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THE VEGETATION CHARACTERISTICS OF WADI AL QUF FOREST RESERVE (WAFR).

By

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Dedication

I dedicate this work to the Palestinian people, who do their best to protect their environment and forest, despite of hard political situation**.**

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Abstract

The study aims at addressing the vegetation characteristics of WAFR flora, trees, understory layer and soil physical and chemical properties. We examined slope effects on the composition, structure, density of the plant communities, tree canopy and diameter at breast height (DBH) as well as soil physical and chemical properties. Two representative sites were randomly selected within the WAFR area, to be studied. One is located within the north facing slope aspect (NFSA) and the other is located within the south facing slope aspect (SFSA).

The results showed that slope aspects had significant effects on the composition, structure, biomass, density of the plant communities developing in both slope aspects and soil physical and chemical properties. Vegetation structure within the (NFSA) and (SFSA) were different. In addition, our finding showed difference in different year of the study. The soil chemical and physical properties also showed different values when comparing the (NFSA) and (SFSA). It is assumed that the differences in vegetation characteristics are related to differences in resources availability in addition to the fact that (SFSA) receives many times the amount of solar radiation that received by (NFSA). Consequently these plants are more xeric (warmer and drier) resulting in higher evapo-transpiration rates and higher daily maximal temperature during summer water stress period. The vegetation that developed in (NFSA) undergo phases of higher resources availability particularly soil moisture, compared to that of the south facing slopes. Higher soil moisture content in the (NFSA) compared with (SFSA). Ammonium and Nitrate concentration were significantly different between two slopes. The Electrical conductivity also was significantly different between the (NFSA) and

(SFSA).Our results were in agreement with many regional and international studies.

Chapter One: Introduction

Historical Palestine is a small country rich in biodiversity. This results from Palestine's location at the crossroads of three bio-geographical (Mediterranean, Desert and Steppe) and botanic regions of various climatic conditions, topography, geomorphology, geology and soils. This endows the Palestinian Territories with a rich variety of plant and animal life including some 2780-plant species (Feinbrun-Dothan and Danin, 1991). Its biodiversity was enhanced by the historical and geological events in the area (Frankenberg, 2002). The area remains, however, mostly arid with limited natural resources.

The climate in Palestine is typical Mediterranean, with a long, hot, dry summer, a rainy winter and a drier-than-spring autumn season. The temperature and the evaporation rate increases towards the south of the West Bank and towards the Jordan Valley, with rainfall ranging from 100 to 700 millimeters annually, depending on the location (Palestinian Central Bureau of Statistics (PCBS), 2003)

The West Bank contains about 260,000 dunums assigned as forested area, according to (Abed Rabboh, 1995). More than 195,000 dunums (75%) are natural forests and just 37,100 dunums (25%) are man-made forest areas. An additional 28,400 dunums are unplanted area with forest potential. In the southern areas (Hebron, Bethlehem, Jerusalem) the majority of the forested areas about 20,000 dunums, (8%), are introduced and mostly coniferous, made up mostly of pine species. While not native, in many cases they often harbor significant wildlife and plant genetic resources (Abed Rabboh, 1995). Historical and recent natural data indicate that these areas were probably naturally planted with tree species such as juniper, carob and oak, as well as cultivated species such as olives and fruit trees (Robinson 1838, Guerin 1852, Tristram 1892). In many cases, there has been a mixing of the various species in these areas, so that forested areas are often made up of both introduced coniferous and other species. Um Safa forest, is the oldest planted forest in the West Bank. The Tulkarem and Jenin sub-districts make up the largest forested areas in the West Bank, making up more than 235,000 of the total 260,000 dunums of forest. Because these sub-districts are relatively less populated than the rest of the West Bank and receive relatively more rainfall, they tend to be more suited for naturally occurring forested area. The forests tend to be diverse, composed of *Pinus halepensis, Pistacia* spp.*, Ceratonia siliqua, Cupressus* and *Quercus* spp., among others (Sultan and Abu Sbaih, 1996).

In Palestine, as in the world at large, the decline of biodiversity is largely a result of accelerated development, population increase and resulting from destruction of habitat, habitat fragmentation in addition to the long life Israeli occupation and land confiscation (Sultan and Abu Sbaih,1996). The declaration of protected areas in the West Bank began under the British Mandate & has continued under Israeli administration. According to (Abed Rabboh, 1995) and based on the Israeli nature reserve map 1992, there are 102 natural forests and 26 man-made forests in the West Bank. Protection of many populations is impossible to achieve within the reserve system, while out side the reserves, development, habitat degradation and conflicts with agriculture and other human activities, make it difficult to preserve small Palestinian populations(Palestinian Environmental Authority, 1999).

One of the main responsibility of the Environment Quality Authority (EQA) is the protection of the Palestinian environment through the formulation of Palestine Environmental Law which provides the present legal structure for the protection of natural habitats, natural assets, and wildlife and the formulation of National biodiversity strategy and action plan for Palestine in 1999, which was another step carried out towards the proper management of the Palestinian scarce natural resources, including forests, rangelands, farmlands, marine and fresh water resources (Palestinian Environmental Authority,1999).

The present study aims at addressing the vegetation characteristics and attributes such as (plant biomass, plant cover; density; frequency; and soil chemical & physical properties) and the influence of slope aspects north & south facing on these vegetation's characteristics, at (WAFR).

Chapter Two: Literature Review

2.1. Plant biodiversity in Palestine.

Drylands ecological systems in Palestine as well as the West Asia –North Africa (WANA) regions are known for their within species genetic diversity and variability rather than for their species richness (International Network for Cultural Diversity (INCD), 1995). However, they contain a significant number of species or populations of species that normally exist within and between biotic communities. Palestine, due to its geographical location in West Asia, at the edge of the fertile crescent, together with its geo-morphological and topographical diversification, in addition to the climatological variation and human activities, is regarded as a distinct natural reservoir of plant and animal species and a unique place of visible biological diversity within a very small area (Sultan and Abu Sbaih, 1996).

Aaronsohn (1934) gave a general description of plants in Hebrew but provided little information on plant geography. According to Zohary, (1966) and Feinbrun-Dothan, (1986), the area of the West Bank marks important phytogeographical territories (Mediterranean, Sudanian, Irano-Turanian and Saharo-Arabian) and comprises five botanical districts with many important food crops, forages, land races, forest trees and many wild species.

Reviewing the literature search on flora and fauna in Palestine reveals that the study of floristic biodiversity is the least developed in the West Bank and Gaza (Aloun, 1992a, 1992b). While Flora Palaestina (Zohary, 1966), indicates the great number of species occur in the West Bank and Gaza, representing a high degree of biological diversity. Still little is known about the documentation of species chorology and distribution pattern.

In terms of the scope of literature available on flora in Palestine, there are records on this topic dating back to the 19th century, when Tristram (1892) wrote the *Natural* History of Palestine, which drew on the work done by the Palestine Exploration Fund to produce Flora of Palestine in the late 1880s. While useful as a historical record, the work, and even the updates done through the 1940s by the Palestine Exploration Fund, has at this point been surpassed by publications that are more recent.

Zohary (1966) and Feinbrun-Dothan, (1986) divided the West Bank into four phytogeographical districts, known as Samarian, Judean mountains, Judean desert and the lower Jordan Valley, while Pitmann et al, (1983) has added another district to eastern side of Samaria named as the Eastern Samaria. This comes because of its unique, rather different climatological and topographical characteristics, which ultimately affect the type of the native flora and the richness of its biota. Most of the available plant collections are deposited at the Herbarium of the Hebrew University in Jerusalem. Although, Pitmann et al, (1982) and Feinbrun-Dothan and Danin (1991) presented their taxa on grid-shaded maps, it is unfortunate that the documentation of taxa abundance and distribution in the literature is rather general and only refers to the phytogeographical districts mentioned above.

Attempts from the Palestinian side to study the plant biodiversity and to evaluate composition and distribution of species have been somewhat limited, making the identification of areas and the justification for these decisions challenging. Abu-Irmeileh (1988) highlighted the existence of poisonous plants in the region and evaluated important rangeland and garden plant species in the Palestinian-Jordanian environment. However, nothing is found in his account about chorological and distributional patterns. A significant portion of the available literature on plants in the region has been mainly devoted to the medicinal, agricultural and cultural attributes, rather than viewing them from the ecological or scientific perspective (Najim, 1992).

According to Waisel (1984) and Shmida et al, (1990), the pool of genetic resources and vegetation biomass in the region is declining. Therefore, it is now of the utmost importance to undertake investigations on the ecological status of these species and figure out the appropriate means of conservation and management (Danin, 2003).

According to Al-Joaba (2006), there is a great potential to rehabilitate the degraded rangelands/forests in the southern parts of Palestine.

In the last 40 years, great economical, industrial, urban, and political changes have taken place in the Palestinian Territories. The influence of these on the status of biological diversity have been destructive, especially in the sense that their geographical and habitat range have narrowed and in the sense that local populations are small, as many as 40 plant species are reported endangered and about 150 are known to be rare. Some of these plants are reported now as protected species, of which their conservation, management and monitoring is highly required (Sultan and Abu Sbaih, 1996).

2.2. The Flora

The historical Palestine is a meeting area of plant geographical regions and has high climatic, lithologic, and edaphic diversity. These factors, together with prolonged influence of human activity, have led to the development of rich flora and diverse vegetation. The basic taxonomic research of the country's flora, flora Palaestina, was completed in 1986 (Feinbrun-Dothan, 1986).

