new agricultural technology by smallholder farmers in developing countries. *Journal of Economics and sustainable development*, 6(5), 208-206.

Nicolopoulou-Stamati, P., Maipas, S., Kotampasi, C., Stamatis, P., & Hens, L. (2016). Chemical pesticides and human health: the urgent need for a new concept in agriculture. *Frontiers in Public Health*, 4, 148.

Peeters, A., Zude, M., Käthner, J., Ünlü, M., Kanber, R., Hetzroni, A., Ben-Gal, A. (2015). A multivariate spatial clustering method for partitioning tree-based orchard data into homogenous zones. In Precision agriculture'15 (pp. 384-396). Wageningen Academic Publishers.

R Core Team. (2018). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna. Retrieved from https://www.R-project.org.

RStudio Team (2020). RStudio: Integrated Development for R. RStudio, PBC, Boston, MA URL http://www.rstudio.com/.

Scrucca, L. (2013). GA: A Package for Genetic Algorithms in R. *Journal of Statistical Software*, 53(4), 1-37. https://doi.org/10.18637/jss.v053.i04

Servadio, P., Verotti, M. (2018). Fuzzy clustering algorithm to identify the effects of some soil parameters on mechanical aspects of soil and wheat yield. *Spanish Journal of Agricultural Research*, 16(4), e0206.

Singh, G., Atwal, S.K. (2017). Classification and clustering in yield prediction based on soil properties. *International Journal of Advanced Research in Computer Science*, 8(7), 253-258.

Sun, Z. X., Liu, J., Qiu, Z. L., Zhao, S. P., & Zang, L. (2003). Study on the variation of cold resistance of tea plant in shandong province. *Journal of Tea Science*, 23(1), 61-65.

Tarımsal Ekonomi ve Politika Geliştirme Enstitüsü. (2022). Tarım ürünleri piyasaları: Çay. Retrieved from https://arastirma.tarimorman.gov.tr/tepge/Belgeler/PDF Tar%C4%B1m %C3%9Cr%C3%BCnleri Piyasalar%C4%B1/2022-Ocak Tar%C4%B1m %C3%9Cr%C3%BCnleri Rapor%C4%B1/%C3%87ay, Ocak-2022, Tar%C4%B1m %C3%9Cr%C3%BCnleri Piyasa Raporu--+.pdf

Tea & Herbal Infusions Europe (THIE), Tea growing countries. Retrieved from http://www.thie-online.eu/tea/tea-growing-countries/.

Thambipillai, T. P. (2015). *Strategic clustering of foundation suppliers of Sri Lankan tea and their impact on the macro supply network* (Master dissertation). Retrieved from http://dl.lib.uom.lk/handle/123/10632.

Tie, J., Chen, W., Sun, C., Mao, T., Xing, G. (2018). The application of agglomerative hierarchical spatial clustering algorithm in tea blending. *Cluster Computing*, 22(3), 6059-6068.

Türkiye İstatistik Kurumu (TÜİK). (2019). Retrieved from https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr.

Tozlu, B. Okumuş, Şimşek, Aydemir, (2015). On-line monitoring of theaflavins and thearubigins ratio in Turkish black tea using electronic nose. *International Journal of Engineering*, 7(05), 8269.

Wu, X., Zhu, J., Wu, B., Sun, J., Dai, C. (2018). Discrimination of tea varieties using FTIR spectroscopy and allied Gustafson-Kessel clustering. *Computers and Electronics in Agriculture*, 147, 64-69.

