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Al-Quds University

Plant Biodiversity and Nature Protection of the UNESCO Site of Battir Including Wadi Al-Makhrour.

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M. SC. Thesis

Jerusalem, Palestine

1442/2021

Plant Biodiversity and Nature Protection of the UNESCO Site of Battir Including Wadi Al-Makhrour.

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A thesis Submitted in partial fulfillment of requirements for the degree of master of Science in environmental studies department of applied earth and environmental studies faculty of science and technology Al-Quds University.

1442/2021

Al-Quds University

Deanship of Graduate Students

Environmental Studies Program

Thesis Approval

Plant Biodiversity and Nature Protection of the UNESCO Site of Battir Including Wadi Al-Makhrour.

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Master thesis submitted and accepted, on ---5/6/2021----------

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Jerusalem - Palestine

1442 / 2021

Dedication

To my parents who spared no effort to raise, and teach me, God Bless them.

To my beloved husband who helped and supported me in my journey of this work until it came to light.

To my precious children may God bless them.

To my teachers and all sincere hands that helped me.

I dedicate my work.

Declaration

I certify that this thesis submitted for the degree of Master is the result of my own research, except where otherwise acknowledged, and that this thesis (or any part of the same) has not been submitted for a higher degree to any other university or institution.

Name: …….

Signed ……..

Date: / /

Acknowledgements

First and foremost, I thank God for he who enlightened my way to the completion of this work.

Gratitude is extended to my parents who supported me in my entire life.

Greatest thanks are extended to all of my teachers at Al-Quds University especially my supervisor Prof. Mutaz Ali Kutob. Appreciation and thanks are extended to Mr. Imad Al-Atrash CEO of The Palestine Wildlife Society for his great assistance in bringing this thesis to light. Finally, I would like to thank the staff at the Environment Quality Authority for their valuable assistance.

The greatest person who supported and helped me and did not spare any effort to assist me in my work and research activities, to my beloved husband I express my deepest gratitude.

Thanks to my children who tolerated me during my path to success.

To all hand that were extended to give me the power to carry on with my studies

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List of Abbreviation

PEF	Palestine Exploration Fund
UNESCO	United Nations Educational Scientific and Cultural Organization
Km	Kilometers
M	Meters
PCBS	Palestinian Central Bureau of Statistics
km^2	square kilometre
PNA	Palestinian national Authority
IPCC	Intergovernmental Panel on Climate Change
PMNH	Palestinian Museum of National History
CBD	Convention on Biological Diversity
G	gram
IAIA	International Association for Impact Assessment
TC	Total Coliform
FC	Fecal Coliform
TOC	Total Organic Carbon
CEC	Cation exchange capacity
REE	Rare Earth Elements
Mm	millimeter
°C	Celsius
WWF	World Wide Fund For Nature
NGO	Non-governmental organization
PCC	Pioneer Consultancy Center
IUCN	International Union for Conservation of Nature
EC	Electrical Conductivity
PH	Phanerophytes

N	North
E	East
BOD	Biochemical Oxygen Demand
ICP-MS	Inductively Couples Plasma Mass Spectrometry
O	Organic
A	Surface
Cm	centimeter
Mg	milligram
WHO	World Health Organization
L	Letter
Fe	Iron
Ba	Barium
V	Vanadium
Cr	Chromium
Co	Cobalt
Ni	Nickel
Cu	Copper
Zn	Zinc
As	Arsenic
Pb	Lead
Se	Selenium
Cd	Cadmium
Mn	Manganese
Ti	Titanium
Be	Beryllium
Al	Aluminium

Abstract

Biodiversity is an essential element of human life as it provides economic, social, and environmental benefits. Plant biodiversity is a major element of the total biodiversity on planet Earth. Plants, with all species, constitute a breathing lung for the human being and other living animal kingdom. Conservation of biodiversity has become a major and urgent issue for humanity mainly due to the scientific observation its significant decline that is caused by the extensive industrialization and human errors in treating the environment. The environment is the major effect on biodiversity conservation, therefore, keeping healthy environment guarantees sustainable biodiversity. Battir and Wadi Al-Makhrour represent the biodiversity of the Bethlehem area of Palestine. This research is a study to provide a list of all the plants that constitute plant biodiversity in the latter, provide an evaluation for the water quality that comes out of the natural springs in the former as well as an analysis for the soil in Battir to provide an analysis for its constituents of minerals and heavy metals. The main aim of this research is to investigate the water and soil quality in order to identify any problems that may affect the conservation of the plant diversity in those areas. The analysis of the three activities were analysed and revealed that a) plants in Wadi Al-Makhrour were diverse and distributed in such a manner that some plants were present along the trail from start to finish, many of the plants were of medical use. b) the water test showed that the water that come out from the natural springs are free from both Fecal and Total Coliform, however, BOD showed that water was polluted with organic matter. Heavy metals measurements were within the allowed percentages quoted by the WHO and the Palestinian Authority standards. d) The soil test results showed that the soil of Battir is mainly Tarra Rossa origins and that the soil types are mainly Clay in both areas with Silty Clay resting on Dolomite rock in one sample. The other sample was on Limestone rock and with the same soil types. The color of the soil samples was the same. TOC showed that both places were of the same level of contamination. pH levels were alkaline. Battir village, as this study revealed suffers from persisting underground pollution due to the use of cesspits as a wastewater system which allows contaminated water to infiltrate into the underground which may well hit the aquifers. Data must be then brought to the attention of decision-makers and stakeholders in order to obtain support from the local surrounding communities.

Keywords: *biodiversity, environment, Battir, Wadi Al-Makhrour, conservation, sustainability.*

الملخص

يعتبر التنوع الحيوي من العناصر المهمة في استمرارية الحياة للإنسان والحيوان والنبات على وجه الأرض. التنوع الحياتي النباتي من العناصر الرئيسية في كامل التنوع الحياتي على وجه الأرض. لقد أصبح الحفاظ على التنوع الحيوي من المواضيع المهمة والطارئة للإنسانية وذلك بسبب التدهور الكبير والمتواصل للبيئة وبالتالي للتنوع الحيوي وذلك من خلال الملاحظة الحثيثة لما يحدث من تطور صناعي مكثف والذي يسبب الخلل في التنوع الحيوي. وتبعا لذلك فإن المحافظة على البيئة من اهم الطرق للمحافظة على التنوع الحيوي صحي ومستدام. بتير ووادي المخرور في فلسطين يمثلان التنوع الحيوي في منطقة بيت لحم. وهذه الدراسة عملت لتوفر قائمة بكافة النباتات الموجودة في وادي المخرور وطرق المحافظة عليه. وكذلك توفر الدراسة تحليلا لمياه الينابيع الطبيعية في بتير وكذلك تحليلا للتربة وتوفير تحليلا عما تحتويه من معادن ثقيلة وغيرها. وقد قامت الدراسة على البحث في المياه والتربة في بتير بالإضافة الى التنوع الحيوي النباتي. أوضحت الدراسة ان وادي المخرور يحتوي على تنوع حيوي نباتي كبير، خاصة في المسار السياحي و أن المياه المتدفقة من الينابيع الطبيعية خالية من النوعين من الكوليفورم وان فحوصات الأكسجين البيوكيميائي وقد دلت على وجود مواد عضوية فيها. توجد معادن ثقيلة وغيرها حيث وجد ان معظمها تتناسب مع منظمة الصحة العالمية والمواصفات والمقاييس الفلسطينية. أظهرت نتائج الفحوصات للتربة بأن أصول تربة بتير من ترب إقليم البحر المتوسط وهي تربة طينية حمراء اللون. وقد كانت قاعدة التربة في العينة الأولى صخرية رسوبية (دولومايتة) والعينة الثانية تقع على قاعدة صخرية جيرية. وقد بينت الدراسة أيضا ان بتير تعاني من تلوث مستمر للمياه الجوفية نتيجة استخدام كافة المنازل حفر الامتصاص للتخلص من الفضلات المائية والتي تتسرب الى المياه الجوفية وتلوث الابار المائية. وتقترح هذه الدراسة ان النتائج هذه تقدم الى كافة المسؤولين والمعنيين لاتخاذ كافة الإجراءات اللازمة للمحافظة على البيئة وبالتالي المحافظة على تنوع حيوي مستدام في المنطقة.

Chapter One

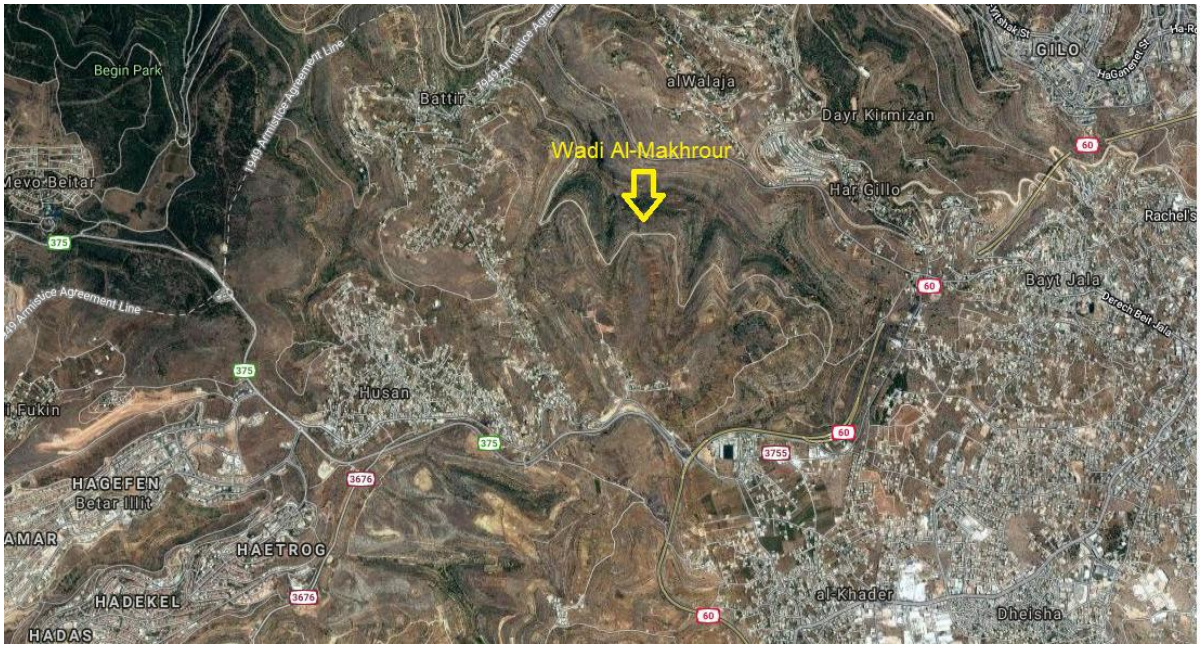
1.Introduction

Palestine is a land that has a lot to offer for its people and the whole world because of its natural resources and unique species. This uniqueness is due to several factors: its location between three major continents (Europe, Asia, and Africa), the climate that provides it with a rich environment, and its rich and generous soil. These elements allow many forms of nature to inhabit this land and make it interesting for biologists and researchers alike (Palestine Wildlife Society).

Palestine is located to the east of the Mediterranean Sea between 29 and 33 North latitude 35 and 39 longitude and the area of Palestine is about 27000 square kilometers. (Palestine Wildlife Society)

Historically, Palestine flora was put understudies dating back to the late 19th century by the PEF (Palestine Exploration Fund), a committee in England dedicated for this purpose. Tristram, H. B. (1884), through the fund, conducted a study of the flora of Palestine and established that Palestine hosts a vast number of floral species and constitutes a considerable share among the area of the Mediterranean basin and biodiversity is abundant. Tristram described the area of Palestine and stated that it is located in the extreme southern province of the Patearctic region which also includes Europe, Africa, Western Asia. He also claims that the analysis of its fauna and flora shows that it belongs to the Palaearctic region. Those are confined to the area of Jordan valley and the Dead Sea basin (Tristram, H. B. (1884).

So, Palestine is a central source of flora biodiversity in the region. In another research, the Geobotanical Research in Palestine 1938-1950, H. R. Oppenheimer (1952) claims that in the 19th century there were numerous travelers visited Palestine and none of them was a botanist resident of it, apart from some Jewish ones after the Balfour Declaration. Oppenheimer indicated that there were problems in the geobotanical research due to the use of the land for colonization after the 1948 war.



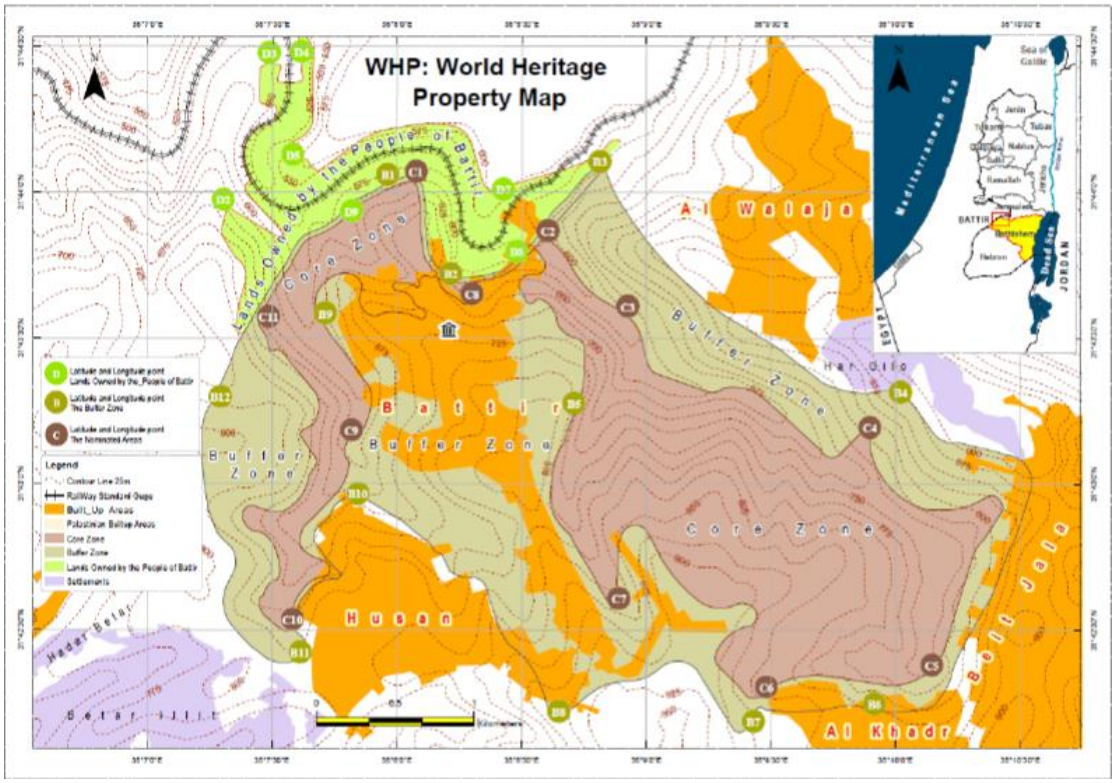
*Figure*Figure 1-1: *A satellite image shows the location of Wadi Al-Makhrour in Bethlehem district Qumsiyeh et. al. (2016).*

As part of the Committee of Palestine Exploration Fund during the last parts of the 19th century, in the survey that was conducted by Conder, C. R.; Kitchener. H. H. (1883) they detail the Topography and Orography of the area around Jerusalem area and covered 371.7 square miles of Palestine. The survey illustrated in its details that Battir is part of the Arkub district at the time where they provide and illustraitoin of the area and the other surrounding villages in the region (Conder, C. R.; Kitchener. H. H. (1883)

In this research thesis, special attention is made on the middle part of the West Bank and in particular the area of Battir and what is called Wadi Al-Makhrour (Al-Makhrour Valley as it is called in many textbooks and references, but we shall call it Wadi Al-Makhrour in this research) (Figure 1-1Figure) where a natural trail extends up to Battir or what is generally known as Battir trail (MAP 1-2).

The findings of Conder, C. R.; Kitchener. H. H. (1883) included a description of Battir (MAP 1-1) village and witnesses the village's historical reference to the Greek era and also states, quote "This place is probably the famous Bether of the Talmud where Bar Cocheba was slain, and the Bether (or Thether) of the Septuagint (Joshua XV. 59)." However, another study by ARIJ (2010), claims that the name Battir originates from the "Phoenician word "Batara", which means sever and slash as it does in Arabic. Other narratives refer the name to Beit At tair (the house of a bird). Therefore, we conclude the historical importance of the village. In 2014 Battir has been inscribed in the UNESCO world heritage site, as Land of Olives and Vine in Palestine. This is due to the presence of many natural phenomena such as natural

water springs, and many historical archeological sites.

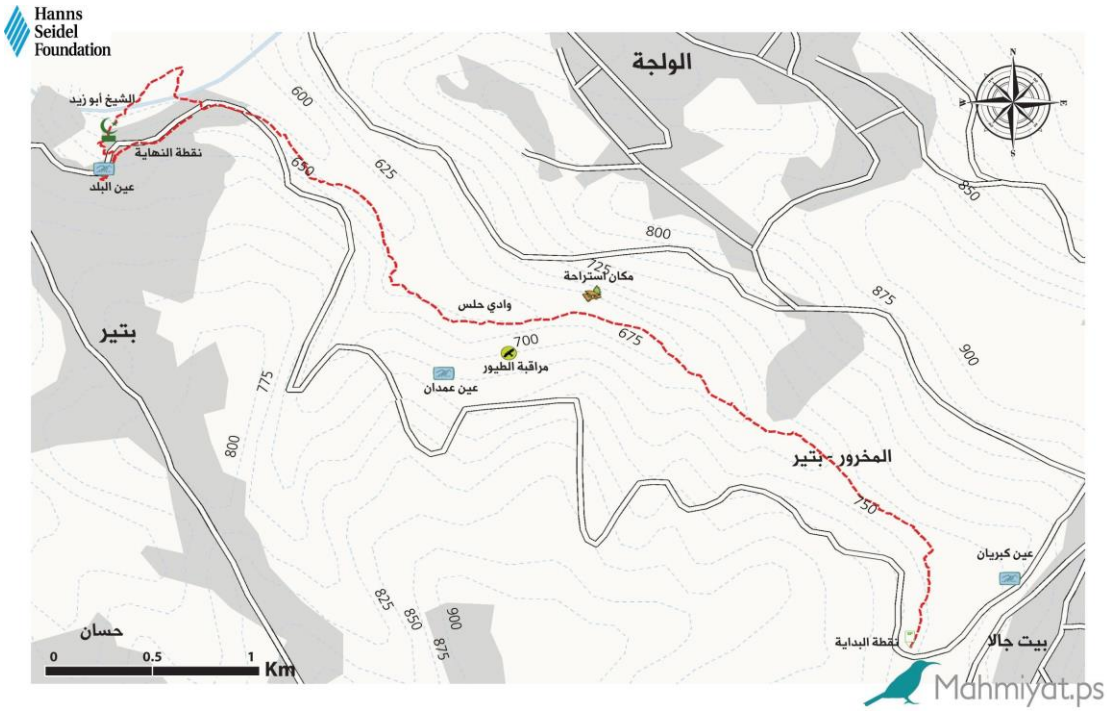


MAP 1-1Battir location and borders. Ghattas, Roubina; Abu Ayyash, Adel; Rishmawi, Marian. (2019).