Within Historical Palestine's boundaries of the vegetation map, including, the number of plant species is 2780 in an area of 29,600 km^2, this number is high compared with many other countries. For example, the Californian coastal zone, with an area more than twice as large as Palestine has 2325 species (Johnson and Raven, 1970). The number of species divided by the area or the log species/log area of Palestine has the highest value when compared to Mediterranean and European countries. Palestine's high species richness expressed as species/area or log species/log area results from two factors. The first factor is that the Palestine position in a meeting zone between plant geographical regions, each with a typical flora; and the second factor is the existence of many habitats that are needed to support these species. Danin et al,(1989).

The wealth of habitats derives from the climatic transition between the relatively moist area in the northern part of the country and the desert in the southern part. Topography is a second factor in creating the warm climates of the Jordan valley, including Dead Sea, and Arava valleys, and the relatively cold climate of mountains. In a similar way, other highlands and lowlands have local climatic influence, which increases Palestine's habitat diversity. The geomorphologicall structures are relatively small but the number of rock types is high. As a result, many soil types develop in a small area (Dan and Raz, 1970) increasing the diversity of habitats. A long history of human activity of cultivation, and grazing by domestic animals led to strong stress on the existing flora and enabled the introduction of many alien species. Many of the latter established themselves in synanthropic habitats .Zohary, (1972); Danin et al,(1989); and Danin and Orshan, (1999).

2.2.1. Vegetation

The plant communities, which occur in a particular place, are influenced by their phytogeographical positions, climatic factors, lithology, soil, and human activities. The principal woodlands are found in the mountains of West Bank, Carmel, and Galilee. In most of the area, cultivated plants have replaced the spontaneous trees. A few thousand years ago, people in Palestine, as in the neighboring Mediterranean countries, started to clear the natural vegetation in order to create agricultural land and trees have been domesticated from the spontaneous flora of Palestine (Zohary and Spigel-Roy, 1975), such as olives (*Olea europaea*) and almonds (*Amygdalus communis*) today cover large parts of the previously existing woodlands. The timber derived from the forests and maquis was used for the construction of houses, for agricultural tools, and for fuel. Areas of suppressed maquis support herbaceous vegetation, which has higher nutritional value than the evergreen trees and shrubs (Danin, 2003). For the last few millennia, shepherds burned large woodland areas to open paths for the domestic animals, and improve pasture quality while suppressing the arboreal vegetation (Danin, 2001).

After cultivated ground is abandoned, low herbaceous and low lignified plants populate the area for dozens of years. This vegetation formation of Mediterranean semi-shrubs covering the entire area is locally known as "batha" (phrygana) (Rabinovitch, 1979).

In many places in Historical Palestine and its neighboring countries, it is evident that *Quercus* Spp woodlands formations were found. Pinus trees are considers to be another type of woodlands formations in Palestine (Rabinovitch, 1979). *Ceratonia Spp* Park Forest develops on all hills at the foot of the central mountain range of the Mediterranean zone of Palestine. Spiny trees of Sudanian origin, mainly *Ziziphus spina-christi* and in a few places, *Faidherbia (Acacia) albida* grow in areas that seem to be too warm and dry to support Mediterranean trees. These trees are accompanied by Mediterranean herbaceous vegetation (Rabinovitch, 1979). The vegetation boundary of the Mediterranean territory towards the desert, where mean annual rainfall is 250-350 mm, is bathas of semi shrubs. Trees are rather rare and are confined to habitats where additional water concentrates such as wadis and crevices of large outcrops of smooth rocks. Semi shrubs grow over most of the slopes and hills in the area that has 80-250 mm mean annual rainfall (Monod, 1931). The vegetation formation is often referred to as shrub-steppe (Monod, 1931) named this pattern of distribution "mode diffus" as opposed to "mode contracte" where plants occur mainly in dry watercourses (known as wadis). The distribution of steppe communities of the West Bank desert and the Negev is highly correlated with rock and soil properties.

There is a gradual transition between the steppe vegetation, in the area with more than 80 mm mean annual rainfall, and desert vegetation in drier areas. Many Saharo-Arabian species prevail on slopes of the area with 70-90 mm mean annual rainfall. Within this area, edaphic conditions and micro topography are the most important factors affecting moisture regime and thus the distribution of plant communities. Communities of Zygophyllum dumosum and Gymnocarpos decander populate areas. These communities are floristically less rich than the steppe vegetation. There are plant communities of the xerohalophyte semi shrubs *Suaeda asphaltica, Agathophora (Halogeton) alopecuroides, Salsola tetrandra* and others (Danin, 1991a).

The main sandy areas are situated in a different climatic zone. This vegetation resembles a vegetation formation of Central Asia. The Dead Sea and Jordan valleys constitute the warmest zone in our area. Temperatures are much higher than in the neighboring areas at the same latitude. It is also the base of erosion, i.e., runoff water and underground water accumulate in it. Constant supply of fresh water and high temperatures enabled thermophilous trees of Sudanian origin to establish in oases. Several desert springs support the salinity resistant date palm, *Phoenix dactylifera* that is accompanied by *Juncus rigidus* (*J. arabicus*) (Danin, 1981). Salinas where salty water moistens the soil throughout the year occur along the Jordan, Dead Sea and, near the Mediterranean Sea (Danin, 1981). The low areas of the salt marshes are populated by *Arthrocnemum macrostachyum, Sarcocornia fruticosa, Limonium angustifolium, Atriplex portulacoides,* and *Tamarix tetragyna* (Danin, 1991a).

The composition of vegetation in the areas that are intensively managed by man can be easily differentiated from that of the intact areas, or areas of small interference. The most intensively cultivated areas along the coastal plain are the cultivated areas where remnants of *Quercus ithaburensis* occur; or where the spontaneous trees are *Ziziphus spina-christi*; or is the area where both *Z. spina-christi* and *Acacia raddiana* can be found. Synanthropic species occur all over the country (Danin, 1991a). Perennial grasses germinate and annual grasses regrow at the end of the winter when the herbicides have already disintegrated. Such grasses are the following: *Hyparrhenia hirta, Dichanthium annualtum, Sorghum halepense, S. virgatum, Tricholaena teneriffae, Cynodon dactylon, Panicum maximum, P. capillare,* and *Paspalum dilatatum* (Danin, 1991b). *Prosopis farcta* and *Alhagi graecorum*, which emerge from their perennial underground organs.

2.3 Forest history & development in Palestine

During the period of British Mandate (1917-1947), and despite their biased political agenda, the British contributed to the rehabilitation of forests in Palestine. Afforestation programmes were first implemented during that period. In 1927, the first law for the protection and development of forests in Palestine was introduced. About 230.6ha of mountainous and steep land in the West Bank were planted with *Cupressus* and *Pinus* Species. The 1948 war had disastrous consequences for the Palestinian society. The State of Israel was founded on approximately 3/4 of Palestine. During and after the war, a transfer policy was carried out and about 714 000 Palestinians became refugees. This resulted in a sudden increase in the population of West Bank and Gaza Strip and therefore increased pressure on natural resources. Afforestation continued in the Jordanian administration (1948-1967). Tree seedlings were distributed free of charge. National Tree Planting Day was celebrated every year on January 15th. About 2 000 ha were planted during this period. Israeli occupation (1967- to date), the expansion policy and confiscation of Palestinian land to establish Israeli colonies seriously affected Palestine's forests. In 1971, the Israeli government stopped all forestry activities and closed forestry nurseries. Only one nursery was left functioning, but its potential was reduced to only 10 000 seedlings of trees per year (Palestinian Environmental Authority, 1999).

2.4 Importance of forest vegetation.

According to the National Biodiversity Strategy and Action Plant for Palestine (NBSAPP) 1999; forest in Palestine produce timber, used mainly as an energy source (fuel). In this regards, according to the PCBS (2003) the average household wood consumption in the Palestinian territory during the month of January was 259.0 kg. This average varies depending on region and type of locality. It reached 658.0 kg in the south part of the West Bank (Hebron & Bethlehem districts). The average household wood was 321.0 kg in rural areas and 240.0 kg in urban areas and 127.0 kg in refugee camps.

The major benefit of forests in Palestine is the microclimate they induce, the filtering of air pollutants generated from urban areas, the retention of water in the ground and the fixing the mobile sand dunes and soils, prevention of soil erosion; restoration of soil fertility and soil organic matter and reduction of dry land salinity emergence (Abed Rabboh, 1995). Recreation and eco-tourism can also transform forest areas into a major source of economic revenues (Young, 1997). The Forest beauty in the West Bank gives a significant beauty & ornamental importance to the area. The Palestine forest are used also as a source of food from fruits and leaves of oak; pistachio; summaq; carob. Forest also used as a source of Medicinal material, mint, oregano. Many forest fruits are used as a raw material for manufacturing tourist's Souvenirs from oak; pine and pistachio trees. The Gum and Honey production are mainly based on the welfare of the Palestinian forests. (Palestinian Environmental Authority, 1999).

2.5 Forest degradation

Deforestation is one of the most important reasons of land degradation, which is defined as the lowering of the productive capacity of the land through process such as; deforestation soil erosion; loss of soil fertility and soil salinity; Poverty; political instability; overgrazing; and bad irrigation practices can all undermine the land's fertility (Young, 1997).

Land degradation can be temporary but may become permanent if left unchecked. Sever land degradation is wide spread in developing countries, in areas ranked as arid, semi-arid, and dry sub-humid areas. It is caused primarily by human activities and climatic variations. (Young, 1997).