Appendix 1:

	Tea Purchasing Center	Factory		Tea Purchasing Center	Factory
1	AKDERE VILLAGE	Pazar	216	YAYLACILAR VILLAGE	Derepazarı
2	AKKAYA VILLAGE	Pazar	217	CAGLAYAN VILLAGE	Büyükköy
3	ARICILAR VILLAGE	Çayeli	218	CAYIRLI VILLAGE	Büyükköy
4	ARMAGAN VILLAGE	Pazar	219	DULGERLI VILLAGE	Büyükköy
5	ASAGIDURAK VILLAGE	Çayeli	220	ESENDERE VILLAGE	Büyükköy
6	BAYIRCIK VILLAGE	Çayeli	221	ESENTEPE VILLAGE	Büyükköy
7	BEYAZKAYA VILLAGE	Pazar	222	FINDIKLI VILLAGE	Büyükköy
8	CIRAKLAR VILLAGE	Pazar	223	GECITLI VILLAGE	Derepazarı
9	DOGANAY VILLAGE	Çayeli	224	HURMALIK VILLAGE	Büyükköy
10	DUYGULU VILLAGE	Pazar	225	HUSEYINHOCA VILLAGE	Büyükköy
11	ESKIARMUTLUK VILLAGE	Ardeşen	226	INCI VILLAGE	Salarha
12	GUNDOGAN VILLAGE	Çayeli	227	KAYABASI VILLAGE	Büyükköy
13	GUNEY VILLAGE	Çayeli	228	ORMANLI VILLAGE	Derepazarı
14	HOSDERE VILLAGE	Pazar	229	PINARKOY VILLAGE	Salarha
15	KACKAR VILLAGE	Zihniderin	230	SEYRANTEPE VILLAGE	Büyükköy
16	KIRAZLIK VILLAGE	Çayeli	231	SOGUKSU VILLAGE	Büyükköy
17	KOPRUKOY VILLAGE	Çayeli	232	UNALAN VILLAGE	Büyükköy

18	KURTULUS VILLAGE	Pazar	233	YENIGECITLI VILLAGE	Derepazarı
19	KUCUKKOY VILLAGE	Ardeşen	234	YENIKOY VILLAGE	Büyükköy
20	MANGANEZ VILLAGE	Çayeli	235	YESILKOY VILLAGE	Büyükköy
21	ORTAALAN VILLAGE	Ardeşen	236	YOKUSLU VILLAGE	Büyükköy
22	ONDER VILLAGE	Çayeli	237	YOLBASI VILLAGE	Salarha
23	OZGUR VILLAGE	Çayeli	238	YUMURTATEPE VILLAGE	Salarha
24	PINARLI VILLAGE	Çayeli	239	AKARSU VILLAGE	Selimiye
25	PIRINCLIK VILLAGE	Pazar	240	AKPINAR VILLAGE	Selimiye
26	SERINDERE VILLAGE	Pazar	241	AKTAS VILLAGE	Selimiye
27	SESLIKAYA VILLAGE	Pazar	242	AMBARLIK VILLAGE	Pazarköy
28	SINAN VILLAGE	Çayeli	243	AYANE VILLAGE	Salarha
29	SEHITLIK VILLAGE	Çayeli	244	AZAKLIHOCA VILLAGE	Salarha
30	SENDERE VILLAGE	Ardeşen	245	BALIKCILAR VILLAGE	Selimiye
