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M.Sc. in Civil Engineering

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GRADUATE SCHOOL OF

NATURAL AND APPLIED SCIENCES

SOIL EROSION PROBLEMS AND SOLUTION IN MOSUL CITY

M.Sc. THESIS

IN

CIVIL ENGINEERING

BY

TAREQ AZEEZ ALI

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Hasan Kalyoncu University

Supervisor

Prof. Dr. Mehmet KARPUZCU

by

Tareq Azeez ALI

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Tareq Azeez ALI

ABSTRACT

SOIL EROSION PROBLEMS AND SOLUTIONS IN MOSUL CITY

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MSc. in Civil Engineering
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Soil Erosion and Solutions in Mosul City, (SES). The Mosul Governorate geographically located on latitude 3919 north and latitude 9 - 43 east and rising above sea level by 222.5 meters and the rainfall rate between 400 - 600 mm. The study area begins with the water dividing line between the valleys heading towards the Tigris River and there are some valleys. As for the north, it was identified with the beginning of the valleys. Semi ends in the discharge of the Tigris River while the city of Rabiah is located in the western part of the study area. Through the study and loading of the water and wind erosion operations in Mosul are Through the study and loading of the water and wind erosion operations in the Nineveh region. Water erosion is one of the most dominant geomorphological processes in the world. The area has the most impact on soil erosion and the dredging of wind erosion with evidence of magnitude. Erosion, whether it is by water, wind or tillage, involves three distinct actions – soil detachment, movement and deposition. Topsoil, which is high in organic matter, fertility and soil life, is relocated elsewhere "on-site" where it builds up over time or is carried "off-site" where it fills in drainage channels. Soil erosion reduces cropland productivity and contributes to the pollution of adjacent watercourses, wetlands and lakes. Soil erosion can be a slow process that continues relatively unnoticed or can occur at an alarming rate, causing serious loss of topsoil. Soil compaction, low organic matter, loss of soil structure, poor internal drainage, salinisation and soil acidity problems are other serious soil degradation conditions that can accelerate the soil erosion process. Soil erosion remains a key challenge for Mosul agriculture. However, the reason is not management and not doing crop production technology in the Mosul that have increased soil erosion, Awareness usually occurs only when property is damaged and productive areas of soil are lost. The increase in extreme weather events predicted with climate change will magnify the existing water and wind erosion situations and create new areas of concern.

Keywords: Soil Erosion and Solutions, Douglas equation, Bergsma, Wind erosion, Water erosion, Soil erosion in Mosul

ÖZET

MUSUL ŞEHRİNDE TOPRAK EROZYONU SORUNLARI VE ÇÖZÜMÜ

ALİ, Tareq Azeez
Yüksek Lisans Tezi, İnşaat Mühendisliği Bölümü
Tez Yöneticisi: Prof. Dr. Mehmet KARPUZCU

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53 Sayfa

Musul Şehrinde Toprak Erozyonu ve Çözümleri. Çalışma alanı, Dicle Nehri'ne doğru uzanan vadiler arasındaki su ayrım hattı ile başlar ve bazı vadiler vardır. Kuzeye gelince, vadilerin başlangıcı ile tanımlanmıştır. Rabiah şehri çalışma alanının batı kısmında yer alırken Dicle Nehri'nin tahliyesinde yarı uçlar. Mosel'deki su ve rüzgar erozyonu çalışmalarının incelenmesi ve yüklenmesi sayesinde Ninova bölgesindeki su ve rüzgar erozyonu çalışmalarının çalışması ve yüklenmesi ile. Su erozyonu dünyadaki en baskın jeomorfolojik süreçlerden biridir. Alan, toprak erozyonu ve rüzgar erozyonunun büyüklük kanıtı ile taranması üzerinde en fazla etkiye sahiptir. Erozyon, ister su, rüzgar veya toprak işleme olsun, üç ayrı eylem içerir - toprak ayrılması, hareket ve biriktirme. Organik madde, doğurganlık ve toprak ömrü bakımından yüksek olan üst toprak, zaman içinde biriktiği veya drenaj kanallarını doldurduğu "saha dışı" bir yerde başka bir yere "yerinde" yerleştirilir. Toprak erozyonu ekili alan verimliliğini azaltır ve bitişik su yollarının, sulak alanların ve göllerin kirlenmesine katkıda bulunur. Toprak sıkışması, düşük organik madde, toprak yapısının kaybı, zayıf iç drenaj, tuzlanma ve toprak asitliği sorunları, toprak erozyonu sürecini hızlandırabilen diğer ciddi toprak bozulma koşullarıdır. Toprak erozyonu Musul tarımı için önemli bir sorun olmaya devam etmektedir. Ancak, Musul'da toprak erozyonunu arttıran mahsul üretim teknolojisini yönetmemek ve yapmamak nedeniyle, Farkındalık genellikle sadece mülk hasar gördüğünde ve toprağın verimli alanları kaybolduğunda gerçekleşir. İklim değişikliği ile tahmin edilen aşırı hava olaylarındaki artış, mevcut su ve rüzgar erozyonu durumlarını büyütecek ve yeni endişe alanları yaratacaktır. Toprağı erozyona karşı savunmasız bırakan daha yüksek riskli durumlara özel önem verilerek tarım arazileri mümkün olduğunca korunmalıdır.

Anahtar Kelimeler: Toprak Erozyonu ve Çözümleri, Douglas denklemi, Bergsma, Rüzgar erozyonunun, Su erozyonu, Musul'da Toprak Erozyonu

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LIST OF SYMBOLS AND ABBREVIATIONS

SES	Soil erosion and solution
AE	Groove erosion rate (m/km^2)
∑L	The sum of the lengths of the grooves within the unit area
A	Unit area (km^2)
R	Rainfall power (mm) (Cherry precipitation)
P	Annual precipitation amount (mm)
RV	Regression ratio = vertical interval
HD	Horizontal distance

CHAPTER 1

INTRODUCTION

The issue of water erosion is an important issue because of its negative effects on the geographical environment through the removal of the surface soil layers and the resulting environmental, economic, and social problems as torrential floods, running rivers, and falling snow contribute to the removal and transfer of surface soils from their original places to different places through a number of erosion processes, sedimentation, and transport. This complex process comprises a series of mechanical and chemical events characterized by erosion and sedimentation. Many of the plains have been created through sedimentation. In the case of large rivers, such as the river in the province of Nineveh, river erosion and lateral erosion have occurred through the process of clearing and deepening the course of the river, resulting in the erosion of banks, as large amounts of soil have been removed and transported by river for deposition in other locations to the south of Mosul in order to increase the effectiveness of the river. These events have resulted in the emergence of river islands in middle of the Tigris River, such as the island of Umm al-Rubayah in the forested area in the city of Mosul. This is especially evident during the flood season when there are high flows caused by the abundance of rain and snowmelt from the high peaks of the recharge basin. Given all the negative consequences of water erosion, there must be a set of solutions to help limit and reduce these effects.

1.1. Aim of the Study

The study aims to determine the best and most successful methods to treat and reduce the negative effects of the erosion that occurs in the city of Mosul. This includes the effects of both water and wind erosion and involves possible scientific methods.

1.2. Manner of Study

The method of field and office research was adopted. The necessary information about the city and the nature of water and wind erosion was collected from climatic data of the city of Mosul. This was combined with field research to locate the geographical locations and trends of water and wind erosion.

1.3. Study Problems

The city of Mosul suffers from the effects of wind and water erosion, which produce many environmental and economic effects. The problem of the study is summarized in the questions below:

- What is the nature of water erosion and wind erosion that affects the city of Mosul?
- What are the effects of this erosion, including the environmental and economic effects?
- What measures and procedures are in place to reduce these effects?
- This study presents a detailed case of this situation in the city of Mosul.

1.4. Research Results

Through desktop exploration and fieldwork, the study identified the geographical location of a connector city and examined the trends and dimensions of the mechanical and chemical processes of water and wind to determine which areas are most important and exposed to those processes. The study then determined the negative economic and environmental effects and identified solutions to those problems, with the intent of reducing the extent of those effects.

CHAPTER 2

LITERATURE REVIEW

2.1. General

Soil erosion is a global problem that threatens all soil types in the world in all climates. However, the most susceptible soils are those of sub-desert, desert, and mountainous areas. The overall area affected by soil erosion globally is estimated at 16.43 million km^2, of which about 10.94 million km^2 is affected by soil erosion and about 5.49 million km^2 is affected by wind erosion. The impact on these lands ranges from simple to severe erosion of soil. It is estimated that about 3.43 million km^2 of land is affected by the erosion of soil by water. The average land area affected by water erosion is estimated at 5.27 million km^2, while the land area affected by water erosion is estimated at 2.24 million km^2. The land area affected by wind erosion was severely affected by the wind until 1994, at about 0.26 million km^2. The land affected by this type of soil erosion is estimated at 2.54 million km^2. Finally, the area of land affected by soil erosion by wind is estimated to be 2.69 million km^2.

The land area at risk of erosion in the dry and semi-arid regions is estimated at 88.24 million km^2, of which about 55.87 million km^2 is subject to water erosion and about 32.37 million km^2 is at risk of wind erosion. The severity of this risk ranges from low to very high. The land area at a high risk of erosion is about 12.2 million km^2 for water erosion and about 9.32 million km^2 for erosion by Riyadh. Land at high risk of soil erosion is estimated at 10.97 million km^2 for water drift and 7.79 million km^2 for wind drift. The average land area at risk from soil erosion is estimated at 15.37 million km^2 for water erosion and about 6.31 million km^2 for erosion by Riyadh. Land at risk of simple soil erosion is estimated at 17.33 million km^2 for water drift and about 9,25 million km^2 for wind erosion (URL-1).

2.2. Soil Erosion Problems and Solutions in Mosul City

There are two types of soil erosion problems that occur in the city of Mosul: water erosion and wind erosion.

2.2.1. Water Erosion

Water erosion occurs in several ways in Mosul City, most notably erosion by running water as described in the following sections.

