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ARAŞTIRMA MAKALESİ RESEARCH PAPER

# The Effect of Polyacrylamide Application on Soil Transport and Surface Runoff[*]

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**Abstract:** In addition to the slope reclamation studies to prevent erosion, one of the recently alternative approaches is the application of artificial polymers to the soil to improve the soil structure and aggregate stability. In this study, it was aimed to determine the effects on runoff and soil loss by using different doses of Polyacrylamide application and different slope reclamation methods. Because of this, in order to reveal the effects of different Slopes reclamation measures on the amount of erosion, runoff parcels were established to identify the amount of runoff and the amount of soil carried on a slope land with similar characteristics in terms of topographic characteristics (slope, aspect, elevation, etc.), climate characteristics (rainfall, temperature, etc.), and soil characteristics (bedrock, texture, depth). In this context, seven different parcels have been studied. According to the findings obtained from the parcels; total erosion carried as suspended and swab materials, 2,583 tons/ha in control parcel, 1,747 tons/ha in OT parcel, 1,672 tons/ha in PAM3 parcel, 1,480 tons/ha in PAM1 parcel, 1,278 tons/ha in PAM2 parcel, 1,075 tons in parcel of stone/ha and knitted fence parcel is 0.748 tons /ha. Accordingly, it has been determined that the most effective methods to prevent erosion are knitted fences and stone cords and the most effective PAM ratio is PAM-2 (6,666 gr/10 m²).

**Keywords:** Erosion, polyacrylamide, sediment, slope reclamation, surface runoff.

# Poliakrilamid Uygulamasının Toprak Taşınımı ve Yüzeysel Akışa Etkisi

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**Öz:** Erozyonun önlenmesine yönelik şev ıslah çalışmalarına ek olarak son dönemde alternatif yaklaşımlardan biri de toprak yapısını ve agregat stabilitesini iyileştirmek amacıyla toprağa yapay polimerlerin uygulanmasıdır. Bu çalışmada farklı dozlarda Poliakrilamid uygulaması ve farklı şev ıslah yöntemleri kullanılarak yüzeysel akış ve toprak kaybı üzerindeki etkilerinin belirlenmesi amaçlanmıştır. Bu nedenle farklı yamaç ıslahı tedbirlerinin erozyon miktarı üzerindeki etkilerini ortaya koymak amacıyla, topoğrafik özellikler açısından benzer özelliklere sahip (eğim, bakı, yükseklik vb.), iklim özellikleri (yağış, sıcaklık vb.) ve toprak özellikleri (ana kaya, tekstür, derinlik) bir arazide yüzeysel akış miktarını ve taşınan toprak miktarını ortaya koymak için yüzeysel akış parselleri oluşturulmuştur. Bu kapsamda aynı koşullara sahip bir yamaçta farklı erozyon control tedbirleri ile farklı dozlarda poliakrilamid uygulamlarını içeren yedi farklı parsel oluşturulmuştur. Parsellerden elde edilen bulgulara göre; Askı ve sürüntü malzemesi olarak taşınan toplam erozyon, Kontrol parselinde 2.583 ton/ha, OT parselinde 1.747 ton/ha, PAM3 parselinde 1.672 ton/ha, PAM1 parselinde 1.480 ton/ha, PAM2 parselinde 1.278 ton/ha, 1.075 ton parsel taş/ha ve örme çit parseli 0,748 ton/ha'dır. Buna göre erozyonu önlemede en etkili yöntemlerin örme çitler ve taş kordonlar olduğu, en etkili Poliakrilamid uygulamasının ise ikinci doz PAM uygulamasında (PAM-2) (6.666 gr/10m²) gerçekleştiği tespit edilmiştir.

