

Research Article

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Teaching Geography in Higher Education: A Case Study of Problem-Based Learning

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Abstract

This article aims to investigate problem-based learning in teaching geography in higher education. In addition to the main goal, the research set out to introduce a practical study that can facilitate graduate students' academic research skills. The study was conducted using action research. Findings obtained from qualitative interviews and the observations produced the following results: The reason why problem-based geography instruction has not found much room in Turkey is mostly due to extensive use of traditional teaching methods in such as lectures. As a matter of fact, the participants reported that they initially had difficulty in getting accustomed to problem-based geography instruction. The most important factor in the challenges they experienced was related to the fact that they were not used to teaching methods that are characterized by inquiry-based teaching strategies (problem-based learning, project-based learning and so forth). This study aimed not only to investigate how problem-based geography instruction can be utilized in higher education institutions and but also to support the development of graduate students' academic research skills. It essentially investigated the reasons for failure in using the water of the Kızılırmak in the Upper Kızılırmak Basin located within the borders of Sivas, a province in Middle Anatolia, for agricultural irrigation. Analysis of the interview transcripts revealed that that this process positively contributed to their self-confidence and the development of their academic research skills by taking responsibility. Their responsibilities included collecting data from primary sources in the field and secondary sources in relevant institutions and analyzing these data and interpreting the findings. This process helped them to associate theory and practice.

Keywords

Geography Instruction, Problem-Based Instruction, The Upper Kızılırmak Basin, Action Research

"The topic and content of the science of geography is the investigation of human-nature interaction" (Özçağlar, 2009, Şahin 1998). Human and economic activities are dependent on the nature. However, all human and economic activities conducted by

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people may not be compatible with the nature. In that case, human activities may cause unexpected problems in the natural environment (landslides, desertification, loss of wetlands, use of agricultural land for other purposes and so forth). Geography instruction is crucial to solve spatial problems.

Geography instruction should include little or no memorization, and it should not overwhelm students with encyclopedic and statistical information but it should guide them out of the four walls of the classroom and have them question and think analytically. One of the biggest deficiencies of geography instruction is inadequate fieldwork. Unless theoretical knowledge is supported by practice, students cannot utilize geographical information to solve spatial problems. When the most dominant activity in the geography classroom is lecturing, teacher centered teaching is utilized and learners receive information passively. When students are provided only with information, it becomes difficult for them to define spatial problems as well as collect data to develop and test hypotheses to solve these problems. In order for students to grasp the topic and content of geography, their scientific processing skills should be enhanced beyond the level of information transfer to include the dimensions of comprehension, analysis, synthesis and evaluation. Problem-based instruction as an applied approach, can be used to develop students' scientific processing skills by facilitating student research to solve problems, collect and synthesize data and approach events more realistically. In order to have students comprehend, analyze and synthesize human-nature interaction, geography classes should predominantly focus on research, discovery and inquiry. This study utilized Problem-based and inquiry-based geography teaching.

“Geography education students might be exposed to PBL because their training implies the acquisition of abilities to solve real-world situations at various geographical scales” (Aubrey & Osvaldo, 2013:432).

“As a teaching method, problem-based learning was first used in Case Western University Medical Faculty in the US in 1950. However, problem-based learning as a basic learning-teaching method was first utilized in Mc Master University Medical Faculty in Canada in the 1960s. First trials included small groups of students who were expected to make decisions about the problem and the situation” (Uslu, 2006:19).

Problem-based instruction, which was initially limited to teaching medicine was started to be used in other disciplines in time. Problem-based instruction was utilized in various fields of study including but not limited to the field of teaching medicine (Barrows, 1996), science and technology instruction (Aydoğdu, 2012; Moralar, 2012; Çınar & Aslan, 2007, İnel, 2009; Kaptan & Korkmaz 2001; Korucu, 2007; Şenocak & Taşkesenligil, 2005, Yaman & Yalçın, 2005), mathematics (Günhan 2006; Duatepe & Çilesiz 1999; Uslu, 2006; Buran, 2012, Çakır & Aztekin 2016; Yıldırım, 2016), physics (Dochy, Segers, Van den Bossche & Gijbels, 2013; Taşoğlu, 2009, Kan, 2013), chemistry (Baran, 2013; Kuzey, 2013; Merhametli, 2013; Elagöz, 2014) geography (Chatterjea & Hung, 2000; Spronken-Smith 2005; Pawson, Fournier, Haigh, Muniz, Trafford & Vajoczki, 2006; Chappell, 2006, Fournier, 2002; Aubrey & Schalk 2015; Koçak & Ünlü,

2013; Aksoy, 2004; Oban & Buldan, 2007; Yeung, 2010; Aubrey & Osvaldo, 2013;), social sciences (Spronken-Smith & Walker 2010; Karakuş, 2006), nursing (Donner & Bickley, 1993; Günüşen & Üstün, 2011) and engineering (Brodeur, Young & Blair 2002).

Although geography discipline is appropriate for interdisciplinary studies and problem-based instruction, as can be understood from the literature reviewed, the studies on problem-based instruction in the field of geography are not as common as in the fields of medicine, physics, chemistry and so on. The problem-based research in international geography field can be summarized as follows: Chatterjea and Hung (2000) claimed that problem-based instruction in their work can be successfully applied in geography lessons, and problem-based instruction practices contribute to students' knowledge of geography, social solidarity and learning skills.

Spoken-Smith (2005) has argued that since geography is suitable for interdisciplinary studies, it is possible to apply problem-based instruction practices more successfully with small groups in laboratory and field work.

“In spite of the novel and challenging nature of PBL, students in this study could obtain a satisfactory score in terms of self, peer, and teacher assessment. Improvements, however, can be made by giving them an overview of PBL procedures and their possible benefits in relation to deep thinking, and the determination of criteria for assessments” (Yeung, 2010: 197).

The most important difference between this study and other problem-based studies in teaching geography is the fact that the current study was conducted based on a problem in a manner that included the steps of problem-based learning. This study aimed to present an example about how problem-based geography instruction can be implemented in higher education institutions. In addition to this main goal, it set out to introduce a practical study that can facilitate graduate students' academic research skills (identifying the problem, developing a thesis, collecting field data, analyzing the data, testing and evaluating the hypotheses, writing up the results in an academic style by focusing on a problem.

Methodology

Research Model

Adopting a qualitative research method, this study was conducted by utilizing action research. “Action research can be defined as investigating a real classroom of school situation in order to understand or improve the quality of actions or teaching” (Hensen, 1996, Schmuck; 1997; Johnson 2014). “Action research is a systematic and organized way for teachers to observe their practices of investigate probable aspects of a problem or an action” (McNiff, Lomans and Whitehead, 1996; Johnson, 2014).

Research and practice are conducted together in action research. By utilizing action research, this study aimed to implement problem-based geography instruction on students, identify the problems experienced during implementation and practice.

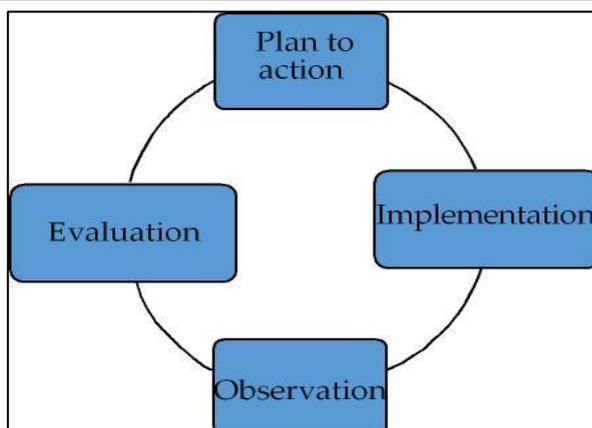


Figure 1. Action Research Cycle

The first phase of the cyclical process of action research includes planning that will guide the identification and definition of the problem. In the second phase, the plan generated by the researcher is implemented. The third phase includes the collection of data related to the process and the results. Along with data collection, observations are also recorded. Analyses may result in reorganizing the process. The process is discussed in the fourth phase by evaluating it as a whole. Action is re-planned after the evaluation and this process continues in a cyclical manner (Johnson, 2014; Köklü, 1993). (Figure 1).

Participants

The participants were graduate students studying at the Institute of Educational Sciences, and Geography Education. A total of two students selecting the course “New Orientations and Approaches in Geography Education (One is male and the other is female and both are 22 years old), were included in the study to fulfill their course obligations.

Procedure

The researcher, working in the field of geography education in the Faculty of Education of Cumhuriyet University, carried out this study within the scope of undergraduate curriculum and PBL procedures with the participant students. Guidance activities offered by the researcher to the participant students in accordance with the steps of PBL process are as follows:

Awareness of the Problem. This section provides information on the operational steps of problem-based geography instruction, researcher’ observations and the perspectives of the participants. The researcher ensured that the students comprehended the problem at this stage.

Researcher’s impressions from his observations at this phase. Students were momentarily confused. Their confusion ended when the researcher provided them with the short information provided below:

“Rivers are one of the crucial natural sources used by human beings for drinking and agricultural irrigation. When rivers are considered across Turkey, we see that Kızılırmak

has the biggest basin. Sivas, Kayseri, Nevşehir, Kırşehir, Kırıkkale, Ankara, Çankırı, Çorum and Samsun provincial borders are located in this basin (See the appendix, Figure 2).