2.2.2. Gully Erosion

After the filling of small tables, as with an increased precipitation result, the flow of water increases and is accompanied by the movement of limestone with stones, which sculpt and erode of the bottom and sides of streams into the shape of a groove. The grooved shape consists of deep sides in the case of decomposed soil layers, where the sub-surface layer is more cohesive than the surface layer, and the grooves are generally active in the absence of plants on the sides working to repair the large extent. Grooves can also be classified as small, medium, and large according to the average depth, which is between 1 and 5 m, with the pool of slitters in the direction of the slope consisting of deep grooves due to the increasing capacity of running water on the soil. With these grooves forming, the stretch begins toward the top (Sharif, 1985).

Figure 2.1: Gully erosion

2.2.3. Rill Erosion

When the amount of running water on the slopes increases during rainstorms and begins to consist of simple solids with a water depth greater than the neighboring areas, the capacity of water running on the soil cliff is greater. The large collection consists of small and non-narrow waterways fixed on the slopes due to rainfall, and the increasing erosion causes surface soils and fragmented rocks from marginal areas to be transported to low areas at the feet of mountains and valleys. Rivers that are located beyond the boundaries of the study area, such as those of the Valley of Aikkab, are waterways that contribute to this liquefaction. An increase in the degree of slope and a decrease of plant density increases the in-depth process of vertical and lateral sculpting by water over time, forming a steady stream to help carry the sediment transported by water formed from rainfall. In addition, the water carries crumbs and shatters resulting from weathering to sewers and rivers that are increasingly wider and larger, resulting in the erosion of soil hillsides, plateau highlands, lowlands, and feet of mountains. As in the case of the highlands (Khir Beko), the features of most of the geological formations in the area of study are due to configurations that are characterized by low resistance to water erosion.

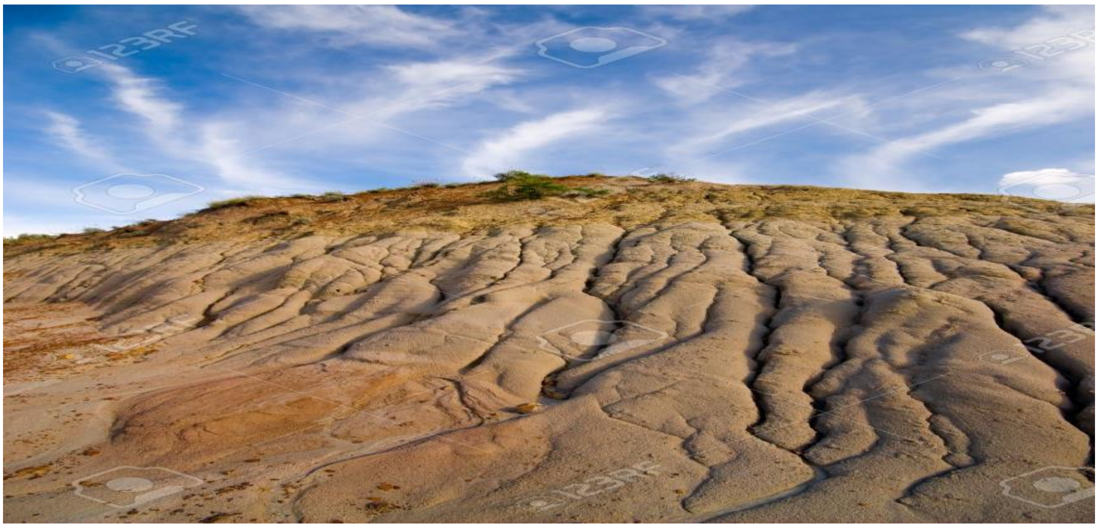

Figure 2.2: Rill Erosion

2.2.4. Sheet Erosion

When the rain rate increases the rate of water soaking, this excess accumulates on the surface of the soil and moves in the direction of the slope in form of a membrane or plate until it is collected in soles, and then into reefs or grooves (Al Mohammadi

2004). When the soil is devoid of plants, the soil granules drift with the platelet flow in equal form off the field, taking from the soil its top layer rich in organic and food materials. Sudden rainfall helps to wash away the soil and removes microcosms from the surface, and the thin layer of the Earth's surface heads towards other areas and decreases, leaving the coarse rocky layer of soil surface area. The study area is often subjected to such erosion due to the mild slope which is generally low, the algae level in the Jumbia Jatia, and the top vegetative cover that, if anything, is an obstacle to this process. What happens on the slopes of the mountainous highlands located in the region, which run from the northwest to the southeast, from the north slopes towards the southern parts of the area? How do measurements of erosion illustrate the effects of rainfall on the study area with regard to drift soil erosion?

Table 2.1: Size of Erosion For 1977–2009 (Al-Shalash, 1985).

Erosion size	**Effective rainfall (mm)**	**Yearly temperature average (mm)**	**Yearly rain amount (mm)**
1.716	18.50	23.1	299.2

Table 2.2: Rill Erosion Intensity Size Number (Fournier, 1960)

Rainfall Erosion Intensity	**Erosion Intensity Drift**
Weak	Less than 50
Moderate	50–500
High	500–1000
Very High	More than 1000

Table 2.3: Annual and annual rates of rainfall erosion (1977–2009) according to the quation **(**Sharif 1985).

Temperatures (°C)	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**eptember**	**October**	**ovember**	**December**
Avg. Temperature (°C)	7.2	9.2	12 .5	17.5	23. 7	29. 2	32. 9	32. 2	27.6	21. 1	15	9

Min. Temperature (°C)	1.9	3.5	6.2	10.3	15.4	19.4	22.9	21.8	17.1	11.8	8	3.3
Max. Temperature (°C)	12.6	15	18.8	24.7	32.1	39	42.9	42.6	38.1	30.5	22	14.7
Precipitation / Rainfall (mm)	68	73	95	65	26	0	0	0	1	14	46	68
Rainfall erosion	6.95	7.57	9.85	7.2	4.7				0.0001	0.44	5.9	6.95

Source: Prepared by the researcher based on blindness ministry of Transportation, General Commission for Iraqi Atmospheric Meteorology and Seismic Monitoring, Climate section, unpublished data based on Table 2.5 (Sharif, 1985). It is found that the rainfall capacity in the region of the study was weak (44.42) according to the applied equation. The amount of rainfall fluctuates from year to year with the abolition of the role of the rest of the natural controls of the study area. Despite this, the poor outcome was evidenced by repeated field visits during the rainy season in the study area. Anya has an effective and positive impact due to the nature of rock detectors with rocks of varying hardness due to different geological times and moisture in all aspects. Availability and regression of the slope from natural vegetation was quantified and provided a natural environment suitable for the activity of water erosion with high capacity.

Figure 2.3 : Sheet Erosion

2.3. Raindrops in the City of Mosul

When the raindrops hit the surface of soil that is not covered with plants, the kinetic energy carried in these droplets leads to the jumping of the soil granules from the impact site. The grains orientation in the direction of the slope is greater than in the opposite direction, resulting in the drifting of soil in the direction of regression over time. This type of soil erosion increases the smaller the size of vegetation, the higher the slope, and the greater the volume and intensity of raindrops. When rivers turn, the water in the opposite side stream crushes soil into the river and sweeps it with the water downriver (Sharif, 1985).

2.3.1. Raindrop Splash Erosion in Mosul

Water erosion begins with the mechanics of falling rainwater as it hits the earth's surface. According to American Geomorphologists, drops of rain fall at a speed equivalent to an average of 904 cm/s. When colliding directly with the surface of soil devoid of plants, the water causes the soil to scatter a distance of 152 cm away from the site of impact and to a height up to 61 cm. Torrential rain is characterized by large droplets that move the granules of the soil and the water to merge on the surface, and the soil loses the ability to contain the water. This makes the drainage and the water of spray erosion more effective and affects the semi-arid regions where rainfall is rare but heavy and dense, and where the earth's surface is fragile and without any protection (Allawi and Azzouz, 1994).

There are no trees to break the falling of raindrops and no vegetation or herb cover to absorb its impact on the ground. The effect of rainfall depends on its average rate and the response of soil to the force of rain for dispersion and transport, and to the surface factor, which may be an adjunct to precipitation or a support for soil resistance as well as vegetation, but it is often an adjunct to soil in the steadfastness of the raindrops, and the raindrops affect erosion through scattered rain on the soil consisting of soft sand and salts. The coarse grains do not move readily given their size and weight, and the effect on clay soil is less due to its large qualitative surface. But heavy rainfall showers can directly affect the structural units and scatter soft granules to fall on the surface formed of superficial crust that is solid when dry.

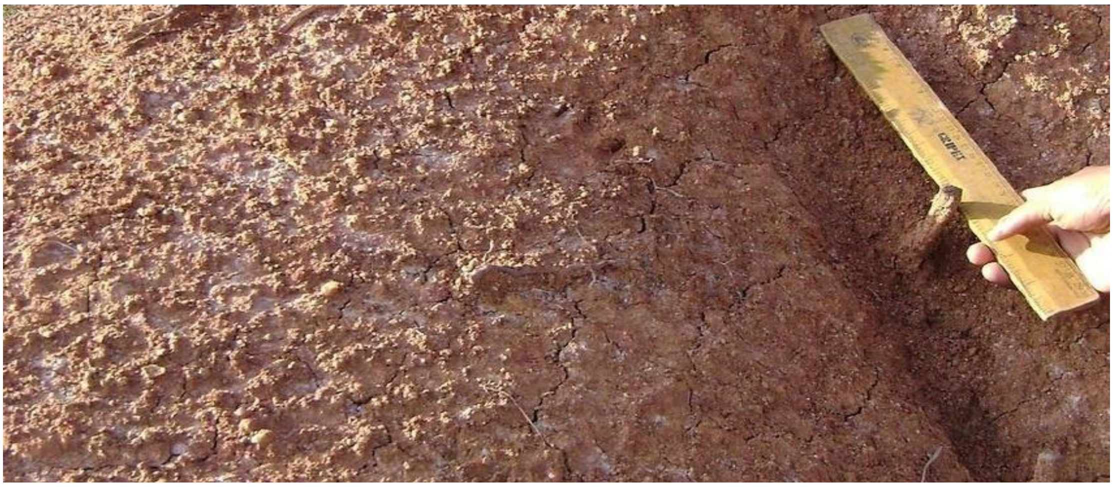

Figure 2.4: Raindrop Splash Erosion in Mosul

The area of the study is characterized by the fact that the effects of water running in it are more severe due to prevailing climatic conditions, which are represented by similar climatic conditions to dry climates characterized by high annual temperatures (23.1°C) for the period 1979–2009, which increase significantly during the summer months up to 33.8°C while decreasing to about 11.1°C during the winter months. The thermal range is 22.7°C (Al-Mohammadi, 2004), and therefore, changes occur. Sudden thermal changes on the rock masses lead to peeling and shattering as the rock breaks up, making it more susceptible to water drifting in the area of study, which is especially apparent in the study area when it experiences a peak of torrential rain. The geological structure of the study area causes poor resistance to erosion processes, as it often consists of sandy rocks and mud and other fragile alluvial soils.