Conservation of biodiversity has become a major and urgent issue for humanity mainly due to the scientific observation of the significant decline in biodiversity that is caused by the extensive industrialization in the 19th, 20th, and now 21st century. In their report (UNEP (2003) strongly argue that Biodiversity is an indicator of environmental health and emphasizes that Biodiversity is one of the major issues is the main conduit to the achievement of sustainable development in the Occupied Palestinian Territories (OPT).

Palestine contains a "tremendous diversity of climates and ecosystems" (Isaac, Jad; Gasteyer, S. 1995). This environment has suffered from neglect and environmental mismanagement for centuries, and particularly through the occupation's practices. And in spite of the many clear clauses in the Oslo II Accord conditions that gave the Palestinian Authority the rights to conserve and maintain the environment laterally or bilaterally with the Israeli side, the Israeli occupation still forbids them from enjoying this right under many fallacies (UNEP 2003). Therefore, the denial of the right to access, and the occupation deprivation of the Palestinians from developing their environmental rehabilitation incurred great damage to the biodiversity especially the floral part of it (Isaac, Jad; Gasteyer, S. 1995). Isaac also argues that there is a

considerable decrease in areas of rain fed farming where shepherds are forced to graze their livestock of "far too little land", notwithstanding the agricultural aspects. Therefore, The environment in the Palestinian Territories suffer greatly for many reasons; direct degradation due to military operations, increasing human population pressure on natural systems, the rapid growth of Israeli settlements and the roads around them limiting the implementation of environmental management measures, the construction of the separation wall that effectively blocked movement and cut natural ecological corridors, threats from solid waste and wastewater pollution, and finally clearing of land of vegetation by the Israelis for the alleged security (UNEP 2003). The PNA (Palestinian National Authority) has issued many laws that pertain to the preservation of the environment, particularly the biodiversity on the Palestinian soil.



MAP 1-2The Wadi Al-Makhrour Battir Trail.
http://www.mahmiyat.ps/uploads/3_Map_1-18_Battir.jpg.

In her report on the impact of the Israeli environmental atrocities (Ramahi 2012) stresses the serious infraction of the Draft International Treaty on Third-Generation Rights acts which protect the right of people to a clean and healthy environment "suitable for their economic, social, cultural and legal growth" (Article-14) and "not to negatively alter normal living conditions in a way which may damage the health of individuals and future generations" (Article-15). Albeit that, Israel is still committing violations.

Based on the topography and climate variation, The Palestinian Territories could be divided into five distinctive regions: 1) Jordan Valley region, 2) Eastern Slopes

region, 3) Central Highlands region, 4) Semi-coastal region and 5) Coastal region (Gaza Strip).

1.1.Biodiversity in Palestine

Ever since the beginning of the Palestinian rule of areas in the West Bank and Gaza and in order to comply with the need for a governmental body responsible for the environment in Palestinian Territories, the Palestinian Environment Authority was created in December 1996. It was later elevated to the Ministry of Environmental Affairs (MOEA) in 1998. A presidential decree in June 2002 created the Environmental Quality Authority (EQA) as a successor to the MOEA. The EQA mandate derives from the above-mentioned law in addition to the national environment strategy (Qumsiyeh, Mazin; Amr, Zuhair. (2016).

Many of the Palestinian areas where flora and fauna are abundant, they needed to be protected to conserve the biodiversity in the countryside. Agriculture Law No. 2 for the year 2003 is the legal reference for some aspects of protected areas or nature reserves. Article (1) of section (1) defines a protected area as: "*A geographically delineated area that is organized and managed for the purpose of its protection and to conserve its biodiversity*". Article (9) of section (1) of this Law states that: "*The Ministry in cooperation with other competent authorities shall develop nature reserves management plan and conserve all plants and living organisms living in protected areas*" (ibid).

There exists a richness of biodiversity resources in Palestine. They are represented by the number of species, ecosystems, and landscapes. Despite the small size of the Palestinian land, it contains a "wide variation in elevation, geology, climate leading to a broad range of habitats" that is vivid in the "high diversity of plants and animals (ARIJ. (2015). Palestine is located, geographically, on the crossroads between Europe, Asia, and Africa, it is also located between "the Mediterranean and the Red Sea and a number of botanical zones" (ARIJ 2015). Additionally, Palestine has a biodiversity that is a result of its bio-geographic convergence, Palestine is known for its great wealth of biodiversity resources in terms of the number of species, ecosystems, and landscapes surviving there. Although considered small in terms of landmass, Palestine displays a wide variation in elevation, geology, climate leading to a broad range of habitats, which is reflected in a high diversity of plants and animals (ARIJ, 2007b). This bio-geographic convergence is reflected in the region's high biodiversity value. As well as a center of wild plant biodiversity, the region is also an historic center of crop diversity and cultivation, highlighting the importance of its agrobiodiversity (ARIJ. (2015).

No wonder, and Palestine is part of the KBA (Key Biodiversity Area) of the world. The KBA is defined by the UN-WCMC to be

> "Sites contributing significantly to the global persistence of biodiversity. They represent the most important sites for

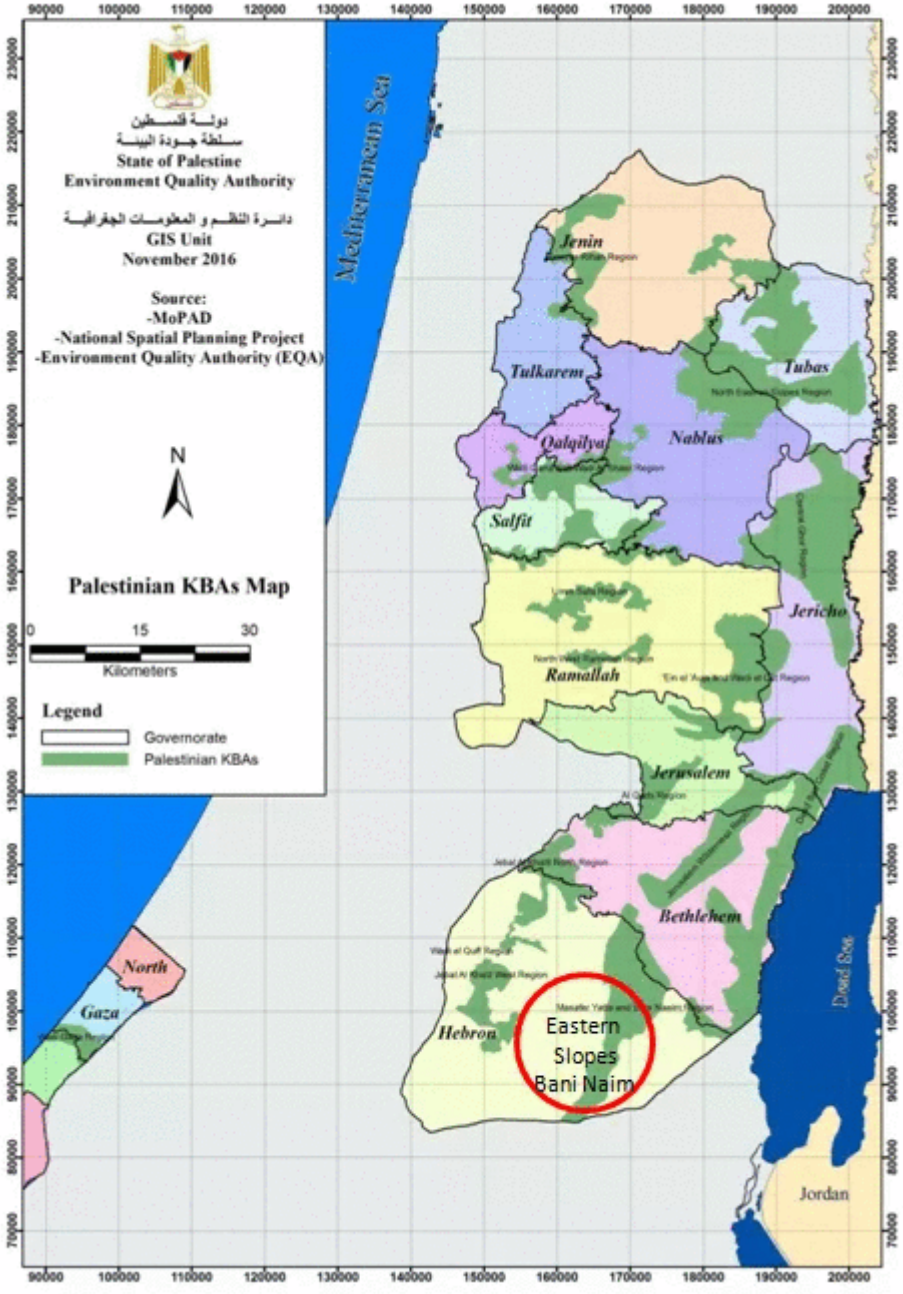
> biodiversity conservation worldwide, and are identified nationally using globally standardized criteria and thresholds. Sites that contribute significantly to the global persistence of biodiversity, in terrestrial, freshwater and marine ecosystems. They represent the most important sites for biodiversity conservation worldwide, and are identified nationally using a Global Standard from the International Union for the Conservation of Nature (IUCN)" (UN-WCMC).

The Mediterranean area particularly has a great significance in this phenomenon. The Critical Ecosystem Partnership Fund reported on Palestine and affirmed that Palestine is a biodiversity hotspot in the Mediterranean Basin (MAP 1-3).

MAP 1-3: The Mediterranean Basin Hotspot

The Environment Quality Authority in Palestine produced a map (MAP 1-4) that shows all the biodiversity significant areas in Palestine. And as they appear on the map, those areas constitute a large area of Palestine.

Palestine inhabits 2076 species, whereby 1959 species in 115 families are growing in the West Bank and 1290 species in 105 families are growing in Gaza strip; of which 117 species are growing only in the Gaza Strip. The most dominant families in the West Bank area are the Papilionaceae with 202 species, Compositae with 201 species, Graminae with 198 species, Cruciferae with 103 species. In addition, the most dominant families in the Gaza Strip area are Papilionaceae with 176 species, Graminae with 138, Compositae with 137 species, (ARIJ, 2007b)



MAP 1-4: *A map of Key Biodiversity Areas (KBAs) of Palestine*

1.2.The environment and Biodiversity

The status of the environment has an enormous impact on biodiversity. Byron argues that we are "losing biodiversity at an unprecedented pace" where it is vital to human lives as it provides economic, social, and environmental benefits (Byron, H. 2000:1). Because biodiversity matters to life and as it is an essential part of the sustainability of

human existence, "its loss impoverishes the environment and reduces its capacity to support people now and in the future (Slootweg, R., Rajvanshi, A., Mathur, V. B., & Kolhoff, A. 2009). More and more hard evidence proves that biodiversity and healthy ecosystem services that are linked to biodiversity and are "in rapid decline" and "has put biodiversity on the agenda of decision-makers (Slootweg, R., Rajvanshi, A., Mathur, V. B., & Kolhoff, A. 2009)." In her article in the Middle East Monitor, Ramahi, S. (2012) poses the devastating impact of the Israeli occupation to the Palestinian environment. Notwithstanding the international stance on the importance of a clean preserved environment to human beings, the Palestinian people are deprived from the right to maintain a sustainable clean environment via the Israeli occupation vigorous practices on the ground albite all the agreements that were signed priori. Ramahi included the two articles devoted to the environment (Article 14 and 15 of the Draft International Treaty on Third-Generation Rights[1]).

In 1999, the PEnA published a report on the *National Biodiversity Strategy and Action Plan for Palestine* and that was a Regional Project that was conservation, sustainability, and enhancement of biodiversity in Palestine. The report also included the improvement of people's attitudes and participation for the conservation of biodiversity and sustainability where Palestinians share the benefits of biodiversity and develop Palestinian institutional and human resource capacity in biodiversity. The report illustrated the dangers that biodiversity was facing due to the occupation where the Palestinians are "crowded out of the native species of plants and animals of local and global importance towards extinction (PEnA. (1999)." As one of the main problems that PEnA has worked around to solve is the "inadequate awareness and commitment to biodiversity" that was caused by the Israeli occupation as it "damaged the infrastructure in all aspects of life including education and environment (PEnA (1999)."

In the late 20th century, the conservation of biological diversity became recognized as an urgent issue for humanity the PMNH (Palestinian Museum of National History). 2019) stated in their report on the Biodiversity Conservation and Community Development in Al-Makhrour Valley in Bethlehem. Wadi Al-Makhrour hosts what is called Battir trail, a natural path used for ecotourism, extends for as long as 6.5 Km requires more attention and conservation due to the hazardous environmental conditions it is under from visitors' vandalism and the practices of the Israeli occupation.

Therefore, Since the signing of Oslo I and II in 1993 and 1995 respectively, there has been a recognition of the importance of the environmental condition of the West Bank

[1] Article 14 confirms that all persons have the right to a clean environment suitable for their economic, social, cultural and legal growth. Article 15 demands that Member States commit themselves not to negatively alter normal living conditions in a way which may damage the health of individuals and future generations. Since its inception, the International Labour Organisation has been concerned with working environments, and in 1976 it adopted the international programme to improve working condition in order to make labour more humane.

and Gaza (Amra, Z. 1998). In the Protocol, it was agreed that Israelis and Palestinians shall act together for the protection of the environment and the prevention, among other things, of environmental risks, hazards, and nuisances (AI-Hmaidi, M. 1998). Amra listed some of the factors that affect the environment and results in harmful issues to all aspects of life starting with human beings, animals, and plants ending with the total biodiversity in the area. Those factors such as the unavailability of a proper sewage system, wastewater, and water treatment plans or strategy, inflated the environmental situation. In addition to air pollution due to the burning of solid waste such as garbage and uncontrolled wastewater discharge into the streets in some areas with litter, are all indicative of the state of the environment in Palestine (Amra, 1998). Other important factors laid out in a World Bank report in 2019 stating that there are other diverse factors such as "the pressure over limited land, forest and rangeland resources have led to widespread overgrazing by livestock and deforestation through depletion of plant cover via over-exploitation and clearing of woody vegetation for cropland (World Bank, 2019)" this also has a negative impact on the protected areas of flora and fauna, as the report states, where this also rendered the environment low quality and unsustainable which invalidated the natural resource that is essential for the livelihood for communities (Ibid)."

1.3.Battir as a UNESCO site

"Battir is situated 11 km southwest to Jerusalem and 6.4 km northwest of Bethlehem city. It is bordered by Beit Jala town and Al Walaja village to the east, Husan village to the south, and the 1949 Armistice Line (the Green Line) to the north. The total area of the Battir is 6795 dunums, including 6435 dunum as agricultural land and 159 dunums as residential land. Battir is located approximately 761 m above mean sea level and is well known all over the region with its agricultural crops (ESCHIA, 2012)."

People in Battir are continuously dependent on agriculture "as a major source of income" and that made it renowned for its unique cultural landscape (Ferrato, Elias. (2020). Battir was famous for its agricultural products and landscape and once "known as the "vegetable garden of Jerusalem" due to the presence of natural springs, permanent crops, and arable land (McHugh, C. et al. (n.d)). Its proximity to Jerusalem gave the area special agricultural cultural status. As has been stated above Battir has been inscribed in 2014 in the UNESCO world heritage site, as Land of Olives and Vine in Palestine. "Despite its small size, Battir hosts some modest tourism infrastructure, including hiking trails, an eco-museum, and a guest house (Isaac, R. K., Hall, C. M., & Higgins-Desbiolles, F. (Eds.). (2015)."

1.3.1.Battir Religious and Archaeological Sites

In terms of religious establishments, there are four mosques in Battir: Sayed Ash Shuhada' (Hamza) Mosque, Fatima Az Zahra' Mosque, Az Zawiya Mosque, and Ein Jame' Mosque.

As for the archaeological sites in the village, there are two sites: Ein Al Balad and Ein Jame', and a Romanian bathtub. Both are natural fresh underground water springs where people can consume the water for their living matters including drinking.

According to the Palestinian Central Bureau of Statistics (PCBS), the total population of Battir in 2007 was 3,967; of whom 1,992 are males and 1,975 are females. There are 798 households living in 981 housing unit

1.4.Wadi Al-Makhrour plant biodiversity

Wadi Al-Makhrour has significant importance in the biodiversity of its plants. And as we have seen above that biodiversity plays an important role in preserving the environment intact from deterioration and decay. As we shall also see later in this research that there are many different plants found in a specific area in it. In particular, the walking trail that is called the "Battir trail" starts at the western verge of Beit Jala and ends in Battir village center.

Wadi Al-Makhrour, however, (Figure) "is a valley located about 7 km south of the old city of Jerusalem and about 6 km west of the old city of Bethlehem (PMNH, 2019)." As it has been mentioned above, it was mentioned in many of the old books written by orientalists in the 19th century, especially travelers assigned by the PEF of Great Britain at the time. It "is an important part of the system that refills the water aquifer of the Bethlehem District area, and the freshwater springs pass from the center of old trees planted there. The area is the last remaining biodiversity-rich area south of Jerusalem and in Bethlehem and Jerusalem districts." Wadi Al-Makhrour is one of the richest biodiversity in the area, according to PNA and it spans 2.6 Km^2 (PMNH, 2019). The valley (Figure), rich in biodiversity, is located in area C, according to the Oslo Accord that was agreed in the early 90's. This location imposed many diverse issues that the valley suffers from (1) habitat loss and land fragmentation; causing biodiversity loss, (2) challenging livelihood conditions as a result of the lack of economic motivations, no subsidies for farming practices, and inadequate markets for extra production and others products (PMNH, 2019).

The importance of Wadi Al-Makhrour does not only lie in the plant's diversity it but more in the valley's pathways that represent a natural attraction. The pathways are visited by eco-tourists every year. A conservation plan is set to preserve the plant biodiversity in it. Wadi Al-Makhrour represents the breathing lung for the area, especially Bethlehem governorate.

1.5.Battir Water and Soil

As mentioned above, Battir on the one hand is an historical site and has its deep roots in history where the many archeological sites in it stand as witnesses. On the other hand, Battir is known for its fertile soil and abundance of water springs (Figure) that made it one of the most places for plant biodiversity. There are four water natural

springs (Ein El Balad, Ein Jame', Ein Al Baseen, and Ein 'Amdan) (ARIJ 2010). This research is intended to analyze the water that emerges from those springs and verify their purity for human consumption (see chapter seven).

Due to the present wastewater treatment system through the use of cesspits in every house in Battir (IPCC, 2012) where wastewater is allowed to penetrate the underground and hence pollute the soil that is used for agricultural purposes in many places of Battir, the soil is deemed unfit for that purpose.