**Anahtar kelimeler:** Erozyon, poliakrilamid, sediment, şev ıslahı, yüzeysel akış.

[*] *This study was produced from the master thesis.*

## INTRODUCTION

Sloping land with poor vegetation is more susceptible to soil erosion. Especially on eroded land surfaces without natural vegetation, the impact of raindrops that fall on soil surface breaks the soil aggregates and ruins the clay distribution (Kumar and Saha, 2011). Vegetation reduces surface runoff and erosion by reducing the erosive effect of raindrops. Yüksek and Yüksek, (2015), the highest sediment concentration was detected in bare lands (10.4 g l−1, 2006), and the lowest sediment concentration was detected in sainfoin lands (1.76 g l−1, 2008). Results revealed that vegetation was the main factor reducing runoff and sediment production, and Sainfoin showed great potential in reducing both erosion and runoff. With the kinetic energy of rainfall, the soil surface gets compressed over time and becomes an impermeable layer. Because of this impermeable layer on the soil surface, infiltration rate of the soil decreases and ponding occurs on the surface (McIntyre, 1958). Water that accumulates on the surface generally tends to increase the flow and cause greater soil loss, depending on the slope of the land (Farres, 1978). Soil particles also get torn from their place and the soil begins to wear away with the energy of the water flowing on the surface. As a result of this, the soil surface becomes eroded and this causes large amounts of soil loss (Taysun, 1989). Therefore, it is important to identify suitable materials that can improve the structure of degraded soil and reduce erosion (Li et al., 2005, 2006; Yang et al., 2011). Ayrıca

Among the measures developed to reduce and even eliminate soil loss caused by erosion, one of the alternative approaches that has attracted attention in the last 20 years is the use of artificial polymers that make the soil more resistant to erosion. Polyacrylamide (PAM) has been widely used for a while now in many industrial applications such as soil erosion control, soil structure improvement, irrigation control, wastewater treatment, and so on (Letterman and Pero, 1990; Nadler et al., 1996; Zhang and Miller, 1996; Stutzmann and Siffert, 1997; Sojka et al., 1998, 2007; Pefferkorn, 1999; Yang et al., 2011). The most applications, PAM mainly reacts with clay minerals in the soil. In particular, the adsorption of PAM into soil particles depends on both the polymer and the properties of the soil. Polyacrylamides differ in molecular weight and density. These properties determine the size and shape of molecules in the solution and their interaction with soil particles, thus altering their effectiveness for soil stabilization (Lentz et al., 2000; Sojka et al., 2007). In addition, soil texture and structure, soil salinity, and clay mineralogy are main soil characteristics that affect PAM adsorption (Seybold, 1994; Levy and Agassi, 1995; Laird, 1997; Levy and Miller, 1999; Green et al., 2000, 2004; Yang et al., 2011). As a result of the land surface becoming an impermeable layer, the water that starts to flow on the surface can be controlled with organic polymers that stabilize aggregates by flocculating soil particles (Bradford et al., 1986). When polymers are applied to the soil surface, they strengthen the chemical bonds between primary particles containing soil aggregates, resulting in reduced aggregate breakdown (Ben Hur and Letey, 1989). A small amount of polymer sprayed to the surface or added and dissolved in irrigation water significantly reduces surface runoff and soil erosion by reducing surface impermeability and decreasing the crust formed on the surface (Barvenik, 2004). Polymers are used as soil conditioners that have adhesive properties, which can aggregate soil particles in order to get better soil structure. With the adsorption of polymers, water resistance is achieved on the clay in the soil, and insoluble complexes that maintain adhesive properties occur (Schamp and Huylebroeck, 1973). The application of chemical soil conditioners to the soil in order to improve or maintain soil structure and aggregate stability is effective in providing high water infiltration and reducing runoff and erosion. In fact, with the use of polymeric soil conditioners, soil erosion can be minimized or completely eliminated (Wallace and Wallace, 1986).