Humans also play an important role in increasing erosion through misuse, plowing and land abandonment in agricultural areas, digging of quarries, and gravel and sand extraction, which increase the severity of erosion and its negative effects on the geomorphological environment of the region. Erosion increases with the slope; the highest contour line for the study area was 550, and the lowest was 150, whereas the vertical interval was about 400, and the blindness of the study area is up.

This increases the surface runoff, unlike regions that are less steep or semi-flat, and the proportion of water filtration to the subsoil degrades land through the processes of disintegration, crushes the rock masses, moves the debris to lower areas, and often leaves large volumes of sediments such as gravel and stone at the bottom of the valleys, including the Gripko and Goza Raqqa valleys in the south and the Druoneq valley in the north. In the eastern part of the study area, this process increases friction disintegration, and the collision of the fragments increases their disintegration, liquefaction, and transport—the factors causing water erosion. We find that the rainfall capacity in the study region is weak (44.42) according to the applied equation. Depending on the rainfall amount, the region oscillates from year to year with the abolition of the role of the rest of the natural controls of the study area. Despite these, the weak result turned out by repeated field visits in the course of the rainy season in the study area had a positive effect. This is due to the nature of rock detectors with rocks of varying hardness and due to different geological times and the response to moisture in all its manifestations with availability of the regression factor and the absence of these slopes of natural vegetation.

This quantified and provided a natural environment suitable for the activity of water erosion with high-capacity erosion of water slides. With rill erosion, the large collection consists of small and non-narrow waterways fixed on the slopes due to rainfall, and increasing numbers increase the degree of slope, decrease plant density, and thus increase the process of erosion of surface soils and rocks fragmented and broken through weathering that is different for low areas at the feet of mountains and in the valleys of Gribko, Bourneq, and Gozah Raqqa. At the estuaries, these flushes often help transfer sediments from the upper sources of rivers that lie outside the boundaries of the study area, such as the valley of the Akkab, through the waterways that lead to these liquefactions.

After adding the results of the equation for twelve months, the area capacity is extracted through the climatic data available to us about the study area from the meteorological station Climate Connector and on the adopted by the world to measure the intensity of rain erosion listed in Table 2. The results have been included from the equation applied to the study area in the below Table 2.4.

Table 2.4 : Degrees of wind sculpture and description according to Chepil classification.

Year	**The amount of annual rain (mm)**	**The amount of annual rain (inch)**	**Average temperature ºC**	**Average temperature (Fahrenheit)**	**The rain Effective**	**Average wind speed (m/s)**	**Average wind speed (Mile/h)**	**Erosion rate**	**Description**
1979 - 2009	290.94	12.10	20.6	73.50	29.84	2,3	5.14	58.8	moderate

2.3.2. River Erosion

The river is one of the most helpful geomorphological factors in the formation of land surface features (Al-Younis, 1980). The lights perform erosion through carving of the sides of the valleys and their brightness in several ways, including:

1. Dissolution (chemical action). Solution produced from the chemical reaction between water and chemical solvents with rocks and granules at the bottom of the stream (Sherif, 1992). The geological formations of rocky layers that blindly pass through the waters of the light are different, so they differ in the degree of responsiveness to the processes of endurance and melting, and this process is the result of the water's interaction with the rocks of the earth's surface, especially soluble rocks like limestone. The chemical action gradually increases as chemicals such as carbonic acid interact with water, which helps to increase dissolution in running water. This is also aided by the role of groundwater in supplying rivers with solvent-containing water.

2. Hydraulic action occurs through the pressure of water on the rock formations of the watercourse, leading to the entry of water through the pores and cracks in the rock masses. This leads to expansion, especially at the time of freezing, until the rock breaks, as it does in the course of Wadi (Gozo Raku and Wadi al Akkab) (Sheikli, 2009)

3. Sculpture corrosion depends qualitatively on the amount of cargo carried in running water.

The kinetic energy resulting from the collision and friction of rock-born sediment forming the bottoms and sides of the valleys leads to fragmentation and removal of sediment (Al- Shalash, 1985). Erosion begins with the fall of raindrops that raise the mishmash of soils. These soils take run along with the flow of water, form torrents, and then cascade down the slope. This increases the erosion process along with the speed of the watercourse, and the friction of rocks and crumbs with each other increases the fragmentation, as in the valleys of Nir Allond, Nir Rahma, Wadi Beko, and others.

2.4. The Solutions

Protecting the soil from erosion by water entails improved leveling direction lines. Tape farming, where each two strips are sequential, helps prevent water from dredging the soil. Making terraces of stone walls, taking care to be perpendicular to the slopes, which in turn gets rid of excess water, protects against soil erosion. Strict penalties should be imposed for loggers. The use of barriers that mitigate wind, which in turn help prevent soil erosion, are encouraged, as is the use of organic fertilizers instead of chemicals, which can improve and strengthen the soil. Trees can help to stabilize the soil and protect it from drifting. Fertilizers should not be overused, as this leads to weakened soil. Spreading awareness about the importance of soil conservation and erosion protection is critical. Drainage of water used for grazing should be done by good channels. Industrial water should not be discharged into rivers and streams, as this will cause damage to soil. Pools and dams can be constructed to collect rainwater. Efforts should be made to improve vegetation and maintain grassland. The use of torrent water in the agricultural process should be encouraged, and trees should not be cut down for use as an energy source. People should not throw dirt and waste on the soil. Retaining walls can be built on mountainous and sloping areas to prevent erosion. Crop rotation means that a particular piece of land is planted with a particular crop for one year or more, depending on the type of crop and according to a special farming system, in order not to strain the soil and thus enrich it with organic materials. Soil can be protected from water erosion by conducting agriculture in the direction of leveling lines; these methods are effective in protecting low-sloped land. Cultivation by tapes is beneficial, provided that each band is consecutive and not cultivated in the same crop, and that agricultural operations are not performed for them at the same time. Here, the water that accumulates prevents the second tape and acts as a barrier of gonorrhea and drift. Construction of terraces with stone walls can be conducted perpendicular to the slopes, where the terrace is separated from the stone wall, with a slight inclination to prevent avalanches from strong rains and provide a drain outlet for excess water. Other ways to protect the soil from wind and water erosion are discussed below.

2.4.1. Mulch

Mulch is a protective type of covering that is in the direct contact with the ground and provides more protection than the canopy cover. It can be composed of straw, compost, wood chips, or sawdust. The mulch spreads evenly on the ground, helps to reduce water evaporation, controls weeds, and enriches the soil. It is likewise significant in protecting the soil where vegetation hasn't had sufficient time to establish itself. By absorbing the destructive forces of rain and wind, mulch reduces the erosion until seedlings are mature enough to provide their own protective cover.

Figure 2.5: Mulching of Soil as a Solution

2.4.2. Terracing

Terracing is an aggregate of contouring or land shaping in that the earth embankments or tops are designed to channel runoff water to a specific outlet. Terraces decrease erosion by lessening the steepness and length of hillside slopes and preventing damage by surface runoff.

There are essentially two terraces types: bench terraces and broad-base terraces. The bench terrace is one of the oldest terrace shapes and is used to reduce the land slope. The broad-base terrace is used to control and keep water on the surface of sloping land.

2.4.2.1.Types of Terraces

Terrace types vary depending on the adverse environmental conditions, the socio-economic status of the inhabitants of the areas where they are built, and other factors.

2.4.2.2.Horizontal or Level Terraces

These terraces are completely in line with the bypass lines on the slope and have sufficient capacity to receive all the amount of rainfall between each successive runway and are established in dry areas with deep soils where the slope is about 2–8% and its base broad is sufficient to allow for mechanized agriculture. There are three types: short flat terraces, long flat terraces, and single semicircular terraces.

2.4.2.3.Graded-Channel Terraces

Graded-channel terraces are constructed in the form of special drains that transport excess water from extreme rain and with a suitable slope that allows stagnant water in the runway to flow into a stream or trench. This runway is covered with vegetation before the runway is constructed, and the gradual slope of the runway is proportional to the water speed and soil type.

2.4.2.4.Listed Terraces

These arise on a simple gradient and are identical to the contour levels to receive the full water and transport, but the width varies by soil, mechanization, and services, and they are classified into two categories: broad-gradient terraces and narrow-gradient terraces.

2.4.2.5.Stone Terraces

These are some of the as oldest and most widely used agricultural terraces, in use since the antiquity of agriculture, and they are still used on many mountain slopes and in the valleys of Green Mountain in Libya, Morocco, Tunisia, and Algeria, as well as in the mountains of Yemen and China, as seen in many abandoned agricultural areas.

These terraces rise in steep lands and gradually build up their walls according to the slope with the available stones and fill the spaces behind the walls with agricultural soil, where the walls correspond to the bypass lines and the length varies according to the ability of the farmer, his possessions, and available labor.

2.4.2.6.Steppe Terraces

Steppe terraces arise inland and in dry areas with little rain. They must maintain an adequate layer of soil within the runway or transfer soil to it, and the walls are dry stone.