Yamula Dam, built on the Kızılırmak which is born from Sivas and flows to the Black Sea, produces electric and it is planned to have Kızılırmak run through the city center (still in the process of project). Canoe sport is done for tourism on Kızılırmak in Nevşehir Avanos. Hirfanlı Dam in Kırşehir, Kapulukaya Dam in Kırıkkale, Kesikköprü Dam in Ankara, Obruk Dam in Çorum and Altinkaya Dam in Samsun were built on the Kızılırmak River. These dams are used for producing electricity and providing water for agricultural irrigation. Also, boat tours are organized in Şahinkaya canyon located in Kızılırmak Basin in Samsun provincial border. Although there are several projects for irrigation, energy production and tourism in the provinces, where Kızılırmak flows through, there is little or no activity in terms of using the river water for drinking, irrigation and energy production on Kızılırmak in Sivas, which houses the spot where the river is born. Sivas is the province which benefits from Kızılırmak the least among the provinces located in the borders of Kızılırmak Basin. This limitation can be seen in İmranlı (Sivas) scale. While Kızılırmak flows through Sivas in a long course, there is nothing done for tourism either and the river is not sufficiently used for irrigation. “What can be the reasons why this river is not sufficiently utilized for irrigation in İmranlı, Zara, Hafik, Sivas city center, Şarkışla and Gemerek districts especially in summer months although Kızılırmak is born from Sivas city border” (See the appendix, Kızıldağ /Figure 3).

Identification of the problem. After the researcher ensured that the students became aware of the problem, he asked the participating students to define it. Students were given a week for this task. One of the reasonable answers provided by the participants to define the problem became the slogan that was used. The slogan “Kızılırmak is flowing; Sivas is doing nothing” was unanimously accepted as the name of the problem.

Some of the titles used by participants (P1 nd P2) to define the problem are provided below:

P1. “Red Problem of Sivas” (referring to the name of the river which literally means Red River) / “Kızılırmak is flowing, Sivas is doing nothing” / “Kızılırmak is asleep in Sivas”

P2. “The Kızılırmak: The place where the heart of Sivas stops” / “Salty and red in colour, can it be so?”

“The Kızılırmak: The treasure that nobody stakes a claim to in Sivas”

Obtaining required data to solve the problem. After the researcher informed the participants as to how to obtain primary and secondary sources data and how and where to gather water, rock and soil samples, he directed them to the research field. By utilizing geographical information systems, participant students created a map of the research field and identified water, rock and soil sampling points (See appendix, Figure 4).

Students were involved in field work in October 25, 2016 to collect water, rock and soil samples from the points identified in Sivas city center, Hafik, Zara and İmranlı. Students collected water, rock and soil samples on October 28, 2016 from the identified points in Şarkışla, Gemerek and made observations in the study field (See appendix, Figure 5). With guidance from the researcher, the participants took the water samples they collected to General Directorate of State Hydraulic Works, 19th (Sivas) Regional Directorate and the soil samples to Şarkışla Soil Clinical Analysis Lab. They took the collected rock samples to Cumhuriyet University Geology Engineering Petrography Department for identification. The qualities of the rocks were determined in the Petrography Department. When the participants were involved in the secondary sources about the study field, i.e. literature review, they came across the scientific studies by Yıldız, 1995; Sönmez, 1986; Çirer, 1993; Değirmenci, 1995; Sağdıç and Koç, 2012, Arslan, Bilgil and Veske, 2016. Long term temperature and precipitation data were also obtained from Sivas Provincial Directorate of Meteorology as a secondary source of data.

Creating hypotheses to solve the problem. After the researcher gave the participants information and examples on concepts such as theory, assumption, hypothesis etc., he asked them to develop hypotheses to solve the problem. The students developed the hypotheses below under the guidance of the researcher:

Hydrological factors are effective in not benefiting from the Kızılırmak for irrigational purposes in Sivas.

Geological factors are effective in not benefiting from the Kızılırmak for irrigational purposes in Sivas province borders.

Petrological factors are effective in not benefiting from the Kızılırmak for irrigational purposes in Sivas province borders.

Climatological factors are effective in not benefiting from the Kızılırmak for irrigational purposes in Sivas province borders.

Analyzing the data and testing the hypotheses to solve the problem. At this stage, the researcher informed the participants about how to calculate and interpret the collected water samples according to Wilcox and US salinity diagrams, how to associate the collected soil samples with soil types and how to draw and interpret meteorological data according to Thornthwaite method. The participants tested their hypotheses based on the researcher's suggestions.

Hydrological factors are effective in the failure to benefit from Kızılırmak for irrigational purposes in the provincial borders of Sivas. The researcher informed the students that suitability of surface and underground water for irrigation could be displayed by presenting the chemistry analyses on diagrams. The researcher also presented an example of how to calculate this with Wilcox diagram.

As a result of calculations based on Wilcox formula, the participants arrived at the conclusion that water collected from 6th and 7th collection points during draught when

agricultural irrigation was needed the most was unsuitable for agricultural irrigation due to its chemical characteristics. The participants also concluded that chemical qualities of the water in 5th, 8th, 9th and 10th water collection points were classified as doubtful or unsuitable (See appendix, Figure 6). The participants found that chemical qualities of the water in 1st, 2nd, 3rd and 4th collection points were good or excellent (See appendix, Figure 6).

The researcher presented the participants with the formula for the US Salinity Lab Diagram and an example on how to calculate salinity using this formula. The participants found the result of $C_4 - S_2$ for the water collected from 6th and 7th collection points (See appendix, Figure 7). (Kalm Location and Cumhuriyet University Location). According to US salinity lab diagram, $C_4 - S_2$ is classified as water with high salt content that is unsuitable for irrigation. After analyzing the water samples collected from the 8th, 9th and 10th sample collection points (Çepni Location - Saraç Location - Tekmen Location), the participants arrived at the result of $C_4 - S_1$. According to US salinity lab diagram, $C_4 - S_1$ is classified as high salt-low sodium (unsuitable for irrigation).

As a result of chemical analyses of the water collected from 5th, 4th and 3rd sample collection points (Durulmuş Location - Dışkapı Location - Tödürge Location), the participants found $C_3 - S_1$ classification. According to US salinity lab diagram, $C_3 - S_1$ shows that the water has high salt content and is unsuitable for irrigating plants without drainage. The participants found $C_2 - S_1$ classification for the water collected from 1st and 2nd sample collection points (İmranlı and Kadiriye). According to US salinity lab diagram, $C_2 - S_1$ points to water with low salt and sodium content that is suitable for irrigation (See appendix, Figure 7).

Geological factors are effective in not benefiting from Kızılırmak for irrigational purposes within the provincial borders of Sivas. There are several geological units in the Upper Kızılırmak Basin (See appendix, Figure 8). The researcher provided the following information about the geological structure of the study field during this phase:

“Magmatic and metamorphic rocks, which are harder to dissolve compared to sediment rocks, exist where Kızılırmak is born (Kızıldağ), between İmranlı and Zara and around Köseadağ. Ophiolite rocks are rich in magnesium (Mg), iron (Fe), calcium (Ca), aluminum (Al) combinational minerals, whereas metamorphic rocks are rich in sodium (Na), potassium (K), aluminum (Al), iron (Fe) and magnesium (Mg) silicate minerals. Volcanites found in the field from the Eocene era (basalt and andesite type) are rich in sodium (Na), calcium (Ca), aluminum (Al), iron (Fe) and magnesium (Mg) silicate minerals. “In the field where these rock types are found, water has low lime and salt content and can be drunk but sometimes the water is sourish and acrid due to very high Na and K content” (Sönmez 1986 :38). This geological unit of the study field has made the running water in the area suitable for irrigation.

Since the basin that the river goes through Hafik and Zara districts is formed of gypsum and limestone series, the dominant anion in the water is sulphate and the dominant cation is calcium mineral. High calcium is observed in water fed with limestone, whereas high

sulphate content is observed in rivers that flow through gypsum series. Sulphate is one of the most important ions that mix to water with natural ways. Anhydride (CaSO_4) and rock salt (NaCl) are also found in the mixture of rocks in Hafik district in addition to gypsum, an evaporite mineral ($\text{CaSO}_4+2\text{H}_2\text{O}$). These minerals have an ionic cage and easily dissolve upon contact with water. In this case, water quality can easily degenerate in settings where rock types created by minerals from gypsum rocks are dominant. The surface where evaporite group minerals dissolve naturally becomes dirty. Large part of the surface water around Sivas is salty and bitter water with very high total amounts of ion dissolved as a result of Hafik formation gypsum.

The participant graduate students made the following comments based on figure 8 and the researcher's explanation:

“High sulphate values in Hafik, Sivas central district, is related to salt and gypsum beds in the area. The fact that the southern part of the Kızılırmak Basin is composed of rocks with salt and gypsum and the southern branches that feed the river flows through these salt and gypsum beds has made the water of Kızılırmak calciferous and salty. High amounts of lime and salt have damaged water quality. Therefore, although it starts with a very low amount of ion at the point where it springs, Kızılırmak has increased sulphate ratios in the water especially in the 5th, 6th, 7th, 8th, 9th and 10th sample collection points due to passing through gypsum land in İmranlı District where gypsum dissolves and mixes with the water. Rivers that flow along a specific gradient dissolve and carry the minerals included in the rocks and soils along the river bed with corrosion based on the geological and petrological qualities of the land. Chemical characteristics of rivers change as a result of mixing with the characteristics of the rocks and soil of the area where they flow through. In addition to abrasion of rivers, the resistance of rocks is effective in changing the chemical qualities of rivers. Like every other river that has been affected from the regions it passes through, the Kızılırmak is also affected from the geological qualities of the Upper Kızılırmak Basin, where it is located”.