In most of the studies conducted, PAM was applied directly to the soil surface in either liquid or solid powder form (Yang et al., 2011). Many studies have been conducted and different results have been obtained in order to reveal the effects of artificial polymers with different physical and chemical soil properties, soil mineralogy, polymer properties, application method and doses of polymers. It has been observed that, in coarse and medium-textured soils, high molecular weight PAM application is more effective than low molecular weight PAM application in maintaining high infiltration rates (Mamedov et al., 2007). Levy and Agassi, (1995) preferred to use a low molecular weight PAM because it is easier to apply. Mamedov et al., (2007) reported that most of the PAM is adsorbed by the outer surfaces of soil particles, with only a small part entering the pores. After PAM application, aggregate stability increased as well as the clay content in the soil (Mamedov et al., 2007). Wallace and Wallace, (1990) stating that the effectiveness of polymers change depending on clay content and organic matter content of the soil in their study on PAM, concluded that a higher PAM concentration is needed if clay content of the soil is high. According to the results of PAM and PAM-MAG application on sandy loam soils obtained from a mine site, it has been determined that with PAM application, soil loss due to runoff decreased by 97.5%, and with PAM-MAG application, soil loss by surface flow decreased by 90.8% (Zheng et al., 2020). A lot of research has also been carried out on soil's response to different PAM formulations. Levy and Agassi, (1995) investigated the effects of 0.2 and 20 Mg/mol anionic PAMs on infiltration rate and erosion in three soils with different textures. It was found that, in the parcels where phosphogypsum (PG), polyacrylamide (PAM), and polyacrylamide + phosphogypsum (PAM+PG) mixture were applied, infiltration decreases and soil loss increases as the rainfall increases, and PAM +PG mixture significantly increases infiltration while decreasing erosion compared to other applications (Levin et al., 1991). According to the results of the research in which 60 mm/h of precipitation was repeated 5 times, it was found that PAM increases permeability while decreasing soil losses (Levy et al., 1992). Lei et al., (2003) applied artificial precipitation at different intensities on soils with different slopes, to which they applied PAM. According to the results of the research, PAM applications were found effective in reducing soil erosion. In the parcels where dry and solution PAM was applied, as a result of artificial precipitation, the surface flow and the amount of sediment generated by surface flow and splash decreased, while infiltration increased (Teo et al., 2006).

In general, soil conditioners, which are more economical and have long-term effects, have been used widely in recent years in order to prevent erosion on soil surface. In addition, the literature review clearly shows that more research is needed on the use of PAM for erosion control due to its potential to cause very serious harm to the environment and human health.

***Study Area:*** The study area is Dodurga region within the borders of Osmancık district of Çorum Province, located in the Middle Black Sea region of Turkey (Figure 1) (40° 52' 30''.79 N 34° 49' 26''.84 E). The most important factor in choosing this region as the study area was that the region has severe and very severe erosion areas (Anonymous, 2012).

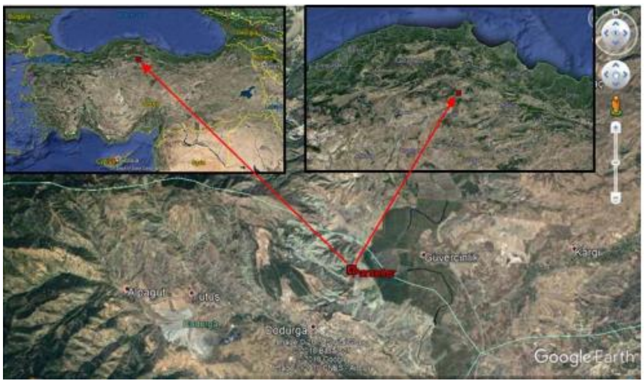


**Figure 1.** The location of the study area

The average temperature of the study area is 10.8°C, the minimum temperature is -4.3°C in January and the maximum temperature is 29.4°C in August. The total annual precipitation is 432.2 mm. According to the rainfall balance created with Thornthwaite method, the climate type of the area was determined to be C1, B'1, s, b'3 (semi arid-low humid, 1st degree mesothermal, moderate water surplus in winter, summer evaporation rate: 54.3%) (URL-1).

The main soil types of the study area, which has an area of 214 km and an altitude of 510 m, are alluvial, colluvial, and brown forest soils. There are forests as natural vegetation in higher areas, and there are steppes with shrubs and short grasses as you go down (Anonymous, 2012).

## MATERIAL AND METHOD

***Material:*** The research material consists of the runoff parcels established in erosion areas in the Dodurga region, and the data obtained from these parcels. Data collection from runoff parcels was carried out throughout 2019. Within the scope of the study, a total of 7 parcels were used, including 1 control parcel, 1 forest soil parcel (FS), 2 slopes reclamation measures, and 3 PAM application parcels.