Table 2.5 shows the monthly and annual rainfall ability rates. According to the Fournier equation, temperatures for 1977–2009 are highest on average in July at around 32.9°C. At 7.4°C on average, January is the coldest month. The variation in precipitation between the driest and wettest months is 95 mm. The variation in annual temperature is around 25.5°C.

Table 2.5: Monthly and Annual Rainfall Ability Rates

Details	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Precipitation / Rainfall (mm)	67	72	95	64	26	0	0	0	1	1	46	64
Avg. Temperature (°C)	7.4	9.2	12.5	17.5	23.8	29.2	32.9	32.2	27.6	21.2	15	9
Min. Temperature (°C)	2.1	3.5	6.2	10.3	15.5	19.4	22.9	21.8	17.1	11.9	8	3.3
Max. Temperat	12.7	15	18.	24.	32.	39	42.	42.	38.1	30.6	22	14.

ure (°C)			8	7	1		9	6				7
Rain filling capacity	10.95	7.57	5.85	2.7	2.3				0.0001	0.0001	10.25	12.0

2.4.3. Benefits of Agricultural Terraces

Terraces have enormous environmental benefits. They contribute effectively to soil conservation and protection from erosion and washing, as well as to the conservation of water and reduced surface runoff. They increase the rate of internal absorption, the feeding of springs and streams, and flow and continuity, and they support the water reserves of surface and groundwater reservoirs. The terraces also work to improve the chemical and physical properties of the soil and increase its fertility and revitalization, especially the content of organic matter from the plants grown in it. They contribute to the preservation, support, and enrichment of plant and animal biodiversity in the region and reduce festering in winter, spring, and summer dust. The terraces also serve to protect roads in mountainous areas from landslides, especially in winter. The terraces greatly facilitate agricultural service work such as mechanical tillage, comfortable irrigation, etc. The flow of rivers and sluices can be controlled almost permanently in their streams by creating stone terraces to the right and left of their courses to protect neighboring lands from erosion or backfilling.

In an example of a successful Chinese experience, the Loess Plateau is located in northwest China, home to more than fifty million people. Its name is due to its dry and windy soils, and the highlands have been overused and over-grazed, which has resulted in increased soil erosion and poverty. The World Bank has undertaken a project to convert the severely degraded land, through one the largest soil erosion control programs in the world, into a sustainable agricultural production area through the establishment of agricultural terraces.

Sustainable farming practices have been introduced that have doubled farmers' income levels from about $70 to $200 per capita, reviving the degraded environment and protecting natural resources. With large areas of this plateau having been destroyed, this project has promoted natural regeneration of grasslands, tree cover, and shrubs on formerly cultivated slope lands. The re-planting of these areas and the ban on grazing has increased the percentage of permanent vegetation from 17 to 34%.

The flow of sediment from the plateau to the smaller river has fallen by more than 100 million tones, and improved sedimentation control has reduced flood risks through a network of small-scale dams to help store water for the needs of towns as well as for agriculture when rain falls. In the past, recurrent droughts have caused crop failures on slopes, and land scaling (in the form of terraces) has not only increased average crop yields but also dramatically reduced their variability. During the implementation of the second project, cereal production per capita increased from 365 to 591 kg per year, contributing to the restructuring of the agricultural sector and adapting it to a market-oriented economic environment. This has created appropriate conditions for soil sustainability and water conservation. Land scaling has required the paving of a network of roads to facilitate access for vehicles, farm equipment, and labor. Combating sedimentation and converting previously unproductive land to valuable crop areas has also helped to increase water storage for community use.

Figure 2.6: Terracing of Soil as a Solution

2.4.3.1.Vegetated Waterways

Vegetated waterways are structured to protect soil against the concentrated runoff erosive forces of sloping lands. By concentrating and collecting overland flow, the waterways absorb the destructive energy that causes gully formation and channel erosion. The waterways can have cross-sections in the parabolic, triangular, or trapezoidal form, depending on the functional requirements. Some of these demands are channel capacity, climate, and the desired flow velocity. Grass linings should be strong and dense and include perennials adapted to the geographical region and the soil. The grass should be sheared periodically, fertilized as necessary, and not be subjected to prolonged traffic by either livestock or vehicles.

Figure 2.7: Vegetated Waterways of Soil as a Solution.

2.4.3.2.Contouring

Contouring entails tillage and crop planting on or near the same rising or “contour.” It is applicable to comparatively short slopes of up to about eight percent steepness with fully stabilized soils. By planting against the slope rather than up and down it, contoured hills slow or stop downhill flow. Between those contours the water is captured, thus reducing water erosion and increasing soil moisture. The effect of contouring on the yearly soil loss rates differs with the slope steepness, but typically from about one half and up it is reduced with down the hill farming when the slope is between four and seven percent.

Figure 2.8: Contouring of Soil as a Solution.

2.4.3.3.The Strip Cropping

Tape planting is an effective and inexpensive way to control soil erosion. It is a mixture crop rotation and contouring where alternative rows of line crops and soil conservation crops or produce are grown on the same slope, perpendicular to the flow of water or wind. When soils are separated by row crops from wind or water forces, dense crops can protect the soil particles and reduce wind translation and/or runoff (URL-2).

Figure 2.9: Strip Cropping of Soil as a Solution.

CHAPTER 3

METHODOLOGY

3.1. Soil Slides (or Soil Runoff)

There are slight soil slides (or soil runoff in the areas surrounded the city), especially on the slopes of hills in areas of fragility to the plain where the rain is stripped and thus distributed to the slopes, as in the mountains of Atshana surrounding the city. It's a rare occurrence that curses the people of Mosul. When the soil is composed of spongy and thick soil, the soil can absorb water and lose its rigidity, thus becoming flexible enough for a simple push to make it move, as once completely moistened with water, it acts like a real liquid. In all cases, the moving mass moves somewhat clear of the segment located in a peak pitch and lands in the shape of a lens or may take the shape of a sculpture composed of sequential sticks and studs. "Soil slides" is a term used to denote the movement of rocky debris that permeates the soil (Al-Omari and Jasim Ali Jasim, 1985).

The water drift is caused by runoff of the surface water or by the impact of raindrops on the soil, and it increases the effect of water erosion when the rain is heavy so that the soil cannot absorb water. Soil erosion is an extreme threat to flora and fauna in different areas in the world, which makes it more dangerous than soil processes that, are very slow. To form a layer of soil thickness of 18 cm between may take between 1,400 and 7,000 years, and it is estimated more than 23% of agricultural land has deteriorated in the past of 100 years due to erosion (Bathers and Vibor, 1995). Soil mass movement is a phenomenon associated with water erosion, as this movement is a result not of water's kinetic energy but of water-lubricated action whereby a layer of mud becomes saturated with the water.

Figure 3.1: Soil Slides (or Soil Runoff) of Soil as a Solution.

Conservation of natural habitats and development of natural vegetation can help remediate this problem. The following conditions allow the soil masses to slide down:

- High-intensity slope allows sliding soil mass.
- The presence of a layer with little soil permeability is somewhat far from the Earth's surface.
- There is enough water in the soil mass to saturate the layer above the sub-layer.

Although soil erosion has been a natural phenomenon since time immemorial, it has significantly increased as a result of human activities:

- Removal of natural vegetation.
- Overgrazing, particularly in the dry period.

Informed agricultural practices, such as plowing the soil in times of drought, are not appropriate as they can break the soil surface layer and make it vulnerable to erosion.

Means of reducing soil erosion and desertification:

- Especially in harsh and semi-harsh areas, conservation and natural resources development, such as installation of dunes, constitute the most important of these means. Environmental surveys can help find out the reasons leading to the deterioration of ecosystems.
- The establishment of front and defensive barriers as first lines in front of the progress of the sand. Establishment of small windbreaks.

- Covering dunes as follows:
- Dead plant materials.
- Petroleum products, chemicals, or rubber materials.
- The planting of dunes with suitable plants for the middle of the dunes**.**
- Stopping the expansion of rainwater at the expense of natural grazing.
- Exploitation of floodwater in agriculture.
- Stopping vegetation logging as a source of energy.
- Control of irrigation and review of current irrigation and drainage methods.
- Dry agriculture, if plants are needed for low water and are highly resistant to drought.
- Improving soil structure by adding organic matter to it and plowing it with the plants that live in it.
- Elimination of the steepness of the land by establishing terraces.
- Plowing land in the first rainy season. Creating ponds and lakes in grooves to stop runoff.
- Establishing dams to reduce the power of floods.
- Preserving vegetation and avoiding overgrazing runoff from trees and shrubs.
- Surrounding fields and grasslands vulnerable to factors affecting erosion by water (Abu Ayana, 2004).

Many factors affect the rate of water erosion, including nature of the rainfall, soil composition, geography of the area, vegetation, and human activity.

3.2. Raindrop Size

The greater the volume of droplet falling, the greater the kinetic energy in it because kinetic energy of a body is equal to the body's mass times the square of its velocity. The energy exerted by raindrops is greater on a shelf of bare soil without vegetation, as the amount of volatile soil granules absorbs the impact and the distance to which these granules jump increases **(**Al-Kaabi, 2001).

The degree of surface runoff depends on several factors:

- The amount of rain falling and its system and density.
- Degree of slope. Surface runoff is greater on a steep slope because flow velocity reduces the time available for water absorption.

- Infiltration capacity. Clay soil, characterized by its low permeability, does not allow water through, so the quantity of running water above its surface is greater as opposed to sand. With gravel, which is more permeable and allows water through, there is little water left for surface runoff.

3.3. Nature of Vegetation

Grass reduces the impact of rainfall and impedes surface runoff. Absorption is assisted by root structures. It is established that with fine granular weathering materials with surface flocculation abatement that are minimal or non-existent above the crest of the slope, the transport is evident and rises much above and away from the slope (Horton, 1945). The top is due to the verity that the erosion did not occur in a known area on dividing lines where water is the centerpiece of the crest of the slope. The width of this range differs depending on the absorption of the material cover weathering on the slope, the intensity of rain, and the degree of the surface slope away from the top. The degree of descent of the slope is particularly important, as the observations indicate that transport through erosion increases steadily as the gradient increases to 40 degrees, then it decreases transport until there is no erosion at all upon reaching the existing ramp (90 degrees). Many dissected species are seen in areas that are not affected by water erosion, while the roofs of the plateau appear to be moving away from those peaks.