Paedology factors are effective in the failure to benefit from the Kızılırmak for irrigational purposes in the provincial borders of Sivas. The researcher provided the following information about the paedology structure of the study field during this phase of the process: “Based on the results obtained from the lab analysis of soil samples taken from the study field, soil in the study area (Tekmen Location, Saraç Village Location, Kalın Location, Dışkapı Village Location) is good or of medium quality in terms of organic substances. On the other hand, the amount of organic substance is rather low in Çepni Location, Cumhuriyet University Location, Durulmuş Village Location, Tödürge Village Location, Zara Location and İmranlı Dam Location (Table 1). Since brown forest soil and brown soil are rich in lime, pH analysis of the soil samples collected from the study area shows that all soil samples other than the sample collected from İmranlı Dam Location has light alkali (Table 1). It is noteworthy that the soil is rich in lime and salt in almost all soil samples (other than Zara and İmranlı locations) collected from the study field (Table 1). Also, soil samples were found to have high potassium (K) values, whereas their phosphorus (P) values were low. It is difficult for plants to benefit

from phosphorus in soil rich in lime and high in pH. Results from soil analyses show that high salt and lime as well as low organic substances in all points may have affected the amount of phosphorus in the soil.”

Table 1

The Results for the Analysis of the Upper Kızılırmak Basin Soil

| Location | pH | %Total Salt | Lime (CaCO ₃) | Organic Substance | Phosphorus (P) | Potassium (K) |
|-----------------------|--------------|-------------|---------------------------|-------------------|----------------|---------------|
| İmranlı Dam Exit | Light Acid | Very Salty | Medium cretaceous | Little | Very Little | High |
| Zara Exit | Light Alkali | Very Salty | Medium cretaceous | Little | Little | High |
| Tödürge | Light Alkali | Very Salty | Cretaceous | Little | Very little | High |
| Dışkapı | Light Alkali | Very Salty | Cretaceous | Medium | Very little | Medium |
| Durulmuş | Light Alkali | Very Salty | Cretaceous | Very little | Very little | Sufficient |
| Cumhuriyet University | Light Alkali | Very Salty | Highly Cretaceous | Very little | Very little | Medium |
| Kalın | Light Alkali | Very Salty | Highly Cretaceous | Good | Very little | High |
| Saraç | Light Alkali | Very Salty | Highly Cretaceous | Good | Little | High |
| Çepni | Light Alkali | Very Salty | Cretaceous | Little | Little | High |
| Tekmen | Light Alkali | Very Salty | Highly Cretaceous | Medium | High | High |

The participant graduate students made the following comments in the direction of Figure 8, field observations and the researcher's explanation: “Insufficient precipitation and high evaporation especially in arid and semi-arid climate zones, lack of drainage, agricultural operations and soil characteristics are the main reasons for salinity that affect large areas. Upper Kızılırmak Basin is located in a semi-arid climate zone as well and covered with gypsum series based on its basin geology; so therefore river water is generally salty and there are drainage and aridity problems in the bottom land. Salt and lime accumulation were observed when soil samples were taken. High salt and lime values in the soil make Kızılırmak water to have high salinity and lime. Also, as a result of large areas covered with reddish soil in the Upper Kızılırmak Basin causes the river run red due to erosion”.

Climatological factors are effective in the failure to benefit from Kızılırmak for irrigational purposes in the provincial borders of Sivas. In this phase of problem-based geography instruction, the researcher provided information on the climatological characteristics of the study field and how to use the Thornthwaite method in drawings: "Drought is defined as a natural phenomenon that causes negative impact on land and water resources and creates disruptions in the hydrological balance as a result of lower than average precipitation levels” (Türkeş, 2012, p.19). Wilhite and Glantz (1985) classified drought in four groups as “meteorological draught, agricultural draught, hydrological draught and socio-economic draught.” It is very important to make use of

both underground and surface waters for agricultural irrigation during times of draught. Several climate classification systems are used such as Erinc and Thornthwaite in order to determine the spread and duration of arid periods. In this context, the tables and graphics of the metrological stations located in Upper Kızılırmak Basin were prepared according to Thornthwaite climate classification system. According to Thornthwaite method, İmranlı has low humidity, is micro-thermal, rather warm, has severe water shortage during summer (shortage of soil humidity), water surplus is medium in the winter and has a climate close to ocean impact. Zara, Hafik and Sivas have low humidity and are meso thermal with medium water surplus in winter and have a climate close to ocean impact. Şarkışla has low humidity, is meso thermal and has a climate close to ocean impact” (See appendix, Figure 9, 10, 11, 12).

The participant graduate students made the following comments based on Figure 9, 10, 11, 12, and the researcher's explanation:

“Summer aridity is prominent in all the meteorological stations located in İmranlı, Zara, Hafik, Sivas city center, and Şarkışla in the Upper Kızılırmak Basin. There is a dire need for agricultural irrigation due to aridity. Since there is no sufficient precipitation in the Kızılırmak and its branches during the summer months, salinity in the river increases rather than decrease. Increased amounts of salt result in the inability to sufficiently use the river water for agricultural irrigation. Increases in water use in the summer months along with a decrease in rain lead to a critical increase in drought temperatures in the region”.

Wrapping up the problem and proposing solutions. In this part of the research, the causes of the problem were identified and solutions were developed with the guidance of the researcher.

“In order to decide whether the Kızılırmak water can be used for agricultural irrigation from its source to Sivas – the provincial border of Kayseri; water analysis results were transferred over to Wilcox and US salinity diagram. According to Wilcox diagram method; the chemical characteristics of the water collected from the 6th and 7th water collection points displayed water with high salt content unsuitable for irrigation, chemical characteristics of the water collected from the remaining 5th, 8th, 9th and 10th water sample collection points were doubtful or unsuitable. Evaluating the results based on US salinity method shows that water samples were classified as C₄ S₁, C₄ S₂ and C₃ S₁. According to US salinity diagram, the chemical characteristics of the water samples collected from the 6th and 7th collection points were classified as C₄ S₂. The water in these groups are very salty with less sodium and unsuitable for irrigation in terms of salinity.

Since a large part of the basin from Zara to the provincial border of Kayseri is composed of gypsum series, dissolved ion amount is high in the water. This fact causes the water to become very salty and bitter. Rich lime and salt values as a result of the climate and main rock factors in the Upper Kızılırmak Basin has caused the water of the Kızılırmak to be rich in salt and lime. It is also the reason why the river runs red. Water balance sheet tables prepared according to Thornthwait method display the need for

agricultural irrigation in the Upper Kızılırmak Basin due to drought. Since there is not sufficient rain during the summer months, salt in the river water cannot thin and salt content increases. Increased levels of salt make it highly unlikely to benefit from Kızılırmak water for irrigational purposes during summer months in the area from Hafik to Gemerek”.

Proposals. Bio-technical studies may be encouraged in the Upper Kızılırmak Basin to generate new types of plants that are resistant to water. Small scale treatment systems (membrane water tankers) can be used on Kızılırmak especially after the borders of Hafik district to decrease salinity values of water. The water whose salinity values are decreased in tankers can be used for irrigation. It could be useful to make floating islands composed of water and salt resistant plants on the Kızılırmak to test how to decrease values. In this manner, a more aesthetical outlook can be created on Kızılırmak and Upper Kızılırmak water, which can be used both for agricultural irrigation and for landscape by decreasing the salinity value of the water”.

Data Collection

During implementation of problem-based instruction, data were directly collected from the field by sampling method. Also, the researcher observed graduate students during problem-based instruction in action research process and reflected on his impressions. Additionally, the researcher interviewed graduate students at certain intervals by using semi-structured questions. Questions used in interviews are as follows:

a. What kind of problems did you experience during the phase of problem identification and how did you overcome these difficulties?

b. What kind of problems did you experience during the data collection process and how did you overcome these difficulties?

c. What can you tell about the concepts such as hypothesis, theory and prediction? What did you learn about these concepts during problem-based geography instruction process?

d. What can you tell about the difficulties and your experiences during hypothesis testing?

e. How did problem-based learning affect your perspective of geography and your geographical knowledge?

f. What kind of differences did you observe between your awareness about and knowledge of the Kızılırmak and Sivas before and after you were involved in the problem-based learning process?

These research questions created based on the literature were confirmed by three experts in the field of geography apart from the researcher. In line with the opinions of the experts, similar questions were removed and questions that were initially 10 in number were reduced to six.

With respect to the validity and reliability of qualitative studies, not only use of methods that will increase data diversity such as interviewing and observation but also auditability of every process is important (Silverman 2009). Therefore, comprehensive

data from different sources were collected in this study. In addition, each step of the process is discussed in detail. Moreover, the direct quotations from the participants helped increase the credibility of the data presented in the present study.

Data Analysis

The data obtained from interviews were analyzed with the help of content analysis method and interpreted descriptively. Credibility of the findings was ensured by spending quite a lot of time in the environment and collect data from different sources to ensure triangulation.

Findings

The observations of the researcher and the opinions of the participant graduate students on PBL process were reported in this part of the research. After the process of problem identification was completed, the researcher asked the participants the following question:

What Kind of Problems did You Experience during the Phase of Problem Identification and how did You Overcome These Difficulties?

Some statements are provided below:

P1. "I felt foreign to the educational system you used in the process of defining and naming the problem and had great difficulty at first since I have always received a different type of education from my previous teachers. We had to perceive the content and philosophy of problem-based instruction which you were trying to help us get accustomed to". Researcher: What kind of a difference? Can you elaborate on this?

P1. "Both in my high school and undergraduate years, my previous Geography teachers lectured us. We listened to our teachers and took notes. We were given no responsibilities whatsoever. Our teachers neither gave us a problem to define, nor did they ask us to collect data and analyze them. During this process, when you wanted us to define the problem and think analytically, I did not know what to do. With the habit of my past educational experiences, I directed the question you asked me to my other geography teachers when I left the classroom. I mean, instead of researching and defining the problem, I wanted to get it ready from someone else due to my past habits. It was not easy for me to break them." Researcher: What were the main instructional delivery methods employed by your previous teachers?