Figure Figure 1-2: Natural water springs in Battir (Photos by the researcher)

According to a report by ARIJ (2010) "Battir is a Palestinian village in Bethlehem Governorate located 6.4km (horizontal distance) north-west of Bethlehem City. Battir is bordered by Beit Jala town and Al-Walaja village to the east, Husan village to the west, Husan and Al Khader to the south, and the 1949 Armistice Line (the Green Line) to the north." (MAP 1-1). The report also illustrates that "Battir is located at an altitude of 761m above sea level with a mean annual rainfall of 653mm. The average annual temperature is 16^{o} C, and the average annual humidity is about 61 percent (ARIJ GIS, 2009).

Figure 1-3: Wadi Al-Makhrour (PMNH 2019)

1.6.Problem statement

Battir and Wadi Al-Makhrour are two important areas that are characterized by the vast natural landscape that represents the biodiversity in the region. Battir in particular is a village that is recognized by UNESCO as a cultural site and has been inscribed in 2014 as one of the world's cultural sites (Ministry of Tourism and Antiquities. 2017).

Battir suffers from the contamination of the soil due to the environmental hazards that cause contamination for the underground water, hence, contaminate the soil. Water that is coming out of the natural springs is also contaminated due to the same reason. Other reasons, such as solid waste produced by the inhabitants, is also a contaminating factor.

Plants of Wadi Al-Makhrour, which constitute the main biodiversity in the area need to be preserved and a record must be kept for all the plants of the area detailing the bio data of those plants. This study is considered to be the first of its kind in the area.

1.7.Objectives

The main objectives of the present work include

- Classification of the plant cover in Wadi Al-Makhrour and specifically Battir Trail, to record the plant biodiversity in the area.
- Identify the environmental hazards and threats to the historical and cultural village of Battir and problems that face the plant biodiversity of Wadi Al-Makhrour.

- Study the underground water of Battir (from the water springs) and measure its quality by taking samples for testing in preparation for a complete wastewater rehabilitation plan should it be carried out in the future.
- Provide analysis for the soil of Battir for future references, in order to monitor the effect of the environmental hazards on the soil quality and safety.

1.8.Previous Studies

The literature on Battir and Wadi Al-Makhrour is abundant during the past decade or so. Projects have been done on the environment, archeological sites, water springs, and many other subjects. Some studies were made by an assignment by the Palestinian Authority in cooperation with NGO bodies and many others were conducted as independent academic studies. In the following section, I shall discuss some of those studies, especially ones that is close to this thesis. This activity will also become a piece of supportive information to develop a biodiversity conservation plan, the identification of sites of restoration needs, building relevant capacities, change attitudes, and public stakeholders' outreach.

Ghattas, R. et. al. 2019

In response to an assignment by the Pioneer Consultancy Center (PCC), Ghattas and three other researchers conducted a study on the Plant biodiversity of Al Makhrour Valley. The study was conducted during the period from Autumn 2018 going into winter until the early time of spring 2019. The main objective of the study was to present a better understanding of the plant biodiversity in Wadi Al-Makhrour in preparation for better protection for plants in the area and its supportive habitats. The outcome of the study is a comprehensive assessment of plant biodiversity status including their relevant habitats and ecosystem.

The methodology is based on an inventory that was taken by the researchers themselves. They implemented the data collection using up-to-date scientific methods and approaches for plant species surveying on site along with investigation of their habitats, their supporting abiotic elements such as soil and topography of the site, and other aspects. Threats found on the plants also recorded with the human interface.

The inventory was made according to the specification of international methods for proper inventory for vegetation cover and the recommendation of the National Biodiversity Strategy and Action Plan for Palestine and international guidelines for recording and assessing the status of species such as the ones set by IUCN species survival commission and global species programme. Several visits to Wadi Al-Makhrour were necessary to complete the work.

The researchers adopted the Braun & Blanquette (1964) methodologies for plant surveys. The Braun-Blanquette cover-abundance scale was used to estimate plant species importance and abundance in the study. All aspects of the geographical

specifications of the area were taken into considerations (refer to page 5 in the research document for details). This method is used for its provision of sufficiently accurate baseline data to allow environmental impact assessment and vegetation assessment studies. The method also helps in comparing pant communities over the particular area which presents a basis for geographical comparison of habitats, vegetation mapping of areas, and analyze the rate at which taxa appear to be bound to one or several communities. Plant cover estimated through estimates of vertical plant shoot-area projection as a percentage of quadrat area. Transects covering the target area were used for field sampling. The researchers used 33 transects of 70*70 m and within transects, one to four quadrats of 25*25 m were specified and surveyed. The survey in each transect was made by counting the number of each species growing in the quadrat recording for each one of the species type, name, structure, and abundance. Each transect was selected based on a set of criteria including the location of the transect, the topography, the type of vegetation cover, and its habitat. Care was taken to cover the most comprehensive geography of the valley with the diverse habitats, plant species, and others. Considerations were given for the accessibility of the land, the slope, and the density of the plants. Some of the transects were located in a very steep place that the team could not cover properly. Trees, shrubby and herbaceous vegetation were all studied in each transect. The habitat, soil type, and elevation of each transect were specified and interpreted with the type and abundance of species surveyed (Ghattas et. al 2019).

The Line Transect methodology of the Braun & Blanquette was also used where the plant coverage in relation to soil and rock coverage was estimated where the plant species occurrence was recorded at regular of subjectively determined intervals along the line transect covering each block transect. The line transect length was 100 meters taken diagonally in each square transect block. The measurement was made with a measuring tape. The plant coverage was calculated by estimating the coverage of the plant versus the rock and soil in each block transect.

The survey area included the valley from Beit Jala side reaching the natural valley between Battir and Husan villages where the highest point was 813 meters above sea level and the lowest point was at 602 meters above sea level.

The findings were distributed on the ecosystem and the habitat of Al Makhrour Valley. The main results and conclusions of the research are a comprehensive description of the Wadi Al-Makhrour covering its natural structure, its habitat of plants of the different species. The ecosystem criteria described were listed in an ecosystem field sheet that contained the individual criteria. Table 3.1 page 10 contains the information. The results revealed that there is intensive human intervention in the valley. The valley is cultivated and protected by locals and that is apparent from the existence of the monitoring houses made of hard stone called ‘manateer’ or ‘qusoor’.

The researchers counted 270 vascular plant species until the date of the report. This shows the high number of vascular plants at the time of the survey, autumn, winter,

and early spring seasons 2018/2019. The diverse habitat form asupporting environment for the growth of diverse plant species. The Wadi Al-Makhrour hosts 55 plant families; most dominantly are Compositae, Papilionaceae, Labiatae, Graminae, and Cruciferaceae. The total number of tree species is 16 trees, where there were also 38 shrubs and sub-shrubs and 216 herbaceous plant species. A fair amount of description of the dominant tree species growing in Wadi Al-Makhrour specifying their age (20-80 years) for the naturally grown and (2-50 years) for the reseeded ones. It was found that the valley also supports a large number of rare species. It was found 38 rare and very rare plants some of the plants are listed in the IUCN Red List.

Endemic species were found in Wadi Al-Makhrour and families were listed in the results tables where they were listed according to whether they were local or local and global or listed in the IUCN Red List. Criteria also included being very common, common, frequent, somewhat rare, rare, very rare, or not registered in the study area before but found during the survey.

Jebreen, Hassan. (2014) conducted a comprehensive study on the spring water of the western catchments of the western part of the West Bank. The main aim of the work was to compensate for the lack of information about hydrochemical characteristics of the springs water, as well as to identify the different pollutants and impact on the spring water, and assessment of the environmental recharge of spring water. Samples were collected from the testing area. Tests were carried out to determine the EC, pH, TDS, and temperature of the samples first, then the other tests were performed for cations, anions, and heavy metals. The total and fecal coliform bacteria count was tested in the laboratory. The study concluded that the spring water in the area was unsuitable for drinking by humans and animals, but it is suitable for irrigation purposes. The main reason being that the spring water in Soreq mixes with leaking wastewater.

Nazer, D. W. (2010) presented in the doctoral dissertation a study to reuse wastewater in the West Bank through a developed framework for the sustainable management of water resources. In the research, Nazer provided an inventory of the existing water use in the West Bank, produced an evaluation of options for water management suitable for Palestinian social, cultural, religious and economic conditions.

Zimmo, O. Al-Sa'ed. et al. (2005) study was to assess the prospects of the reuse of wastewater in Palestine. Considering the water scarcity in the Middle East in general and in Palestine in particular Zimmo realized that although there is general reluctance from the Palestinian public to reuse wastewater in agriculture due to cultural and public opinion, the reuse of wastewater can lower the burden and pressure on the

water resources. The research suggests that this can be achieved through proper management systems of wastewater.

Chapter Two

2.Theoretical Framework

This research thesis is qualitative action research. This chapter contains the theories that qualify biodiversity as an essential element for the conservation of a sustainable healthy environment and the balance of nature, and it presents the main elements of biodiversity. It also presents aspects of soil and its quality and validity in addition to other aspects of water resources from natural water springs in Battir such as purity and validity for human use. Wastewater and its effect on underground water aquifers and irrigation water is also dealt with hereunder.

2.1.Biodiversity

The term biodiversity is a short-expression for Biological Diversity, says (Magurran, 2004) as it was apparently proposed in 1985 by Walter G. Rosen during the planning of the 1986 National forum on BioDiversity as it was introduced to a wider range after a book entitled *Biodiversity* edited by E. O. Wilson in 1988. Scientists, especially biologists and nature researchers, have an overwhelming consensus that biodiversity is an essential factor in the continuity of life and sustainability on planet earth. In order to continue the conservation of biodiversity, the world met in Rio de Janeiro and drafted a treaty that "was signed by more than 150 nations on 5th June 1992 at the United Nations Conference on Environment and Development, held in Rio de Janeiro, and came into force approximately 18 months later (Gaston & Spicer 2004). This was termed an 'the Convention', although elsewhere it is commonly referred to by its acronym, CBD. The definition that CBD adopted is *""Biological diversity" which means the variability among living organisms from all sources including, inter alia, terrestrial, marine, and other aquatic systems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems* (Gaston & Spicer, 2004)."

2.1.1.Elements of biodiversity:

Biodiversity is the variety of life on earth and includes variation at all levels of biological organization from genes to species to ecosystems. Genetic, organismal, and ecological diversity are all elements of biodiversity with each including a number of components (Gaston & Spicer 2004). They argue that "Biodiversity is not distributed evenly across the Earth", however, an important aspect of biodiversity is the ability to measure it in order to qualify it, as Gaston & Spicer put it "only then can one address such fundamental questions as to how biodiversity has changed through time, where it occurs, and how it can be maintained (Gaston & Spicer 2004).

Stoolweg, et al. 2009 called them levels of biodiversity as they appear in the CBD, 1992 definition, namely genetic, organismal, and ecological. Stoolweg puts them together and argues that those levels complement each other where it starts at the

genetic diversity than the individual specimens up to the Earth as an ecosystem. This creates a hierarchy of "biological organization" which is usually expressed in terms of gene – organism – population – species – community – ecosystem – biome – biosphere Stoolweg et al. 2009). Stoolweg further explains that in fact there is no clear-cut distinction between those levels, however, as they were even more simplified to three elements genes – species – ecosystems division which presents a "clear distinction among the most fundamental levels in biodiversity (Ibid). The main relationship between the three elements, according to Stoolweg is that Genetic diversity represents the cause of evolution which results in Species diversity where ecosystems are the way those species coexist together in a nonrandom manner (Ibid).

2.1.2.Genetic diversity:

Gaston & Spicer argue that "few would disagree that genetic diversity is a critical component of biodiversity (Gaston & Spicer 2004)." Genetic diversity represents the presence of genetic differences between organisms within species, both between and within populations. Stoolweg, et al. 2009 states that the genome of a single individual is the start of genetic diversity as they explain that genetic diversity among individual specimens from the same species is the "fundamental currency of diversity". Stoolweg et al. argue that genetic variability is a characteristic associated with adaptation to changing environmental conditions (Stoolweg et. al. 2009). In more details goes Gaston & Spicer to say that genetic diversity includes the components of the genetic coding that is involved in the structure of organisms (nucleotides, genes, chromosomes) where "variation in the genetic make-up between individuals within a population and between populations" (Gaston & Spicer 2004). Although nucleotides, genes, and chromosomes are discrete, readily recognizable, and comparative units, it is not as easy to identify genetic diversity when we come to deal with individuals and populations where difficulties may arise in identifying spatial limits to populations (Gaston & Spicer 2004).

It is clear that now is the time for Palestinians to act in working to promote plant genetic resources and biodiversity (Isaac, Jad; Gasteyer, S. (1995). With the idea of the establishment of a national gene bank still in its nascent stages, now is the perfect time for Palestinian agronomists and botanists to receive training in gene bank organization, management, and utilization (Isaac, Jad; Gasteyer, S. (1995)

2.1.3.Organismal diversity:

Organismal diversity is one of the building blocks of biodiversity (Gaston & Spicer 2004) it encompasses the taxonomic hierarchy and its components, from individuals upwards to species, genera, and beyond. Gaston & Spicer argue that the organismal elements are human constructs for grouping evolutionary related sets of individuals and believe that it is not always the case. For example, defining groups as Individuals, Populations, Subspecies, Species, Genera, Families, Orders, Classes, Phyla, and

Kingdoms, as **خطأ! لم يتم العثور على مصدر المرجع.** shows above is merely a human activity to organize a hierarchical taxonomy of existing biodiversity on earth. However, it is not within the capacity of this research to pursue this issue.

2.1.4.Ecological diversity:

Ecological diversity includes the "scales of ecological differences" among all types of ecology from biomes to habitat to niches passing through populations (Gaston & Spicer 2004). Gaston & Spicer argue that it is not always easy to label different habitat types because it is not always obvious "precisely where one should end and another begins because no such beginnings and endings really exist (Gaston & Spicer 2004)." Moreover, as Magurran stipulates that "species are distributed unevenly across the earth's surface (Magurran, A. E. (2004)."

2.1.5.Spatial scales of biodiversity and measurement

Magurran 2004 claims that there is no single catalogue of global biodiversity is presently made and there is no exact estimation of the number of species on earth in any magnitude (Magurran, 2004). It is also feared that a large range of mammal, birds, and reptile groups are prone to be lost in the next 300-400 years and the rate at which species evolve is less than the rate of extinction for most of them (Ibid). These concerns drove the world to a new dimension of alert towards biodiversity and its importance to life on Earth.

New measurement techniques are developed to provide more precise estimation tool on biodiversity (Ibid). The development in technology provided a more feasible opportunity for more accurate and larger data management on biodiversity and enhanced measurement tools especially "the use of null models and randomization techniques" (Ibid).

Slootweg explained that measuring biodiversity is done over spatial scales: alpha diversity, beta diversity, and gamma diversity (Slootweg et. al 2009) where alpha diversity is the measure for a certain species in an area, beta diversity is the richness of a number of species in the area, and finally, gamma diversity is the diversity of the overall ecosystem (Ibid) (see Figure 2.1-1 below). In the same realm (Gaston & Spicer 2004) provided a distinction that is commonly made between alpha, beta, and gamma diversities, with alpha diversity being the number of species found within local assemblages or communities, beta diversity being the turnover of species identities between communities, and gamma diversity being the number of species occurring across a region.

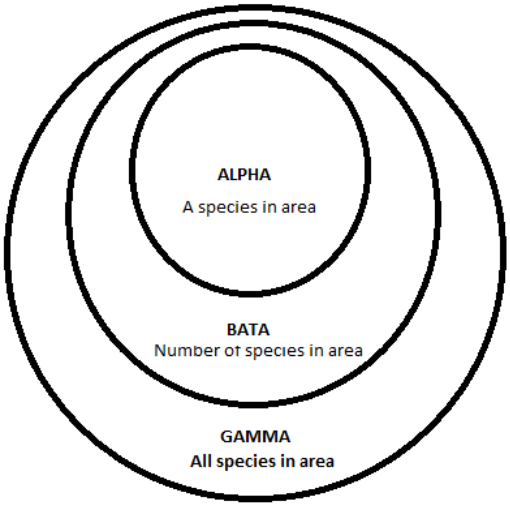


Figure 2.1-1: Spatial scale depicted from the description of (Slootweg 2009) drawn by the researcher

The Braum-Blanquet cover-abundance scale is used to determine the strategy of selecting and collecting species in an ecosystem. Under the Braum-Blanquet method, the ecosystem is divided into small areas (squares or lines) of a specific equal size (Ghattas, R et al. 2019).

Whittaker expressed the division of the base units and argues that the Spatial scale is the base unit used in sampling and analysis but it is not so often held constant due to the geographical nature, the "extent" which might be $1m^2$ or 10,000 km^2 units, and the "focus" that represents the spatial scale used (Whittaker, R. J., Willis, K. J., & Field, R. 2001). Therefore, if we used the Braun-Blanquet method, we define the spatial scale needed at the time, then we count the "alpha", the "beta", and the "gamma" for the ecosystem under study. This method, in turn, correlates with Magurran (2004) who supports the idea that the investigator "typically wants to know if one domain is more diverse than another, or whether diversity has changed over time due to processes such as succession or enrichment". And this answers her question "which entities should be compared, and over what scales can they be studied?" as she termed them as 'communities' (Magurran, 2004). And finally, this conforms to (Slootweg, R., Rajvanshi, A., Mathur, V. B., & Kolhoff, A. 2009) who describes biodiversity as the distribution of species in a certain area

Again, we find that Magurran concluded that there are many challenges in measuring biodiversity, "not only in species-rich tropical systems but also in more intensively studied temperate localities (Magurran, 2004)." She argues that measuring

biodiversity is performed with three assumptions in mind “all species are equal, that all individuals are equal, and that abundance has been measured in appropriate and comparable units.”

2.1.6.The significance of plant biodiversity:

This research is about plant biodiversity in general and in Palestine in particular. Conservation of plants’ biodiversity is crucial to the sustainability of many of the living aspects of life whether it being for humans or other terrestrial vertebrates. According to Hawksworth and Bull plants play a vital role in sustaining the ecosystems of the earth and they represent the sign of a healthy environment, serve in the cycling of nutrients, and ecosystem processes. On the other hand, plants supply dependent organisms with food and habitat. Plants are also the main source of food and fuel consumed by humans apart from the provision of timber and cattle grazing (Hawksworth, D. L., & Bull, A. T. (Eds.). (2007). Gaston and Spicer dedicated a whole chapter to talk about the issue of biodiversity’s importance. In this chapter, they present two types of the significance of biodiversity, first, the direct-use value by which human consumes nature for “food, medicine, biological control, industrial materials, recreational harvesting, and ecotourism.” Second, the indirect-use value where nature provides by itself without human intervention, “The biota annually cycles gigatonnes (1015 g) of elements such as carbon, hydrogen, nitrogen, oxygen, phosphorus and Sulphur, and teragrams (1012 g) of aerosols and particles among the atmosphere, hydrosphere (the waters) and lithosphere (the solid matter forming the Earth’s crust; Naeem 2002). Such biogeochemical cycling modifies physical and chemical conditions, creating an environment that sustains life (Gaston & Spicer, 2004).” In addition to the direct and indirect use, they suggest that there are non-use benefits for biodiversity and that they are divided into four components: Option value, bequest value, existence value, and intrinsic value. Option value refers to the “unexplored potential value possible medicinal and industrial and may be vital for humanity or maybe knowledge embodied in organisms”; bequest value refers to pass biodiversity resources to future generations to compensate for the loss of wealth, production, or ecosystem services. This aspect is included in the final section of the Preamble to the Convention on Biological Diversity which clearly states that parties are “are ‘determined to conserve and sustainably use biological diversity for the benefit of present and future generations.” Existence value refers to the mere fact that biodiversity does exist and continues to do so. Intrinsic value refers to the moral and cultural values of biodiversity some of which are embodied in regional and global treaties for conservation. The CBD opening section, however, does refer to this concept the same as “ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components (Gaston & Spicer 2004).