They have been defined by water tables and have become rough rugged (Al-Matri, 1999). However, some geomorphologists do not agree that irrigation is increasing erosion in a downward direction on the slope. They state that the erosion of the tops of the unit and the reduction of surfaces by different types of surface runoff erosion is very important, and it is expected that the erosion process will be active in a small but sometimes non-natural environment. The environment of the soil is characterized as completely exposed to erosion because it adds to the lack of vegetation naturally. The low rainfall makes the soil dry and more vulnerable to erosion.

Water may mean limited erosion in dry areas. as many researchers believe that the ability of air to complete abrasion and erosion is very limited. Water must be present to complete this work. Despite the deficiency of water due to lack of rainfall lack, it is believed to be responsible for most of the erosion in dry areas. Air has proven to be very ineffective and not as responsible as previously thought for most of the phenomena in dry zones. The air is of low density and lacks the viscosity characteristics which are necessary to complete the process of erosion (Rihani, 1990). However, there are some manifestations on the earth's surface that can only be explained by air erosion.

Air erosion is limited in its impact. Even in dry lands water has a greater impact and is responsible for a massive number of surface features that characterize the mountainous semi-arid regions. The pediments phenomenon, which arises from water erosion, is an important geomorphic problem resulting from erosion as previously discussed.

3.4. Loss of a Large Amount of Rainfall

The loss of the soil surface layer by erosion leads to the emergence of a layer on the surface that is less porous and permeable to rainwater, causing a large part of the rainwater to be lost in the form of surface runoff instead of leaching into the soil. Since plants can only benefit from water that’s been filtered into the soil and stored in the form of moisture in soil areas, the higher the surface runoff, the greater the rainfall amount that could have been utilized in agriculture to improve low soil fertility (Al-Ashaab, 1979).

The erosion of the soil surface layer, whether by running water or wind erosion, results from the loss of large amounts of plant nutrients because the surface layer that is drifting is the affluent soil layer of nutrients. Nitrogen, phosphorus, and potassium are the most important nutrients for plants that are lost by erosion of the soil surface layer.

3.5. Increased Return of Agricultural Land

With the erosion of the soil by running water, deep grooves are formed in places where water flow is concentrated. This makes the soil surface rugged in front of agricultural machinery used for tillage, spraying pesticides, and harvesting.

Irrigation and drainage channels and reservoirs in soils drilled by running water and wind are more costly to maintain and less efficient. The cost of maintaining irrigation channels and water reservoirs in soils in the US was estimated at $15 billion (Al-Bazzaz and Al Ani, 1979).

3.6. Land and Agricultural Landfill

Cultivated areas and the structures for burial are exposed to the transferred materials, especially the creeping sand in desert and semi-desert areas. Entire oases and villages may be lost under creeping sand, as in the case of the Great Desert and the eastern region of Saudi Arabia. The maintenance of land roads from the deposition of sands is a major financial burden in many desert areas, so many countries have installed wood or asphalt barriers on the sides of roads to reduce amount of sand that reaches the paved road (Al-Bazzaz and Al-Ani, 1979).

3.7. Surface Water Contamination

When agricultural soil contains high levels of chemical pesticides and fertilizers, soil erosion by running water leads to pollution of rivers and lakes by these materials.

3.8. Air Pollution

Wind erosion causes fine dust to form in the air, leading to low visibility and health problems, most notably asthma.

3.9. Biodegradability of Rivers and Lakes

When soil drifts occur with surface water, the water of rivers and lakes becomes turbid, resulting in low penetration of sunlight into surface waters (Hassan Ramadan).

CHAPTER 4

STUDY AREA

4.1. Wind Erosion

The issue of wind erosion is an important topic because it has a negative effect on the geographical environment by removing the surface layer of the soil. This results in environmental, economic, and social problems as the wind contributes to the removal and transfer of surface soils from their original places to other places through a range of processes from mechanical air, transfer, and sedimentation processes. This complex process of mechanical events occurs in a series. Many geographical phenomena have arisen because of these processes (sand), and desert creep around the vegetative areas and climatic systems in the province of Mosul is characterized as being driven by wind activity. The wind causes the transfer of soil granules from their original areas to other places at high speed, causing sand accumulation and the emergence of sand dunes which move from place to place according to the speed of the wind. The island region in the province of Nineveh experiences this phenomenon and appears to crawl. The desert is widening to the north where the rain line passes through the south of Mosul city in the urban area and to Sinjar, and we find that the desert invasion has caused a retreat of the rain line to the north of Mosul and transformed these areas to desert areas, resulting in a range of environmental problems. Therefore, the economic work must entail a set of measures to curb this dangerous phenomenon, which will cause significant economic damage if the province does not address it. Windbreaks are established to face environmental challenges in different areas, including winds that arise in nature as a result of the movement of air from high-pressure areas to low-pressure areas, and there are factors affecting the wind, including barriers or natural barriers such as forests, mountains etc. The wind speed observed 33 feet above ground was twice as fast as it was 1.5 feet was twice as fast as it was 1.5 feet above ground. Wind causes various types of damage to plants and disrupts balance due to the abnormal increase in transpiration caused by gaps in the surface of plants. A researcher and environmental expert states that with several environmental organizations based in Malaysia, the loss of water from the vegetative total increases as the wind speed and temperature increase, resulting in lower water content of plants. As water is necessary to regulate various biological processes, the plants then show signs of wilting on leaves, small branches, and flowers. As air currents pass through the moisture-saturated surface of the soil, much of this soil water is converted to vapor, resulting in significant loss of ground moisture without the benefit of plants. The death of some plants grown in areas near the sea, as a result of the excess salts in water vapor carried by marine currents, is an example of this physiological damage.

Mechanical damage occurs to plants when the wind speed is high, causing breakage in branches and the fall of leaves, fruits, and flowers, and can result in more severe mechanics, with large losses to agricultural production. There is damage to the soil because the wind causes aerial drift of the soil, moving it to other places, as well as the movement of sand, especially when winds are high and the ground humidity is low. In such cases, sand may reach places where it can cause danger, such as streets.

Fertile soils are considered to be one of the most important natural resources that must be preserved. It has been proven that for the soil to form a fertile earth layer 3 cm thick requires a period of four centuries or more, depending on the type of soil, vegetation, and geographical location, so the soil must be preserved. The wind usually causes a clear erosion of the soil, and this erosion is intensified in dry and semi-arid areas, and when the wind blows and removes part of the surface of the soil, it also erases the root total of plants, causing further deterioration of economic plants.

This should be addressed through planting of trees, not plowing in dry seasons, and plowing of vertical lines as a result of the decline of agricultural land.

Planting barriers according to the process of wind drift and aerial drift can address the main danger to the soil, as the risk of aerial erosion and loss of soil's most important components and contents has been confirmed by many researchers and those interested in agriculture.

Drought is rarer in wetlands, sub-humid lands, and protected areas due to dense natural vegetation. The importance of bumpers is that they form a plant barrier of trees belonging to the family of shrubs or trees that prune without the wooding of their branches. These are composed of a row or several rows of shrubs and trees that confront the wind before it reaches the fields and orchards, breaking the wind and reducing its intensity and harmful effects on different plants and crops.

4.1.1. Temporary and Durable Bumpers

Fenders are protective in several ways, including division by purpose, and include windbreak pastures as well as agricultural buildings, and others are established for the public benefit protection of agricultural roads and railways. Windbreaks of agricultural crops, which can live for a relatively short period, and are usually grown from fast-growing plants with a suitable vegetative sum, such as castor and corn trees.

Temporary fenders are set up to protect some crops and trees so that they can grow for production, while for permanent windbreaks, high-perennial plants are used. Construction costs for permanent windbreaks are usually higher than the costs of temporary fenders, because the former need more care and agricultural service than the latter. In terms of benefit, the proliferation of permanent bumpers is more beneficial despite their higher costs compared to other types of windbreaks. For non-living and non-green bumpers, other types of windbreaks may be used, which are non-living materials such as palm leaf, wood planks, dry plant branches, and other materials that can reduce wind speed and protect the soil from erosion. Dry plants can be used in the installation of sand dunes in order to protect the seedlings that are planted in these dunes, and palm leaf is used to protect fruit seedlings during planting, where the palm leaf is organized around the seedlings in a circular form to protect them from the wind. Usually, non-living fenders are used during the growth of cultivated plants, as well as permanent bumpers, so as to achieve the purpose for which these type of fenders were established. The effects of reduced wind speed include reduced water loss from soil and plants and moderated temperature. The benefits include protection of agricultural and horticultural products and an increase in their production, as well.

4.2. Wind Erosion in Mosul City

Wind erosion is active in the desert and semi-desert areas where the soil is bare of vegetation and not coherent due to drought. Soil offspring by wind causes a loss of soil from large areas or loss of parts of the fields. Soil erosion is carried out in several ways, mainly suspension in the air of soft soil grains, such as clay and pellet granules, the saltation process for larger grains like sand, and surface rolling for larger grains. The wind moves slowly and gently and increases until it causes damage so great that buildings and large trees are destroyed. This is the case with the prevailing winds in the area of study in the northwest of Mosul, while the rest of the wind waves are a significant proportion compared to the main trends which vary with the different seasons of the year and atmospheric pressure centers in the season of summer. In winter, this is mirrored, so the trends in prevailing winds vary from season to season. The previous year’s season will increase the activity of the erosion factor in the region. The protected wind in the fire is blind in tilt because the earth’s surface in the jet is hotter. The air, through the friction of the toxic layer of the earth's moving air, leads to a thermal increase. It rises to the blind to protect a lower heat layer, but in the tilt the ground becomes colder, leading to stability of the air conditioning such that the blind rate of wind speed is 6.3 to 9.3 m/s for the station in Mosul. This is annually marked in the summer, while wind speed in winter decreases due to variations in heat and humidity. The year’s seasons affect the surface erosion of the area in general, especially in the summer, and separation of soil particles occurs with the help of other climate elements of high temperature and humidity peak, as well as the impact of wind. Also, wind erosion occurs along with water erosion and requires the absence of vegetation to be evident and highlight the disadvantages, as vegetation weakens the action of wind and reduces the fall of water. The action of the air is evident in low-rainfall areas with little or no vegetation. Due to lack of water, the soil is exposed to rain and air erosion in the case of sandy or organic soil, which dries quickly, and the granules in the wilderness are incoherent, of light density, and small.