31	SENYAMAC VILLAGE	Pazar	246	BESTEPE VILLAGE	Salarha
32	SENYURT VILLAGE	Ardeşen	247	BILDIRCINKOY VILLAGE	Salarha
33	YAMACDERE VILLAGE	Pazar	248	BOGAZ VILLAGE	Selimiye
34	YAVUZ VILLAGE	Pazar	249	CAMIDAGI VILLAGE	Pazarköy
35	YENIKOY VILLAGE	Çayeli	250	CAYBASI VILLAGE	Pazarköy
36	YENIYOL VILLAGE	Ardeşen	251	CAYCILAR VILLAGE	Salarha
37	YESILTEPE VILLAGE	Pazar	252	CIMENLI VILLAGE	Pazarköy
38	YUKARIDURAK VILLAGE	Çayeli	253	DEREBASI VILLAGE	Pazarköy
39	YURTSEVER VILLAGE	Ardeşen	254	DORTYOL VILLAGE	Pazarköy
40	ZEYTINLIK VILLAGE	Pazar	255	DUZKOY VILLAGE	Salarha
41	BEHICE VILLAGE	Çayeli	256	ELMALI VILLAGE	Pazarköy
42	BOGAZICI VILLAGE	Güneysu-Ulucami	257	ERENKOY VILLAGE	Büyükköy
43	CATKOY VILLAGE	Camidağ	258	GOLGELI VILLAGE	Salarha
44	CAYIRDUZU VILLAGE	Çayeli	259	GUZELKOY VILLAGE	Pazarköy
45	DIKKAYA VILLAGE	Pazar	260	GUZELYURT VILLAGE	Pazarköy
46	GULLUKOY VILLAGE	Pazar	261	KARASU VILLAGE	Pazarköy
47	GUROLUK VILLAGE	Çayeli	262	KARAYEMIS VILLAGE	Pazarköy
48	KALE VILLAGE	Camidağ	263	KETENLI VILLAGE	Selimiye
49	KOMILO VILLAGE	Pazar	264	KIRKLARTEPESI VILLAGE	Salarha
50	KOPRUBASI VILLAGE	Pazar	265	KOCATEPE VILLAGE	Salarha
51	MEYDANKOY VILLAGE	Camidağ	266	KOPRULU VILLAGE	Pazarköy
52	MOLLAVEYIS VILLAGE	Güneysu-Ulucami	267	KURTULUS VILLAGE	Selimiye
53	ORTAKLAR VILLAGE	Camidağ	268	KUCUKCAYIR VILLAGE	Pazarköy
54	ORTANKOY VILLAGE	Güneysu-Ulucami	269	KUCUKKOY VILLAGE	Salarha
55	ORTAYAYLA VILLAGE	Camidağ	270	MELEK VILLAGE	Pazarköy
56	SIRAKOY VILLAGE	Camidağ	271	ORTAPAZAR VILLAGE	Salarha
57	SENKOY VILLAGE	Güneysu-Ulucami	272	ORNEK VILLAGE	Pazarköy
58	SENYUVA VILLAGE	Güneysu-Ulucami	273	PAZARKÖY VILLAGE	Selimiye
59	TOPLUCA VILLAGE	Çayeli	274	PEKMEZLI VILLAGE	Selimiye
60	YAYLAKOY VILLAGE	Camidağ	275	PINARBASI VILLAGE	Selimiye