In the selection of the areas where the parcels are established, taking into account the erosion, slope, aspect, slopes shape, and land use, it was ensured that it is a very steep sloping, sunny and clear area with erosion problems. The area on the upper slope where the parcels are established is very steep, with an average slope in the range of 80-85%. The general view of the area faces west and has a sunny aspect.

***Methods:*** The methods of identifying and measuring soil erosion are classified under various assessments or titles. Generally, the methods used to measure erosion are divided into direct, indirect, and predictive measurements. There are also classifications made by measuring erosion directly at the field or in the laboratory and identifying it with predictive methods (Balcı, 1996; Şensoy et al., 2011). Direct measurement (field erosion measurement) can be carried out using various methods. Measuring erosion, soil loss, and runoff by establishing a runoff parcel is one of these methods (Şensoy et al., 2011).

In this study, in order to reveal the effects of different Slopes reclamation measures on the amount of erosion, runoff parcels were established to identify the amount of runoff and the amount of soil carried on a slope land with similar characteristics in terms of topographic characteristics (slope, aspect, elevation, etc.), climate characteristics (rainfall, temperature, etc.), and soil characteristics (bedrock, texture, depth) (Kalıpsız, 1976). The dimensions of the runoff parcels have been established on the land as 2m X 5m (10m²) by taking the structure of the land into consideration (Presbitero, 2003).

The runoff parcels established within the scope of the study: A total of 7 parcels were established, including 1 control parcel, 1 FS, 2 slopes reclamation measures and measures (knitted fence, stone cord), and 3 different doses of PAM application parcels (Table 1).

**Table 1.** Plots prepared within the scope of the study.

| Slopes Reclamation Measures | PAM UYGULAMASI |
|---|---|
| 1. Knitted Fence Parcel | 1. PAM - Dose 1 (3.333 gr/10 m²) |
| 2. Stone Cord Parcel | 2. PAM - Dose 2 (6.666 gr/10 m²) |
| 3. Forest Soil (FS) Parcel | 3. PAM - Dose 3 (33.333 gr/10 m²) |
| 4. Control Parcel | |

While preparing PAM solutions in the laboratory, the amount of PAM in powder form determined for each PAM application was dissolved in 600 ml of distilled water at a maximum temperature of 70°C (Stefanson, 1973; Uysal et al., 1995, 1996). Then, it was then diluted with distilled water and sprayed directly to cover the entire surface of the parcels by means of a manual pump in the field. After PAM was applied, the amount of sediment transported from the parcels by runoff was collected and measured in the runoff collection system set up at the bottom of the parcels (Figure 2).

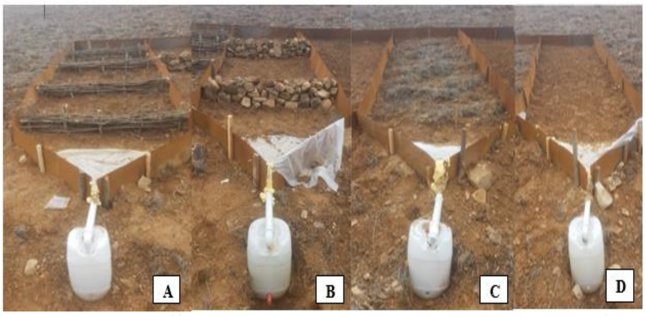


**Figure 2.** The runoff mechanism established to measure the amount of soil transported from the parcels; Knitted Fence (A), Stone Cord (B), Forest Soil (C), Control Parsel (D)

Soil samples were taken from the runoff parcels and some physical and chemical analyses were made, and the similarity of the soil properties of the parcels was identified. Thus, when identifying the amount of erosion in the parcels, only the effect of erosion control measures will have been identified. In this context, in soil samples taken from parcels; Bouyoucos' hydrometer method was used in texture analysis for identifying the soil type (Irmak, 1954; Bouyoucos, 1936; Gülçur, 1974), Walkley-Black method was used for identifying the amount of organic matter to erosion (Walkley and Black, 1934; Gülçur, 1974), soil reaction was analyzed with 1/2.5 distilled water suspension (Gülçur, 1974), and electrical conductivity with 1/5 distilled water suspension (Gülçur, 1974; Eruz, 1979).