P1. "I had difficulty to grasp the scale of the problem because the Kızılırmak, which we limited as the problem, is a river one end of which starts in Sivas and the other reaches to Samsun. I can state that the size of the area was the biggest problem I encountered during the problem identification process. I solved this problem by examining and learning the philosophy of problem-based instruction method. Also, minimizing and scaling the area helped me solve this issue." Following the completion of data collection, the researcher asked the following question to the students:

What Kind of Problems did You Experience during the Data Collection Process and How Did You Overcome These Difficulties?

Responses of some of the participants are given below:

P2. "During data collection process, it was necessary decide on what state institutions we needed to contact after the problem was defined. Since the problem was related with water and the Kızılırmak Basin, we started by contacting the Directorate for State Hydraulic Works. However, the personnel in this institution regarded sharing data as a problem and tended not to help us. We had problems in data sharing among the institutions. I solved this problem with the help of an official letter I took from Cumhuriyet University Directorate of Educational Sciences Institute. However, it took a long time for me to take this letter and collect the data from other institutions".

P1. "Until I came across problem-based geography instruction process, I had never been to the field and collected samples. I had never made observations and done interviews to solve a problem. They were the firsts in my life. Again, in the same vein, I had no idea or experience about primary and secondary data sources. I received information about these during problem-based geography instruction. This process gave me an identity that does research, asks questions and makes inquires". Researcher: you stated that this process gave you an identity that does research, asks questions and make inquires. Can you give an example?

P1. "For instance, while we were collecting water samples, I saw that the water ran red at the location where the Fadlım Creek met Kızılırmak. I sought answers to the question why the river ran red. With the help of problem-based instruction, I found the answer as well. I observed that reddish brown soil took a large part along the Upper Kızılırmak Basin. As a result of erosion caused by floods and gully erosions, this type of soil causes Kızılırmak to run red".

Impression of the researcher at this stage from his observations. My students were foreign to teaching strategies that utilized research and investigation. I solved this problem by guiding them to collect primary source data and directing them to secondary data sources. After the hypothesis production stage of problem-based geography instruction was completed, the researcher asked the participants the following question:

What can You Tell about the Concepts Such As Hypothesis, Theory and Prediction? What did You Learn about These Concepts during This Experience?

Responses of some of the participants are given below:

P2. "I had learned the concepts of hypothesis and theory in my thesis; however, this experience helped me to learn these concepts in clearer manner with implementation".

P1. "I had already known these concepts with the help of books on scientific research methods. However, I realized that I had some misconceptions on these topics during the

problem-based geography instruction.” After data analysis and hypothesis testing parts of process was completed, the researcher asked the the participants the following question:

What can You Tell Me about the Difficulties and Your Experiences during Hypothesis Testing?

Some student remarks are as follows:

P1. “Since the number of hypotheses identified to solve the problem was more than one, at first there was confusion as to which one to start with. I felt the need to talk with the field experts to get their opinions. The experience I gained as a result of my discussion with the experts, I started my task by testing the hydrological characteristics. However, it was not easy for me to express the data in a scientific style. This process gave me a serious responsibility. When you asked me a question about my ideas during the period in which I was not able to write down the process, this responsibility turned into psychological pressure. But your guidance and support to make connections not only helped me to overcome the pressure but also gain self-confidence”.

P2. “In the phase of testing the hypotheses and scholarly writing, we needed to have detailed academic knowledge especially in geology, pedology and climatology. I realized that the information I had learned during my undergraduate training was very superficial and thus insufficient. I even thought of quitting my graduate studies. However, when I tried the steps of “research, examine, analyze, evaluate and synthesize” in the face of this problem, I was able to express my opinions even on topics I did not know much about. During the process I also realized that unless people are not deeply pulled into the problem, they will not be able to make progress”.

Impression of the researcher in this stage. As the participants tested the hypotheses and developed their academic research skills, their self-confidence increased. Following the completion of finalizing the problem and presenting the proposals for solution during problem-based geography instruction, the researcher asked the the participants the following question:

How did Problem-Based Learning Contribute to Your Perspective of Geography and Your Geographical Knowledge?

P2. “I have realized that analytical thinking and critical approach exist in problem-based instruction. The systematic study of geography includes disintegration, comparison and causality. Operational steps of problem-based learning are highly useful to present the cause-effect relationships of geography. For instance, when I went to the study field, examined the causes of an event and created cause-effect relationships, I highly benefited from the operational steps of problem-based learning.”

P1. “Problem-based learning essentially includes practice and involves hands-on-learning. Since geography examined the interactions between natural environment and men, I was able to observe and examine a natural phenomenon in its location. Hence, I had hands-on learning experience in a natural environment. I had the experience of analyzing the events and explore cause-effect relationship”.

What Kind of Differences did You Observe between Your Awareness About and Knowledge of The Kızılırmak and Sivas before and after You Were Involved in Problem-Based Learning Process?

P2. “Before this experience, I thought that algaeas were responsible from the red color of Kızılırmak. Again, in the same vein, I believed that the reason why farmers in Sivas did not use the river water for irrigation depended on the bed depth of the basin and the distance instead of the chemical qualities of water. However, with the help of problem-based geography instruction, I became aware that use of Kızılırmak water in agriculture was problematic and the issue was more complicated than I thought as some chemistry was involved. During the process I learned that geological, pedological and climatological factors directly played a significant role in the salinity levels of the water in the Kızılırmak. I learned via this method that this river is not used much in irrigation due to reasons based on its high salinity.”

P1. “The information I had on the Kızılırmak before problem-based geography instruction experience was similar to that of a geography teacher. I had no specific awareness. However, during this experience, my knowledge and awareness immensely increased since I took part in all the phases of problem identification, data collection and analysis, interpretation and evaluation. I can even say that I have self confidence and competence to conduct a scientific study on the topic.”

Result and Discussion

The results below were obtained from findings gathered in the light of the participants' statements and researcher's observations of the graduate students:

Problem-based geography instruction that focused on a problem was highly effective since scientific thinking and research skills such as writing hypotheses, collecting data to test hypotheses, analyzing the collected data, evaluating the results and developing solutions were provided in combination without discrepancies between theory and practice.

This study has contributed positively to the development of communication, critical thinking and inquiry skills of graduate students in the adaptation of team work. This result coincides with the results of the study carried out by Chatterjea & Hung (2000).

The reason why problem-based geography instruction has not sufficiently developed in Turkey is related to the fact that traditional teaching methods such as lectures and presentations are dominantly used in high schools and universities, where the main teaching method in geography is the use of presentations (Yaşar & Şeremet 2010, Tomal 2004, Turan 2004, Artvinli, Kılıcaslan and Bulut, 2003). As a matter of fact, students in the study expressed that they initially had difficulty in adjusting to problem-based geography instruction. The most significant factor in this hardship was related to the fact that they were foreign to teaching methods suitable for teaching via research and discovery (problem-based learning, project based learning).

This study was conducted to present an example on how to use problem-based geography instruction in higher education institutions and to increase the usability of this

method in teaching geography. It also investigated the reasons why Kızılırmak water cannot be used for irrigational purposes in the Upper Kızılırmak Basin in Sivas provincial borders. Some solutions were suggested in the study. The participants' statements show that this process had positive contributions to the development of self-confidence and academic writing skills. A similar result was reported in the studies conducted by several other researchers (Aubrey & Osvaldo, 2013; Chatterjea & Hung, 2000; Yeung, 2010).

The participants took responsibility in this study which can be listed as collecting data from primary and secondary sources, analyzing the findings and interpreting the analyzed results in an academic manner. This process helped students to associate theory and practice. They expressed that theoretical knowledge is highly beneficial during implementation and problem-based geography instruction is highly useful in testing the validity of theoretical knowledge.

As can be gleaned from participant students' statements, geography is a discipline that helps students to comprehend/understand what is going on around them and develop an understanding as to how to solve spatial problems (analysis, synthesis, evaluation) generated as a result of humans interacting with the environment. "Geography, by its very nature, is interdisciplinary and a course such as research methods is well suited to a PBL approach" (Spronken-Smith 2005:217).

In this respect, students need to have scientific processing skills at the level of analysis, synthesis and evaluation so they can comprehend the interactions between nature and men, which is the essence of geography. This teaching process highly contributed to students' acquisition of scientific research skills.

If we want students to take primary responsibility in determining the problems that exist in different geographies and at various scales and in producing suggestions for solutions, PBL should be included frequently in geography education. The graduate students who participated in this study also took active responsibilities to identify the real-life problem in the Upper Kızılırmak Basin and in producing suggestions for solutions. This was supported by Aubrey & Osvaldo (2013).

"A Sample Study for Problem-based Geography instruction: Inadequate Utilizing of the Kızılırmak River for Irrigation" is a problem-based study that combined theory and practice. In this respect, it is different from other Problem-based Geography instruction studies previously conducted in Turkey (Kocak ve Unlu 2013, Aksoy 2004, Oban ve Buldan 2007).

Since conducted using an action research, this study differs from international studies, such as Pawson, et. al., 2006, Chatterjea & Hung, 2000; Spronken-Smith, 2005 and from national studies such as Koçak & Ünlü, 2013; Aksoy, 2004; Oban & Buldan, 2007 in geography education.