4.3. Factors Affecting Wind Erosion

Various factors control wind erosion rate. These factors are related to the characteristics of the wind and to the soil nature itself, especially its physical properties, and include the quality of vegetation, human activity, and practices that destroy or maintain the soil.

4.3.1. Wind Speed

When the wind blows on the surface of soil composed of unbreakable granules, there is a limit velocity that begins when the soil granules move. This marginal velocity, which begins with the movement of granules, depends on the granule diameter and density and the density of the air (Al-Younis, 1980).

4.3.2. Size of Soil Granule Particle Size

The greater the size of soil granules, the greater their resistance to erosion due to the increase in weight. Because wind power is limited to carrying or moving material on the soil surface, fine particles such as clay and grit are suspended in the air. The wind cannot carry the sand but is driven by jumping or rolling over the surface. Concerning the size of the sand, the small grits only move from the road winding over the surface, while the larger grains of the wind cannot be swept away. Therefore, we find that many areas have been washed by the wind of their soft soil materials, and the drift was stopped after the surface became covered with a brush of gravel, which was separated (Sherif, 1992).

4.3.3. Soil Moisture

The moisture of the soil is inversely commensurate with the ease with which the wind dissolves the soil granules. The more soil moisture in the surface area, the more cohesive these particles become, thus reducing the chance of the wind being recovered or rolled back. Therefore, wind erosion in desert areas disappears after rainstorms and in areas that are wet due to their proximity to groundwater that is attracted to the soil surface by the poetic property (Sheikli, 2009).

4.3.4. Soil Crust

Among the soft soil materials that have been sunk by wind, in what is known as the phenomenon in some desert areas, there is a constant supply of groundwater or irrigation water to evaporate from surface of the soil, which concentrates the salts in the solution of soil until they reach the degree of saturation and then deposition occurs in the soil voids in the nutrient form composed of superficial crust. This makes it resistant to wind erosion (Al- Shalash, 1985).

4.3.5. Human Destruction

Through human activities on the surface of sedimentary soil, the soil erosion rates have recently increased in desert areas, the city of Mosul, and in areas of stability and human activity. This is because of the destruction of the surface layers of the soil, which has reached a stage of stability and ecological balance so that the winds can no longer affect it, as in the scattered areas in the desert. However, the irresponsible use of modern means of transport, especially cars, has resulted in the fragmentation and abrasion of these surface layers of soil and made the process of soil erosion accelerate again in these areas (Al-Shwara, 2004).

4.3.6. Cut-Down Trees

In some societies, people in the semi-desert and desert areas cut trees irresponsibly for many reasons, leading to a decline in vegetation density in the region or desertification, which makes the soil surface exposed to wind that can dissolve soil components (Sahawiya, 2014).

4.3.7. Overgrazing

Overgrazing of sheep and livestock is more likely to be tolerated by natural pastures. In desert and desert-like areas especially, it reduces vegetation density and soil cohesion, making the soil susceptible to the wind erosion. This problem usually prevails in areas where good rangeland management is not practiced (Al-Samarrai, 2008).

4.4. Transferring the Soil

4.4.1. Transfer

When the wind-driven energy on soil granules is greater than the resistance of these grains, which is related to the weight of the grains, it begins to move these granules. Smaller soil grains, represented by clay and sand grains, are the ones that the wind can extract from soil granules due to their low weight near the plateau. Once these fine particles are removed from the surface of the soil, they remain stuck in the air due to the swings associated with the wind, so the particles are moved away from the places where the particles were previously (Mohsen, 1985).

4.4.2. Jumping

When the grains of soil are the size of sand, the wind usually can only take them a short distance to fall again on the surface of the soil, where the impact of the jump is transferred to other granules, and so on. Usually, the wind force on the soil granules is limited and cannot lift the larger soil granules such as the spines, but it is enough to roll these grains over the soil surface without lifting them above the surface (Al-Nuaimi, 1987).

4.4.3. Weathering

Weathering is the dismantling of large, cohesive rocks into smaller parts ranging in size between large pebbles and ions. The latter results from the rocks' destruction and the removal of their component parts. The weathering is done in two complementary ways: mechanical and chemical.

4.4.4. Mechanical weathering

Mechanical weathering occurs through the cracking of the rocks and their fragmentation under the influence of external and internal factors, including:

- Movements of the earth's crust in cross-sectional cracks, which are the beginning of the eruption of rocks on a large scale.
- Multiple small cracks caused by temperature inconstancy that make the rocks subject to expansion and contraction. This heat effect is shown in the most severe desert areas where the difference in temperature is large.
- Water leakage in cracks and pores in periods of moisture and evaporation in during drought, followed by a comprehensive movement of the rocks that contributes to cracking.
- Freezing of the water in the cool areas inside the cracks and pores because of their increased size, thus causing cracking of the rocks.
- The growth of plant roots contributes to the expansion and creation of cracks in the rocks.

4.5. Vegetation Density or Vegetation Cover Control Period

Vegetation works to minimize wind erosion through several mechanisms. The denser the vegetation, the greater the friction of the wind and the lower the speed of the layer near the surface of the soil and thus a reduction of its ability to dissolve materials of the soil. The roots also support soil cohesion, increasing resistance to wind erosion. The third mechanism is limitation by the vegetation cover of the erosion of the soil by the wind, represented in the prevention of grains of sand from jumping and rolling as the branches and leaves reduce the drift rate (Al-kaabi, 2001).

Important means include an environmental survey to identify the reasons that lead to the deterioration of ecosystems. Installation of dunes includes the establishment of front and defensive barriers as the first line in front of the progress of the sand.

Establishment of small windbreaks for the cover dunes includes the following:

- Dead plant materials.
- Petroleum derivatives and chemicals or rubber.
- Plantings of dunes suitable for the center of the sand dunes.
- Preservation of natural pasture and development of natural vegetation.
- Stopping the expansion of rain-fed agriculture at the expense natural pastures.
- Exploitation of floodwaters in agriculture.
- Stopping the cutting trees and shrubs for use as an energy source.
- Control of irrigated agriculture and reconsideration of current irrigation and drainage methods.
- Dry agriculture: cultures of plants that require little water and are highly resistant to drought.
- Improving soil structure by adding organic matter to it and plowing it with the plants that live in it.
- Elimination of the steepness of the land by the establishment of terraces.
- Plowing the land in the first rainy season.
- Creation of ponds and lakes in grooves to stop runoff.
- Construction of dams to reduce the strength of floods.
- Preserving vegetation and avoiding overgrazing.
- Circulation of fields and lands prone to erosion by screens or fenders of trees and shrubs (Saad, 1999).

4.6. How to Conserve the Soil Erosion from the Wind

Ways to conserve the soil from drifting from the wind include controlling wind erosion through crop and pasture management. The most common crop production systems in Alberta are courses that include the summer and autumn. Continuous cultivation involves growing irrigated crops and fodder production. Wind erosion is a menace to soil in all four crop and grazing systems. You can maintain production and prevent wind erosion and by establishing protective vegetation in the soil. Tilling summer fields dries the topsoil, making it prone to erosion. Abstract fields are particularly prone to wind erosion in late winter and spring at the end of the fallow period, immediately after planting of the next crop.

The crop residue cover reduces evaporation, and tree residue collides with snow to obtain additional spring moisture. Also, crop residues reduce the wind speed on the soil surface, standing steadily in the soil. To maintain crop cover, some farmers choose to eliminate tillage and rely entirely on herbicides. Others replace one or more fallow periods with the application of herbicides. For example, you can control the annual winter herbs during late autumn or early spring. This allows you to delay the first transplant during fallow times until late May or early June. Also, rotary harrows can control the weeds without disturbing the waste cover if they are set to minimum activity. If you decide to do without them, keep plowing speeds at 8 km/h (5 mph) or less. When planting, use wide blades or low-crown sweepers that protect the waste cover. To leave more standing, remove combs from the farms. Avoid planting during the summer season after late August. The remaining grass will not drain too much moisture, but it will help trap snow and reduce wind erosion in the winter. Avoid erosion of tillage. Just upload your app when you are on Knoll. Finally, try to avoid falling into canola peels. They collapse easily and provide only limited corrosion protection and limited moisture retention benefits. Dense plants protect the soil from drifting due to wind. Preventing overgrazing and over-logging will help to preserve vegetation.

Work to reduce the erosion of the fertile the soil surface layer, creating barriers that reduce the wind speed. The use of compost helps the soil to hold and resist erosion. Selection of afforestation enhances soil stabilization. Human intervention in the process of solving the soil erosion problem entails the use of fertilizers with limited systems and standards. Spreading awareness of environmental education among farmers, herders, and livestock keepers should be a priority. Drainage of water used for irrigation should be done by making good channels. The source of irrigation water should be safe and pure.

4.6.1. Protecting Continuously Cropped Fields

Wind erosion in crop systems is usually caused by tillage practices that bury most or all of the waste from the previous crop. Reducing or removing tillage will preserve the waste cover to control erosion with the added benefit of keeping the soil moist. When you decide to plow, use a low plowing speed, choose tools that bury less waste, and avoid the painful pillar base.

Reduced or zero-tillage systems should include crop residue management. Waste management begins at harvest. Use the mixture to spread the straw evenly and peel the overall width of the pieces. Regular deployment helps reduce problems such as the delivery of seed equipment and uneven crops.