## RESULTS AND DISCUSSION

The analysis results of the soil samples taken from the study area are given in Table 2.

According to research results, pH values vary between 6.2 and 7.5, they have mild acidity and very slight alkaline characteristic. It was found that the electrical conductivity values are between 103.7 µS/cm and 166.1 µS/cm and the amount of organic matter vary between 1.92% and 2.53%. It was found that sand values between 55.54-71.36%, dust values between 12.46-24.25%, and clay values between 14.77-21.93% in soil texture, which is important for erosion and runoff, and the soil texture was identified to be sandy loam. According to the analysis results, it was found that some physical and chemical properties of the soils are in all parcels.

**Table 2.** Some physical and chemical properties of soils taken from experimental plots.

| Parcel number | Type of experimental plots | Total swab sediment (gr) | Totalswab sediment (gr/m²) | Total suspended sediment (gr/ m²) | Total suspended sediment (gr/m²) | Total sediment (ton/ha) | Total sediment (gr/m²) |
|---|---|---|---|---|---|---|---|
| 1 | Knitted fence | 720.26 | 72.03 | 27.48 | 2.75 | 0.748 | 74.77 |
| 2 | Stone cord | 1044.04 | 104.40 | 31.07 | 3.11 | 1.075 | 107.51 |
| 3 | PAM 1 | 1450.70 | 145.07 | 29.41 | 2.94 | 1.480 | 148.01 |
| 4 | PAM 2 | 1240.47 | 124.05 | 37.73 | 3.77 | 1.278 | 127.82 |
| 5 | PAM 3 | 1574.50 | 157.45 | 97.00 | 9.70 | 1.672 | 167.15 |

In the study area, the total amount of transported soil (erosion) was found by identifying the amount of swab sediment collected from the storage area in front of the parcels and the amount of suspended sediment stored with the runoff water in the runoff storage bin. From the data obtained, it was found that the total swab sediment was collected in the control parcel the most with 2532.10 grams and in the knitted fence parcel the least with 720.26 grams. It was found that the most amount of suspended sediment was in the FL parcel with 125.60 grams and the least amount in the knitted fence parcel with 27.48 grams.

According to the findings obtained from the parcels, the total amount of erosion transported as suspended and swab material was 2.583 tons/ha in the control parcel, 1.747 tons/ha in the FL parcel, 1.672 tons/ha in the PAM3 parcel, 1.480 tons/ha in the PAM1 parcel, 1.278 tons/ha in the PAM2 parcel, 1.075/ha tons in the stone cord parcel, and 0.748 tons/ha in the knitted fence parcel.