As can be gleaned from the literature, problem-based instruction method has not received widespread recognition in Turkey, especially in geography instruction. In Turkey, problem-based learning is dominantly used in fields such as medicine and

teaching science. Usability of this method in social sciences is rather limited. This study provides theory and implementation steps in combination. With this aspect, the study is expected to present a model in problem-based geography instruction.

This study was conducted in small groups and as a field study. It is understood from the statements of the participants that PBL contributed positively to hypothesis writing, hypothesis testing, scientific thinking and writing skills of the participants. The result shows consistency with the results of the study conducted by Spoken _ Smith (2005).

Suggestions

This study mostly focused on student impressions of problem-based instruction process. It is believed that quantitative aspects of the study should also be investigated. This study was conducted with the participation of graduate students. Similar studies can be implemented with secondary level students as well to investigate their impressions on problem-based instruction process. This research can only be generalized in the context of the research area where the study was conducted and the participants involved in the research. However, it is possible to say that this study will contribute to geography education in Turkey and in the international area.

References

- Artvinli, E. & Kılıçaslan, A., Bulut, İ. (2003). An Evaluation as Students' View on Effective Teaching and Instructional Methods Skills of the Geography Teachers in High Schools in Trabzon. *Doğu Coğrafya Dergisi*, 8 (10), pp. 21-41.
- Aubrey G. & Osvaldo A. M. (2013). Are South African Geography education students ready for problem-based learning? *Journal of Geography in Higher Education*, 37(3), pp. 432-455, DOI: 10.1080/03098265.2013.794332
- Aubrey, G. & Schalk R. (2015). Problem-Based Learning to Foster Deep Learning in Preservice Geography Teacher Education, *Journal of Geography*, 114(2), pp. 58-68, DOI: 10.1080/00221341.2014.894110
- Aksoy B. (2004). *Problem-based learning approach in geography learning*. (Unpublished Doctoral Thesis), Gazi University Institute of Educational Sciences, Retrieved from <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>
- Arslan, O. Bilgil, A. and Veske, O. (2016). Kızılırmak Basin's Meteorological Draught Analysis via Standard Pluvial Index Method. *Ömer Halisdemir University Journal of Engineering Sciences*, 5(2), 188-194.
- Aydoğdu, C. (2012). Effects of Problem-based Learning approach in teaching the topics of electrolysis and battery. *Hacettepe University Faculty of Education Journal*, 42(42):48-59.
- Baran, M. (2013). *Effects of Problem-based and Context Based Learning in teaching the Topic of Thermodynamics*. (Unpublished Doctoral Thesis), Atatürk University Institute of Educational Sciences, Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>
- Barrows, H.S (1996). Problem-based Learning in Medicine and Beyond: A Concise Overview. *New Methods for Teaching and Learning*, (68), pp.3-12.

- Buran, O. (2012). *Impact of problem-based instruction method on 8th graders' academic achievement while teaching first degree equations with one unknown and identity*, (Unpublished Master's Thesis). Atatürk University Institute of Educational Sciences, Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>
- Brodeur, D. R. Young, P. W. & Blair, K. B. (2002). Problem-based learning in aerospace engineering education. In *Proceedings of the 2002 American Society for Engineering Education Annual Conference and Exposition*, (pp. 16-19), Montreal, Canada.
- Chappell, A. (2006). Using the “grieving” process and learning journals to evaluate students' responses to problem-based learning in an undergraduate geography curriculum. *Journal of Geography in Higher Education* 30 (1): 15–31.
- Chatterjea, K., & Hung, C. C. (2000). Problem-based learning within traditional university geography courses: A learning experience. *Proceedings of the 2nd Asia-Pacific conference on problem-based learning*, Singapore, 4–7 December.
- Çakır, S. & Aztekin, S. (2016). Effects of Problem-based Learning Method on Student Motivation and math Anxiety Level in Math Classes. *Abant İzzet Baysal University Education Faculty Journal*, 16(2), 377-398.
- Çirer, F. (1993). *Investigating Sivas City Drinking Water Parameters*, (Unpublished Master's Thesis), Cumhuriyet University, Institute of Science, Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>
- Çınar D & Aslan, I. (2007). Effects of utilizing problem-based learning approach in primary school science teaching on higher thinking skills and academic risk taking level, *Journal of Educational Sciences Research, International E- Journal*, 3(2):21-34.
- Değirmenci, M. (1995). Pollution of the Section of Kızılırmak in the Vicinity of Sivas with Natural and Urban Water, *Cumhuriyet University Journal of Environment Department*, 8, pp.1-12.
- Donner, R.S & Bickley, H. (1993). Problem-based learning in teaching American medicine: a general overview. *Medical Library Association Bulletin*, 81 (3), 294.
- Dochy, F. Sergers, M. Vanden Bossche, P. & Gijbels, D. (2013). Effects of problem-based learning: A metaanalysis. *Learning and instruction*, 13(5), pp. 533 – 568.
- Duatepe, A. & Çilesiz, S. (1999). Development of Mathematical Attitude Scale. *Hacettepe University Journal of Educational Sciences*, 16 (16), pp. 45-52.
- Elagöz, E. (2014). *Teaching the Concepts of Enthalpy via Problem-based instruction Approach*, (Unpublished Master's Thesis). Atatürk University Institute of Educational Sciences, Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>
- Fournier, E. J. (2002). World regional geography and problem-based learning: using collaborative learning groups in an introductory-level world geography course, *Journal of General Education*, 51(4), pp. 293–305.
- Günüşen, N. & Üstün, B. (2011). The Relationship between Nursing Students' Problem Solving Skill Levels and Locus of Control. *Dokuz Eylül Üniversitesi Hemşirelik Yüksekokulu Dergisi*, 4 (2), 72-77
-

- Günhan, B.C. (2006). A Study on the Applicability of Problem-based Learning in Math Classes in Primary School Second Level. Dokuz Eylül University Institute of Educational Sciences (Unpublished Doctoral Thesis). Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>
- Hensen, K.T. (1996). Teachers as researchers. In J. Sikula (Ed), *Handbook of research on teacher education* (2nd ed., pp.53-66). New York: Macmillan.
- İnel, D. (2009). *Effects of Using Problem-based Learning Methods in Science and Technology Classes on Student Conceptions of Concept Structuring Levels, Academic Achievement and Inquiry Learning Skills*. Dokuz Eylül University of Educational Sciences, (Unpublished Master's Thesis), Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>
- Johnson, A.P. (2014). *Action Research Handbook* (Y. and ve M. Özten Anay, translation). Ankara: Anı Publishing.
- Kaptan, F. and Korkmaz, H. (2001). Problem-based learning approach in science teaching. *Hacettepe University Faculty of Education Journal*, 20 (20):185-192.
- Karakuş, U. (2006). Practicing Problem-based Learning Approach in Social Science Classes. *Ahi Evran University Kırşehir Faculty of Education Journal*, 7(2):163-176.
- Kan, S. (2013). *Assessment of Project Based and Problem-based Learning Practices in Teaching Physics*. Karadeniz Teknik University Institute of Educational Sciences, (Unpublished Doctoral Thesis). Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>
- Koçak, M. & Ünlü, M. (2013). Effects of using problem-based learning approach in teaching geography on student performance and motivation, *Marmara Coğrafya Dergisi*, Issue 28, pp. 526 – 543.
- Korucu, E. (2007). *Effects of Problem-based instruction and Cooperative Learning Methods on Primary School Students' Achievement*. Selçuk University Institute of Science, (Unpublished Master's Thesis), Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>
- Köklü, N. (1993). Action Research. *Ankara University Faculty of Education Journal*, 26 (2), 357-366.
- Kuzey, B. (2013). *Investigating the Effectiveness of Problem-based instruction Model while to Teach the topic of "Chemical Kinetics"*, Atatürk University Institute of Science, (Unpublished Master's Thesis). Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>
- McNiff, J. Lomax, P. and Whitehead, J. (1996). *You and your action research project*. New York: Routledge.
- Merhametli, R. (2013). *Adapting Problem-based Teachnig Model to teach the topic of "Surface Tension": An Experimental Study*, Atatürk University Institute of Educational Sciences, (Unpublished Master Thesis), Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>
- Moralır. A. (2012). *Effects of using Problem-based Learning Approach in Teaching Science on Academic Achievement, Attitude and Motivation*. Trakya University Institute of Science,

(Unpublished Master Thesis). Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>