Grazing is considered a disturbance of both biotic and a biotic parameters that may lead to degradation of forests and rangelands by affecting the habitat structure and lowering the vegetation cover of legumes and grasses, which expose the soil microphytic crusts and accelerate the soil erosion and increase runoff water (Zaady et al, 2001). Grazing might lead to the domination of unpalatable plant species, weeds mainly *Sarcopoterium spinosum*, which is considered as indicator of forest and rangeland degradation (Mohammad, 2000 and Al-Joaba, 2006). According to Adam (2007), deforestation increase the runoff generation and sedimentation production; which might increase the possibility of land degradation and affect directly the soil water content.

In Palestine, the human infringement upon the composition of native vegetative cover has occurred primarily in four ways: gathering of wood for fuel and lumber; overgrazing by livestock, conversion of forestland to arable land, and forest fire, both accidental and planned. Cutting of forests in Palestine began centuries ago, a practice which has continued ever since with varying degree of intensity (Applied Research Institute –Jerusalem (ARIJ), 2005).The Palestinian forest suffered and still suffering from the prolonged Israeli occupation measures taken since 1967 and onwards. During the first and second intifada, pressure on forest could be as a result of land confiscation to build more Israeli settlement and military areas; Bypass road construction and the segregation wall construction (Environmental Quality Authority, 2004).

2.5.1 Forest improvement in Palestine.

Both types of natural and man-made forests were exposed to much destruction by both Israelis and Palestinians. Large areas of these forests have been confiscated by Israel and declared as closed military areas and military bases as well as for construction of Israeli colonies (settlements) (Palestine Environmental Authority, 1999).

Restocking or re-planting new seedlings in the cleared patches of forest were implemented in Nuba part of WAFR by the Palestine Environmental Authority in the years 1998-1999 (Palestine Environmental Authority annual report,1997). In their study (Al-Joaba, 2006) concluded that plant dry biomass and species density increased, and new plant species appeared when water harvesting were constructed which indicates that the rangelands of West Bank have the potential for natural re-vegetation when suitable management practices are used, but it needs time specially in dry areas. Covington (2000) underscored such human intervention, and emphasized that these interventions also posed risk and suggested that diverse treatments, incremental approach, and careful monitoring would provide most useful results. The ecological management of forest lands will have to dwell on land capability surveys based on the study of vegetation, soils and other natural resources as well as socio-economic parameters in order to determine their real improvement potentials (Le Houerou, 1993 b). Afforestation practices in general and using *Pinus halepensis* seedling have improved the structure of natural communities through the addition of pine stratum to establish of pluri forests in addition to the important role of pine in succession process after degradation of the soils, by doubling the soil Organic matter contents, which subsequently increase the aggregate stability (Ariza, 2004).

2.6 Influence of slope aspect

Many studies showed that the slope aspect has a significant effect on the vegetation characteristics. According to Sternberg and Shoshany (2001), the slope aspect north and south have significant effect on the plant composition, structure and density of the plant communities developing in both sites. The above mentioned Authors added that the vegetation structure changed significantly in the short distance separating the north and south-facing slopes which is the valley area. According to Sternberg and Shoshany, (2001) an important changes in the plant structure and composition of the vegetation are associated with climate changes, land use and long life history of human intervention through fire, grazing of domestic herbivores, but there is much uncertainty regarding the biomass of vegetation types and its distribution. Zaady et al, (2001) concluded that habitat orientation (south- against north facing slope) had an effect on the species composition. Sorriso-Valvo et al, (1995) found that runoff generation was rapid with higher a mount of sediment in south facing slope aspect with little understory vegetation compared with the north facing slope aspect with more dens vegetation.

Al-Seikh (2006) mentioned that land topography (slope aspects; and degree) influence the soil moisture storage.

According to Auslander et al, (2003) South-facing slopes may receive six times higher solar radiation than north-facing slopes. Consequently they are more xeric (warmer and drier), which dramatically affect the microclimatic conditions and subsequently the biology of organisms at all levels. The xeric slope has higher plant diversity and is predominated by winter-and spring-growing annuals. Auslander et al, (2003).

Holmgren et al, (1997), found that in xeric slopes, water limitation could generate strong belowground competition; thereby causing plants invest more resources in root development rather than on the above-ground biomass. Pugnaire and Luque, (2001) reported increasing root competition between species from mesic to xeric habitats, thus plants dominating on the xeric slopes could exclude other species by belowground competition, and thereby the species richness within the stressful environment (xeric slopes) is higher.

2.7 The effect of grazing on forests ecosystem.

Grazing is considered as a type of disturbance that affects the ecological processes, especially if grazing pressure is high. Nevertheless, low pressure can encourage and increase vegetation productivity (Heitschmidt and stuth, 1991). High pressure retards growth and destroy vegetation. Grazing affects vegetation in several ways: density, diversity and community composition, as well as quality (chemical composition) of green forage for the herbivores (Perevoltsky, 2001). In addition the trampling by the animals, can affect the biotic processes of the ecosystem, such as soil erosion and nutrient and water flow. Grazing can enhance desertification by decreasing soil, water, and nutrient resources, (Zaady et al, 2001). Grazing could decrease the annual and herbal vegetation that are competing with trees for the available resource. Al-Seikh, (2006) concluded that rangeland degradations leads to increase soil compaction due to decrease in plant cover, reduction in aggregate stability and fertility, and decrease in soil water content due to high runoff rates. Maintaining stable and suitable vegetation covers can enhance soil stability, (Mohammad, 2005). Al-Joaba (2006) concluded that due to overgrazing the central highland and eastern slope areas of the West Bank are dominated with shrub called *Sarcopoterium spinosum*. According to Xin et al, (2004) the effectiveness of plant interception which is defined as the capture of precipitation by canopy cover is proportional to vegetation cover type and present.

In their study, Gyssels et al, (2005) concluded that there is a shift in the role of plants with respect to time and growth stages: in the early plant growth stages roots seemed to be more important in reducing soil loss by flow due to the limitation in above soil vegetation mass. Once shoots appear abundantly then they took over the roots in reducing soil erosion.

2.8 Effect of forest on soil and water erosion conservation.

Afforestation is one of the most important approaches to reduce the risk of soil erosion and land degradation (FAO, 1985). Although the results of scientific research in this aspect were contradictory. Chirino et al, (2006) reported that Afforestation with *Pinus halepensis* does not significantly reduce erosion in long term period. Bellot et al, (2004) reported that *Pinus halepensis* has negative effect on the soil moisture content. Strenberg et al, (2000), found significant increment in species richness and diversity after tree clearing, which probably due to the increase in resources availability (light and moisture), as a perennial dominated were the clearance happened. In addition, he added that annuals and geophytes competently suppressed by perennial could establish themselves too. Facelli et al, (2002) mentioned that the presence of tree and shrubs canopy inhibits the growth of annual species, probably by reducing the availability of light. Also he added that shrubs might positively effect the annual plant growth through their root system out side the canopy area. Emmerson et al, (1996) found that drier years have higher abundance of annuals that symbiosing with shrubs. Mohammad, (2005) mentioned that *Sarcopoterium spinosum* had an important role in protecting plants hiding inside their it's canopy, especially under overgrazing conditions. Fowler, (1986), concluded that competition can reduce plant biomass and growth rates and decrease their ability to survive and reproduce.

2.9 Allelopathy and pine straw

Allelopathy is the inhibition of seed germination and growth of plants through the release of chemical hydroxylated aromatic compounds (also referred to as “tannin-like compounds”) that may be released from three possible mechanisms: 1) volatilization of chemicals from plant parts, 2) leaching of growth inhibitors from plant parts, and 3) decay of plant tissues, which releases chemicals, (Mary et al, 2006). Allelopathic effects of pine straw could be positive (weed control) or negative (inhibiting growth or survival of landscape plants).

Fallen pine straw as mulch are known to buffer soil temperature,(Stinson et al, 1990);and prevent water loss from the soil by evaporation.

The soil protection provided by pine straw as mulch prevents wind and water erosion, and the incorporation of mulch may increase organic matter of the soil and therefore its tilth and structure (Mary et al, 2006).

Pine straw is rich in N and P, and these nutrients could be leached, also may acidify the soil (Stinson.et al, 1990).

The three main groups of compounds that influence the plant residues mulch’s desirability as a food source are 1) carbon and energy sources, 2) nutrient sources, and 3) chemicals that might inhibit or stimulate decomposer activity (Mary et al, 2006).Total carbohydrate levels of pine straw (35%) pine straw to have the highest decomposition rates. Lignin is the most important feature of mulches and litters and has been used as an index to predict decomposition of litter in forests, (Mary et al,2006). The higher the lignin, the more recalcitrant the material is to decomposition high lignin concentrations were found in pine straw nutrient elements provide a necessary food source for decomposer microorganisms, (Mary et al,2006).In general, the highest concentrations of nutrients are found in deciduous leaf-litter, followed by conifer leaves and lastly woody tissues, (Mary et al, 2006).

2.10 Study objectives

The study aims at addressing the vegetation characteristics of WAFR flora, trees and under story layer and soil physical and chemical properties with respect to slop aspect (North & South facing).