Based on the total amount of erosion that occurred as a result of different methods applied on the parcels, it is seen that the most effective slope reclamation method is the knitted fence parcel, and when the effects of different PAM doses are examined, it is seen that the applied polymer applications in three different doses are effective in reducing the soil loss by runoff. However, the highest effect on soil loss was obtained in PAM 2 application (6.666 gr/10 m²). According to the data obtained from the study, it has been found that PAM applied in different doses has different effects in terms of preventing erosion, and depending on the amount applied and the soil structure, the optimum amount of PAM to be applied in order to obtain the maximum amount of benefits varies. Most of the studies on this subject prove that polymers have different effects depending on the properties of the soil in the area of application, the dose of the polymer applied, and whether it is applied in solid or liquid form (Yang et al., 2011). Majed et al., (2007) in their study conducted in field and under natural rainfall conditions, found that by applying different doses of PAM (10 and 30 kg/ha), surface runoff and soil loss decreased, and they found that 30 kg/ha dose was more effective in reducing soil loss. As a result of the study conducted with PVA and PAM solutions prepared in 1 and 5 g/lt doses, it was found that the best result was obtained with 5 g/lt dose application (Uysal et al., 1995). As a result of PAM applied in three different doses of 0 - 0.4 and 1 g/kg in the upper soil layer, an increase was observed in the infiltration rate, while a significant decrease in soil loss was found (Shengqiang and Dongli, 2018). In the study conducted by spraying 20-80 and 120 kg/ha PAM in clay-textured soil samples, it was found that the application with 80 and 120 kg/ha doses significantly reduced the amount of runoff and sediment (Martinez et al., 2007). It has been found that, in sandy clay loam textured soils containing high amounts of limestone, polymers significantly reduce the amount of surface flow due to the formation of soil crust (El Hady and Wahba, 2003). Michelle et al., (2004) reported that PAM applications reduce runoff and soil loss, increase infiltration, and PAM applied in solution is more economical and effective. As a result of the application of double polymer composite material (DPCM) prepared from a mixture of carboxymethyl cellulose (CMC) and polyacrylamide (PAM) in order to identify the resistance of sand particles to water and erosion, it has been found that sandy slopes have excellent resistance to water erosion against a rainfall density of 120 mm/h (Yuan et al., 2020). It was found that the infiltration rate increased by 6% as a result of 10mg/l PAM application in silt loam and silt clam loam soils (McNeal et al., 2017). As a result of the application of PAM and PVA in the structure of clay loam and sandy loam, it was determined that the surface runoff, soil loss and the resistance of the crust strengths decreased in both soil samples, but in the sandy loam soil sample, the surface flow and the resistance of the crust strengths decreased significantly (Yönter and Uysal, 2010). In the study carried out to identify the effects of PAM polymer under moist and dry conditions with optimum application methods, it was found that dry PAM application to dry soil increases the infiltration while decreasing the runoff, and the most effective application in reducing soil loss is applying PAM solution + mulch to dry soil (Espinosa et al., 2000). Lentz et al., (2000) concluded that medium and high density PAM produced the greatest increase in infiltration in silt loam. Green et al., (2000, 2004) stated that there is a significant interaction between soil type and the effects of different PAM formulations on water infiltration rate and aggregates. As a result of the study of 20 kg/ha PAM application in silt loam and clay erosion parcels, it was found that the surface flow in the control plots was 39-53% higher than the parcel where PAM was applied (Ben, 1994). As a result of PAM application on a sandy loam textured soil under natural rainfall conditions, it was found that the surface flow decreased by 44-67% and the soil losses by 16-19% (Zhang et al., 1998). I was seen that after applying dry PAM and solution PAM in highly erodible silt loam soils, sediment loss decreased by 70-94% and infiltration rate increased by 15% (Lentz and Sojka, 1996), application of PAM polymer solution in loam soils increased aggregate stability, but this effect was insufficient when rainfall exceeded a certain level (Lehrsch et al., 1996).

The total amount and distribution of precipitation in the area during the study, with 1 rain gauge installed in the area where the parcel trials were carried out, are shown in Table 4.

**Table 4.** Precipitation values measured in the research area.

| Date | Precipitation ($mm/m^2$) | Date | Precipitation ($mm/m^2$) |
|---|---|---|---|
| 01.03.2019 | 3.26 | 28.04.2019 | 1.92 |
| 10.03.2019 | 2.50 | 05.05.2019 | 4.80 |
| 18.03.2019 | 6.72 | 09.05.2019 | 17.28 |
| 31.03.2019 | 2.88 | 12.05.2019 | 14.40 |
| 10.04.2019 | 1.92 | 19.05.2019 | 2.40 |
| 17.04.2019 | 3.84 | 25.05.2019 | 20.16 |
| 19.04.2019 | 2.88 | 07.06.2019 | 8.64 |
| 22.04.2019 | 1.92 | Total Precipitation ($mm/m^2$) | 95.52 |

The total amount of precipitation in the research area in a 3-month period was measured as 95.52 mm. The total amount of precipitation measured at the meteorological station in Laçin district near the area was determined as 130.00 mm (Table 5). According to the data obtained, it is seen that the highest rainfall amounts occur in the spring, between April and May.

**Table 5.** Laçin meteorological station monthly total precipitation data ($mm=kg \div m^2$) (URL-1 2021).

| Year/Month | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 2019 | 38.2 | 35.8 | 15.0 | 46.2 | 68.8 |

Surface runoff amounts and dates measured after rainfall in the research area are shown in Table 6.