- Oban, R. & Buldan, I. (2007). An Application Approach in Problem-based Learning and Geography, *Selçuk University, Faculty of Arts and Sciences Journal, Issue: 17*, 231-244
- Özçağlar, A. (2009). *Introduction to Geography*, Umit Ofset Printing, Ankara.
- Pawson, E. Fournier, E. Haigh, M. Muniz, O. Trafford, J. & Vajoczki, S. (2006). Problem-based learning in geography: Towards a critical assessment of its purposes, benefits and risks. *Journal of Geography in Higher Education*, 30 (1), 103-116.
- Sağdıç, M. and Koç, H. (2012). Climate in Upper Kızılırmak Basin. *Journal of Turkish Geography, Issue: 58*, pp. 1-20.
- Silverman D. (2009). *Doing Qualitative Research* 3rd ed. Newbury Park, London: SAGE Publiction Ltd.
- Spronken-Smith, R. & Walker R. (2010). Can inquiry-based learning strengthen the links between teaching and disciplinary research? *Studies in Higher Education*, 35:6, 723-740, DOI: 10.1080/03075070903315502
- Spronken –Smith R. (2005). Implementing a Problem-Based Learning Approach for Teaching Research Methods in Geography, *Journal of Geography in Higher Education*, 29 (2): 203-221, DOI: 10.1080/03098260500130403
- Sönmez, H.Y. (1986). *Impacts that Create Hardness and Salinity in Kızılırmak from Its Source to Sivas and Solutions*, Cumhuriyet University Institute of Science, (Unpublished Master's Thesis). Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>
- Şahin C. (1998). *Introduction to Geography*, Gündüz Education and Publishing, Ankara.
- Şenocak, E. & Taşkesenligil Y. (2005). Problem-based Learning and Its Applicability in Teaching Science, *Kastamonu Journal of Education*, 13(2):359-367.
- Taşoğlu, A. (2009). *Effects of Using Problem-based Learning in Teaching Physics on Students' Achievement, Scientific Processing skills and Problem Solving Attitudes*, Dokuz Eylül University Institute of Educational Sciences, (Unpublished Master's Thesis). Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>
- Tomal, N. (2004). Lise Coğrafya Öğretmenlerimizin Kullandıkları Öğretim Yöntemleri, *Milli Eğitim Dergisi, Issue 162*, Retrieved from: https://dhgm.meb.gov.tr/yayimlar/dergiler/Milli_Egitim_Dergisi/162/162-icindekiler.htm
- Türkeş, M. (2012). Observed and Foreseen Climate Change in Turkey, Draught and Desertification, *Ankara University Journal of Environmental Sciences*, 4(2):1-32.
- Uslu, G. (2006). *Effects of Using Problem-based Learning in Secondary School Mathematics Classes on Students' Attitudes Towards Classes, Academic Achievement and Permanence of Lessons*, Balıkesir University Institute of Science, (Unpublished Master's Thesis), Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>
- Wilhite, D.A. & Glantz, M.H. (1985). "Understanding the drought phenomenon: The role of definitions", *Water International*, 10 (3): 111-120.

Yaman, S. & Yalçın, N. (2005). Effects of using problem-based learning approach in teaching science on creative thinking skills. *Primary Online*, 4 (1):229-236.

Yaşar O. and Şeremet M. (2010). Yükseköğretim coğrafya eğitiminde kullanılan öğretim yöntemleri ve materyallerinin bazı değişkenlere göre incelenmesi, *Uluslararası İnsan Bilimleri Dergisi*, 7(1): 675-701.

Yıldırım, Y. (2016). *Effects of Using Problem-based instruction Method to Teach Linear Equation Graphics on Secondary School Third Grade Students' Academic Achievement*, Atatürk University Institute of Educational Sciences, (Unpublished Master's Thesis), Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>

Yıldız, E. (1995). *Investigating Water Pollution of Kızılırmak (between İmranlı- Kalın)*, Cumhuriyet University Institute of Science, (Unpublished Master's Thesis), Retrieved from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>

Yeung S. (2010). Problem-Based Learning for Promoting Student Learning in High School Geography, *Journal of Geography*, 109 (5): 190-200.

Biographical Statement

Dr. Hakan KOÇ is an associate professor at the Faculty of Education, Cumhuriyet University, Sivas, Turkey. His work focuses on problem-based learning in geography instruction, map skills, mind maps, map education for children.