61	YAZLIK VILLAGE	Camidağ	276	SELIMIYE VILLAGE	Salarha
62	YOLKIYI VILLAGE	Güneysu-Ulucami	277	SOGUKCESME VILLAGE	Salarha
63	YUKARISIMSIRLI VILLAGE	Çayeli	278	SOGUTLU VILLAGE	Selimiye
64	ZILKALE VILLAGE	Camidağ	279	SUTLUCE VILLAGE	Pazarköy
65	ABDULLAHHOCA VILLAGE	Zihniderin	280	TASKOPRU VILLAGE	Pazarköy
66	ARMUTLU VILLAGE	Cumhuriyet	281	TASLIK VILLAGE	Selimiye
67	AŞIKLAR VILLAGE	Zihniderin	282	TASPINAR VILLAGE	Selimiye
68	BASKOY VILLAGE	Veliköy	283	TEKKE VILLAGE	Pazarköy
69	BESIKCILER VILLAGE	Cumhuriyet	284	TOPKAYA VILLAGE	Salarha
70	BEYAZSU VILLAGE	Cumhuriyet	285	TUGLALI VILLAGE	Salarha
71	BUZLUPINAR VILLAGE	Veliköy	286	UZUNKOY VILLAGE	Salarha
72	CATALDERE VILLAGE	Veliköy	287	UCKAYA VILLAGE	Salarha
73	CESMELI VILLAGE	Cumhuriyet	288	VELIKOY VILLAGE	Selimiye
74	CINARTEPE VILLAGE	Zihniderin	289	YEMISLIK VILLAGE	Salarha
75	CILINGIR VILLAGE	Zihniderin	290	YENIDOGAN VILLAGE	Selimiye
76	CUKURLUHOCA VILLAGE	Veliköy	291	YENIGUZELKOY VILLAGE	Pazarköy
77	DEMIRHISAR VILLAGE	Cumhuriyet	292	YENIKALE VILLAGE	Selimiye
78	DERECIK VILLAGE	Cumhuriyet	293	YENIKASARCILAR VILLAGE	Pazarköy
79	DUZGECIT VILLAGE	Zihniderin	294	YENISELIMIYE VILLAGE	Salarha
80	ERDEMLI VILLAGE	Zihniderin	295	YESILDERE VILLAGE	Pazarköy
81	ERENLER VILLAGE	Zihniderin	296	YOLUSTU VILLAGE	Salarha
82	ESENDAG VILLAGE	Zihniderin	297	YOLVEREN VILLAGE	Pazarköy
83	GEMICILER VILLAGE	Cumhuriyet	298	ZINCIRLIKOPRU VILLAGE	Selimiye
84	GURGENLI VILLAGE	Cumhuriyet	299	AKBUCAK VILLAGE	Ambarlık
85	GURPINAR VILLAGE	Veliköy	300	AKMESCIT VILLAGE	Aşıklar
86	GUZELTEPE VILLAGE	Cumhuriyet	301	AKTAS VILLAGE	Aşıklar
87	HAREMTEPE VILLAGE	Cumhuriyet	302	AKTEPE VILLAGE	Aşıklar
88	INCESIRT VILLAGE	Cumhuriyet	303	ALCILI VILLAGE	Aşıklar
89	INCESU VILLAGE	Veliköy	304	BALIKCI VILLAGE	Aşıklar
90	KACKAR VILLAGE	Zihniderin	305	BASKOY VILLAGE	Guneysu-Ulucami
91	KAPTANPASA VILLAGE	Veliköy	306	BOGAZLI VILLAGE	Ambarlık
92	KARAAGAC VILLAGE	Cumhuriyet	307	BUCAK VILLAGE	Ambarlık
93	KEMERKOY VILLAGE	Zihniderin	308	DAGDIBI VILLAGE	Aşıklar
94	KESTANELIK VILLAGE	Zihniderin	309	DARILI VILLAGE	Aşıklar
95	KOPRUBASI VILLAGE	Zihniderin	310	DEREBASI VILLAGE	Ambarlık
96	LATIFLI VILLAGE	Zihniderin	311	DERINSU VILLAGE	Aşıklar
97	MALTEPE VILLAGE	Cumhuriyet	312	DERNEK VILLAGE	Ambarlık
98	MUSADAĞI VILLAGE	Cumhuriyet	313	ELMALIK VILLAGE	Aşıklar
99	ORMANCIK VILLAGE	Veliköy	314	GUNEY VILLAGE	Aşıklar
100	ORTAKOY VILLAGE	Cumhuriyet	315	HAMIDIYE VILLAGE	Ambarlık
101	SARISU VILLAGE	Zihniderin	316	HANDAGI VILLAGE	Ambarlık
102	SEFALI VILLAGE	Zihniderin	317	HASKOY VILLAGE	Aşıklar
103	SELIMIYE VILLAGE	Zihniderin	318	HISARLI VILLAGE	Aşıklar
104	SESLIDERE VILLAGE	Zihniderin	319	IRMAK VILLAGE	Ambarlık