2.1.7.Sustainability and biodiversity conservation:

A multitude of tools and techniques are currently used by companies, governments, certifying agencies, and the like, to predict, measure, or report on the human impacts on biodiversity (Slootweg, R., Rajvanshi, A., Mathur, V. B., & Kolhoff, A. (2009).

One of the major processes that must be ensured is the environmental impact assessment (EIA) that must be performed to protect the environment from affecting biodiversity in any way. Slootweg et. al. suggests a program that they called Environment Impact Assessment that can be used in the development of biodiversity conservation programs. The International Association for Impact Assessment (IAIA) is a voluntary membership organization that provides the international forum to advance best practice and innovation in impact assessment and advocates for its expanded use for the betterment of society and the environment. IAIA formulated the biodiversity impact assessment principles.

Biodiversity, being at high risk of suffering unsustainability, and as far as the Palestinian Occupied Territories (OPT) is concerned obstacles are abundant due to the Israeli prohibition of free movement in the West Bank and their unethical legislation of prohibition acts and orders. As it has been put by the (ARIJ, 2007) report on the status of the environment in the Occupied Palestinian Territory "the ongoing process of disengagement, which is resulting in increased fragmentation of the Palestinian space and in the appropriation of the OPT's resources (ARIJ, 2007). Adding to the dilemma that the Palestinians are suffering from is the ongoing building of settlements around major cities where the vital natural landscape is being destroyed beyond repair and in an irreversible state. This prevents any conservation plans to be implemented by the Palestinians which in turn damages the sustainability of biodiversity, which has devastating consequences on the environment and henceforth on people's health, economy, and all other aspects of sustainable living.

2.1.8.Threats to biodiversity:

The main reason for the signing of the global treaty on biodiversity that has laid out the consensus over the issue of biodiversity conservation is the vital role of biodiversity in the sustainability of humankind, although humans have had a strong negative impact on biodiversity (Gaston & Spicer, 2004). Biodiversity loss is irreversible and human activities on biodiversity have been the main cause for the extinction of species as there has been a huge impact on the extinction of "many large-bodied species of birds and mammals" and other groups or brought to extinction by "anthropogenic ecosystem disruption" (Ibid). Population extinction, as well as decline in species local abundance, have been a major problem and a threat to biodiversity. There are four main reasons as to why species losses take place and other declines in biodiversity. Those reasons, as Gaston & Spicer laid it out are: "(i) direct exploitation; (ii) habitat loss and degradation; (iii) introduced species; and (iv) extinction cascades (Ibid)."

Palestine suffers greatly from many biodiversity conservations challenges and one major is the habitat loss and destruction caused by: a) the Israeli aggressions, b) unplanned urban expansion, c) over-exploitation, d) deforestation and badly planned forestry activities, e) desertification and drought, f) invasive alien species, and g) pollution and contamination. In addition to other Israeli destructive activities such as trees uprooting, land shaving, land division of areas A, B, and C (CBD, 2015). Due to the Israeli area separation of the West Bank and serious damage settlements make to natural wild flora and fauna are unable to reproduce naturally among other natural catastrophes like the depletion of groundwater reservoirs and loss of control over them, notwithstanding the huge contamination by the Israeli settlements' wastewater and solid waste (CBD, 2016), (see below).

2.2.Water and wastewater and the environment

Water pollution is caused by materials that make it unusable for a given use by humans (Butt, Masood et. al. 2005). Improper management of wastewater introduces environmental threat through deterioration of nature and biodiversity (ARIJ 2007). The use of cesspits is still common in many areas, and unfortunately, areas with biodiversity importance such as of Battir, in addition to the discharge of wastewater to the open areas as in the case of the whole of West Bank (Ibid). This type of wastewater management style results in major and serious public health risks where there will be spreading of disease from contaminated water, food, and soil. Therefore, this issue of water and wastewater became an urgent concern for the Palestinian Environmental Strategy (PES) (Ibid).

In theory, the government bodies in the OPT are responsible for issuing the regulations and standard guidelines for the treatment of wastewater and underground water (Arafat, L. Y. A. (2015). But in practice, unfortunately, the Israeli occupation is always pressing against any development in the direction of the environment of the OPT, therefore, the process of wastewater treatment goes at a slow pace.

Some studies showed that it is possible to reuse the water that can be extracted from wastewater. The water studies institute at Birzeit University conducted research on the issue of reusing the water from wastewater. The report claims that 95% of the wastewater that is released from humans, industries, and other activities is dumped into the environment without treatment which makes it the most polluting and contaminating to the marine environment (Zimmo, O et al. (2005). This, however, imposed a great challenge to the process of developing a sustainable sewage system.

The same study claims that 'water stress' starts when it reaches less than 1700 m3 per capita per year. The WHO (1993) estimated that 150 liters per capita per day is standard, wherein Palestine it is estimated to be 82 liters per capita per day and this causes a high deficit. One of the major problems that contribute to escalating the problem is the underground water contamination by untreated wastewater (Zimmo, O et al. (2005).

One of the important issues that play a major role in deciding the water quality and validity for human consumption is the presence and percentage of Coliform in the water. There are two types of Coliforms in water; Total Coliform and Fecal Coliform. Fecal coliforms are the group of the total coliforms that are considered to be present specifically in the gut and feces of warm-blooded animals. Because the origins of fecal coliforms are more specific than the origins of the more general total coliform group of bacteria, fecal coliforms are considered a more accurate indication of animal or human waste than the total coliforms. Heavy metals in water degrade its use and render it toxic for humans "through direct ingestion of contaminated water or accumulation in the tissues of other organisms that are eaten by humans (Jebreen, Hassan. (2014)."

One of the main problems that face Palestinians is the lack of pollution control, particularly nitrogen emission control where escalates the problem of water scarcity in arid and semi-arid areas in Palestine. In a technical report on the cultural landscape, prepared by the Ministry of Tourism and Antiquities in 2006, it was reported that springs' water is the main source for drinking water for domestic animals and wildlife in areas such as Battir (west of Bethlehem). It has a deep underground aquifer system and it is deep (bout 100 meters beneath the ground surface (Cultural landscape technical report 2006). Daghara, et al. 2019 suggested that spring water must be tested every period of time in order to promote its public use. There are three aquifers in Palestine (West Bank) but they are controlled by Israel. Poor water quality is caused by local practices of waste disposal and wastewater discharge (Daghara, er al. 2019). Daghara explains that "toxins can penetrate through soil and rock into the groundwater resources, resulting in physical and substance changes and in water quality" (Ibid) where the absence of proper sewage systems in many areas, especially rural ones, and the reliance on cesspits in many households, in addition to improper waste management escalates the problem.

The Israeli occupation is the major cause of the water scarcity in Palestine. Israeli settlements control and misappropriate Palestinian water supplies (Ramahi, S (2012). Contrary to what has been agreed upon in both Oslo conventions, Israel is still not supplying the Palestinians with the amount of water they signed for. One other major catastrophe the Palestinians are suffering from is the contamination of wastewater that is discharged from the Israeli settlements which cause severe damage to underwater aquifers. Ramahi adds that wastewater "increases the proportion of salts and nitrates in the water which makes it unfit for human consumption and even unsuitable for agricultural use, as is the case with the water in the River Jordan (Ibid). In terms of numbers, more than one-third of Israeli settlements discharge their untreated wastewater (around 60%) and release it into the valleys and streams of the west bank and onto agricultural land causing the serious threat of contamination to the land and the underground waters (Ibid). Ramahi also adds that it is estimated that 56 million cubic meters of wastewater (90%) go untreated, relying on a report published in 2009 by the Israeli human rights organization BTselem. In addition, there are 18 million cubic meters of wastewater from the Jerusalem area flow from settlements into the west bank (Ibid).

The United Nations Environment Programme posted a report on the environment in Palestine and particularly on waste management. In this report, they claim that 47% of all waste along with hazardous waste is disposed of in unsanitary dump sites where only 3% of the rubbish is recycled and the rest is left untreated. This in turn when left unaddressed cases will pose environmental risks hence human health problems to Palestinians who are committed to solving those issues. Nonetheless, there are obstacles in this process facing the Palestinians due to the geopolitical status. Despite all that, the authority has established a national committee to deal with hazardous waste and chemicals. Projects made by the State of Palestine to combat illegal transportation of hazardous waste, chemical waste, and electronic waste.

Battir as a UNESCO focal point in the eyes of the PNA has had its share of developmental projects. A sustainable plan for Battir has been developed with the aim to better manage the natural cultural features along with an economic empowerment plan to improve living standards. Development plans included, but not limited to, an irrigation system to replace the present ancient one, as well as projects to enhance the environment. Battir does not host a wastewater network, instead, every house has a cesspit to dispose of wastewater. Water in Battir is supplied to houses through the local water network that is managed by the Palestinian Water Authority. Solid waste is handled by the Joint Services Council which collect the waste on a weekly basis and transfer it to a dumping location.

The unstable environment has an impact on human wellbeing and on the ecosystem, health (UNEP, et al. 2020:45), and the exploitation of the Israeli occupation of all the resources in an "unsustainable manner" has an adverse effect on the Palestinian environment and henceforth on the Palestinians wellbeing (CBD, 2015). The World Bank report in 2019 identified five environmental issues that are affecting Palestinians lives: Increased pollution that went uncontrolled due to solid waste and wastewater and other types such as waste from used batteries and healthcare places; threatened natural resources by land degradation, encroachment on habitat, droughts, and desertification; climate change over all of the sectors; the unreliable environmental administration; and finally the uncontrolled increasing pollution (World Bank, (2019).

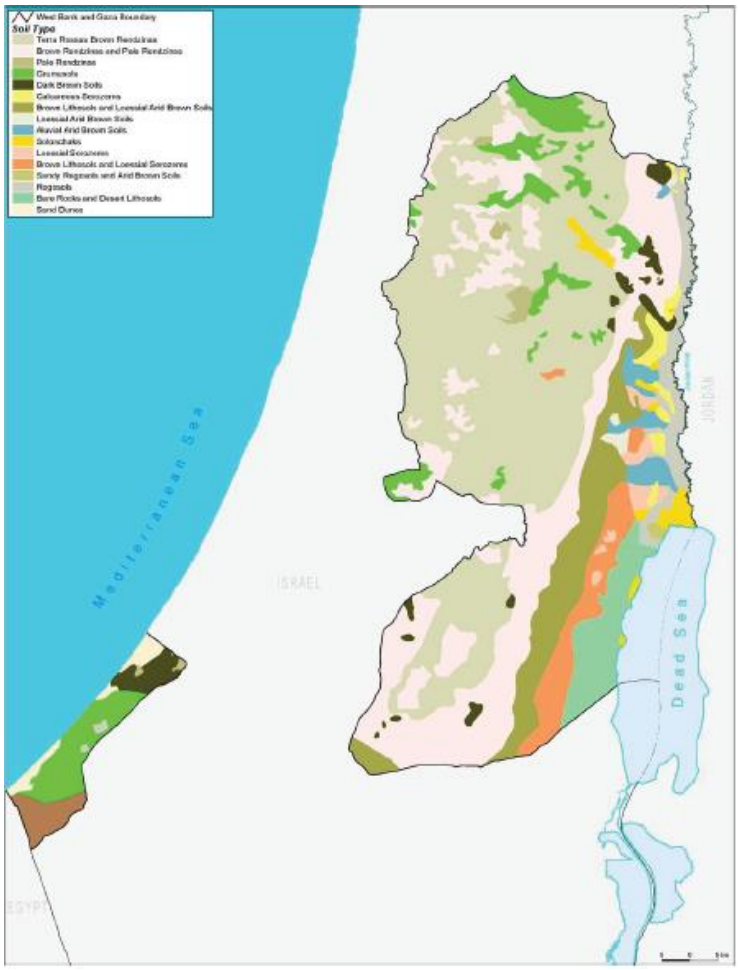
One of the most important biodiversity areas in Palestine is Wadi Al-Makhrour that hosts a multitude of biodiversity and represents the breathing lung for the Bethlehem governorate. This Wadi Al-Makhrour accommodates the system that refills the water aquifer for the Bethlehem area where freshwater passes through its valley.

2.3.Soil

The soil is formed on the earth's surface as deposits of weathered, loosened, and transported particles stemming from what is so-called parent materials (ARIJ, 2007; (Zaid, Mahmoud. 2017). therefore, it is the surface layer of the earth's crust. Soil, according to Zaid is composed of several components in a mixture form; mineral particles, organic matter, water, air, and living organisms. Soils are non-renewable resource and it is slow formation (Ibid). According to (ARIJ, 2007), soils are the host for all intruders buried and deposited beneath or on its surface and also acts as a filter

for physical, chemical, and biological of the natural environment including decomposition of organic materials and precipitation of rainfall (ARIJ, 2007).

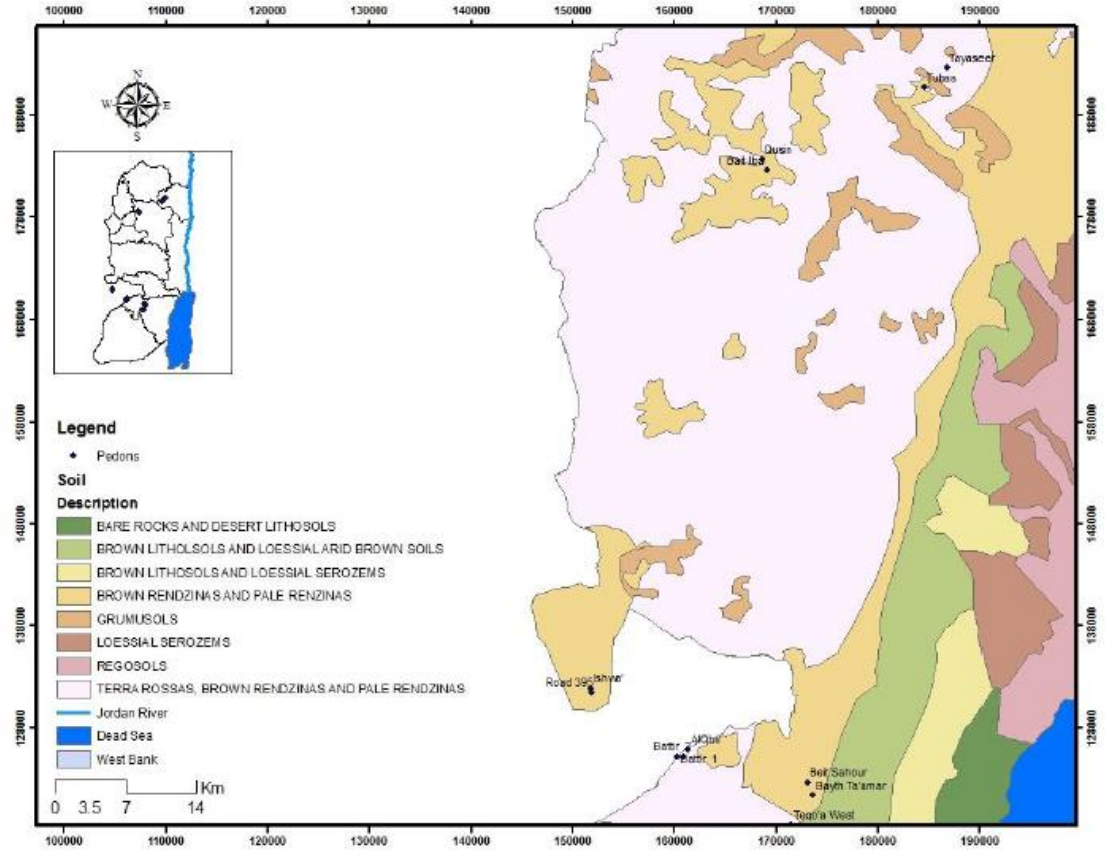
Since Palestine was developed under the Mediterranean climate then it follows that its soils are mainly Terra Rossa and Rendzina (Zaid, Mahmoud. (2017). According to ARIJ 2007, several conditions played a role in the formation of soil in the OPT (Palestine). Those conditions include climate, physical weathering from wind and water and other topographical materials, geology, and vegetation. The following map shows the soil distribution in Palestine (MAP 2.1-1)



MAP 2.1-1: Soil types in Palestine (Curtsey ARIJ, 2007:5)

In general, there are two major types of soil in Battir, Terra Rossa and the Rendzina, however, the bulk of soil type is Terra Rossa is mainly located in the area. (Cultural landscape Technical report 2006). In more detail, Zaid provided a description of the soil formation in Battir and claims that "The main soil types in Palestine are: lithosols and desert soils, Terra Rossa, Pale Rendzina, Brown Rendzina and grumusol (vertisol) (MAP 2.1-2). Terra Rossa is developed on hard calcareous rocks, mainly limestone, dolomite, while Rendzina types are developed on soft calcareous rocks, mainly chalk,

chert, and calcrete (Zaid, Mahmoud. (2017).”



MAP 2.1-2: Soil types in Battir (Zaid, Mahmoud. 2017)

The Soil in Battir is not far away from being polluted and contaminated by the sewage water leaching from house cesspits that are commonly used for wastewater due to the lack of a modern sewage system for wastewater in the village despite the many projects that were proposed by diverse donors to erect but none was implemented.

The main causes of soil pollution were summarized in the environmental strategy as increased desertification and soil erosion, soil pollution due to mismanagement of liquids and solid waste, natural and manmade soil erosion, and soil pollution caused by Israeli occupation power military activities (CBD, 2015).

Asrari (2014) presented a complete curriculum on heavy metal contamination in the soil as well as water. Humans consume heavy metals ever since, knowing in advance the adverse health effects of this consumption. Therefore, it is wise to restore the soil to its original healthy constituents and save the ecosystem from being harmed. This evidently needs a remediation process that reduces associated health and ecological risks and restores the land for safe cultivation. The risks can be through: “direct ingestion or contact with contaminated soil, the food chain (soil-plant-human or soil-plant-animal-human), drinking of contaminated groundwater, reduction in food quality (safety and marketability) via phytotoxicity, reduction in land usability for agricultural production causing food insecurity, and land tenure problems (Asrari,

2014).” Heavy metals in soil occur either naturally in the soil environment (Asrari, 2014:2) or “the discharge of wastewater into wadis and agricultural lands (CBD, 2015).”