The detailed objectives of this study are as follow:

1. To study the vegetation characteristics of WAFR flora with respect to slope direction;
2. To record the status of the Species occurring in term of distribution & other aspect of phonology and analysis;

Chapter Three: Materials and Methods

The study was conducted during the month of April of the years (2006-2007), at Wadi Alquf forest reserve (WAFR) (Figure 1). The climate of the study site is Mediterranean, with a mean annual rainfall ranging between 450-580 mm, which falls mostly in winter (October-to April), Summers are hot and dry (PCBS, 2003). Winter winds are cool and humid, generally coming from the north-west direction (Mediterranean Sea) whereas summer winds are dry and hot. The site is in the Mediterranean phytogeographical region (Zohary, 1972), and the vegetation developing in this area varies from evergreen trees to semi-deciduous shrubs with herb associations.

3.1. The study area

Wadi Alquf Forest Reserve (WAFR), was established in 1927 during the British mandates time (Braighith, 1995). It covers an area of 3477 dunum (ARIJ, 2001). WAFR is located in north-western part of Hebron city (31^{o} 33' N, 35^{o} 07' E). The main habitats are mountains and deep valleys (wadis). The forest is classified as mixed forest, consisting of natural and man made plantations. (Braighith, 1995).

The (WAFR), Like many of the West Bank reserves, designated for nature protection and in actuality are wholly unprotected and under threat. The WAFR is a system of mountains and valleys, extending from the top of the western central highlands towards lowlands of semi coastal region. The elevation drops from around 700-to less than 400 meters and less than that in some places. It embraces two major bio-geographical zones and four distinct vegetation zones. The number of species recorded so far consists of (50-100) plants, majority of which are forestry planted trees and pasture or wasteland plants (Abed Rabboh,1995) and (Braighith, 1995). *Pinus Spp*; *Rhamnus palaestinus*, (buck thorn) *Quercus* *calliprinos* (oak), *Cyclamen persicum* which is a well known protected plant, and *Populus euphratica* Olivier (Hour tree).. There are two varieties of *Cupressus, C. sempervirens* L. *C. horizontalis* (Mill) (Gordon), *Phlomis pungens* Willdr. & *P. brachyodon* and many *Eucalyptus* trees. Terracing exists which is said to date back to Byzantine and Roman times, (Sultan and Abu Sbaih, 1996).The Ministry of planning and international cooperation (1988), classified the area as an area of ecological significant in the West Bank. The area is considered as an important bird area in Palestine (Palestine Environmental Authority, 1999). Apart from its wildlife, WAFR could be a good model of integrated conservation and development, where the protection of biodiversity goes hand-in-hand with improving the social and economic welfare of local people.

The tough living criteria (Poverty; Israeli occupation) imposed on the peoples of the surrounding areas to follow a non-balanced and non-systematic regime in utilizing the natural resources in addition to several socio-economic and political attributes helped in the formulation of the current status of WAFR. The area is usually used by shepherds and surrounding villagers for grazing their animals (goats and sheep); as well as a non timber forest products (NTFP) including fire wood collection; ornamental and medicinal plants collections. (Palestinian Environmental Authority,1999).

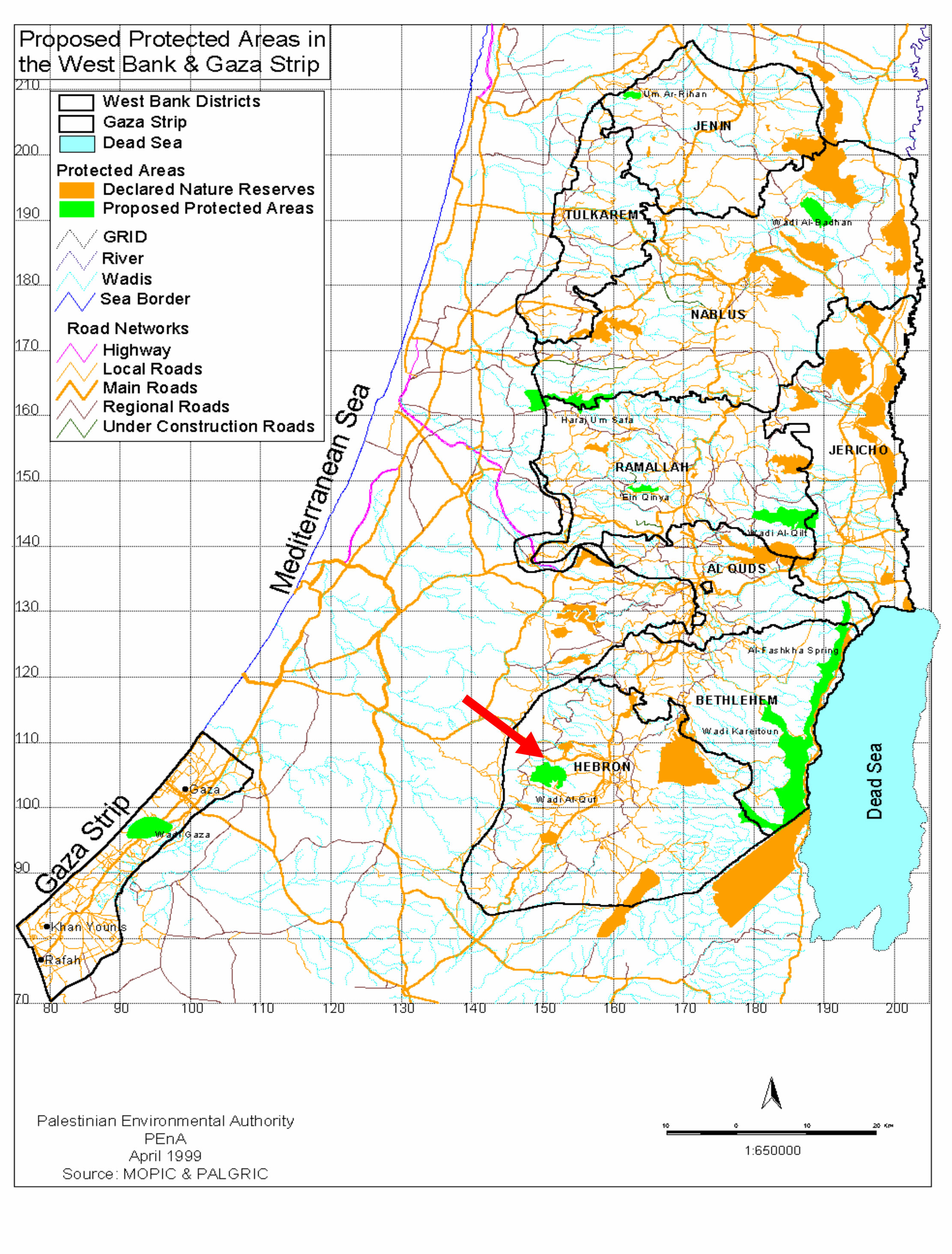

Figure 1: Proposed protected areas in the West Bank and Gaza Strip, showing WAFR.

3.1.1. Research sites.

The topography of the sites is hilly terrain, with moderate to steep slopes. Valleys separating between numbers of mountains whereas WAFR is situated, and representing the north and south facing slope aspects.

3.2 Soil survey

Six soil samples were taken randomly from each slope aspect in August 2006, during the drier period of the year. Three samples were taken from the lower part of each slope and another three samples were taken from the upper parts of each slope aspect. To determine the chemical and physical soil properties; including organic matter (OM%), soil (pH), Electrical Conductivity (EC), Calcium Carbonate ($CaCO_3$), available phosphorus (P),available Potassium (K^+), Sodium (Na^+), Nitrate (NO_3^-), Ammonium ($NH4^+$), soil texture (%clay, % silt, % sand). Holes were drilled with augur to a depth of 25 cm for taking soil samples. The collected samples were immediately placed in plastic bags, well closed, and then taken to the laboratory weighed and oven-dried at 105 C^o over two nights. The dried samples were crushed using a pestle and mortar; then it passed through a 2 mm sieve and the following analyses were conducted.

3.2.1 Soil chemical analysis

The soil pH and the electrical conductivity (EC) were measured through the preparation of a saturated soil extract (1:2.5) distilled water(FAO, 1980), and (Skoog and West,1976);.

Organic matter contents were measured using the Walkey and Black method (Nelson and Sommers, 1982). Extractable bases were measured by displacing them with 1 M NH4O (Thomas, 1982). The Olsen method was used to measure extractable phosphorus using a molybdate reaction for colorimetric detection

(Nelson and Sommers, 1982), CaCO3 content measured using the calcimeter instrument.

3.2.2 Soil physical analysis

The Mixture of soil particles size (Soil Texture) was measured using a pipette method (Bouwer, 1986). Soil moisture content was measured using gravimetric method.

3.3 Surveying trees and herbaceous vegetation

3.3.1. Surveying the trees

Within each slope, fifteen-frame quadrates of size 10mX10m were allocated randomly in August 2006. The names and numbers of individual plant species occurring within each quadrate were recorded. (William, 1996). The canopy cover which is defined as (The area of a vertical projection on a horizontal surface of a polygon drawn around the plant's perimeter which ignore small gaps between branches) for each tree was measured using a meter tape which passed horizontally through the approximate center of the plant from one side to the other. (William, 1996). The radius at that point was recorded. At least 4 radiuses were taken then the mean was calculated and considered in calculating the polygon area. The stem diameter (Girth) of each tree at the breast height (dbh) (1.4 m height), which is (The area of exposed stem if the plant were cut horizontally at dbh were measured using a measuring tape (William, 1996).