Appendix

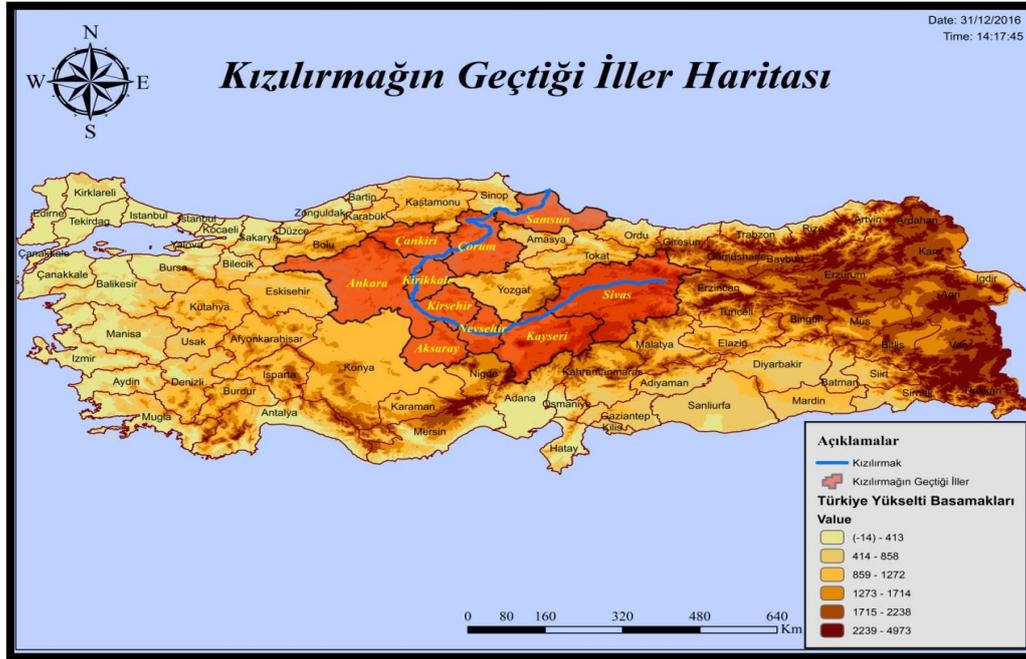


Figure 2. The Kızılırmak Basin

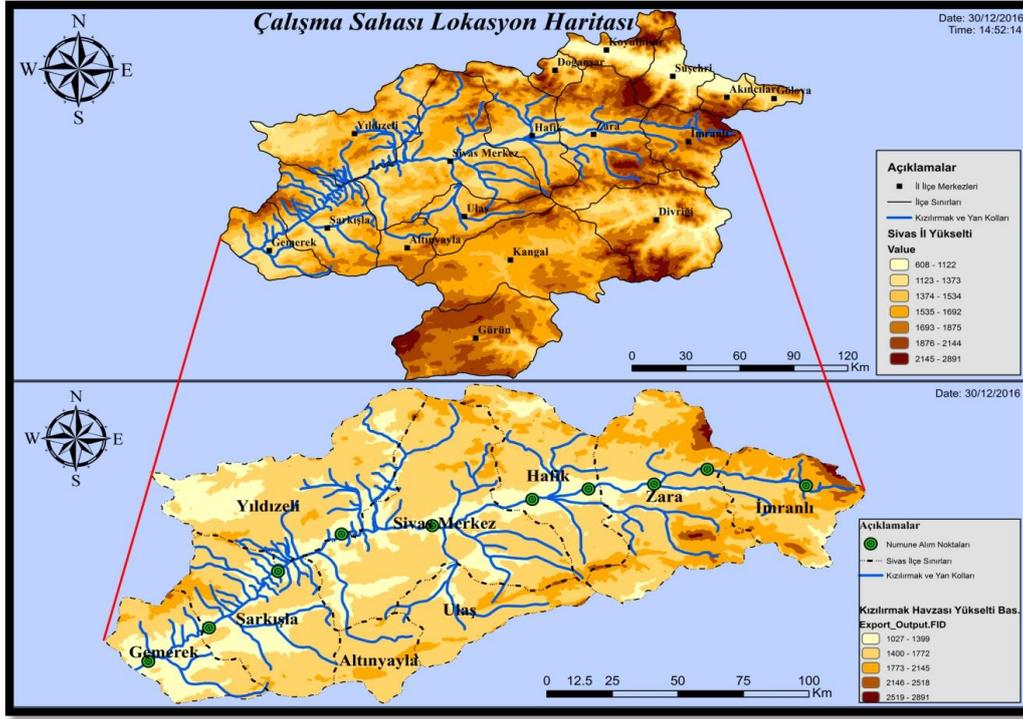


Figure 3. Study Field Location Map

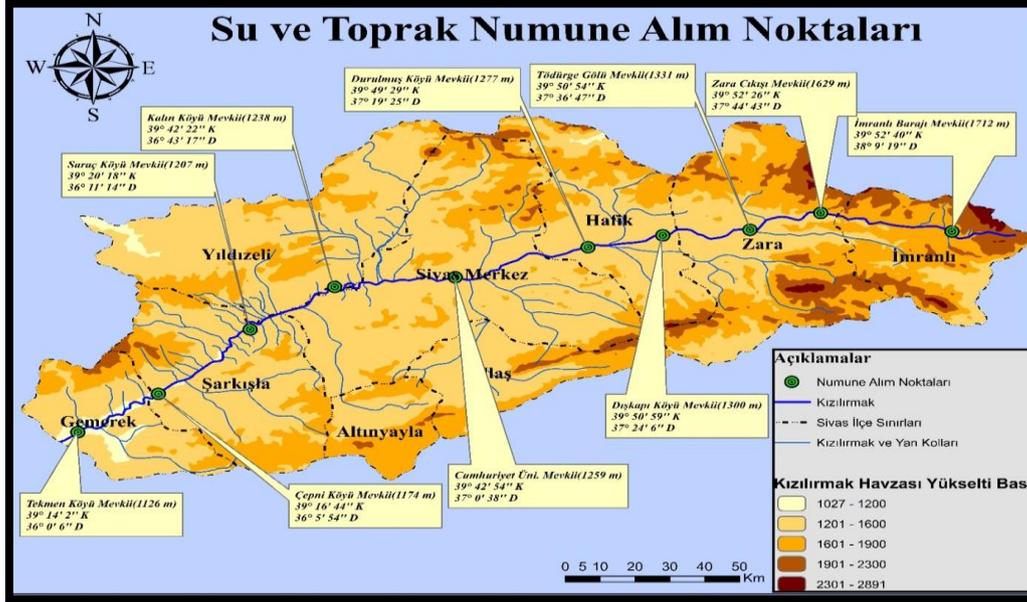


Figure 4. Water and Soil Sample Collection Points



Figure 5. Study Field Photos during Sampling

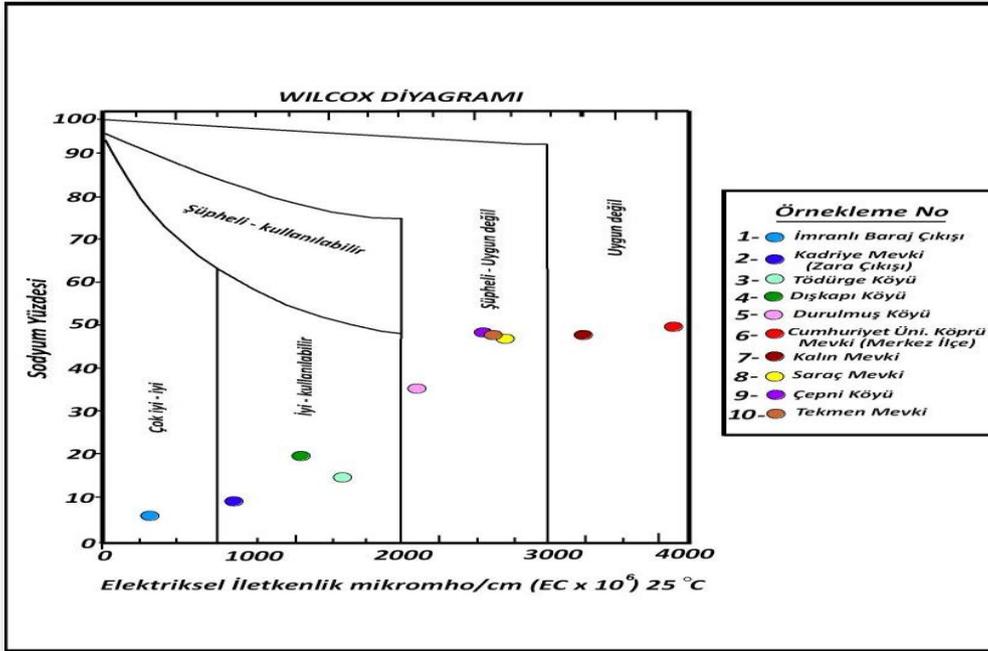


Figure 6. The Diagram for Wilcox Salinity Values

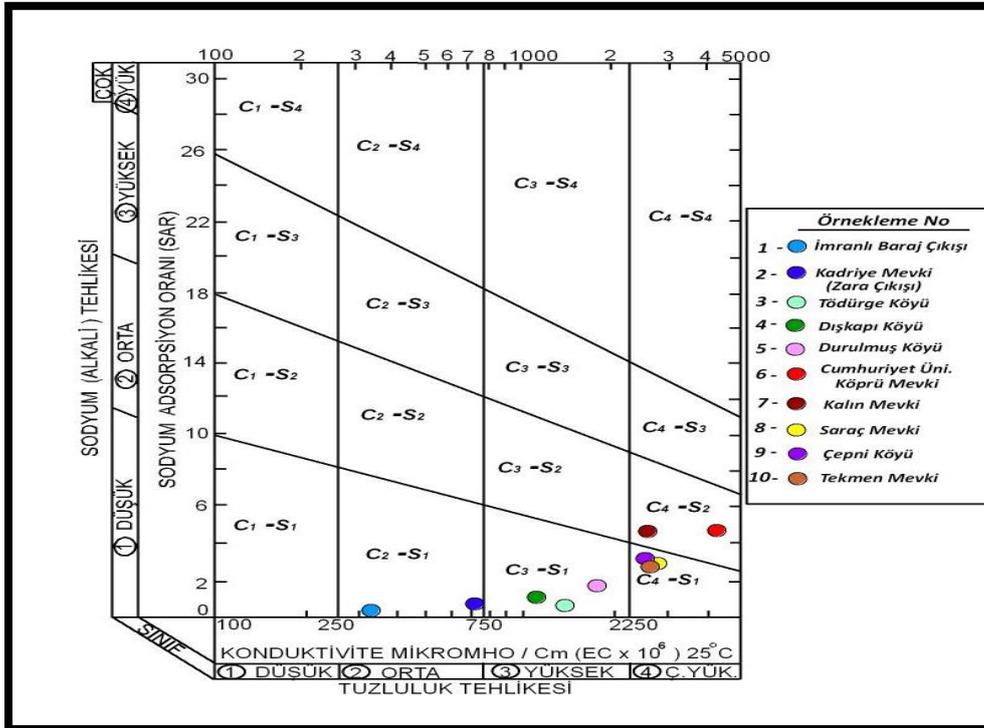


Figure 7. US Salinity Diagram

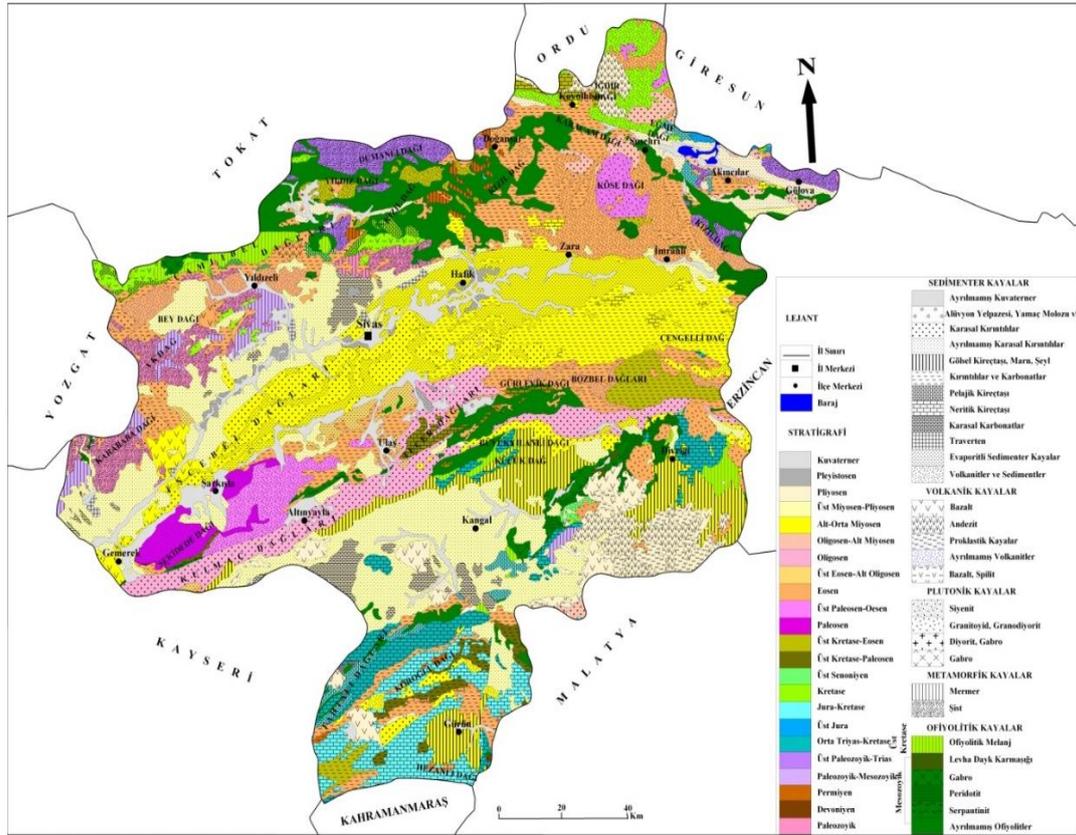


Figure 8. Sivas Province Geology Map

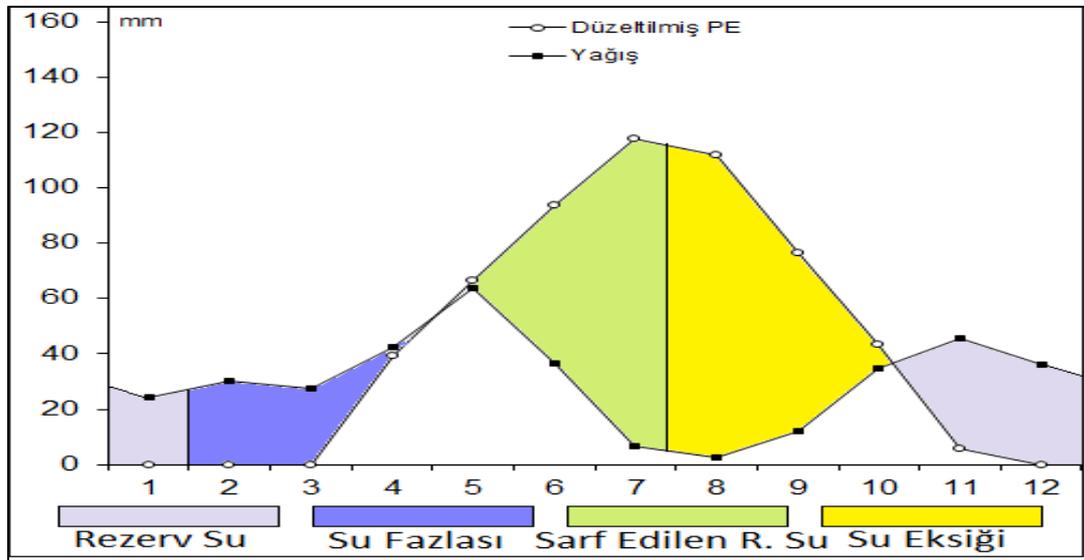


Figure 9. Water Balance Sheet of İmranlı (Based on Thornthwaite Method)