Figure 4.1: Protecting Continuously Cropped Fields of Soil as a Solution. In Reduced and Zero Tillage Systems, Crop Residues Must Be Spread Evenly.

For direct seeding systems, use high-clearance growers. Often, the process of planting seeds in stagnant hair is not as difficult as planting seeds through a diluted stalk. The types of ground opener range from those that barely disturb the soil to those that disturb the soil enough to provide some control over the weeds during sowing. After harvesting, you may need to use oscillating harrows to spread straw lumps. A rotary or loose mower can be used in the spring to cut very heavy waste or tall straws. Avoid burning an harvested crop or widespread straw. Burning humus destroys the soil and organic carbon, making the soil vulnerable to erosion.

4.6.2. Protect Irrigated Fields

In irrigated fields, waste management often involves burial of heavy crop residues produced by high-yielding crops (such as soft wheat). This can leave these fields extremely prone to wind erosion. As with other crop production systems, the best method to control wind erosion on irrigated land is to preserve the cover of crop residues by reducing or eliminating tillage. If possible, cut crop residues and spread them evenly using the set. Make sure that the cutting and assembly equipment in the kit works well enough to clean the seeds in the spring. You can also manage very heavy waste by cutting it with a mower or rotary mower. Bales and heavy waste disposal are another option as long as there is sufficient residue to conserve the soil from erosion. Irrigated produce like sugar beans, beets, and potatoes leave little residue. Special measures are needed to prevent wind erosion in these areas. For crops that are harvested early, cover the oat or rye crop. Crop yields are able to grow sufficiently before winter to protect the soil but will not present a waste problem the following spring.

The irrigated angles of the pivot irrigation fields tend to be the focal point of wind erosion. Planting feed or grass on these corners will protect them from wind erosion.

4.6.3. Protect Feed Fields

Feed fields can also be damaged by wind erosion. The biggest danger is when the fields are divided by heavy discs and plows to convert them into annual crop production to control and regenerate weeds. Direct sowing of feed, oilseeds, and grains in feed racks is the best method to reduce the risk of corrosion from feed conversion.

The seeds can be sown in the feeding position directly after the pregnant woman has been killed with herbicides. Autumn spray, usually using glyphosate, provides a good suppression of forage plants. Research shows equal or better returns compared to plowing.

4.6.4. Pasture protection

Overgrazing reduces long-term pasture productivity and leaves the soil vulnerable to erosion. Grazing should be managed to leave appropriate vegetation. In general, for permanent pastures under continuous grazing, leave about 50% of the current growth of the original range and about 25% for irrigated grazing.

4.6.5. Shelterbelts

Field protection belts can provide additional protection against wind erosion regardless of the harvesting system used. They are particularly very important in dry years when low yields lead to inadequate waste coverage. Field protection belts reduce wind speeds for distances up to 30 times the height of trees. They also trap ice, which increases soil moisture to increase crop yields. This increase in revenue helps offset the loss of revenue associated with the purchase of land from crop production to belt farms.

Figure 4.2: Shelterbelts of Soil as a Solution. Field Shelters Reduce Wind Erosion and Maintain Soil Moisture.

To make the most of harbor belts, you will need design planning, species selection, site preparation, and weed control for the first years, followed by trimming and other maintenance. You will need to choose the right species for your area. New weed control options such as sawdust, cloth, or bark have reduced the effort needed to create shelter belts.

4.6.6. Increased Surface Roughness

The roughest surface reduces wind speed on the soil surface, and therefore the wind is less able to move soil particles. Tearing soil clay: Fragmentation of clay soil with nails is usually performed with non-corrosive clods to create a rough surface. If the clods are likely to break down quickly, then the distance between passes should be about 5 m (15 feet). This way, the procedure can be repeated later if necessary on the untreated strip.

Figure 4.3: Increased Surface Roughness of Soil as a Solution

Shredding is an emergency measure performed to reduce wind erosion in clay soils. The sand soil list is used in sandy soils because it does not produce permanent hills. The menu removes the soil and lifts the firmer soles. It should be done perpendicular to the erosion wind and should always start on the other side of the field. Treatment of the entire field significantly reduces corrosion. Borrow shovels are mounted only on the back strap of heavy-duty endurance farms.

Tree shovels (33 or 38 cm [13 or 15 inches]) are commonly used to produce irrigated potatoes in southern Alberta. After inserted correctly, the flat surface of the field can be changed so that the edges are 25 to 30 cm (10 to 12 inches) higher than the sinks, and about 90 cm (36 inches). For insertion to work, the shovels must be able to reach a depth of 15 to 20 cm (6 to 8 inches).

Figure 4.4: Increased Surface Roughness of Soil as a Solution.

4.6.7. How the Sandy Soil List Reduces Wind Erosion

When tearing or inserting, tillage speed should not exceed 6.4 km/h (4mph). The surface grossness should be increased before the soil freezes. Even frozen soil can be eroded. The layer can be swollen once if it is thawed and dried only a few millimeters away.

4.6.8. Covering the Soil with Fertilizer or Straw

Fertilizer is preferred as a soil cover because it also enhances soil fertility and tillage. Depending on the soil, a rate of 30 to 60 tones/ha (15 to 30 tones/ha) is needed to conserve the soil. Evenly spread the fertilizer, and do not work in the ground.

The spread of straw from 2 to 4 tons per hectare (1 to 2 tons/ac) also protects against soil erosion. Straw should be torn rather than used in small bales. It should be installed with the disc lock to install it against the wind. Place the straw before freezing because it is difficult to put straw in the ground once the soil is frozen.

4.6.9. Summary

Wind has plagued the erosion of agriculture for decades. However, with today's farming equipment and practices, controlling wind erosion can easily be part of crop and pasture management systems.

The following measures can help control wind erosion:

- Conservation of vegetation.
- Agriculture or crop residues.
- Reduction of cultivated fallow.
- Reduction or elimination of tillage.
- Selection of a plowing application that will bury less waste and reduce plowing speed.
- Planting and maintaining field shelter belts.
- Avoiding overgrazing.

These measures also benefit crop and pasture production system through conservation.

4.6.10. Soil Moisture to Improve Yield

Modern harvesting equipment and waste treatment allow farmers to effectively manage crop residues. In most cases, a good cover for crop residues can be maintained without impeding subsequent equipment operations or crop growth. The choice of agricultural equipment now provides excellent waste clearance, depth control, and packaging, so you can grow crops by permanently spreading waste. However, constant drought and strong winds can cause wind erosion even if preventive measures are used.

Use emergency controls if wind erosion is imminent or in its early phases. Emergency controls include tearing the soil to fetch hills, rolling to change the shape of the soil surface, and fertilizing the soil with straw or straw. Wind erosion is a serious problem that threatens the long-term productivity of coral soils. With proper conservation cultivation techniques, you can reduce wind erosion in most conditions. Soil is a precious resource that must be protected (URL-3).

CHAPTER 5

RESULTS AND DISCUSSION

5.1. Role of Forests in Mosul as Windbreaks and in Remediation the Soil

Natural forests are one of the most valuable natural resources to be preserved, both for the economic benefits as well as the environmental aspects that have taken center stage as a result of the cultural and industrial developments taking place in the world and what it takes to clean the air of dust and pollution. Natural forests are an effective means of reducing desertification and stabilizing soil as windbreakers. The researcher's choice of Ninewa as the study area was made because the environment of land and climate is suitable for the growth and regeneration of both natural forests (Sinjar, Aqra, Shikhan, Baiksha) and artificial forests (forests in the Mosul area on the banks of the Tigris River, the forests of the Nimrod region). The development of natural and artificial forests in the province is essential, and the development of these forests as windbreakers requires knowing the species that are appropriate for the desired goal and suitable for the climatic conditions to ensure that the city and its regions are surrounded by a green belt. In addition, developing irrigation of river-feeding basins in the governorate such as the Tigris River basin and the Khosr River basin, as well as some of the seasonal valleys in the province, can address the problem the soil erosion to achieve other economic benefits. For all this, it is very necessary to identify the environmental problems that face the region and address them through a set of conclusions and recommendations. The forests in the Ninawa Governorate are geographically located at latitude 39.19° north and longitude 9.43° east and sit 222.5 meters above sea level. The rainfall rate is between 400 and 600 mm. Therefore, the province is within the BShs region, which is considered a transition zone between the dry climate to the south and the wet temperate climate (BWhs), which dominates the northern parts of our country (Hassan, 2003).

Green for most of the year, Ninewa is the fourth largest country in terms of forests, and the natural forests in the governorate cover about 514,300 acres, of which 281,200 acres are dense forests and about 96,680 acres are medium-density forests, as is the case with forests in the area of Atroush and Shikhan. The open forests in the province cover an estimated 121,520 acres as with the forests of Mount Sinjar, Mount Maqloub, and Jabal Aqra. Additional forests on the banks of the rivers and valleys of the seasonal period are estimated at 14,900 (Hassan, 2003).

Table 5.1: Areas of Forest Regions

Position	Percentage	Areas/Acres	Types
Mosul	-	211,200	Intensive Forests
Atrosh/Shekhan	-	96,680	Medium-Intensive Forests
Sinjar/Aqra/Maqlwb Mountain	-	121,520	Open or Unguarded Forests
The Banks of the Tigris River, Khosr River, and seasonal rivers	-	14,900	Forests of Riverbanks

Forests in the Ninewa province are subdivided into natural forests formed without human intervention and artificial forests for which humans have played a major role in their formation. Take a look at the forest map in the province.

Ninewa shows us that the geographical distribution of forests occurs as described below.

5.2. The Forests of the Sinjar Region

This area is clearly visible on the southern slopes of Mount Sinjar and has an area of artificial forests covering 5,600 acres. Pine and cypress are the main species, and the forest of 5,000 acres contains the most important species of natural oak as well as other types of pine trees, pistachio trees, and a bead of green, sumac, and kazurina.

The density of fruit trees and varieties in the forests of Sinjar is due to the abundance of groundwater and its connection to agriculture.