3.3.2 Surveying the herbaceous vegetation.

The vegetation measurements were carried out in April, 2006-2007, during the peak development stage of plant species (Tedmor et al, 1974), (Gutman and Seligman, 1979) . Plant species were identified according to Al-Eisawi (1998); Bonham (1989); Aloun (1992a and 1992b).Checklist of identified plant species were prepared based on AL Sheikh et al, (2000), Flora of Israel and Ori et al,(1999).The methods applied in this study to assess the vegetation attributes in details. The following vegetation attributes were assessed as follow:

3.3.2.1 Ground cover

The ground cover vegetation percentage within each survey site of Wadi alquf forest reserve was studied using line transects methods (William, 1996). The survey unit (line) mean length was around 330 steps. Four randomly laid lines were taken in the north facing slope aspect and another four in the south facing slope aspect in the years 2006-2007 (Figure.2). The plant species; soil; rock; plant residues, were recorded. The sample point were recorded each time the notched boot placed on the ground while walking along the transects. The percentage of soil; rocks; and different plants by species were calculated (Evans and Love, 1957).

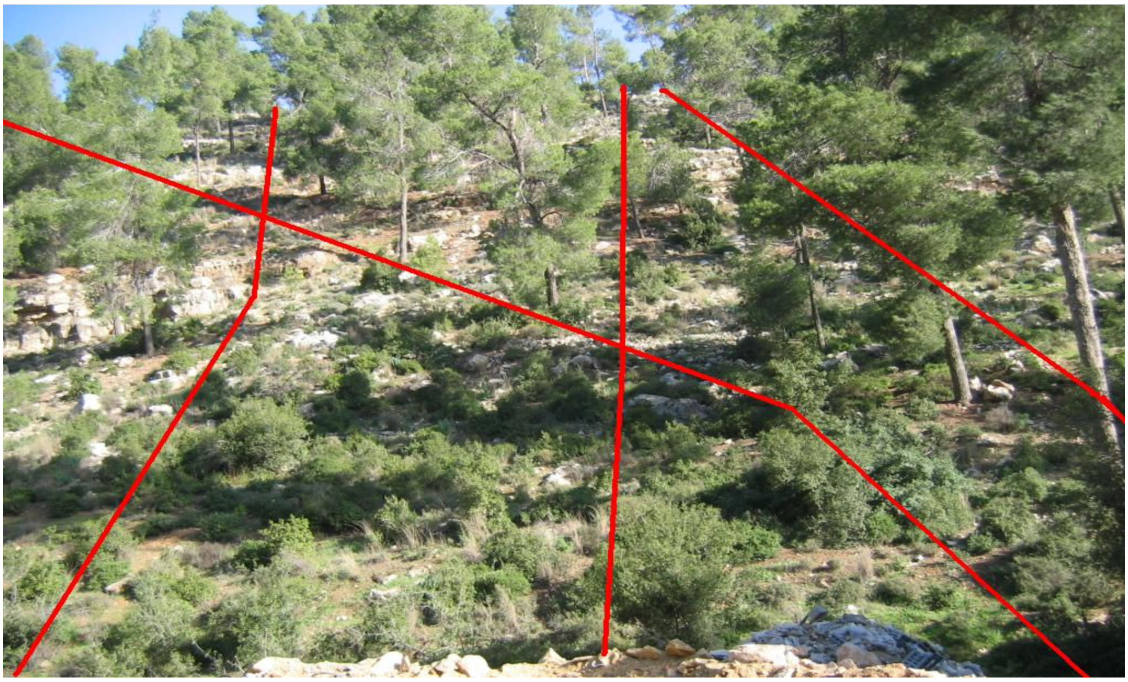

Figure 2: Four lines transects allocated in the North facing slope aspects.

3.3.2.2 Vegetation biomass.

A Frame quadrate method was used to survey the total biomass of understory vegetation in each study site. Thirty quadrates of 0.25 m^2 laid randomly in each study site of each aspect. The above ground parts of the plants were cut from the substratum at close to ground level using a scissor. The plant material was taken to the laboratory in paper bags labeled with numbers from 1-30. The fresh weight of each bag were taken in the laboratory, and dried at 65 C^o for 48 hours.

Figure 3: 0.25 m^2 Quadrate used in the study

3.3.2.3 Species density.

Density is defined as the number of individuals per unit area (Cooper, 1959). Density determination is useful in evaluating a shrub or tree stand. Density was determined by the use of quadrates. Each individual plant species within a quadrate is counted. Thirty quadrates 0.25 m^2 were laid randomly in each study site of each aspect

The Species relative density was estimated as follows:

$$S.R.\text{D} = \frac{\text{Density of species in all quadrates}}{\text{Density of all species in all quadrates}} \text{X}100$$

3.3.2.4 Plant frequency.

In each quadrates of the study, the presence and absence of each plant species was recorded. Frequency represents the percentage of the quadrates in which the species occurs (Holechek et al,1989), and it is usually determined from quadrate density. It can be estimated as following

$$\text{Frequency} = \frac{\text{Number of quadrats in which a species occurs}}{\text{Total number of quardates sampled}} X100$$

3.3.2.5. Species diversity & richness

The diversity of species was estimated using the Shannon-Weiner index, (Gurevitch et al, 2002).The Shannon-Weiner index assumes that individuals were sampled from a very large population and that all species are represented the sample, (Gurevitch et al, 2002). The Shannon-Weiner index (H) is calculated from the following formula:

$$H = -\sum_{i=1}^{n} pi \ln pi$$

Pi is the proportion of each species to the total number of species. The value of Shannon-Wiener index usually falls between 1.5-3.5 and rarely surpasses 4.5, (Cook, and Stubbendieck, 1986).

Richness is an expression of the number of species in the population. Richness was calculated as the number of species in an area equal to 7.5 m^2, (30 quadrates * 0.25 m^2 area of each quadrate), regardless of their density.

3.3.2.6 Similarity.

Similarity index of the study area were measured based on the life form which was constructed according to Raunkiaer (1934) and Mueller Dum-bois and Ellenberg (1974). For measuring the similarity in plant composition between the north and south facing slope aspects, we used the Jacquard's Similarity index, which gives a numerical value to comparisons between two different samples sites or aspects. Jaccard's Similarity Index calculated by dividing the total number of species in both slope aspects by the sum of numbers of species found in both slope aspects (a and b) added the , multiplied by 100. The result is a percentage of floral similarity between the north and south slope aspects. The similarity index (Jaccard) values are from 0-1 or in other way of expression as following <25% is weak associations, 25-50% is fair associations, 50-75% is moderate associations, and >75% is high associations (Gurevitch et al, 2002).

Jacquard's index $= \frac{a}{(a+b+c)}$

a= represents the total number of plant species represented in the north and south facing slope aspects.

b= represents the number of plant species represented in the north facing slope aspects only.

c= represents the number of plant species represented in the south facing slope aspects only.

3.4 Slope gradient.

Slope Gradient - The angle of the ground surface (in percent) through the site and in the direction that overland water would flow. A 3% slope, for example, means a difference in level of 3 m over a horizontal distance of 100 m (US National Soil Survey Center, 2002).

The Suunto PM-5 Clinometer was used to measure slope gradient. Ten Measurements were taken, five measurements within the (NFSA) and five within the (SFSA) then the mean for each slope was calculated. The slope was classified based on the US National Soil Survey Center classification which classify the slopes into six categories: Nearly level (0-3%), gently sloping (4-8%), strongly sloping (9-16%), moderately steep (17-30%), steep (31-60%), very steep (>60%), (US National Soil Survey Center, 2002).

3.5 Statistical analysis.

Data were analyzed using SigmaStat 2.03 and SPSS 12. Analyses of variance (ANOVA) with $P \leq 0.05$ were used to determine differences between north and south facing slope aspects. The analyses were carried out in respect to a completely randomized design within the two slopes. The Tukey-HSD (honestly significant difference) test was used to compare differences of vegetation attributes means between slope aspects and sampling years.

Chapter Four Results

4.1. Soil properties

4.1.1. Soil physical properties

The soil physical properties that were surveyed as part of this study are the soil texture, and the soil moisture content

4.1.1.1 Soil texture

The soil texture analysis results for both slope aspects (north & south facing) of WAFR are shown in table (1).

Table (1). The soil texture (Clay; Sand;and Silt %) in both slope aspects of Wadi Alquf forest reserve.

Soil texture fraction	Slope aspect					
	North facing			South facing		
	Down slope	Up slope	Mean	Down slope	Up slope	Mean
Clay %	37.23	61.18	49.21[a]	57.70	61.30	59.50[a]
Sand %	29.92	27.88	28.89[a]	27.19	24.40	25.80[a]
Silt %	32.85	10.94	21.90[a]	15.11	14.30	14.70[a]
Total	100.0	100.0	100.0	100.0	100.0	100.0

*Means followed by the same letter in the same row are statistically not significant at $p \leq 0.05$.

The results show that the soil texture is different, as value in between the north and south facing slope aspects of the study site but statistically not significant. The clay content in the north facing aspect is (49.21%) compared with

(59.50%) in the south facing slope aspect. Based on the soil texture triangle, these results exhibit the clay soil texture class in both aspects.

4.1.1.2 Soil moisture content

The volumetric soil moisture content which is defined as the ratio, expressed in percentage, of the weight of water in a given soil mass to the weight of solid particles.

In figure (3), the data show higher soil moisture content (11.14 %) measured at 25 cm soil depth in the north facing slope aspect compared with (9.23%) in the south facing slope aspect. There was no significant difference at P=0.05 in between the two slope aspects.