Zaid addressed the chemical composition of soil and states that “Major elements are rock-forming elements Ca, Fe, K, Mg, Na, Al, and Si minor elements are Mn, P, S, and Ti. Typically, major and minor element concentrations are presented in weight percent of their oxides.” At the same time, Zaid articulates a list of the trace elements that are typically studied and they are Ag, Al, As, Ba, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, P, Pb, Sb, Se, Si, Sr, Th, Ti, V, and Zn (Zaid, Mahmoud. (2017). Soil retention ability is governed by several soil characteristics such as pH, cation exchange capacity (CEC), particle size distribution, organic matter content, and oxide content (Ibid). As for Rare Earth Elements (REE), Zaid claims that they occur in more than 200 minerals distributed in a wide variety of mineral classes and therefore they occur in most primary and secondary minerals in soils (Ibid). On the other hand, the type of soil and the parent material from which it is issued decides on the variation of REE in soil, Zaid adds that other REE sources in soils are atmospheric depositions, particles, rainwater and snow, and others such as anthropogenic in waste samples, irrigation, and sewage water and fertilizers. The Total Organic Carbon (TOC) is present in soil and it originates from the decomposition of plant and animal residues, toot exudates, living and dead microorganisms, and soil biota.

Chapter Three

3.Study area

The village was listed on the World Heritage List of the United Nations Educational, Scientific and Cultural Organization (UNESCO) on 20 June 2014, including its agricultural terraces. The Palestinian Authority has been interested in performing the heritage list to prevent the establishment of village lands. The landscape includes a series of agricultural valleys and stone terraces It has been developed because of the mountain environment.

Battir's soil, as has been discussed above in chapter 2, is and has always been exposed to hazardous environmental problems, and also suffers from a lack of a proper sewage network and wastewater treatment system. Battir's water as well as wastewater discussed earlier above in chapter 2. Although Battir's freshwater runs inside a proper water network and it encompasses several natural springs (Figure), it suffers from the lack of any sewage system or network where houses in Battir have cesspits for wastewater discharge (see chapter 2 above).

Wadi Al-Makhrour is the breathing lung of the Bethlehem governorate as it hosts the main biodiversity and ecosystem of the area (Figure).

Figure Figure 3-1: Wadi Al-Makhrour (Ghattas, 2019), (below) a satellite view of Wadi Al-Makhrour and shows the geographical layout with Battir

3.1.Biodiversity of Wadi Al-Makhrour

According to a study by Ghattas, R. 2019 on Wadi Al-Makhrour or (Al Makhrour Valley) as the study referred to it, is 3 kilometers of land. It is located in the botanical zoogeographical region and the Mediterranean biogeographical zone (Figure). Its rainfall replenishes the western aquifer. Temperature is between 15° and 18°C with an average precipitation of 250-650 mm. the soil is a mixture of Rendzina and Terra Rossa light brown. Wadi Al-Makhrour is 640 m to 830 m above sea level. It is the most fertile land and it represents the traditional breadbasket for the region. The valley attracts the attention of the world and is designated as of the WWF's 200 priority biomes in the area for conservation (Ghattas, R. 2019).

Wadi Al-Makhrour contains an important eco-tourism attraction, the Battir Trail (MAP 1-2) and (Figure) which starts from Beit Jala and ends at the verge of Battir village. It is 6.5Km length. The Battir Trial is a conservation area and hosts an important biodiversity region in the valley, especially plants. The Trail is an

ecotourism attraction as it receives many visitors (Figure), especially during the Spring and Summertime as the biodiversity is at its peak.

Figure Figure 3-2: Battir trail as an ecotourism attraction (Compiled from Google and edited by the researcher)

3.2.Soils of Battir

Battir is located in the middle part of Palestine (**خطأ! لم يتم العثور على مصدر المرجع.**) and is considered a location with intense plant biodiversity that needs to be preserved to support the sustainability of nature and biodiversity in the area. Soil, however, is the carrying grounds for the plants and this suffers from a number of challenging issues such as desertification caused by the extensive exploitation of the land for urbanization such as trees uprooting and dumping solid waste and affluent, and other factors related to unmanaged processes by the Israeli occupation (Isaac, Jad; Gasteyer, S. (1995). In chapter 2 above we explained the origins of soil in Palestine and the soil characteristics of oil in Battir. Several studies were made on the soil of Battir and the materials embody in it. An important study that was carried out is the one made by Zaid, Mahmoud. (2017) in which he, not only gave a pictorial picture of the soil in Battir but also to many other parts of Palestine.

Battir depends on agriculture and the plantation processes take place on the terraces and on lower grounds in the valley area of Battir (see appendix 1 for photos of plantation projects). It is worth noting here that the ground level where the plantation is taking place is lower than the houses. And knowing that those houses use cesspits

for wastewater discharged from their household activities and human waste, it is only evident that the affluent discharged from those cesspits will eventually dissipate into the soil where the plantation is taking place (Figure).

3.3.Water Resources of Battir

According to the latest report by IPCC in 2020, all households are connected in one way or another to the water network. The last time the network was rehabilitated was in 2016 by a fund from donors. Water is purchased from Israeli water company carrier Mecorot through the Palestinian Water Authority. Water springs are also one source for water but it is mainly used in irrigation and for domestic animals (IPCC, 2020).

There are several springs scattered in different locations in Battir. (Abu Hammad, A 2016) claims that there are five springs (Figure), ARIJ, 2010; ESCHIA, 2012 name four only, where others name more springs. the two springs that are tested for water quality are as follows:

Ein al Balad (Figure Figure Figure 3-3: Ein Elbalad and the collection pool (Roman time) – Photo by the researcher.).: it is located in the northern part of the village in the vicinity of the center of the populated area. The spring is an ancient Roman spring and it has the highest amount of water in the area. The water from this spring is mostly used in agricultural activities (irrigation) a major spring in Battir and it bears heavy activity in irrigation in agriculture. It is famous for its water collecting pool that also dates back to the Roman period.

Figure Figure 3-3: Ein Elbalad and the collection pool (Roman time) – Photo by the researcher.

Ein Jame (Figure).: this is also an old spring that dates back to the Roman period. The limestone rock structure and the cracks in them reduced the amount of water discharged from it. This spring also has water collection pools.

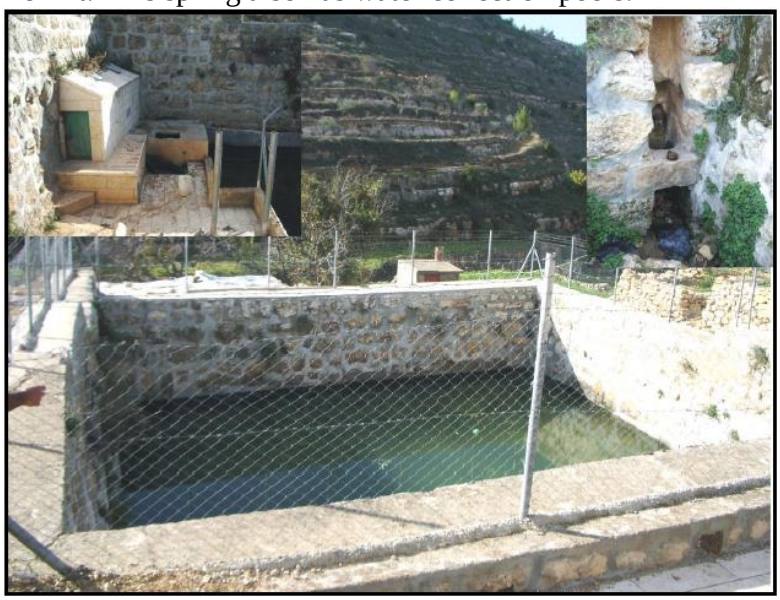


Figure Figure 3-4: Ein Jame, A Roman time spring, Photo curtsey (Abu Hammad, A (2016:8)

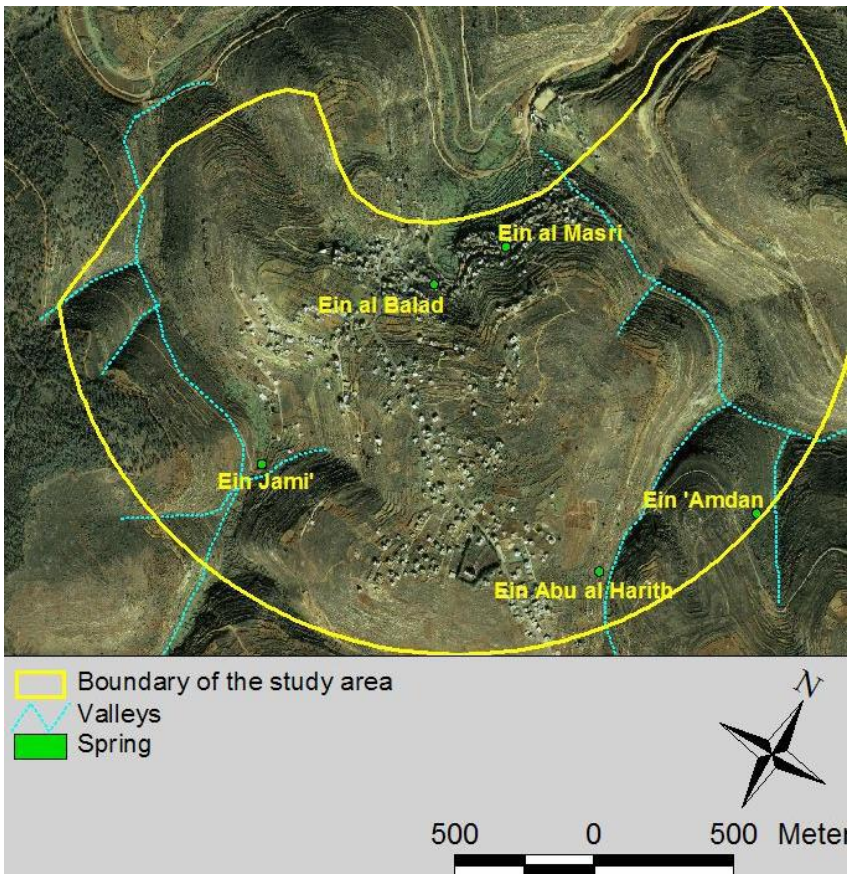


Figure Figure 3-5: The five springs in Battir (Taha, et al. 2006:22)

3.4.Environmental Conditions in Battir and Wadi Al-Makhrour

Battir suffers from many environmental conditions that constitute a major threat to the people's health in general and to agricultural activities (ARIJ, 2010). Those problems, as ARIJ claims, are of two sources: First, the Israeli occupation and domination of Palestinian water resources, second, the water loss rate due to the bad water network (Ibid). The use of cesspits is a major hazard to the environment and to the agricultural sector especially to the groundwater as it may cause diseases and epidemics. Even collected wastewater from cesspits is taken to areas and dumped without any consideration to the environment (Figure).

Figure Figure 3-6: Water leakage from cesspits out of the rocks and underground (ARIJ, 2010:17)

Wadi Al-Makhrour suffers from hazards in the environment and it is an urgent matter that the authorities must attend to in order to save all stakeholders in the Wadi Al-Makhrour from a natural catastrophe. The biodiversity in Wadi Al-Makhrour is being threatened by environmental and human effects. PMNH in collaboration with Prof. Qumsiyeh and other researchers endeavored on a study to pinpoint all the environmental problems and to find a cure to all of the threats. Wadi Al-Makhrour is an important sphere in Bethlehem Governorate as it is the place that refills the aquifers with water where also springs also pass from there. It is the last remaining biodiversity in the region of Jerusalem and Bethlehem (PMNH (2019).

The Israeli occupation has an enormous destructive impact where it prevents farmers from restoring their terraces and watchtowers and install irrigation systems in their lands. Lands of Wadi Al-Makhrour close to settlements suffer from attacks ranging from burning trees to settlers' wastes (PMNH (2019). In addition to the occupation practices, domestic problems such as the lack of national touristic strategy and even the existing plans are not implemented properly. Besides, there is no public awareness of the importance of biodiversity (Ibid).

Chapter Four

4.Methodology

In order to achieve the objectives of this research, the following methodology was adopted to perform the actions needed. This research is a tripartite one which involves a) the plant biodiversity in Wadi Al-Makhrour to provide a classified list of the plant cover along the Battir trail as an ecotourism site for the intention of preservation, b) water analysis of the springs of Battir aiming at evaluating the validity for human consumption, and c) soil analysis of Battir to evaluate the effect of the hazardous environment on the soil contents of metals, nutrients, and other harmful substances. The researcher endeavored to collect and sample the plant cover of Wadi Al-Makhrour and articulate a classification for the plant biodiversity in the valley.

This study started in February 2018 and continued until the beginning of 2020. Due to the pandemic (COVID-19) in the year round of 2020 and until the beginning of 2021, January, the work on plants monitoring restarted again up to April 2021, as the thesis writing and the completion of this document.

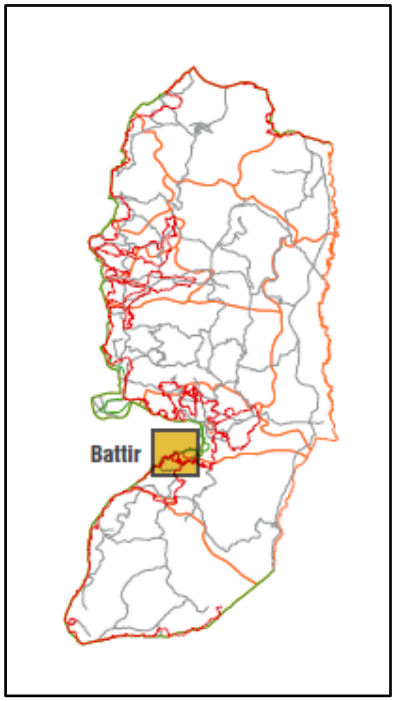
This study is the first of its kind in the area with an academic research as it deals with the plant biodiversity as well as water and soil in the area of Battir and Wadi Al-Makhrour. In addition, this is the first study that contains all three subjects together. All previous studies were conducted as financed projects by NGOs.

4.1. Location of the study

Two areas were targeted to conduct this study. The first is Battir village and the second is Wadi Al-Makhrour. They are geographically adjacent to each other and in fact, complement each other in terms of the natural landscape and habitat.

Battir is a Palestinian village in Bethlehem Governorate located 6.4 km (horizontal distance) north-west of Bethlehem City. Battir is bordered by Beit Jala town and Al Walaja village to the east, Husan village to the west, Husan and Al Khader to the south, and the 1949 Armistice Line (the Green Line) to the north (MAP 4-1).

Battir is located at an altitude of 761m above sea level with a mean annual rainfall of 653mm. The average annual temperature is 16º C, and the average annual humidity is about 61 percent (ARIJ GIS, 2009).



MAP 4-1: A map of the West Bank and shows Battir's location (IPCC, 2020)

4.2.Material and methods

The researcher adopted the Braun & Blanquette line method along the Battir Trail in Wadi Al-Makhrour. Material and tools used are:

- Measuring Tape of 10 m length (see appendix 2).
- Adhesive tape
- Mobile camera
- A pair of scissors
- Ruff paper from old newspapers

4.3.Plants

Maintaining a record of biodiversity of any species entails not just a count of numbers of species, it also involves the quality of those species and the quality of the environment that surrounds them. Nonetheless, there are also other aspects of determining the biodiversity levels in any area. Gaston & Spicer (2004) defined several other factors; the size of the area under study, the number of species counted in that area(Alpha), and the occurrence of each one in the area (Beta) (see 2.1.5 above). However, as Gaston & Spicer argue that "whilst biodiversity can be measured in a host of ways, in practice it tends most commonly to be measured in terms of species richness, the number of species (Gaston & Spicer 2004).

Nonetheless, this research shall make a survey of the plant population in Wadi Al-Makhrour, precisely along the Battir trail in the area between (31° 42' 52"N, 35° 10'

26”E) and (31° 43’ 48”N , 35° 08’ 39”E) (Figure) through direct collection of sample plants and classify their biological information for reference and in order to monitor their existence in the area, and the season in the year they appear in, where the complete classification table is found in the results chapter. The samples were selected by the researcher herself from Wadi Al-Makhrour using the line transect methodology (Ghattas, et al. 2019) rather than the Block transect along the trail with a narrow distance on the sides of the walk which extends up to 6.5 Km of Wadi Al-Makhrour. This is performed by taking photographs of each of those plants and recording the biological data on each of them, namely, family, scientific name, English name, Arabic name, a brief description of the plant, and a photo of it. (Table 5-1).

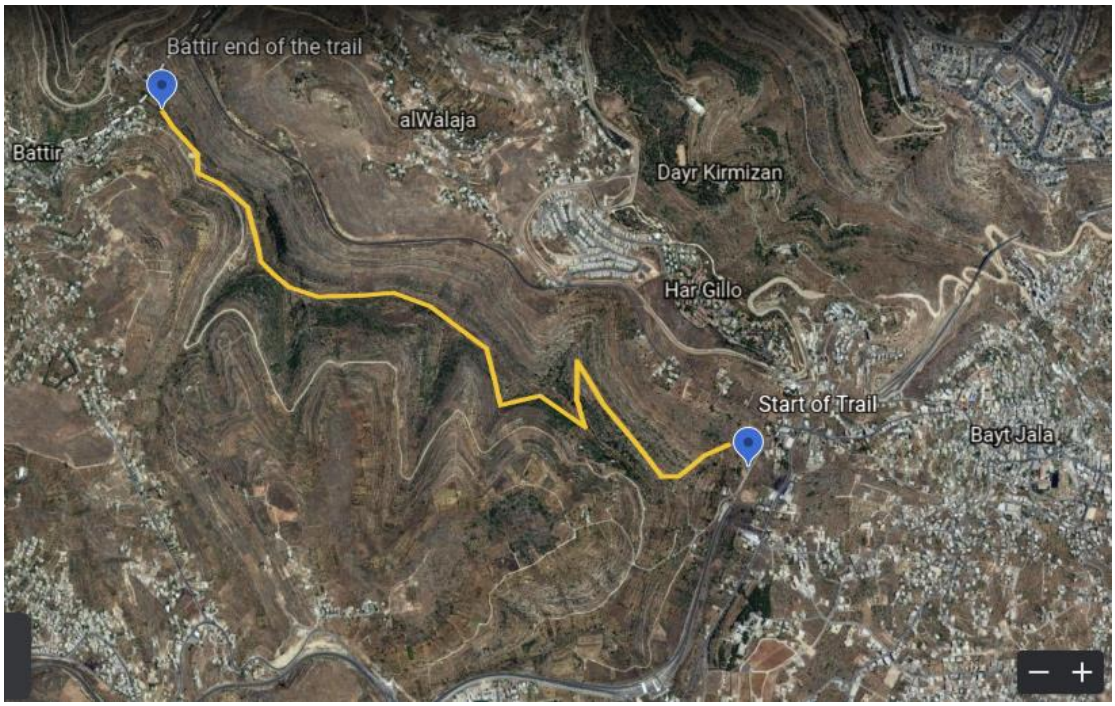


Figure Figure 4-1: Battir Trail Satellite photo (prepared by the researcher from Google Earth) 2021

Plant species were counted on both sides of the walking trail, as far as 1 to 10 meters on either side depending on the presence of the plants’ diversity and counting. The distances were measured using the measuring tape (Appendix 2). A photograph was taken for each different species using the mobile camera (see appendix 3 for a collection of photographs) with high-definition quality.