105	SIRTKOY VILLAGE	Zihniderin	320	IRMAKYENIKOY VILLAGE	Ambarlık
106	SIRINKOY VILLAGE	Cumhuriyet	321	KAYAGANTAS VILLAGE	Pazar
107	UZUNDERE VILLAGE	Veliköy	322	KESIKKOPRU VILLAGE	Aşıklar
108	YAMAC VILLAGE	Zihniderin	323	KUZAYCA VILLAGE	Zihniderin
109	YANIKDAG VILLAGE	Cumhuriyet	324	MERDIVENLI VILLAGE	Aşıklar
110	YAVUZLAR VILLAGE	Zihniderin	325	ORTAIRMAK VILLAGE	Ambarlık
111	YENICE VILLAGE	Veliköy	326	ORTAYOL VILLAGE	Ambarlık
112	YENIHISAR VILLAGE	Cumhuriyet	327	ORNEK VILLAGE	Zihniderin
113	YENITEPE VILLAGE	Cumhuriyet	328	PAPATYA VILLAGE	Ambarlık
114	YESILIRMAK VILLAGE	Zihniderin	329	SAHILKOY VILLAGE	Ambarlık
115	YESILKOY VILLAGE	Cumhuriyet	330	SESSIZDERE VILLAGE	Ambarlık
116	YESILTEPE VILLAGE	Veliköy	331	SIVRIKALE VILLAGE	Aşıklar
117	YILDIZELI VILLAGE	Cumhuriyet	332	SIVRITEPE VILLAGE	Ambarlık
118	ZAFER VILLAGE	Aşıklar	333	SUBASI VILLAGE	Aşıklar
119	BAHATTINPASA VILLAGE	Derepazarı	334	SUCATI VILLAGE	Aşıklar
120	BURUCEK VILLAGE	Salarha	335	SULAK VILLAGE	Aşıklar
121	CAKMAKCILAR VILLAGE	Salarha	336	SEHITLIK VILLAGE	Pazar
122	CESME VILLAGE	Derepazarı	337	SENDERE VILLAGE	Zihniderin
123	CUKURLU VILLAGE	Salarha	338	SENTEPE VILLAGE	Ambarlık
124	ESENTEPE VILLAGE	Derepazarı	339	TEKTAS VILLAGE	Zihniderin
125	KIRAZDAGI VILLAGE	Derepazarı	340	TOPLUCA VILLAGE	Ambarlık
126	MALTEPE VILLAGE	Derepazarı	341	TUTUNCULER VILLAGE	Aşıklar
127	SANDIKTAS VILLAGE	Derepazarı	342	UGRAK VILLAGE	Ambarlık
128	UZUNKAYA VILLAGE	Salarha	343	YAVUZ VILLAGE	Aşıklar
129	YANIKTAS VILLAGE	Derepazarı	344	YEMISLI VILLAGE	Ambarlık
130	ARILI VILLAGE	Ardeşen	345	YESILKOY VILLAGE	Aşıklar
131	ASLANDERE VILLAGE	Gündoğdu	346	YUCEHISAR VILLAGE	Ambarlık
132	AVCILAR VILLAGE	Ardeşen	347	ARILI VILLAGE	Kemalpaşa
133	BEYDERE VILLAGE	Gündoğdu	348	ASAGISAHINLER VILLAGE	Kemalpaşa
134	CENNET VILLAGE	Gündoğdu	349	BALIKLI VILLAGE	Tersane
135	CAGLAYAN VILLAGE	Gündoğdu	350	BASKOY VILLAGE	Musadağı
136	CINARLI VILLAGE	Ardeşen	351	BOYUNCUK VILLAGE	Tersane
137	DERBENT VILLAGE	Gündoğdu	352	DERECIK VILLAGE	Kemalpaşa
138	DOGANAY VILLAGE	Gündoğdu	353	DEREUSTU VILLAGE	Kendirli
139	DUZKOY VILLAGE	Çiflik	354	DIKYAMAC VILLAGE	Kemalpaşa
140	GURSU VILLAGE	Ardeşen	355	DULGERLI VILLAGE	Tersane
141	HARA VILLAGE	Ardeşen	356	GUNESLI VILLAGE	Kendirli
142	IHLAMURLU VILLAGE	Gündoğdu	357	GUNGOREN VILLAGE	Kendirli
143	KARAALI VILLAGE	Ardeşen	358	GURGENCIK VILLAGE	Kendirli
144	KIYICIK VILLAGE	Kendirli	359	KAVAK VILLAGE	Kendirli
145	MEYVALI VILLAGE	Ardeşen	360	KEMERKOPRU VILLAGE	Kendirli
146	SAATKOY VILLAGE	Gündoğdu	361	KESTANEALAN VILLAGE	Kemalpaşa
147	SULAK VILLAGE	Gündoğdu	362	KIRECLIK VILLAGE	Kendirli
148	SUMER VILLAGE	Gündoğdu	363	KONAKLI VILLAGE	Kendirli
149	TEPECIK VILLAGE	Ardeşen	364	KUCUKKOY VILLAGE	Kemalpaşa
150	YAYLACILAR VILLAGE	Gündoğdu	365	ORTACALAR VILLAGE	Kemalpaşa