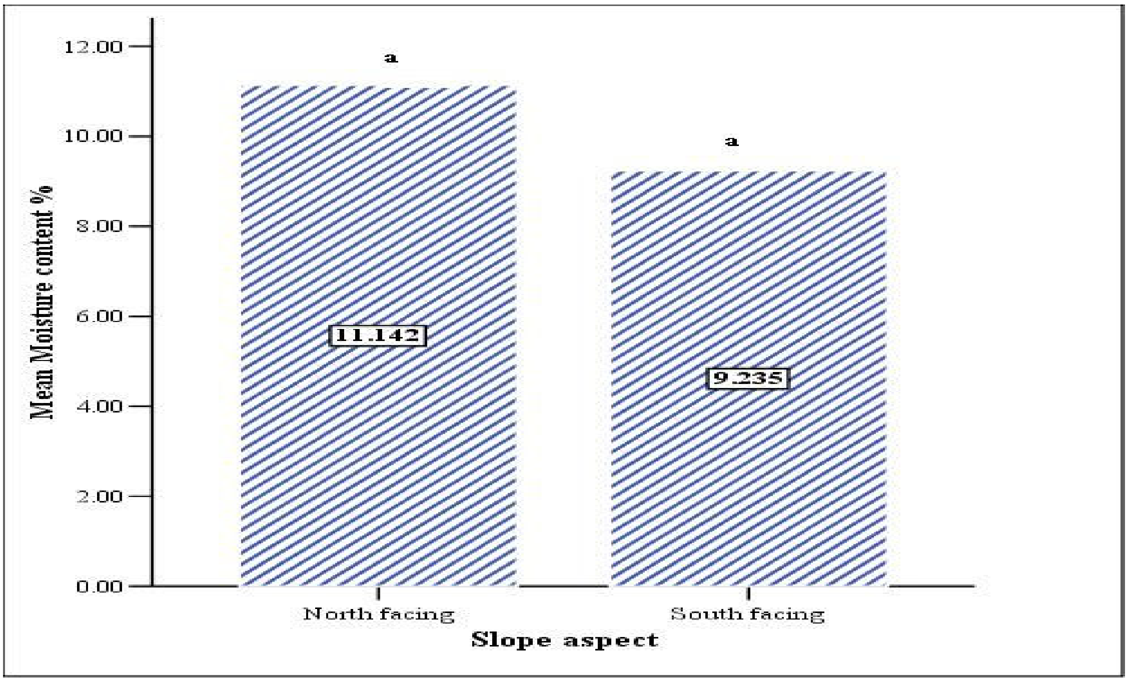

Figure 4: Moisture content percentage in the north and south facing slope aspects.
*Means followed by the same letter are statistically not significant at $p \leq 0.05$.

4.1.2 Soil chemical properties.

The main soil chemical properties tested in this study, were included the following parameters (Soil pH; Electrical conductivity (EC); Organic matter content; Phosphorus; Total dissolved solids (TDS); Calcium; Potassium; Sodium; Ammonium; Magnesium and Nitrate.

Table (2) Soil chemical properties values in both slope aspects of Wadi Alquf forest reserve, 2006.

Chemical properties	Slope aspect	
	North facing	South facing
Ammonium ppm	8.87 [a*]	5.14 [b*]
Calcium ppm	3548.75[a]	3701.35 [a]
Electrical conductivity (EC) meq/100 g	0.96[a*]	0.62 [b*]
Magnesium ppm	568.35 [a]	589.14 [a]
Nitrate ppm	11.95 [a*]	3.53 [b*]
Organic matter content %	6.22 [a]	6.12 [a]
pH	7.08 [a]	7.17 [a]
Phosphorus ppm	16.09 [a]	10.98 [a]
Potassium ppm	184.17 [a]	161.25 [a]
Sodium ppm	181.34 [a]	201.14 [a]
Total dissolved solid (TDS) %	619.73 [a*]	402.13 [b*]

*Means followed by the same letter in the same row are statistically not significant at P≤ 0.05.

Ammonium (NH_4^+) & Nitrate (NO_3^-).

The concentrations of Ammonium and Nitrate were significantly higher in the north facing slope aspect (8.87 and 11.95 ppm) respectively compared with the south facing slope aspect (5.14 and 3.53 ppm) respectively, (Table, 2).

pH & Electrical Conductivity (EC).

The soil pH and electrical conductivity are among the major important soil chemical properties, since they have a major role to play in controlling the solubility of most necessary elements of plant growth. However, our finding showed that the soil pH values were in the optimal range of plant growth. The pH values were (7.08 to 7.17) respectively for the north and south facing slope aspects, (Table, 2). There was no statistically significant difference in between the two slope aspects. According to Marx et al, (1999) the soil is classified as neutral soil. The EC values were statistically different (0.96 and 0.62 meq/100 g) respectively for north and south facing slope aspects (Table, 2).

Plant available Phosphorus (P).

The plant available phosphorus found were (16.09-10.98 ppm) for the north and south facing slope aspects respectively (Table 2). These results show no statistically significant difference. According to Marx et al, (1999) the phosphorus concentration is very low.

Extractable Magnesium (Mg)

The extractable magnesium from both slope aspects were statistically not significant (568.30-589.14 ppm) that are equivalent to (4.69-4.86 meq/100 g soil) (Table 2) for the north and south facing slope aspects respectively. According to Marx et al, (1999) the soil has high magnesium concentration.

Extractable Potassium (K)

The extractable soil potassium from both slope aspects were statistically not significant (184.17-161.25 ppm) that are equivalent to (0.47-0.41meq/100 g soil)

(Table 2) for the north and south facing slope aspects respectively. According to Marx et al, (1999) the soil has medium level of potassium concentration.

Extractable Calcium (Ca)

The extractable soil Calcium from the study sites soils were statistically not significant (3548.75-3701.35 ppm) that are equivalent to (17.74-18.50 meq/100 g soil) (Table, 2) for the north and south facing slope aspects respectively. According to Johnson et al, (1982) the soil has high level of calcium concentration. This results show no statistically significant difference in between two slope aspects (north & south facing).

Extractable Sodium (Na)

High levels of sodium are detrimental to soil tilth and plant growth. The sodium levels are evaluated based on exchangeable sodium percentage (ESP) which is the percent of cation exchange capacity (CEC) occupied by sodium. The results show no statistically significant difference in between two slope aspects (north & south facing).

Organic matter content %

Accurate measurement of soil organic matter is difficult according to Marx et al, (1999). The results showed that the amount of organic matter is (6.22-6.12 %) for the north and south facing slope aspects respectively (Table, 2), and it is not statistically different.

4.2. Slope gradient.

The slope gradient percentage was (46.0 and 39.2 %) for the (NFSA and SFSA) respectively and there was no significant difference found in between the two slope aspects. According to the US National Soil Survey Center,(2002) both slopes are considered as steep slopes.

4.3 Vegetation attributes.

4.3.1 Influence of slope aspect on vegetation attributes.

4.3.1.1 Plant biomass.

The data showed that the mean herbaceous plant biomass expressed in dry matter basis for the north facing slope aspect (992.37 and 1105.15 kg/ha) were greater than the mean plant biomass for the south facing slope aspect (849.20 and 930.80kg/ha) during the years (2006-2007) (Figure, 4). There was no significant difference at $P \leq 0.05$, in the mean plant biomass when comparing between the years of study neither between the slope aspects.

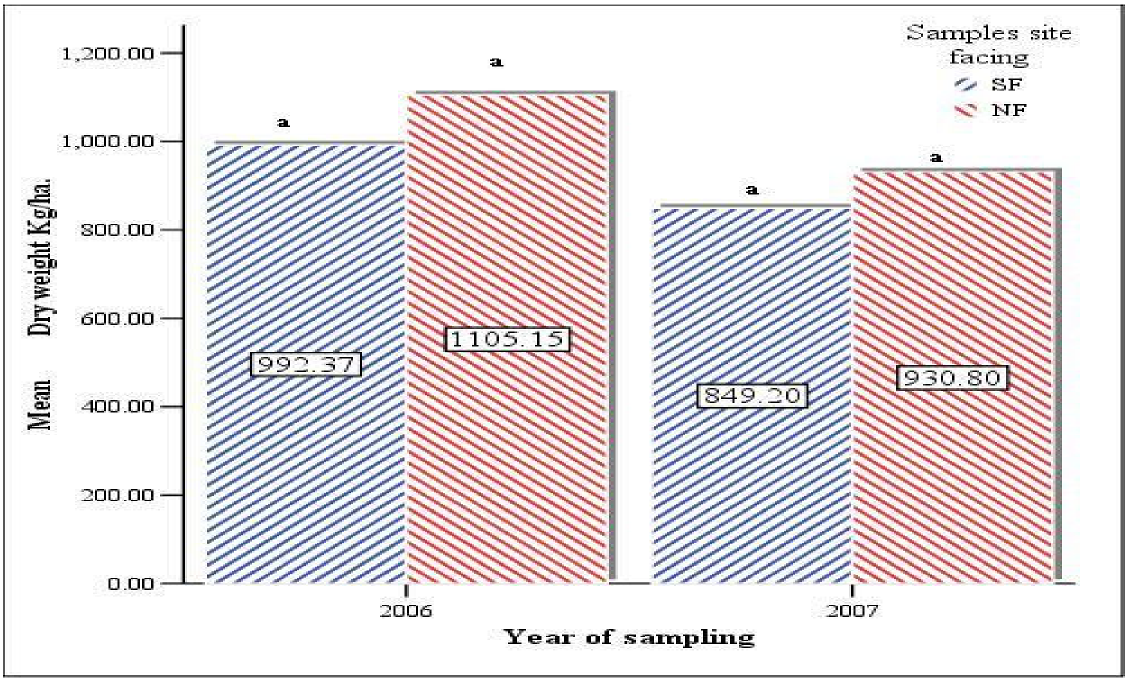

Figure 5: Mean biomass kg/ha, in the north and south facing slope aspect for the years 2006-2007.