In order to obtain the English name and the English description of each plan three websites were searched for each plant; Flowers in Israel, Wild plants in Israel, and the Wikipedia. The latter was searched for the English name using the Arabic known name to the researcher, then the English name obtained from Wikipedia is used in either one of the Israeli references, Flowers and Wild plants to obtain the description. A record is kept for each plant registering the following information on each one: a photo, the scientific name, the English name, the Arabic name, a description of its

average grown size, the family, its use, and the season of growth (Table 5-1). The number of plant species recorded was 58 plants.

4.4.Water

Water samples were collected by the researcher from two different natural spring areas in Battir to analyze and study. The water was collected in a laboratory testing special bottles, 200 ml each. Three samples were collected using three different bottles and the collection method involved filling and emptying each bottle three times to make sure that the bottle is free from any foreign bodies. Two samples were collected from Ein El Balad spring, where the first was collected from the outside street-level outlet and the second was collected from inside the cave of the spring. The third sample was collected from the root of the spring source of Ein Jame spring. Due to the fact that water chemistry can change rapidly once a sample is collected and exposed to light, warm, cold air or any other environmental effects (Jebreen, H. 2014), the samples were taken as the weather was fine and the temperature was 25°C, the time was 9:00 am. The samples were directly taken to Al-Quds University laboratories to be analyzed by the lab technicians.

Fecal Coliform Testing:

The membrane filter method uses a fine porosity filter which can retain bacteria. The filter is placed in a petri (culture) dish on a pad with growth enrichment media (mEndo) and is incubated for 24 hrs. at 35 °C. Individual bacteria cells which collect on the filter grow into dome-shaped colonies. The coliform bacteria have a gold-green sheen.

Total Coliform Testing:

The membrane filter method uses a fine porosity filter which can retain bacteria. The filter is placed in a petri (culture) dish on a pad with growth enrichment media (mEndo) and is incubated for 48 hrs. at 44.5 °C. Individual bacteria cells which collect on the filter grow into dome-shaped colonies. The coliform bacteria have a gold-green sheen.

Biochemical Oxygen Demand (BOD) Testing:

1 water is filled into attesting bottle and the consumed oxygen during five days of incubation is measured.

2 the test method uses five days of incubation time as after five days most organic material has already been degraded.

3 the test sample is continuously agitated under the absence of light and a sensor measures the decline of pressure caused by oxygen consumption.

Heavy Metal Testing:

Determination of heavy metals in the water samples was achieved using Inductively Couples Plasma Mass Spectrometry (ICP-MS) Agilent 7500. ICP- MS is an analytical technique used for elemental determinations. The water samples were tested for its content by the addition of 65% pure nitric acid. 2 ml of the sample were taken for analysis.

4.5.Soil

In the light of the fact that the soil in Battir has been analyzed recently by the researchers at Al-Quds University, the researcher in this study shall continue on the Soil analysis and the results obtained from the latest previous analysis and study performed by the same university laboratory for the same area under research in Battir. The research was started by Zaid, Mahmoud Salahdeen in 2016 for his thesis for the master's degree. Samples were collected from two separated places, around a 50-meter distance from each other. The samples were labeled as Battir 1 and Battir 2 in the following manner:

Battir 1 sample:

This location is 756 m above sea level with mixed vegetation: Cypress and pine trees along with seasonal plants and grasses (Figure).

The soil is Terra Rossa and it has reddish soil and well leached. Formed on dolomite rock of Bethlehem Formation and filled karst depressions.

The sample soil profile is 35 cm labeled O and A1 in the table (Table *4-1*).

Table 4-1 : Battir 1 soil samples .

Horizon	Depth (cm)	Description	Sample Name
O	5	Leaves, pine needles and roots	
A1	30	Brown/red soil, granular structure, small rock fragments, gradual transition, some roots.	JS-4 Depth: 0-15cm

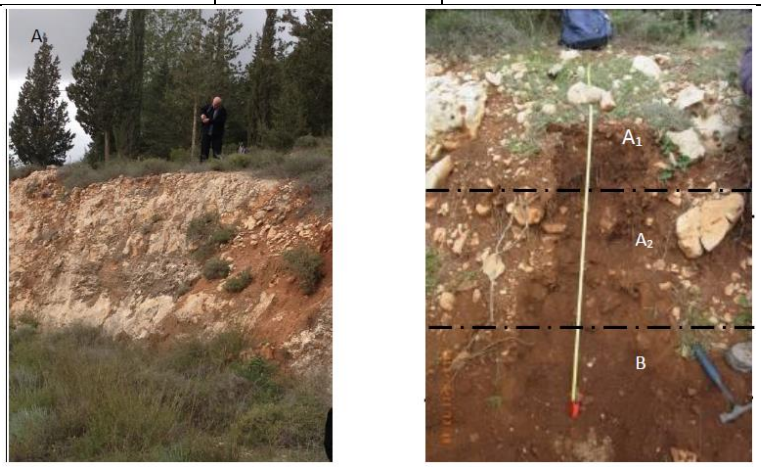


Figure Figure 4-2: The cut in the ground A1 section of the soil, on the left is a general view of the road cut (Zaid, 2017)

Battir 2 sample is only 50 meters away from Battir 1. The location is 750 meters above sea level. The top vegetation was mainly Cypress and Pine trees and some seasonal grass (Table 4-2).

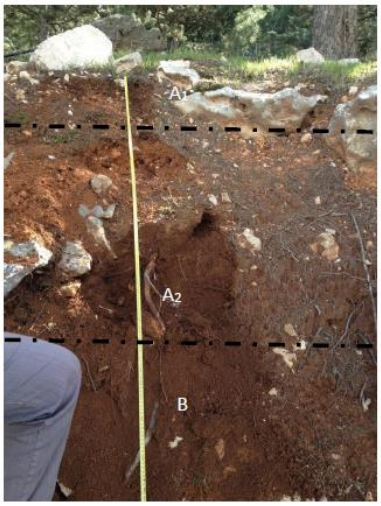


Figure Figure 4-3: Battir 2 sample cut in the ground A1 section

(Table 4-2): Battir 2 soil samples

Horizon	Depth (cm)	Description	Sample Name
O	5	Leaves, pine needles and roots	
A	20	Brown/red soil, granular structure, small rock fragments, gradual transition, some roots.	JS-9 Depth: 0-15cm

Table 4-2: The sample of Battir 2

In both cases, Battir 1 and Battir 2, the samples were 2Kg each and the table (**Table *4-3***) shows the types of soils collected from both locations.

Table 4-3: The site names and the type of soils collected

Site Name	The reasons of choice each pedon
Battir 1	Terra Rossa in higher rainfall in south section over dolomite rock
Battir 2	Terra Rossa in higher rainfall in south section over limestone rock

Bethlehem and Jerusalem, contains: the western transect of the southern section is Battir1, Battir2, which is Karstic, pedons are in Terra Rossa soil.

Soil samples were dried in the laboratory at 50°C until they reached constant weight. The samples were disaggregated and split into two portions. One portion was discarded and the other one was sieved to pass a 2 mm sieve. An aliquot was analyzed for grain size, pH, and water saturation. Another aliquot of about 20 gr was ground by a mullite grinding machine and was used for mineralogical total organic carbon (TOC) and chemical analyses (Zaid, Mahmoud. 2017).

Settled dust (2 samples) was collected in plastic trays covered with three layers of glass marbles (**خطأ! لم يتم العثور على مصدر المرجع.**), on the roof of the College of Science and Technology building in Al-Quds University. After the soil samples were sieved to pass a 2 mm sieve, each sample was taken parts: One part for pH, Water absorption, color analysis; other for TOC analysis; other for grain size analysis; and the last one for mineralogy analysis, chemical composition.

Table 4-4 : Soil pedons in southern and northern sections in Palestine

Location	Samples Name	Horizon	Elevation	Soil Type	Formation	Lithology	Depth (cm)	MAP (mm)
Battir 1	JS-4	Ah	756m	Terra Rossa	Bethlehem	Dolomite	30 cm	590 mm
Battir 2	JS-9	Ah	750m	Terra Rossa	Bethlehem	Limestone	20 cm	590 mm

Testing for the chemical composition of the soil samples is performed for Major elements and Trace elements. The following is how the preparation for those tests is carried out (Zaid, 2017).

For major elements testing:

Major elements reported as oxides, and Sr, Ba, and Sr were determined by inductively coupled plasma optical/atomic emission spectroscopy (ICP-OES). Emission spectroscopy uses inductively coupled plasma to produce excited atoms and ions that emit electromagnetic radiation at wavelengths characteristic of a particular element. 1.25 g of Lithium metaborate (Li2B2O4) was added to 0.25 g of a sample. Each run included repeated determinations of two of the international standards SO-3, BE-N, BHVO-1, SCo-1, NIM-L, and NIM-G every ten samples

For Trace elements:

Trace elements, including REE were determined by inductively coupled plasma mass spectrometry (ICP-MS).

"The sample is typically introduced as an aerosol, produced by passing the liquid sample through a simple pneumatic nebulizer. Larger aerosol droplets are removed from the gas stream by a spray chamber, and the remaining smaller droplets are swept into the central channel of the argon plasma. 500 mg of a sample is mixed with 2.0 g of Na2O2 (sodium peroxide) in zircon crucible and heated in a furnace at 500◦ C for 40 minutes. The hot crucible is put into a plastic beaker with distilled water. After cooling 20 ml HNO3 (3N) are added rapidly using a magnet stirrer until dissolution is completed. The solution is transformed into the volumetric flask. (Zaid, M. 2017)."

Chapter Five

5.Results

In this research three action research activities were made; classification of Wadi Al-Makhrour plant biodiversity through multiple visits to the location, water analysis of Battir's springs, and finally oil analysis of Battir and Wadi Al-Makhrour to find out the effect of environmental issues on the soil in both places. The environment status was looked into and evaluated.

5.1.Plant biodiversity in Wadi Al-Makhrour

During the multiple visits to Wadi Al-Makhrour and the identification process of the plant cover in the area, specifically along the Battir Trail and within a distance of 10 m on either side of the trail's walking path, 58 species were identified that belong to 29 families (Table 5-1). The area under study was approximately 6.5 Km^2. The 10 meters transects contained different species and in considerable number of them there were populated with only one species of plants.

The Asteraceae family were the most noticed plants then The Lamiaceae Family a little less noticed and finally The Leguminous/ Fagaceae Family was the least in numbers. However, there were many other plants that were present all along the pathway of the trail. Dicotyledon plants were found to have more presence than the Monocotyledons. Dicotyledon are a type of the flowering plants, or angiosperms, that contains two cotyledons, in the seed embryo. Monocotyledons are flowering plants whose seeds normally possess just one embryonic cotyledon

The table (Table 5-1: Plants of Battir) below shows the plants found in the area of Battir trail in Wadi Al-Makhrour (Figure). The data for each plant found recorded in the table are: The Scientific name, The English name, The Arabic name, and a description of the plant including the size, the growing season, and the use if necessary.

Certain plants seen on both sides of the trail from its beginning till the end either way have been continuous. Those plants such as *Cistus salviifolius, Calicotome, Anemone coronaria, Anthemis leucanthemifolia Boism, Sinapis arvensis,* and *Silybum marianum.* In addition, there are some threats to the sustainability of plant biodiversity in this area such as introduced species, overgrazing, and human intervention and mishandling. The area is also characterized by the presence of trees of different wild types. Among those found are amount of trees in the area scattered in all directions in a wild manner. Trees such as Oak, cypress, pine, almond, and olive. In addition, some shrubs were identified such as *Anagyris foetida* and *Capparis spinose* located around in Wadi Al-Makhrour. Other herbal plants such as *Orchis amatolica* and *Adiantum Capillus-veneris.*

After listing and classifying plants in Wadi Al-Makhrour, Battir trail as it is known, into families, it was found that some of those plants are used in popular medicine and alternative medicine. Those plants such as: *Silybum marianum, Ridolfia Segetum Paronychia argentea, Lamium moschatum, Colchicum, Ricinus Commusis, Convolvulus althaeoides*. And some other plants that are considered poisonous and must by highlighted and public must be informed about them. Those are: *Mandragora autumnalis, and Solanum luteum*. Some other plants are edible such as *Gundelia, Cichorium endive, Cyclamen pur purascens*. Some plants are used to produce essential oils and in the production of soaps, such as: *Iris Plalestina, Salvia Dominica*. Some of the plants found are eaten by animals such as: *Corifothumur Capitatus, and Trifoliom Clpetum*. Some of those plants can be used as herbs: *Satureja thymbra*. Palnts were found and were used as anesthetics in hospitals in the past, such as: *Hyoscyamus aureus*. Parasitical plants were found such as *Orobanche aegyptiaca*. Some plants found are used for display and decore, such as *Satureja thymbra, and Alcea acaulis*. Some plants are used in die such as *Calicotome*. Some plants are used as a disinfectant such as *Dittrichia viscosa*. Some plants have nice fragrance and also can be put in clay water container to give an odor to the water such as: *Cistus incanus*.

Table 5-1: *Plants of Battir*

5.1.1.Plant of Wadi Al-Makhrour

1- The Asteraceae family

النجمية او المركبة

and it is the largest family in terms of the No. of plants

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Silybum marianum*	milk thistle	شوك الجمل او خرشوف الجبل	Herbaceous plant around me, its height ranges from 30-120 cm It has medicinal value Flowering Period: March, April, May

	*Centaurea hyalolepisBoiss*	Cornflower	المرار	25-40 cm in height It has medicinal value Flowering Period March, April, May, June
	*Scolymus maculatus*	golden thistle	السنارية	20 to 130 cm long it has medicinal value Flowering Period: May, June, July, August

	*Gundelia*	Tumbleweed, Tumble Thistle, Gundelia	العكوب	20-40 cm in height, branching from the base, used for eating spiny plant Flowering Period: March, April, May
	*Reichardia tingitana*	Poppy-Leaved Reichardia	خزام	Stems 4-35 cm Flowering Period: March, April, May

	*Anthemis leucanthemifolia Bois*	Coast Chamomile	الاقحوان	15-50 cm it has medicinal value Flowering Period: February, March, April, May
	*Scorzonera pappos*	Oriental Viper's Grass	قعبارون	10-40 cm tall used for eating, it has medicinal value Flowering Period: March, April, May
	*Cichorium endivi*	Dwarf Chicory	الهندباء	Up to 170 cm tall it has medicinal value used for eating Flowering Period: April, May, June

	*Tragopogon longirostris*	Long-Beaked Goat's Beard	لحية التيس	15-60cm Flowering Period: April, May, June, July
	*Dittrichia viscosa, Inula viscosa*	False yellowhead	الطيون	Stems:branched it has medicinal value Flowering Period: July, August, September, October, November, December

2- the Apiaceae, Umbelliferae family

الخيمية

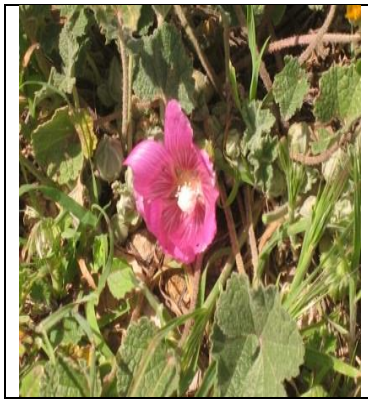
Photo	Scientific Name	English Name	Arabic Name	Definition
Family plants are herbaceous, with an aromatic scent نباتات العائلة هي نباتات عشبية ذات رائحة عطرية				
	*Ridolfia segetum*	corn parsley, or false caraway	الشمر الكاذب	40–100 cm it has medicinal value Flowering Period:April, May, June
	*Artedia squamata*	Fennel-leaved Artedia	ارتيديا	20-60cm high Flowering Period: March, April, May

3-The Malvaceae Family

الخبازية

Family of flowering plants Well-known of economic importance include okra, cotton هي عائلة من النباتات المزهرة معروفة بأهميتها الاقتصادية وتشمل البامية والقطن

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Malva sylvestris*	Wood Mallow	الخبيزة	60-90 cm Flowering Period: February, March, April

		*Alcea acaulis*	Stemless Hollyhock	الخطمية	Used in gardens Flowers: Pink, purple, white Flowering Period: March, April, May

4 The Caryophyllaceae Family

القرنفلية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Paronychia argentea*	Silver nailroot	رجل الحمامة	15-30cm It has medicinal value Flowering Period: January, February, March, April

5-The Iridaceae Family

السوسنية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Gynandriris sisyrinchium*	Barbary Nut	سوسن الطرقات	Up to 30 cm tall Flowering Period: March, April
	*Crocus hyemalis*	Winter Crocus	زعفران	4-8 cm high Flowering Period: January, February, November, December

	*Iris palaestina*	Palestine Iris	السوسن الفلسطيني	An essential oil is extracted from its flowers, which is used in the soap industry 10-20cm high Flowering Period: Januar, Februar

6-The Lamiaceae Family

الشفوية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Coridothymus Capitatus*	thyme	الزحيف	It has a beautiful scent that is used in alternative medicine Flowering Period: May, June, July, August, September, October
	*salvia Dominica*	Dominican Sage	الخويخة	It has a beautiful scent that is used in alternative medicine Up to 100 cm high Flowering Period: February, March, April, May

		*Satureja thymbra*	Thyme-leaved savory	ندغ البساتين	used for seasoning Shrubby stems, branching, 15–50 cm high Flowering Period: March, April, May -
		*Ajuga chamaepitys*	*Ground pine*	عرف الديك	used for decoration hairy stem Flowering Period: January, February, March, April, May
		*Lamium moschatum*	*Musk deadnettle*	قراص كاذب	It has medicinal value Flowering Period: January, February, March, April, May

7 -The Boraginaceae Family

الحمحمية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Podonosma orientalis*	Golden drop	مصيص	It tastes sweet it has medicinal value Flowering Period: February, March, April, May, June
	*Symphytum brachycalyx*	Palestine Comfrey	السمفتوم الفلسطيني	Flowering Period: March, April

8 The Liliaceae Family

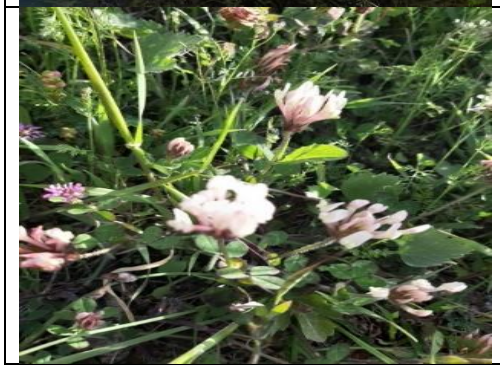
الزنبقيات

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Asphodelus Ramosus*	Onion-leaved asphodel	الغيصلان	Up to 30 flowers along terminal racemes Flowering Period: January, February, March, April
	*Gagea commutata*	Stolonous Gold-crocus	زخرط	8-14 cm high Flowering Period: February, March