151	YENIKOY VILLAGE	Ardeşen	366	SIRTOBA VILLAGE	Kemalpaşa
152	YENISEHITLIK VILLAGE	Gündoğdu	367	SOGUCAK VILLAGE	Tersane
153	ASMALIIRMAK VILLAGE	Azaklı	368	SENKOY VILLAGE	Kendirli
154	BALLIDERE VILLAGE	Pazarköy	369	TEPEYURT VILLAGE	Kemalpaşa
155	BASKOY VILLAGE	Azaklı	370	ULAS VILLAGE	Kendirli
156	BULUTLU VILLAGE	Azaklı	371	ULUKENT VILLAGE	Kemalpaşa
157	CAMLICA VILLAGE	Azaklı	372	UCIRMAK VILLAGE	Tersane
158	DUMANKAYA VILLAGE	Azaklı	373	UCLER VILLAGE	Kemalpaşa
159	GUNELI VILLAGE	Azaklı	374	YILDIZLI VILLAGE	Tersane
160	GURGEN VILLAGE	Azaklı	375	YOLGECEN VILLAGE	Kendirli
161	ISLAHIYE VILLAGE	Azaklı	376	YUKARISAHINLER VILLAGE	Kemalpaşa
162	KIBLEDAGI VILLAGE	Azaklı	377	ADAGUL VILLAGE	Muratli
163	KIREMIT VILLAGE	Azaklı	378	AKPINAR VILLAGE	Çiflik
164	ORTAKOY VILLAGE	Azaklı	379	ALACA VILLAGE	Muratli
165	SELAMET VILLAGE	Azaklı	380	AMBARLI VILLAGE	Muratli
166	TEPEBASI VILLAGE	Azaklı	381	ARALIK VILLAGE	Işıklı
167	YARIMADA VILLAGE	Azaklı	382	ARKAKOY VILLAGE	Muratli
168	YENICAMI VILLAGE	Selimiye	383	ATANOGLU VILLAGE	Işıklı
169	YENIKOY VILLAGE	Azaklı	384	AVCILAR VILLAGE	Muratli
170	YESILKOY VILLAGE	Azaklı	385	BALCI VILLAGE	Muratli
171	YESILYURT VILLAGE	Pazarköy	386	BOGAZKOY VILLAGE	Arhavi
172	YUKARIISLAHIYE VILLAGE	Azaklı	387	CAMILI VILLAGE	Taşçılar
173	YUKSEKKOY VILLAGE	Pazarköy	388	CIVAN VILLAGE	Çiflik
174	AKYAMAC VILLAGE	Güneysu-Ulucami	389	CAVUSLU VILLAGE	Arhavi
175	BILENKOY VILLAGE	Güneysu-Ulucami	390	CAYLIKOY VILLAGE	Çiflik
176	CAMLITEPE VILLAGE	Güneysu-Ulucami	391	CIFTEKOPRU VILLAGE	Çiflik
177	HILAL VILLAGE	Güneysu-Ulucami	392	DEMIRCILER VILLAGE	Çiflik
178	KANTARLI VILLAGE	Güneysu-Ulucami	393	DUZENLI VILLAGE	Taşçılar
179	LEVENTKOY VILLAGE	Güneysu-Ulucami	394	DUZKOY VILLAGE	Çiflik
180	NURLUCA VILLAGE	Güneysu-Ulucami	395	EFELER VILLAGE	Taşçılar
181	YALTKAYA VILLAGE	Güneysu-Ulucami	396	FINDIKLI VILLAGE	Çiflik
182	AYVALIK VILLAGE	Melyat	397	GUNESLI VILLAGE	Arhavi
183	BALLIKOY VILLAGE	Kalkandere	398	GURESEN VILLAGE	Arhavi
184	BASKOY VILLAGE	Camidağ	399	GUZELYURT VILLAGE	Arhavi
185	BAYIRKOY VILLAGE	Melyat	400	IBRIKLI VILLAGE	Muratli
186	CEVIZLIK VILLAGE	Büyükköy	401	KALE VILLAGE	Çiflik
187	CAMLIKKOY VILLAGE	Melyat	402	KARSIKOY VILLAGE	Arhavi
188	CATALTEPE VILLAGE	Kalkandere	403	KAYADIBI VILLAGE	Arhavi
189	CICEKLI VILLAGE	Kalkandere	404	KAYALAR VILLAGE	Taşçılar
190	CIFTEKOPRU VILLAGE	Kalkandere	405	KAYNARCA VILLAGE	Işıklı
191	DEMIRKAPI VILLAGE	Melyat	406	MARALKOY VILLAGE	Taşçılar