*Means followed by the same letters in columns are not statistically significantly different at $P \leq 0.05$ according to Tukey.

4.3.1.2 Plant density.

The results showed that the influence of slope aspect on the plant density is different in different years of study.

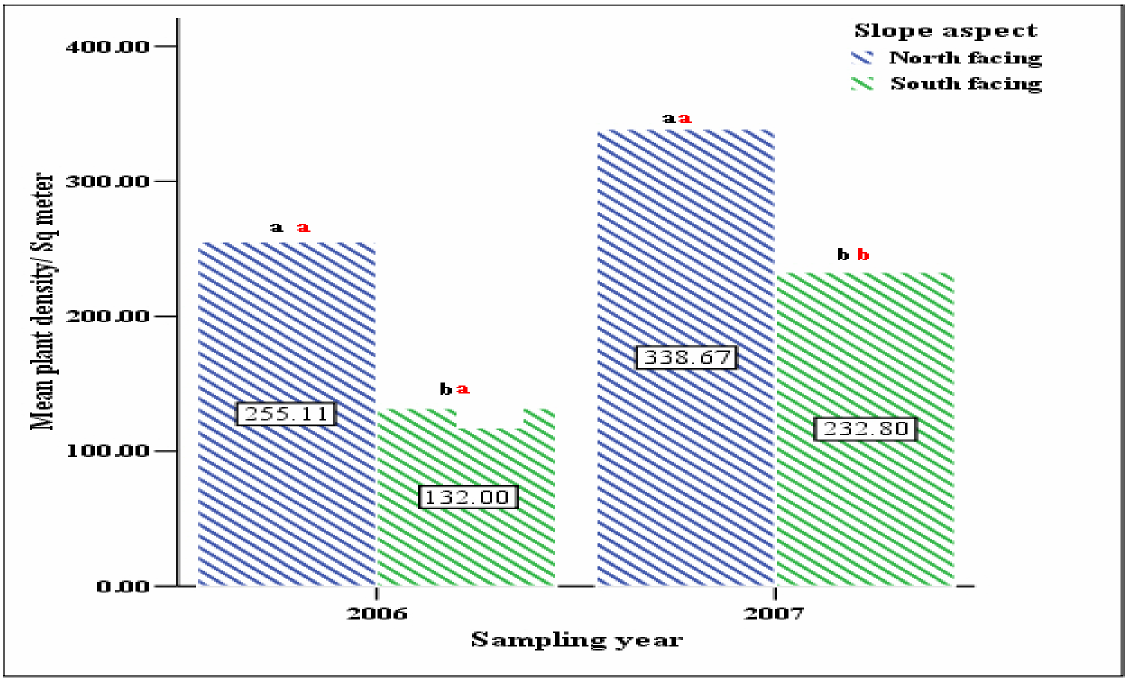

Figure 6: Mean plant density (Plants/m^2) in both slope aspects for the years 2006-2007

*Means followed by the same letters are not statistically significantly different at $P \leq 0.05$ according to Tukey.

*First letters for comparison between sampling years and different slopes. The second letter for comparison between slopes in the same year of sampling.

The results of statistical analysis of the data (figure,5), collected in the year 2006 showed no significant difference at ($P \leq 0.05$) in plant density of the north facing slope aspect (255.11 plants/ m^2) vs. the south facing slope aspect (132.00 plants/ m^2), at (P= 0.001). In the year 2007 there was a significant difference in plant density of the north facing slope aspect (338.67 plants/m^2) vs. the south facing slope aspect (232.80 plants/m^2) at (P= 0.001), (Appendix A, Table,2).

In the other hand the results showed a statistically significant difference in between the same slope aspect, mainly in the case of the south facing slope aspect, in different years of study 2006-2007, at (P=0.015).

The results of the North facing slope aspect of the year 2006, showed that the *Bromus fasciculatus* has the highest density (48.44 plants/m^2); followed by the *Brachypodium distachyon* (47.11 plants/m^2), *Torilis tenella* (33.48 plants/m^2), *Trifolium campestre* (22.07 plants/m^2), *Hedypnois cretica* (14.67 plants/ m^2), *Lolium sp* (12.15 plants/ m^2), then followed by a number of plant species that have less than 10 plants/ m^2 ، (Appendix A table, 2).

The results of the south facing slope aspect of the year 2006, showed that the *Brachypodium distachyon* has the highest density (97.04plants/ m^2); followed by a number of plant species with density less than five individuals / m^2, (Appendix A table, 2).

The results of the north facing slope aspect of the year 2007, showed that the *Torilis tenella* has the highest density (61.60 plants/m^2); followed by *Bromus fasciculatus* (60.53plants/m^2), *Brachypodium distachyon* (34.13 plants/m^2), *Crepis aspera*(24.53 plants/ m^2), *Lagoecia cuminoides* (18.40 plants/ m^2), *Hedypnois cretica*(17.60 plants/m^2). *Phalaris sp* (16.53 plants/m^2), *Trifolium campestre* (16.27plants/m^2), *Micromeria sinaica*(12.53 plants/m^2), *Lolium sp* (10.40 plants/m^2), *Poa bulbosa* (8.80 plants/m^2), *Anagallis arvensis*(8.80 plants/m^2), *Andropogon distachyo s*(5.60 plants/m^2), followed by a number of plant species with density less than five individuals / m^2 (Appendix A Table 2).

The relative density of different life form groups (grasses, forbs; shrubs) showed that grasses as a plant life form have the highest relative plant density in both years of the study and in both slope aspects, followed by the forbs, and the shrubs have the lowest relative density among the group.

The results showed a statistically significant difference in between the slope aspects, and within the same slope aspect, in between three life form groups (forbs, grasses, and shrubs) .

The forbs relative density in the north facing slope aspect was greater than it's relative density in the south facing slope aspect.

Table (3) Relative plant density of different life form groups

Life form	2006-2007	
	North facing	South facing
Forbs	42.52 $^{a\ a}$	10.65 $^{b\ a}$
Grasses	52.20 $^{a\ b}$	84.83 $^{b\ b}$
shrubs	5.28 $^{a\ c}$	4.52 $^{a\ c}$
Total	100	100

*Means followed by the same letters not statistically significantly different at $P \leq 0.05$ according to Tukey.

*First letter for comparison between North & south facing slope aspects. Second letter for comparison between Life forms within the same slope aspect.

4.3.1.3 Plant frequency.

The results showed that the frequency percentage of each species is varied in between the slope aspects as well as in between the years of study. As for the year 2006, and within the north facing slope aspect, *Brachypodium distachyon* has the highest frequency percentage (89.0%), then *Trifolium campestre* (78%) then *Torilis tenella* (74 %), *Hedypnois cretica* and *Sarcopoterium spinosum* (59%) both, then *Lagoecia cuminoides* (52%).

As for the south facing slope aspect of the same year, *Brachypodium distachyon* (85%) has the highest frequency percentage, then *Piptatherum miliaceum* (74%), followed by *Phagnalon rupestre* (52%), and *Anagallis arvensis* (30%), (Appendix A table, 1).

The results of the year 2007, of the south facing slope aspect, showed that *Hedypnois cretica*, *Trifolium campestre, Torilis tenella* are having (73%) that are the highest frequency percentage, followed by *Bromus fasciculatus* and *Crepis aspera* are having (60%), followed by *Lolium sp* (53%), followed by *Phalaris sp* (47 %), (Appendix A, Table, 1).

As for the north facing slope aspect of the same year, the results showed that *Brachypodium distachyon* has (93%) which is the highest frequency percentage, followed by *Aegilops geniculata* and *Piptatherum miliaceum* are having (47%), (Appendix A table, 1).

4.3.1.4 Botanical composition of the study site.

Based on the field survey of the years 2006-2007, a list of the sampled plant species within the two slope aspect, the north facing slope aspect and the south facing, was prepared. A total of 109 plant species were identified during the course of the study. The majority of the identified plant species, 59 species which equivalent to 54.13% of the total list, belongs exclusively to the Mediterranean phyto-geographic region. The second largest proportion of plant species 22 species which equivalent to 20.18% of the total list is common to both, the Irano-Turanian & Mediterranean phyto-geographic regions (Table, 4). The third group of the identified plant species 8 species which equivalent to 20.18% of the total list, belongs to three phyto-geographic regions, these are Euro-Siberian; Mediterranean and Irano-Turanian. The forth group of the identified plant species 7 species which equivalent to 6.42% of the total list, belongs to the Saharo-arabian phyto-geographic region.

Table (4) The identified plant species, sorted by their phyto-geographical region and their proportions.