9- The Leguminous/ Fagaceae Family

البقولية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Anagyris foetida*	Mediterranean Stinkbush	خروب الخنازير خروب الكلب	perennial shrubby plant 1m to 3m high Flowering Period: January, February, March, April
	*Quercus boissieri*	Oak	بلوط	perennial trees height of 10 meters or more Flowering Period: February, March, April

	*Spartium junceum*	Spanish Broom	وزال	1-2 m high Flowering Period: April, May, June
	*Calicotome*	Spiny Broom	القندول	Used in dye It has a beautiful scent Stems: Stem up to 300 cm Flowering Period: January, February, March
	*Trifolium clypeatum*	Helmet Clover	النفل المدرع	food source for sheep Flowering Period: January, February, March, April, May

10 The Ranunculaceae Family

الحوذانية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Clematis cirrhosa*	Fern-leaved clematis/ Virgin's Bower	ظيان جبلي حبل مسكي	Stems: climbing, branched Flowering Period: January, February, November, December

	*Anemone coronaria*	Crown Anemone	شقائق النعمان دحنون	15-45 cm high Flowering Period: January, February, March, April
	*Ranunculus millefolius*	Jerusalem Buttercup	شقيق مقدسي	Flowering Period: February, March, April

11 The Oxalidaceae Family

الحماضية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Oxalis pes-caprae*	Noddind Wood-sorrel	حمصيص عرق الليمون حماضية	Sparsely pubescent Flowering Period: January, February, March, December

12 The Colchicaceae Family

لحلاحية

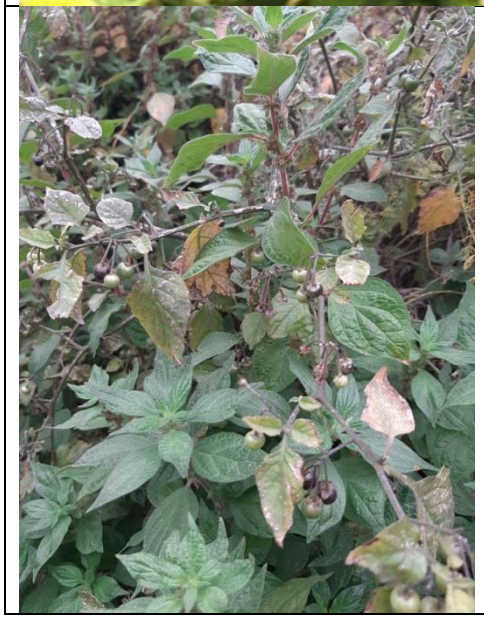
Photo	Scientific Name	English Name	Arabic Name	Definition
	*Colchicum*	autumn crocus,	لحلاح	Flowering Period: September, October

13 - The Solanaceae Family

الباذنجانية

contains many agricultural and wild plants. Some of them are very toxic
تحتوي على العديد من النباتات الزراعية والبرية . وبعضها شديد السمية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Mandragora autumnalis*	Autumn Mandrake	تفاح المجن	Affect the nervous system 15-30 cm high, stemless Flowering Period: January, February, March, December

	Hyoscyamus aureus	Golden Henbane	البنج الذهبي /السكران	It was used as an anesthetic 50 cm high Flowering Period: March, April, May
	*Solanum luteum*	Black nightshade	بندورة الحيات	Toxic plant Stems:Up to 70 cm high Flowering Period: Spring, summer

14 The Cistaceae Family

الخبازية

small family of plants ,known for their beautiful shrubs
عائلة صغيرة من النباتات تشتهر بشجيراتها الجميلة

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Cistus incanus*	Soft-hairy Rockrose	اللبيدة	perennial shrubs Very much branched, short and crowded Flowering Period: March, April, May, June
	*Cistus salviifolius*	White Rockrose	اللباد الابيض	Her beautiful smell 30-60 cm high Flowering Period:March, April, May, June

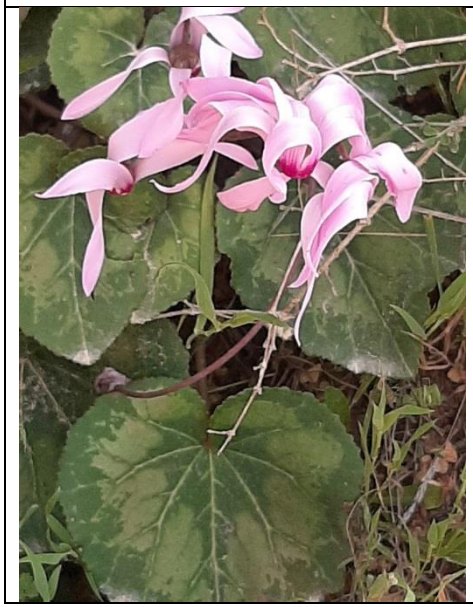
15 The Euphorbiaceae Family

اللبنية او الحلابية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Ricinus commusis*	Castor-Oil Plant	خروع	It has medicinal value Flowering Period: March, April, May, June, July, August, September, October, November

16- The Primulaceae Family

الربيعية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Cyclamen purpurascens*	Persian Cyclamen	قرن الغزال الزعمطوط	The leaves are ovate, narrow-ended, and the base is heart shaped Flowering Period: January, February, March, April

17- The Amaryllidaceae Family

النرجسية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Allium trifoliatum*	Wild garlic	ثوم بري	Stems: 15-45cm Flowering Period: March, April

18- The Papaveraceae Family

الخشخاشية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Papaver umbonatum Boiss*	Corn Poppy	الخشخاش	Hairy stems Flowering Period: March, April, May

19- The Convolvulaceae Family

المدادية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Convolvulus althaeoides*	Mallow-leaved bindweed	اللبلاب الحقلي	15 cm in height climbing Flowering Period: March, April, May, June

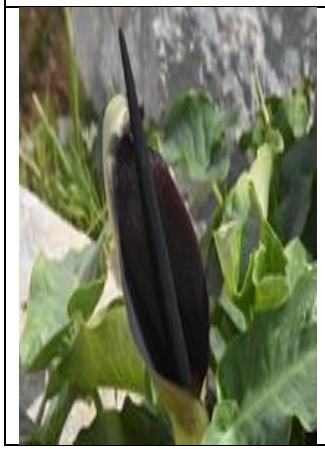
20- The Capparaceae Family

الكباريات

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Capparis spinosa*	Common Caper	الكبار	It has medicinal value Up to 100-150 cm high,many branches Flowering Period: May

21- The araceae Family

اللوفية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Arum palaestinum*	Palestine Arum	اللوف الفلسطيني	20-60cm tall Flowering Period: March, April

22- The Orchidaceae Family

السحلبية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Orchis anatolica*	Anatolian Orchid	السحلب الاناضولي	Up to 40cm in height Flowering Period: March, April

23- The Asparagaceae Family

الهليونية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Ornithogalum narbonense*	Narbonne Star-of-Bethlehem	نجمة بيت لحم	30-60 cm high Flowering Period: March, April

24- The Orobanchaceae Family

الهالوكية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Orobanche aegyptiaca*	Egyptian broomrape	الهالوك المصري	15-50cm Flowering Period February, March, April, May

25- The Cruciferae / Brassicaceae Family

الصليبية الخردلية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Sinapis arvensis*	Charlock	خردل	Stems 120–20cm high Flowering Period: January, February, March, April, May

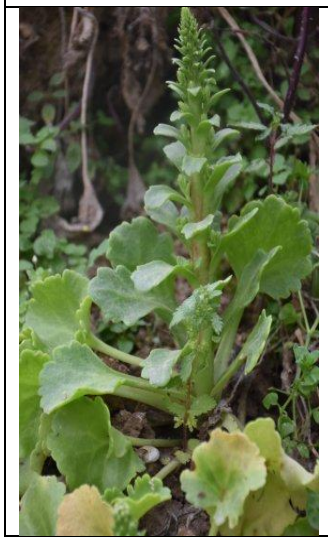
26- The Anacardiaceae Family

البطمية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Pistacia palaestina*	*Terebinth*	البطم الفلسطيني	Stems:3-5 m in height Flowering Period: March, April

27- The Crassulaceae Family

المخلدية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Umbilicus intermedius*	Common pennywort	اذان القط	Stems: stem 20-50 cm Flowering Perio March, April, June

28- The Cucurbitaceae Family

القرعية

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Ecballium elaterium*	Exploding cucumber	قثاء الحمار	Stems: branching Flowering Period: April, May, June, July, August, September, October, November, December

29 The Pteridaceae Family

السرخسيات

Primitive plants They reproduce with spores نباتات بدائية تتكاثر بالابواغ

Photo	Scientific Name	English Name	Arabic Name	Definition
	*Adiantum capillus-veneris*	*Southern Maidenhair*	كزبرة الماء	Stems: creeping Flowering Period: Whole year

5.2.Environment aspects found

Generally, Anyone can realize that the environment in Wadi Al-Makhrour and Battir suffer from the following different factors:

- The presence of the Israeli settlements around Battir and the dumping of solid and wastewater into the Battir outlands poses pollution risks to the water and soil of Battir.
- Road construction and the erection of the apartheid wall activities that results on destruction of the land and nature through trees uprooting. The presence of the wall encapsulates animals from each other and hinders the continuity of biodiversity in the area.
- Overgrazing and tree cutting prevents plants and trees from growing.
- Solid waste from visitors such as food leftovers scattered around in some touristic areas affects the soil when left to decay on the ground.
- In Battir, the absence of a safe environment friendly wastewater system was very clear as all houses in Battir still use cesspits for wastewater disposal.

In their research study in 2015, Isaac, J; Rishmawi, K. (2015), presented several types hazards that affect the environment. The research highlighted the water supply and wastewater issues and the problems that they face due to the occupation's practices, the solid waste treatment. And finally, the effect of those on the biodiversity in Palestine.

5.3.Water Analysis results

The water testing involved two types of investigation. First, the testing for the presence of heavy metals in the three samples collected from the springs in Battir, Ein Al Balad and Ein Jame. There were 18 elements of heavy metals tested for in the samples. However, also listed below the table of concentration levels approved by the WHO and the Palestinian Water Authority (Table 5-2) in order to compare the results to the standard figures. Second, the testing for the total coliform, Fecal Coliform, and finally the BOD (Biological Oxygen Demand) found in (Table 5-3).

Table 5-2:Heavy Metals Test results table

No.	Metal	Sample 1.1 (mg/l)	Sample 1.2 (mg/l)	Sample 2.1 (mg/l)	Palestinian Standards	WHO	Result
1	Be	0	0	0			**N/A**
2	AL	0	0	0			**N/A**
3	Fe	3321.37±142	2748.75± 99.50	2862.92± 98.48	**no limit**	**no limit**	**N/A**
4	Ba	33.03± 1.15	28.39± 0.53	52.24± 1.48	**700**	**no limit**	**LOW**
5	TI	0	0	0			**N/A**
6	V	6.53±0.10	5.57±0.49	7.61±0.23			**N/A**
7	Cr	753.59±16.70	679.63±14.20	661.10±11.60	**500**	**1000-5000**	**HIGH**
8	Mn	0	0	0			**N/A**
9	Co	0.32±0.0	0.18±0.02	0.42±0.07	**20**	**no limit**	**HIGH**
10	Ni	61.37±1.36	55.98±0.83	56.81±0.73	**20**	**20**	**HIGH**
11	Cu	1.92±0.26	0.92±0.02	1.72±0.21	**2000**	**1000-1500**	**LOW**
12	Zn	63.83±2.71	56.66±0.73	59.61±2.16	**3000**	**5000**	**LOW**
13	As	0.32±0.16	0.27±0.23	0.23±0.09	**10**	**10**	**LOW**
14	Se	0.87±5.52	2.95±3.17	2.09±1.93	**10**	**10**	**LOW**
15	Cd	0	0	0			**N/A**

5.3.1.Biological Test Results

Table 5-3: Water Biological Analysis results

sample code	sample name	BOD (mg\l)	Total coliform	Fecal coliform
1.1	**عين البلد**	**360.86288**	**0**	**0**
1.2	**عين البلد**	**154.95524**	**0**	**0**
2.1	**عين جامع**	**327.43256**	**0**	**0**
Standard Deviation		**110.50186**		

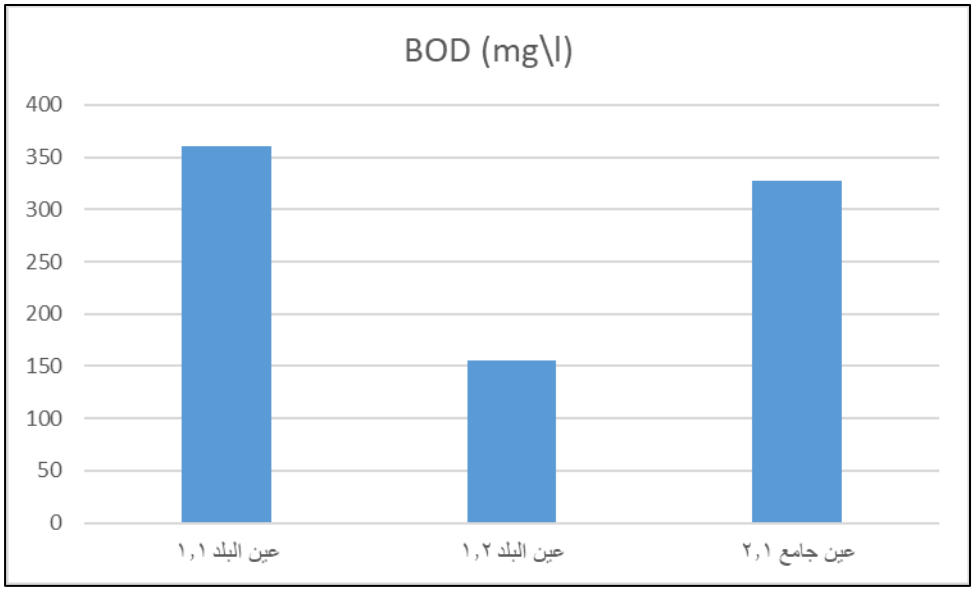


Figure 5-1: BOD levels in spring waters of Battir

The graph shows that BOD levels (Figure 5-1) differ in the three springs, Ein Elbalad 1.1 has the highest level, where Ein ELbalad 1.2 has the lowest level. The Standard Deviation obtained is a lot higher than 1.0 which means that the difference in levels is consequently large.

5.4. soil results

There are two major types of soil in Battir, Terra Rossa and the Rendzina, however, the bulk of soil type is Terra Rossa is mainly located in the area. This work is a continuation for the work started by Salahdeen. (2016) during his master thesis project with my supervisor.

Grain size of Battir 1 and Battir 2 in the samples were found to be one of the three types: Clay, Silt, or Sand. Each of which has its own characteristics of water absorption, pH, Color, and Total Organic Carbon (TOC). Each of the characteristics has its own merits in the soil and gives it specific function or ability.

Color: that gives the soil its lightness or darkness, for example, the Terra Rossa is differentiated from Rendzina by color. The difference in color is due to the mineralogical composition: Terra Rossa is enriched by iron minerals and depleted by calcite relative to Rendzina. This makes Terra Rossa color darker than Rendzina. Color is also affected by the soil texture and grain size. Being clay or silt defines the color and containing organic matter also matters in color.

pH: most of the samples produced numbers between 7.68 and 8.34 which indicates that it is alkaline soil.

Water absorption: slight difference between soils of Battir 1 and Battir 2.

TOC: no difference between soils (**Table *5-4***).

Table 5-4: Color, pH, TOC, water absorption and texture

Soil Site	**Location**	**Sample No.**	**Color**	**pH**	**Water saturation (g/g)**	**TOC %**
Terra Rossa South-West	Battir 1	**JS4**	5 YR 4/6	8.02	0.62	2.0
	Battir 2	**JS9**	5 YR 4/3	7.70	0.58	2.8

Grain size: The grain size is measured by the micron of millimeter "μm". different sizes define the soil type, clay, silt, or sand (**Table *5-5***). The table shows the

percentage of the soil in the samples JS4 and JS9 (selected from the 40 samples used by Zaid because those represent Battir area) where that in turn defined the soil texture.

We notice from the table that Battir's soil is mostly clay. Clay is defined by (V. 2015). as "fine-graded soil or the Þ ne-grained portion of soil that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dried. An earth material with a particle size smaller than 0.002 mm." Where Silt is defined as "Soil passing a 0.075 mm (No. 200) sieve that is non-plastic or very slightly plastic and that exhibits little or no strength when air dried (V. 2015)."

Table 5-5: The percentages of Clay, Silt and Sand

Soil Site	Sample	Clay %	Silt %	Sand %	Soil texture
Terra Rossa West-South	**JS4**	33.6	57.9	8.5	**silty clay**
	JS9	36.0	47.9	16.2	**Clay**

Mineralogy: the samples were composed of quartz, clay, calcite, dolomite, feldspars, and hematite (**Table *5-6***). It is clear that Quarts and Clay are the dominant constituent in Battir's soil, where JS4 that represents Battir 1 in the samples has more quartz than Battir 2. Calcite is prevailing in JS9 that represent Battir 2 sample and location. The rest of the minerals are with low percentages.

Table 5-6: Mineral composition

Sample No.	Quartz%	Clay%	Calcite%	Dolomite%	K-feldspar%	Plagioclase%	Hematite%
JS 4	40 - 45	30 – 35	>2	7	7	7	2
JS 9	25 - 30	25 – 30	25	7	5	4	4

Chemical composition:

A) Major elements:

The major elements in the soil are: Si, Al, Fe, Ti, Ca, Mg, Mn, Na, K, P and S. they were measured for the samples along with the dust and rock samples (**Table *5-7***).

In the south west where Terra Rossa had more silica and less calcium (JS4 55.5 SiO_2 and only 4.7 CaO_2) similarly (JS9 41.1 SiO_2 and 13.3 CaO_2). According to (Zaid, 2017) this is due to the amount of precipitation and leaching thereafter.