5.3. Mosul Forests

The forests of Mosul are located on the banks of the Tigris River and are almost triangular in area. The ancient bridge and its base is Al-Rashidiya, a natural forest with an area of 900 acres. The most important trees in the forests of Mosul are the euphaltopus, pine, cypress, caldera and kazurina. The forests of Mosul have clearly declined as a result of human activities such as offal as well as the climate, as the bulk of the province falls within the dry climate, so the location biogeography has a negative impact on vegetation and the components of the environment. This effect is exacerbated by the fragility of prevailing ecosystems and the over-exploitation of natural forest resources (in addition to the pastoral ones) (Al-Samarrai, 1999).

5.4. Forests in a Nearby Area

A collection of green areas within the study area where olive groves are located covers about 1,578 acres with a total of 148,209 trees. The village's groves come first in terms of area, where the olive trees occupy 1,006 square meters. There has been an expansion in the cultivation of olive trees recently, and the number of planted trees was estimated at about 2,487 in 2000 (Al-Saeedi, 1986).

5.5. Forest of the Nimrod Region

This region is located to the south of the city of Mosul within the basin of the Tigris River and covers an estimated at 223 acres. It contains one of the most famous tree species, the yukaptus, and the geographic conditions have helped the growth of forests, especially the elements of climate and land (Muhammad, 1985).

5.6. Forests as Windbreakers

These are meant to be tall plants that reach certain heights above the earth’s surface and stand in the way of the direction of the wind, reducing its speed and eliminating its intensity.

Windbreakers successfully resist desertification by reducing air pollution, protecting soil from erosion, and protecting agricultural crops, transport routes, and installations. The windbreaks in the Ninewa governorate are simple and need to be developed to increase their efficiency. The bumper consists of a row of trees followed by a row of cypress trees 2–3 meters away to develop an integrated plan of artificial agricultural forests in the province in general and in the city. This sequence creates different heights, which provide density to counter evaporation from the openings, and the cypress trees are planted in the waist of the bumper because they are high.

Ninewa is without any integrated project as a windbreaker (Najm and Hammadi, 1980), and planting fenders in the province faces a range of problems, including:

- Lack of full coordination in planning and application between the various state institutions in the province that deal with agriculture.
- Lack of awareness of the population such that seedlings are exposed in their first days of grazing or are cut off for household purposes when integrating their growth.
- In particular, it is very necessary to limit the project to suitable geographical locations for agriculture and within the city limits.
- By surrounding the city with a green belt of artificial forest trees, the source can be implemented (Iraq Ministry, 2000).

The shape of green lines or belts that extend for a large distance is arranged as follows:

- Faulty bumpers and boulders are made of 1–3 lines of trees spaced 4 meters apart.
- Semi-permeable bumpers be arranged from 1–3 lines of trees with a spacing of 2 meters between the trees and other closed bumpers.
- The bumper consists 3–5 lines, and the distance between trees is one meter (Mohammed Younis, 1998).
- The success of windbreakers in the province in general and the debtor in particular must be necessary to protect the bumper and preserve forests.
- Dead and diseased trees in the forest should be cut and removed.
- Appropriate development processes for programmed parts of existing mitigation.
- Reforestation of the forest by planting trees in the existing spaces.

- Establishment of nurseries to produce forest seedlings.
- Preparation of the necessary staff for the success of the process.
- Raising the necessary awareness with the public about the importance and preservation of forests.
- Enacting laws and legislation to conserve the forest.
- Construction of fire control towers and means of control.
- Organizing grazing within the forest.
- Work on terraces and dams inside the forest. To ensure the success of windbreakers in terms of growth, it is necessary to select appropriate species (Adel, 2000).

To ensure suitability for the geographical environment and to ensure the success of tree planting within the governorate and the city, it is necessary to choose species with the following characteristics:

- Resistance to drought and low need of organics, which are rare in semi-arid areas.
- Rapid growth under the geographical environment of Mosul.
- Strong resistance to the strong winds prevailing in the region.
- Root group that flows horizontally and vertically to exploit underground water.
- Ability to withstand sand (Abu Ali, 2009).
- Based on the above, the most important species suitable for agriculture in the province are eucalyptus, alasakia, and alcazorina.

The green building project around the city of Mosul will lead to several goals, including:

- Environment: Increase the beauty of the natural environment of the city.
- Climate: Improve the local climate of the city.
- Economy: Provide wood material for the furniture industry.
- Tourism: Create a tourist center around the city.
- Health: Windbreaks are the lungs of the city.
- Biology: Protection of animals from winds as it is scientifically proven that the productivity of dairy cows decreases in high winds.
- Phytosanitary protection: Soil protection from erosion.

- Biology: Forests play a main role in maintaining ecological balance (Rahma, 2000).
- Forests as a tool to reduce erosion.
- The force of precipitation decreases as it falls first on the trees, and then the leaves and branches, and drops to the ground after its strength has faded.

Vegetation has a noteworthy role in reducing the surface velocity by reserving vegetation cover to prevent long-term water loss. The low surface velocity directly reduces erosion and sculpting, particularly in the slopes of the recharge ponds (Al Abdullah, 1985).

For the study area, the reflection of the status of the vegetative cover in the process of drifting is a negative factor as a result of over-cutting, which causes severe damage to soil in areas where tree cover is present. It is scientifically proven that water is washed into about 20 g of soil/m^3 in the free soil from the trees, and each 3 m of water carries with it more than 500 g/s of fast-growing soil under shade (this describes the geographical environment of Mosul). Overgrazing within the study area (forest areas) is a negative factor because it reduces vegetation density and inhibits the natural regeneration of forests and trees as the animals eat the buds, preventing their normal growth and making the soil susceptible to erosion (Kharoufa et al., 1984).

Areas exposed to severe water scarcity within the study area comprise up to 3,034 acres compared to areas exposed to very high water quality, which cover 304,000 acres. To control desertification, natural forest areas need to be protected from soil erosion. The important areas that must be included in the plans are the sources of the basin of the Khosrs tributary as well as the banks of the Tigris River north of the city of Mosul. This is necessary to overcome the phenomenon of ignorance and drift (Michael, 1981).

5.7. Prospects for Forests in Ninewa

Natural and artificial forests in the province have deteriorated significantly. As they have declined, their annual growth has declined so that they are far from responding to natural state requirements. The causes of forest degradation in the governorate are explored below (Hassanein and Ayana, 2004).

5.8. Natural Causes and Human Causes

5.8.1. Natural causes

One of the major natural causes of forest degradation in the province is the lack of rain during some years and uneven distribution throughout the year, causing poor forest growth during the high temperatures of the summer season as well as insect and disease infections that attack seeds, leaves, and stems, thereby reducing the forests' economic value (Al-Shalash, 1985).

5.8.2. Humman Causes

The most important human causes of forest degradation in the governorate are the following:

- Overgrazing is one of the main causes of forest degradation that has led to a decrease or disappearance of plants, as in the case of Sinjar.
- Cutting of timber to obtain wood is a negative and detrimental behavior in the forest area of Mosul, as are fires in the governorate's forests.

5.9. Transferring Agriculture

The continuous quest for agricultural land, especially in agriculture areas with water sources, such as on the banks of the Tigris River inside the city of Mosul, has led to the deforestation of large areas of the province. The current state of forests in the province indicates a clear decline in vegetation. It was therefore necessary to draw a clear policy for forestry, concerning both natural forests and artificial forests, through the mobilization of all the possibilities of conservation and interaction with the community and activating the role information in this direction. This was necessary to ensure a better future for forests in the province (Iraq, Ministry, 2000).

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

1. The subject of water erosion is one of the complex and important topics that have negative impacts on the geographical environment through removing the surface layer of the soil and the resulting environmental, economic and social problems, where sweeping torrents, running rivers and fallen snow contribute to removing and transporting an entity of surface soil from its original places to other places Through multiple processes of erosion, transportation, and sedimentation, and this complex process passes through a group of mechanical and chemical activities, represented in the phenomena of erosion and sedimentation, many plains have arisen due to sedimentation factor and in large river streams such as the Tigris River in Nineveh Governorate where the river performs the vertical and lateral erosion process through The process of composing the river, deepening the course of the river, stripping the banks, drifting large quantities of education, removing and carrying it by the river to be deposited in other locations to the south of the city of Mosul, which helped to increase the effectiveness of river river slope and speed of flow, and these activities have caused the emergence of river islands in the middle The course of the Tigris River, as in the case of Umm Al-Rabiah, in the forest area in the city of Mosul, so the waterway is in a tide Mosul has a Tigris river, especially during the flood season, where there is runoff and carrying large quantities of silt and children, and the color of water is revealed in a lot, as is the case in the flood season where the height of the water cause due to the abundance of falling thawed rain from snow above the highlands of the feeding basin and due to all the results Negative to the process of water erosion, it is necessary to find a set of solutions that help reduce these effects.
2. For the wind erosion also is one of the topics and important because of its negative impact on the geographical environment through the removal of the

3. surface layer of the soil and the resulting environmental, economic and social problems where the wind contributes to the removal and transfer of an entity of surface education from its original places to other places through a set of multiple processes from mechanical air, then the process of transportation and sedimentation, and this complex process passes through a set of mechanical activities. Many geographical phenomena have originated due to these processes (sandy) and desert encroachment around the vegetative areas, and due to the fact that the climate of Nineveh Province is characterized by being hot and dry in summer and wind activity, the wind Carrying out an air operation and transferring the soil atoms from their original regions to other places at a high speed, causing the accumulation of sand and the emergence of sand dunes and their movement from one place to another according to the speed of the wind and the island region in Nineveh Governorate from that phenomenon and the desert crawl began to widen to the north if the wind rain line passed South of the city of Mosul in the urban area and to Sinjar and we find that desert encroachment caused the retreat of the line (windy rain) to the north of the city of Mosul due to a desert encroachment what is clear is that the transformation of areas into desert regions resulted in a set of environmental problems at that time, and a set of measures must be taken to reduce this dangerous phenomenon that causes great economic damage from the province if it does not concern.

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