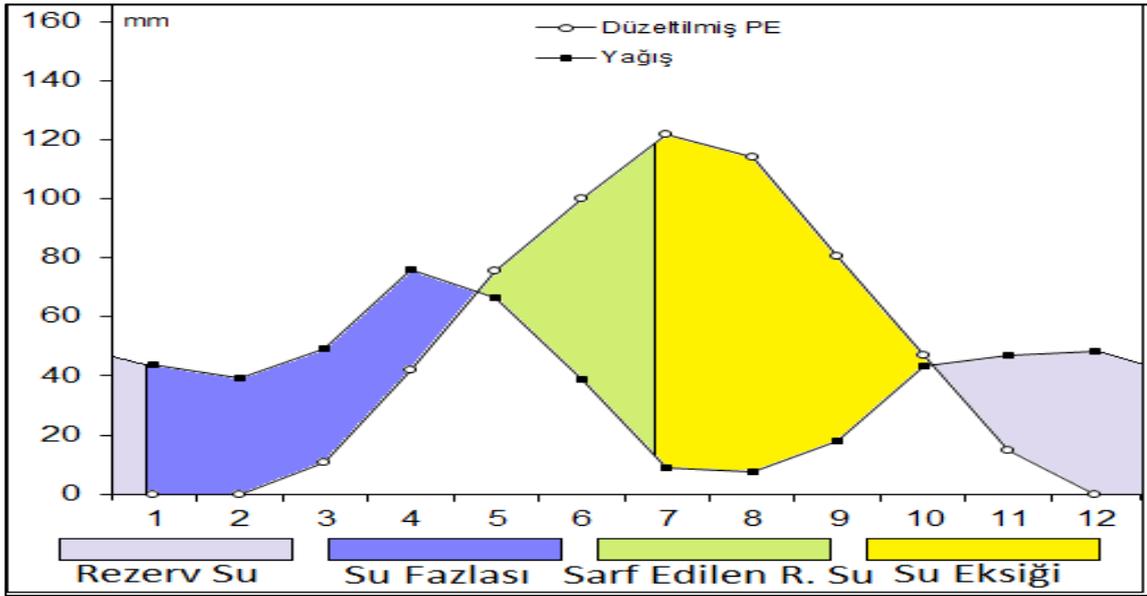


Figure 10. Water Balance Sheet of Zara (Based on Thornthwaite Method)

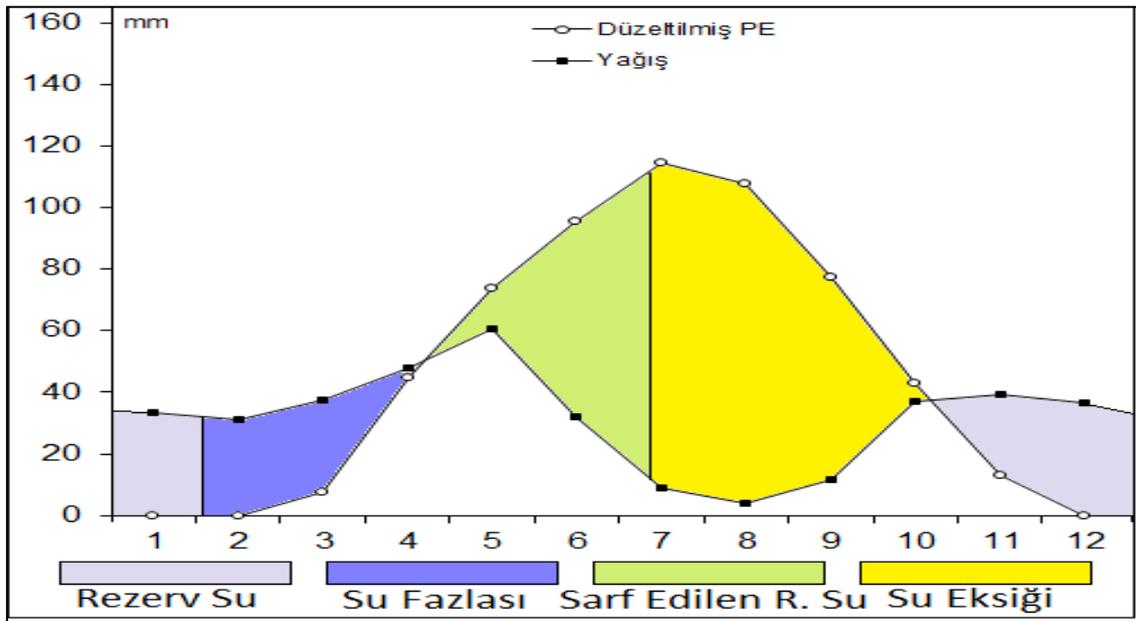


Figure 11. Water Balance Sheet of Hafik (Based on Thornthwaite Method)

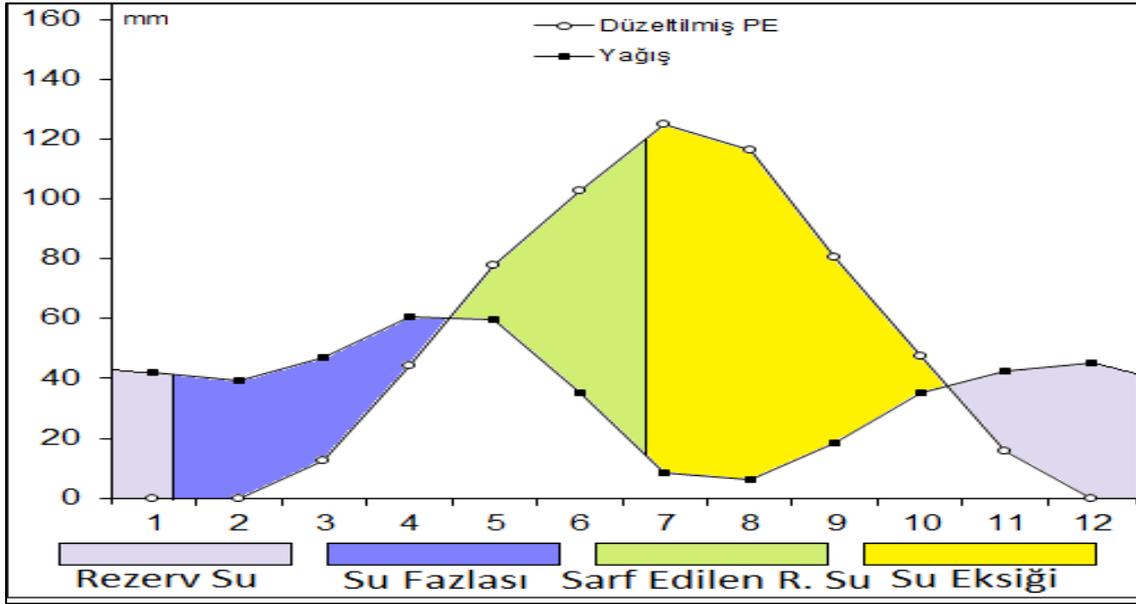


Figure 12. Water Balance Sheet of Sivas Central (Based on Thornthwaite Method).

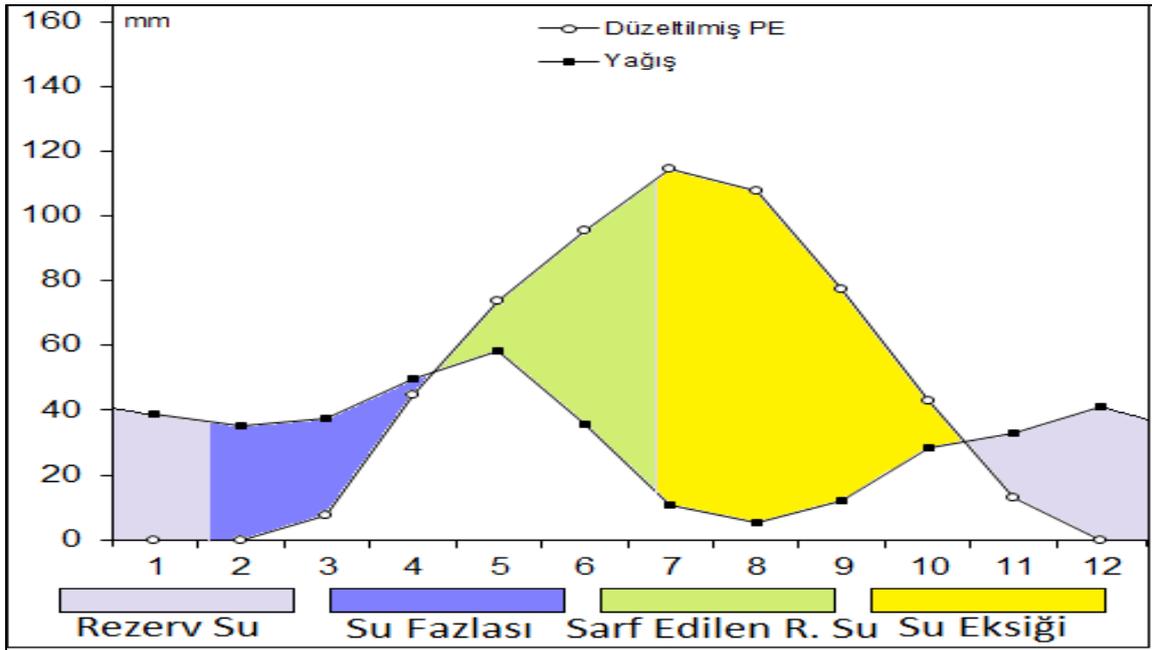


Figure 13. Water Balance Sheet of Şarkışla (Based on Thornthwaite Method).