Table 5-7: Major elements, expressed as oxides

Sample No.	SiO2	Al2O3	Fe2O3	TiO2	CaO	MgO	MnO	Na2O	K2O	P2O5	SO3
Wt%											
JS 4	55.5	13.3	7.1	1.3	4.7	2.7	0.12	0.4	1.3	≤ 0.1	< 0.5
JS 9	41.1	11.2	6.0	1.0	13.3	2.8	0.09	0.2	1.1	0.1	< 0.5

B) Trace elements

The following trace elements: Ba, Co, Cr, Cu, Mn, Mo, Ni, Pb, Rb, Sb, Sr ,Th, U, V ,Zn and Zr elements were measured for soil samples (**Table 5-8**)

Table 5-8: Trace elements results

Sample No.	Ba	Co	Cr	Cu	Mn	Mo	Ni	Pb	Rb	Sb	Sr	Th	U	V	Zn	Zr
mg/kg																
JS 4	297	22	657	38	1030	1.4	65	16	64	0.5	103	9.0	1.9	295	158	515
JS 9	213	18	583	37	793	1.2	59	15	48	0.7	88	7.0	1.6	273	135	343
Standard Deviation	59.40	2.83	52.33	0.71	167.58	0.14	4.24	0.71	11.31	0.14	10.61	1.41	0.21	15.56	16.26	121.6

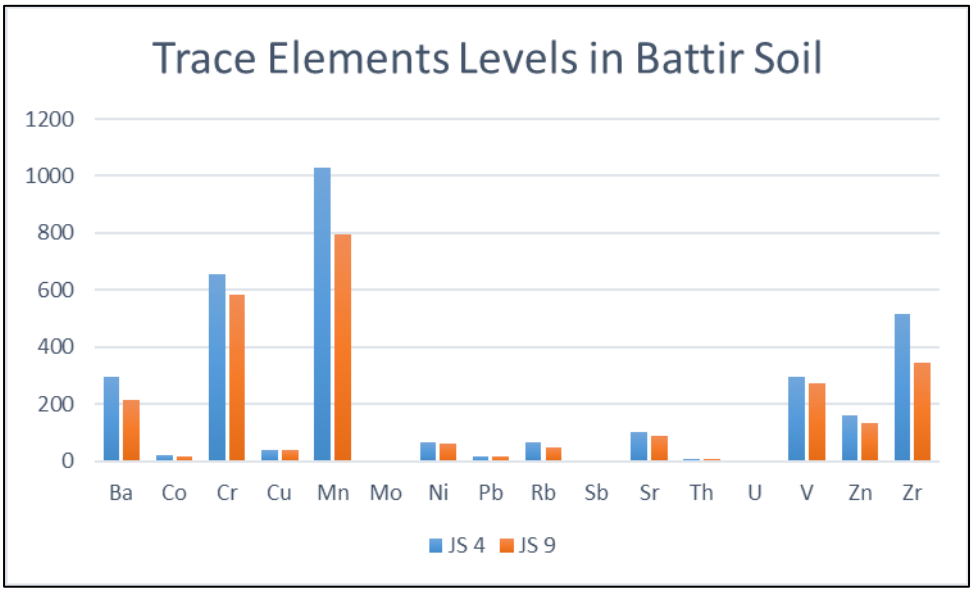


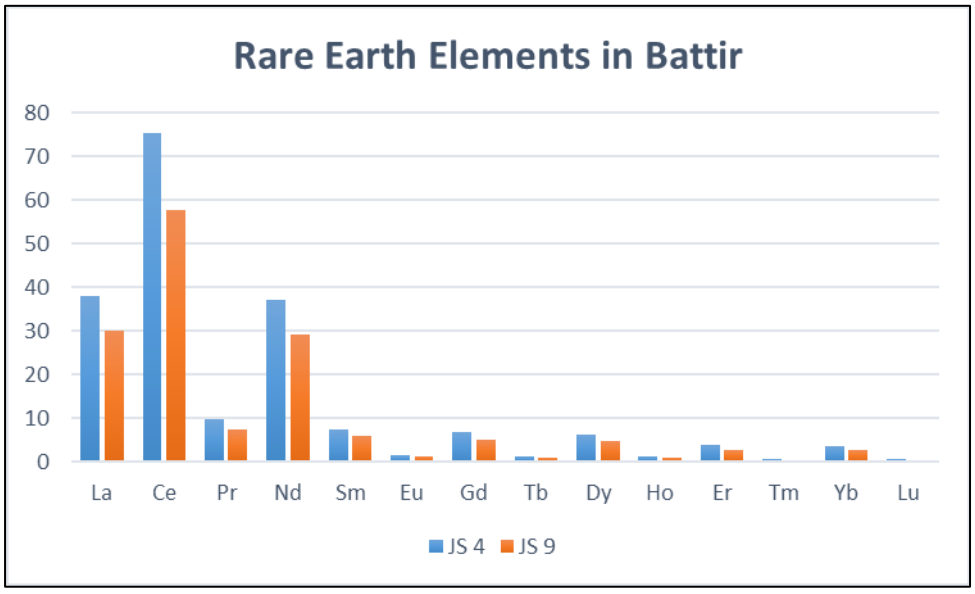
Figure 5-2: Trace elements levels in Battir's Soil

The rare earth elements REE are presented in the table (Table 5-9) where REEs are associated with clays soils where calcite increases less REEs are found and vice versa.

Table 5-9: REEs concentration

Sample No.	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
						mg/kg								
JS 4	38.	75.5	9.6	37.0	7.3	1.50	6.67	1.08	6.16	1.22	3.76	0.51	3.42	0.52
JS 9	30.	57.8	7.5	29.3	5.9	1.25	5.11	0.84	4.71	0.92	2.82	0.39	2.66	0.39
Standard Deviation	6	12.5	1.5	5.44	1	0.18	1.1	0.17	1.03	0.21	0.66	0.08	0.54	0.09

From the table (Table 5-9) it is clear that both areas have REEs concentrated in the soil, nonetheless, they differ in their value. The Standard Deviation indicates that 6 of the elements differ in their presence, some of them considerably. Those elements are La, Ce, Pr, Nd, Gd, and Dy where the value of the Standard Deviation is higher than 1. The elements Sm, Eu, Tb, Ho, Er, Tm, Yb and Lu appear to be close in concentration, where in some cases they are almost equal.



The graph above shows clearly the large difference in concentration in the soil for each REE.

Chapter Six

6.Discussion

6.1.Plant biodiversity and classification

After the collection of 58 samples of plants, and taking photos for each one, we can safely claim that biodiversity of plants is abundant in Wadi Al-Makhrour. Plants types found in Wadi Al-Makhrour were one of medical plants, harmful plants, edible and inedible plants. This in turn satisfies the objectives of biodiversity in sustainability and keeping the living humans, and other species in harmony and coexistence. Hence, the biodiversity is achieved in Wadi Al-Makhrour and the surrounding areas as part of this thesis. Alpha and Beta (Slootweg et. al 2009) plants diversities were identified in the different transects along the trail and on both of it sides. Alpha diversity was found in the trail from its beginning to the end.

It is worth mentioning that the area of Wadi Al-Makhrour is, according to the Oslo Accord 1993, classified as area 'C'. This status quo deprives the Palestinian Authority from many of the development projects to be implemented in it, and if it happens that a project is executed by agreement, it will have many obstacles. That is a main reason why certain important infrastructure cannot be built such as restrooms for Eco tourists to use or Tourist information centers.

Wadi Al-Makhrour is an area known for the large amount of rainfall that it receives in rainy seasons, and this is the main reason that it accommodates high level of biodiversity. This area is also surrounded by the Israeli Settlements where they release wastewater into the area in the intention to destroy it. The leaking wastewater has, of course, adverse effect on the soil quality and affects the biodiversity.

6.2.Water of Battir

The results (Table 5-2) show the reading for 18 heavy metals found in the water samples whereas the table for acceptable concentration of heavy metals of WHO and Palestinian guidelines shows only 10 elements. The result is either N/A where there are no standard figures from either the Palestinian or WHO, LOW if lower than both or either one, or HIGH if higher than both of either one of the two standards.

The results for the biological analysis show that all samples are free from both Total coliform and Fecal coliform. This result correlates with the Palestinian standards and WHO standards for drinking water. The maximum allowed for the total coliform is

(3) where the Fecal level must be (0). It is understood that the value of the Coliform and the Fecal Coliform is affected by the atmospheric conditions that surround the water at the time of taking the sample. According to (Bartram, J., & Ballance, R. (Eds.). (1996) Coliform, in all forms, are incubated at temperature 35℃ and above to show in the colony and as the samples were taken at weather temperature of 25℃, where water temperature is expected to be less than that of the air surrounding it, it is expected to obtain a result of (0) for both types of Coliform.

The BOD according to the WHO for drinkable water is 5-8 mg/L. Battir BOD samples were much higher than the standards indicating orhanic pollution. The results were as follows:

Sample 1.1 Ein El Balad taken from outer part at the street level 360.86 mg/l which means that it is not acceptable as a drinking water.

Sample 1.2 Ein El Balad taken from the rock source and the result was 154.95524 mg/l which also means that it is not acceptable as a drinking water.

Sample 2.1 Ein Jame, taken from the root of the spring, and still has high results of 327.43 mg/l which means that it is not acceptable as a drinking water.

The calculated standard deviation for the BOD results in the three samples, it is seen that the figure 110.50186 reveals a large difference in the purity of the water between the three areas, however, still the BOD, at the least levels found not acceptable.

Those BOD results mean that the water of the springs is polluted with organic matter and not safe for human use. Battir is constantly exposed to underground contamination and pollution. This is due to the fact that the whole village houses depend on cesspits to dispose of wastewater.

In the latest report by IPCC in 2020, they concluded that "There is no wastewater network in Battir. Instead, most houses are connected to cesspits which are periodically emptied by sewerage trucks that dump the sewerage in the surrounding valleys. A house treatment station for 10 houses began operation in 2008 (IPCC, 2020:42)." However, in 2012 an older report was produced by IPCC describing the same situation and presenting the dangers that this process has on the surrounding land. They found out that "The majority of the households depend on thousands of cesspits and the local tradition of wastewater discharge into open wadis (valleys) and land, leading to continuous deterioration in environmental and basic hygiene life conditions (IPCC, 2012)."

6.3.Soil of Battir

Palestine was developed under the Mediterranean climate then it follows that its soils are mainly Terra Rossa and Rendzina (Zaid, Mahmoud. (2017). In the two sample areas that were allocated in Battir, according to the study by Zaid, Battir 1 and Battir 2, it was found that the soil types are mainly Clay in both areas with Silty Clay in Battir 1 area. Where this characteristic was determined through the grain size testing performed on the samples JS4 and JS9 (this is the naming convention adopted by Zaid in his thesis which we adopted in this research). This Terra Rossa was formed on dolomite rocks and filled karst depressions (Zaid, M. 2017). However, Battir 1 sample was on dolomite rock, where Battir 2 sample was on a limestone rock.

As for the color of the soil of Battir, the results showed that both have the same color which means that the mineralogical composition is the same, even though the bed rock for both are different, dolomite and limestone.

The TOC results show that the areas have the same level of organic contamination. The samples were taken at a depth of 20-30 cm from the soil surface.

The pH levels for both samples are at the upper end of the pH measurement scale, which means that the soil is in the alkaline state.

Terra Rossa are developed on hard calcareous rocks, mainly limestone, dolomite, while Rendzina types are developed on soft calcareous rocks, mainly chalk, chert, and calcrete (Zaid, Mahmoud. (2017)

Battir is constantly exposed to underground contamination and pollution. This is due to the fact that the whole village houses depend on cesspits to dispose of wastewater. Usually cesspits are dug in the natural ground in a very close area to the house and in some cases in the nearest natural ground. The base and sidewalls of the cesspits are left undone (i.e. the original soil and rock walls). This in turn allows the wastewater to leach into the soil easily. Eventually, contamination reaches the soil bed.

We notice from the chart (Figure 5-2) that the Trace Elements levels diversify from each other in large numbers. Whereas Mn level is above 1000 mg/kg we find that the Mo is 1.4 mg/kg for sample JS4, and also for Sb at 0.5 mg/kg level. Similar difference in levels found for JS9. By looking at the standard deviation figures it is noticed that the majority of them are above 1.0 and that means that the difference in the REE richness is quite variable. For example, the Zr element in JS4 is a lot higher than that in JS9, as it produced 121.6 standard deviation, similarly the Mn element. By contract, we find that there are elements that are almost equal in value such as the Mo element and the Pb element, where the standard deviation is 0.14 and 0.71 respectively.

Tchounwou, P. B., Yedjou, C. G., Patlolla, A. K., & Sutton, D. J. (2012) in their article *Heavy metal toxicity and the environment* discuss the importance of each of those heavy metals in the soil and also consider the environmental effects on their presence. They argue that those metals are dangerously harmful for human beings and have a high potential to harm the environment as well. The harm that those metals can be harmful depends on several factors like "the dose, route of exposure, and chemical species, as well as the age, gender, genetics, and nutritional status of exposed individuals". The main sources of those metals are geogenic, industrial, agricultural, pharmaceutical, domestic effluents, and atmospheric sources Rare earth elements, where environmental "contamination can also occur through metal corrosion, atmospheric deposition, soil erosion of metal ions and leaching of heavy metals, sediment re-suspension and metal evaporation from water resources to soil and ground water".

Conversely, there are benefits from those metals where "essential heavy metals exert biochemical and physiological functions in plants and animals" as Tchounwou et al. declare. In their article Asati, A., Pichhode, M., & Nikhil, K. (2016) discussed the effect of heavy metals in plant growth. They declare that heavy metals are essential components of the environment. However, some are essential and some are not. Metal contamination of soils is caused by either anthropogenic or geologic activities alike. Heavy metals such as "cadmium, copper, lead, chromium, manganese, iron and mercury are major environmental pollutants, particularly in areas with high anthropogenic pressure". Moreover, their concentration in the soil affects the agricultural products and consequently have effect on food safety. It is also argued that different plant species get affected differently by the toxicity of heavy metals, and many heavy metals are essential for plant growth and "Heavy metals such as Co, Cu, Fe, Mn, Mo, Ni, V, and Zn are required in minute quantities by organisms" where heavy metals such as Pb, Cd, Hg are main threats and harmful for both plants and animals. The effects of heavy metals on plants and humans is enormous and it is not in our capacity in this thesis to further discuss it, the subject is open to other researches to deal with.

Wadi Al-Makhrour is exposed, as mentioned earlier, to the Israeli Settlements' disposal of solid waste of assorted types of materials, metals, plastics and of chemical and organic nature. This activity is capable of contaminating the environment with heavy metals and increase the risk of harm to both humans and plants.

Chapter Seven

7.Conclusion and Recommendation

This research was intended to achieve the following objectives:

- Classification of the plant cover in Wadi Al-Makhrour and specifically Battir Trail, to record the plant biodiversity in the area.
- Identify the environmental hazards and threats to the historical and cultural village of Battir and problems that face the plant biodiversity of Wadi Al-Makhrour.
- Study the underground water of Battir (from the water springs) and measure its quality by taking samples for testing in preparation for a complete wastewater rehabilitation plan should it be carried out in the future.
- Provide analysis for the soil of Battir for future references, in order to monitor the effect of the environmental hazards on the soil quality and safety.

7.1.Plant biodiversity and classification

As per the objectives of this thesis, a classification is made and can be found in (Table 5-1) above. For each plant found along the Wadi Al-Makhrour (Battir) trail in the area defined a picture is provided for each plant, the scientific name, the English name, the Arabic name, and a description on its form, use, and growing season. Plant Biodiversity is abundant in Wadi Al-Makhrour. Great efforts should be done to preserve it. Wadi Al-Makhrour plant biodiversity in particular are essential ingredients for a sustainable healthy environment where it reflects on the quality of life for people and guarantees more oxygen into the atmosphere.

7.2.The environment

The environmental hazards were identified and pin pointed where they were human caused hazards, the Israeli occupation and Israeli settlements destructive effect, and the natural growth of foreign plants due to the weathering activities. The environmental hazards were identified for both Battir and Wadi Al-Makhrour, where in the former environmental conditions were found to be manmade. The presence of primitive wastewater disposal system such as cesspits entailed a high risk of environment contamination and degrading the soil quality.

7.3.The soil

The soil of Battir was under this study. Soil analysis was conducted by (Zaid, Mahmoud. (2017). By utilizing data into this research advancement was made and further results were concluded from them. In order to sustain the environment and the

biodiversity in Battir, and in the light of the soil analysis utilized, minerals, heavy metals, and main characteristics, great care must be taken to preserve a healthy soil. The results of the soil analysis produced several facts about the soil contents of minerals and heavy metals. Some of the heavy metals that appeared in the results may be harmful for plant as well as animals and may be humans as in food production.

7.4.Water analysis conclusion

The study concluded that the spring water in the area was unsuitable for drinking by humans and animals, but it is suitable for irrigation purposes. Battir is constantly exposed to underground contamination and pollution. This is due to the fact that the whole village houses depend on cesspits to dispose of wastewater.

Although the results showed that the water from the springs is free from Coliforms and Fecal Coliforms, still the BOD did not show a healthy sign and the results revealed high level of BOD which means that the water cannot be used for human consumption, or even animal to a certain extent.

7.5.Recommendations

Based on the results found in the three study areas: biodiversity, water and soil in Battir and Wadi Al-Makhrour, the following recommendations are presented here in order to solve or minimize the effect of the environmental hazards, achieve better conservation plans for the biodiversity of the areas, and finally may pave the way for a better water supply fresh and healthy, and finally relieve the area from the dangers of the present sewage system to preserve the underground waters.

The idea of erecting a water purification plant to utilize the water that is available from the springs is not feasible due to the financial restrictions and the nature of the area and the lack of space.

1- More research work is needed on the biodiversity in Palestine in order to maintain the ability to endure healthy environment.

2- The government is obliged to provide all necessary budgets for the conservation of biodiversity. Such as the erection of Botanical gardens to accommodate Palestinian rare spiecs of plants. As a national objective, a seed bank should be established and maintained in order to conserve the seeds for indigenous plants, being for human consumption or mere natural growing ones. A seed bank can also preserve the genetic structure of those plants which in turn will sustain an enduring constant quality of agricultural production that has a healthy and economic impact at the national level.

3- Rehabilitation of affected areas with hazardous practices such as building constructions and road works.

4- Reinforce the experience in the field of biodiversity through the educational system, propaganda campaigns, and public activities where people are involved directly in the preservation activities. Institutions such as the Environment conservation centers like the one in Bethlehem University or a joint venture project between the Ministry of Tourism and Antiquities and the Ministry of Environment to raise the required fund and plan to propose and educational syllabus to be delivered in schools across the country.

5- Bring up to date the national strategic plan for biodiversity and announce protected area with proper administration.

6- Most importantly erect modern wastewater treatment systems in Battir and other marginalized areas to protect the underground water and save the aquifers.

7- Continuous and persistent revision for the quality assurance through testing the soil and waters of rural areas.

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Appendices

7.1.Appendix 1: Photographs of the soil to cultivate area in Battir

Figure 0-1: The terraces prepared for cultivation, the soil is prepared to receive the plants.

7.2.Appendix 2: Photos measuring the distance in the Battir Trail (Wadi Al-Makhrour)

Figure 0-2: During the preparation for the biodiversity study for Wadi Al-Makhrour, the researcher is measuring the distance.

The measuring of the distances in Wadi Al-Makhrour where the area surveyed along the trail using the Line Transect methodology of the Braun & Blanquette was adopted to define the biodiversity areas.

7.3.Appendix 3: Photos of researcher taking pictures of plants

Figure 0-3: Photographs preparation for listing in the plant classification, the researcher is taking the photos.