192	DEREKOY VILLAGE	Melyat	407	ORUCULER VILLAGE	Arhavi
193	DIKTAS VILLAGE	Kalkandere	408	SEREFIYE VILLAGE	Arhavi
194	ESKICE VILLAGE	Kalkandere	409	TARAKLI VILLAGE	Muratli
195	GOLYAYLA VILLAGE	Kalkandere	410	UGURKOY VILLAGE	Taşçılar
196	GURDERE VILLAGE	Melyat	411	YESILKOY VILLAGE	Arhavi
197	GUVENKOY VILLAGE	Melyat	412	ZORLU VILLAGE	Muratli
198	IHLAMUR VILLAGE	Büyükköy	413	BALIK VILLAGE	Musadağı
199	ILICAKOY VILLAGE	Melyat	414	BASKOY VILLAGE	Musadağı
200	KAMA VILLAGE	Kalkandere	415	BASOBA VILLAGE	Musadağı
201	MESEKOY VILLAGE	Kalkandere	416	CAMLI VILLAGE	Kemalpaşa
202	ORTAKOY VILLAGE	Melyat	417	CAVUSLU VILLAGE	Musadağı
203	RUZGARLI VILLAGE	Melyat	418	CIMENLI VILLAGE	Musadağı
204	SIVRIKAYA VILLAGE	Melyat	419	ESENKIYI VILLAGE	Musadağı
205	SIMSIRLI VILLAGE	Büyükköy	420	ESMEKAYA VILLAGE	Musadağı
206	TOZKOY VILLAGE	Kalkandere	421	GUNESLI VILLAGE	Musadağı
207	TULUMPINAR VILLAGE	Melyat	422	GUVERCINLI VILLAGE	Kemalpaşa
208	YAGCILAR VILLAGE	Melyat	423	HENDEK VILLAGE	Musadağı
209	YERELMA VILLAGE	Melyat	424	VILLAGENCULAR VILLAGE	Musadağı
210	BUYUKÇİFTLİKVILLAGE VILLAGE	Derepazarı	425	PINARLI VILLAGE	Musadağı
211	ÇİFTLİK VILLAGE	Derepazarı	426	SUBASI VILLAGE	Musadağı
212	DENIZGOREN VILLAGE	Derepazarı	427	YESILKOY VILLAGE	Kemalpaşa
213	KALECIK VILLAGE	Derepazarı	428	YOLDERE VILLAGE	Musadağı
214	KOSKLU VILLAGE	Derepazarı	429	CUMHURİYET	Kirazlik
215	TASHANE VILLAGE	Derepazarı	430	SELİMİYE	Kirazlik
			431	UZUNYALI	Melyat