Table 6. Surface flow amounts measured in experimental plots

**Table 6.** Surface flow amounts measured in experimental plots.

| Date | Knitted fence | Stone cord | PAM 1 | PAM 2 | PAM 3 | FS | Control | Precipitation (mm) |
|---|---|---|---|---|---|---|---|---|
| 01.03.2019 | 0.45 | 0.30 | 0.50 | 0.30 | 0.38 | 0.50 | 0.30 | 3.26 |
| 10.03.2019 | 0.25 | 0.20 | 0.38 | 0.22 | 0.30 | 0.40 | 0.20 | 2.50 |
| 18.03.2019 | 0.75 | 0.80 | 0.90 | 0.80 | 0.70 | 0.85 | 0.95 | 6.72 |
| 31.03.2019 | 0.10 | 0.10 | 0.10 | 0.15 | 0.15 | 0.05 | 0.15 | 2.88 |
| 10.04.2019 | 0.20 | 0.15 | 0.10 | 0.10 | 0.15 | 0.10 | 0.25 | 1.92 |
| 17.04.2019 | 0.40 | 0.20 | 0.50 | 0.40 | 0.35 | 0.40 | 0.40 | 3.84 |
| 19.04.2019 | 0.30 | 0.15 | 0.35 | 0.25 | 0.25 | 0.25 | 0.20 | 2.88 |
| 22.04.2019 | 0.25 | 0.13 | 0.40 | 0.30 | 0.25 | 0.25 | 0.20 | 1.92 |
| 28.04.2019 | 0.25 | 0.20 | 0.35 | 0.20 | 0.30 | 0.20 | 0.30 | 2.76 |
| 05.05.2019 | 0.50 | 0.40 | 0.40 | 0.45 | 0.40 | 0.45 | 0.40 | 3.96 |
| 09.05.2019 | 2.60 | 2.70 | 3.10 | 2.80 | 2.80 | 2.50 | 2.60 | 17.28 |
| 12.05.2019 | 1.85 | 1.85 | 1.95 | 1.50 | 1.75 | 1.60 | 1.80 | 14.40 |
| 19.05.2019 | 0.30 | 0.25 | 0.35 | 0.25 | 0.30 | 0.30 | 0.25 | 2.40 |
| 25.05.2019 | 2.90 | 2.95 | 3.10 | 2.85 | 2.70 | 2.90 | 3.00 | 20.16 |
| 07.06.2019 | 1.15 | 0.95 | 1.80 | 1.70 | 2.10 | 1.40 | 1.50 | 8.64 |
| Total Runoff (parcel) (mm) | 122.50 | 113.30 | 142.80 | 122.70 | 128.80 | 121.50 | 122.50 | |
| Total Runoff (mm/m$^2$) | 12.25 | 11.33 | 14.28 | 12.27 | 12.88 | 12.15 | 12.50 | |
| Flow Rate (%) | 12.82 | 11.86 | 14.95 | 12.85 | 13.48 | 12.72 | 13.09 | |

From the values obtained, it was determined that the highest surface flow value was in the PAM1 parcel with a value of 14.28 mm/m2, and the lowest was in the Stone Cord parcel with a value of 11.33 mm/m2. In the evaluation made; It was determined that the parcels where PAM application was applied had higher surface flow values than the other parcels.

In conclusion, the results of this study are consistent with many studies where PAM was used for soil erosion control and have shown that PAM is effective in reducing runoff and soil loss. It is supported by the results obtained from studies on this subject that artificial polymers can be procured economically and can be used as an effective method for reducing soil and water losses if they are applied to areas under the effect of erosion, depending on the soil properties. It is a method that can be used in our country, especially in forest soils and areas with high erosion risk, since it is easier and more economical than other erosion control measures.

The results of this study are important in terms of providing data and guidance on the control of soil loss caused by erosion, and for planning and implementation of erosion control projects.

In order to obtain more comprehensive results on this issue, further studies need to be carried out under different circumstances such as different parcel sizes, different rainfall characteristics, different PAM application rates, varying periods after PAM application, different slope, aspect climate characteristics.

The aim of this study is to determine the effect of polyacrylamide application on soil transport and surface runoff with the specific objectives (i) identifying the effects of different slopes reclamation measures on the amount of erosion in slopes with erosion problems, and (ii) identifying the optimum PAM level for erosion control, taking into account the maximum effectiveness on the total amount of sediment transported.


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