Phyto-geographical region/regions	Number of Species	Proportion %
Mediterranean	59	54.13
Mediterranean; Irano-Turanian	22	20.18
Euro-Siberian; Mediterranean; Irano-Turanian	8	7.34
Sahara-Arabian	7	6.42
Irano-Turanian	6	5.50
Mediterranean; Irano-Turanian; Sahara-Arabian	3	2.75
Sahara-Arabian; Irano-Turanian	2	1.83
Irano-Turanian; Sahara-Arabian	1	0.92
Mediterranean; Euro-Siberian	1	0.92
Total	109	100.00

The Species list and their proportions, climate distribution and kind are shown in (Appendix A, Table, 3).

4.3.1.5 Life form

The life form groups were constructed according to Raunkiaer (1934). It showed that the relative density of annual plants in the north facing slope aspect of the year 2006 was 93.50 %, which is greater than the relative density of perennial plant 1.4 % of the same slope aspect and in the same time the relative density of annual plants in the south facing slope aspect of the year 2006 was 88.0%, which is greater than the relative density of perennial plant 5.2% of the same slope aspect, (table, 5).

The results showed that the relative density of annual plants in the north facing slope aspect of the year 2007 was 90.39 %, which is greater than the relative density of perennial plant 3.86 % of the same slope aspect. The relative density of annual plants in the south facing slope aspect of the year 2007 was 94.85%, which is greater than the relative density of perennial plant 2.75% of the same slope aspect.

Table (5) Relative plant density percentage life form wise (annuals & perennials) during the study years 2006-2007

Year	2006		2007	
Slope aspect	North facing	South facing	North facing	South facing
Annuals	93.50	88.0	90.39	94.85
Perennials	1.4	5.2	3.86	2.75

The species list and their life form are shown in appendix A, Table 3.

4.3.1.6 Ground cover percentage.

The results showed that the vegetation cover percentage within the north facing and south facing slope aspects of study years 2006 and 2007 are as shown in table (6).

Table (6) Total plants cover percentage of forbs; grasses and shrubs 2006-2007.

Year	2006		2007	
Slope aspect	North facing	South facing	North facing	South facing
Forbs	37.4	11.1	47.6	10.2
Grasses	57.8	82.2	46.6	87.5
Shrubs	4.8	6.7	5.8	2.3
Total	100	100	100	100

The cover percentage of grasses was the highest in both slope aspects during the year 2006, followed by the cover percentage of the forbs, and the lowest one was the cover percentage of the shrubs. In the year 2007 the cover percentage of the grasses was the highest only within the south facing slope aspect, followed by the cover percentage of forbs. Within the north facing slope aspect, the cover percentage of the forbs was the highest, followed by the cover percentage of grasses. The shrub cover percentage in both slope aspects was the lowest, this might be due to the fact that *Pinus halepensis* reduces native shrub performance. (Bellot et al, 2004).

4.3.1.7 Similarity.

The results of the similarity index in plant composition between the north and south facing slope aspects showed that there is a low similarity in between the two slope aspects, with a value of 39 %, which means fair similarity associations between the north and south facing slope aspect. Some of plant species found in both slope aspects, as forbs (*Scorpiurus muricatus, Torilis tenella, Urginea maritime, Trifolium campestre)* and as grasses (*Aegilops geniculata , Andropogon distachyos, Avena sterilis*,and *Brachypodium distachyon*). shrubs (*Asparagus aphyllus, Cistus creticu, Micromeria fruticosa and Sarcopoterium spinosum),*(Appendix A, Table, 3).

4.3.1.8 Diversity index.

The Shannon- Weiner diversity index showed that the north facing slope aspect has higher diversity index during the study years of 2006-2007 (2.67 and 2.75) respectively compared with the index values of the south facing slope aspect that are (1.39, 1.43) for the study years 2006-2007 respectively,
(Table, 7).

Table (7) Shannon –Weiner index of the north and south facing slope aspect during the study years 2006-2007

Year	2006		2007	
Slope aspect	North facing	South facing	North facing	South facing
	2.67	1.39	2.75	1.43

4.3.1.9 Species richness.

The species richness in the north facing slope aspect was higher than the species richness in the south facing slope aspect, (47 species per 7.5 m^2 and 34 species per 7.5 m^2) accordingly for the year 2006, and (34 species per 7.5 m^2 and 32 species per 7.5 m^2) accordingly for the year 2007, (Table, 8).

Table (8) Species richness regarding north and south facing slope aspect during the study years 2006-2007.

Year	**2006**		**2007**	
Slope aspect	**North facing**	**South facing**	**North facing**	**South facing**
	47	**34**	**34**	**32**

4.3.1.10 Tree canopy cover and density.

The results show that slope aspect has no significant effect on the tree canopy, that were (13%/100 m^2 and 12 %/100 m^2) in the south and north facing slope aspects respectively. The tree density were (2.27/100 m^2 and 1.93 tree/100 $m^{2)}$ for the north and south facing slopes aspect respectively. The slope aspect has significant effect at ($P<0.021$) on the average diameter at breast height (DBH) which was (83.63 cm, and 52.38 cm) for the north and south facing slopes aspect respectively (Figure, 4).

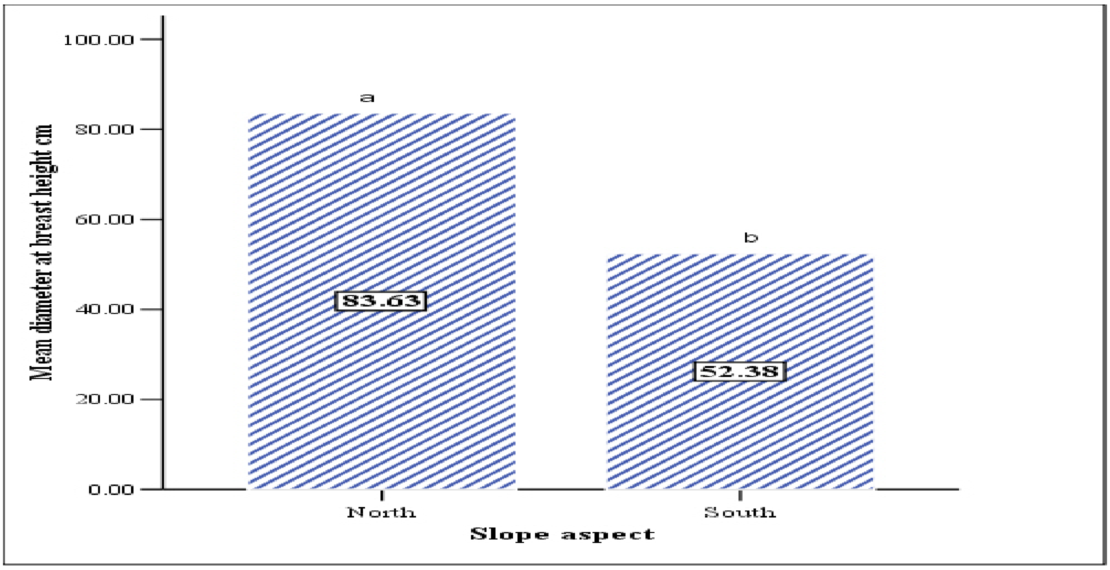

Figure 7: Mean diameter at breast height (DBH) cm in the north and south facing slope aspect.

*Means followed by the same letters are not statistically significantly different at $P \leq 0.05$ according to Tukey.

Chapter Five Discussion

5.1 Soil properties.

The differences in our soil properties finding were due to dynamic interaction between: climatic condition, vegetation, topography, land use, and water contents. The clay content percentage was (49.21% and 59.50%) for the north and south facing slope aspects respectively (Table, 1). Such differences might be explained as a result of intensity of the chemical weathering, which mainly controlled by the long-term influence of the different amounts of precipitation and water content. Although, the history of land use, land degradation process as runoff and soil erosion considered the main reasons which affected the particle size distribution, the movement of clay particles with surface water runoff from up slopes to down slopes.

The soil moisture is usually affected by many factors like topography, soil structure, elevation climatic factors, vegetation cover (Fu et al, 2003 and Al-Seikh, 2006). The results in (figure, 3) showed that the moisture content were (11.14% and 9.23%) in the north and south facing slope aspects respectively, but without having statistically significant difference. The difference in value might be because south facing slopes generally receive more solar radiation flux density, resulting in higher evapo-transpiration rates and higher daily maximal temperatures during summer water stress period (Qiu-Ju et al, 2006). Changes in soil texture require long time to happen, and wasn't expected to happen within the study period.

Soil chemical properties directly influence microbiological process (e.g via nutrient and carbon supply) and these processes together with soil physical-chemical processes determine (1) the supply, and cycle of nutrients, and (2) the availability of water which in turn influence directly exchange reactions, weathering, nutrient distribution, or indirectly by affecting biological activities, (Power et al, 1998).

Soil organic matter was not statisticcally significant (6.22%) in the north and (6.12%) in the south facing slope aspects (Table, 2). These values are high according to Johnson and Todd, (1987), and according to Marx and Hart,(1999), the range of organic matter in soil of semi-arid rainfed areas is less than 1 %. This might be because *P .halepensis* leaves (needles) decompose and add high amount of organic matter to the soil, this statement agreed with the conclusions of Ariza (2004) which says afforestation with *P. halepensis* improved the soil properties by doubling the organic matter contents.

The soil pH is directly affect soil chemical processes and subsequently plant growth and physiology. The pH values in both slope aspects of our study (table, 2) were within the optimum range for plant growth. The small and not significant difference in between slopes might be as a result of soil moisture and tree density of the slopes.

The EC values were significantly higher in the north facing slope aspect compared with the south facing slope aspect (Table, 2). This indicates the higher ion concentrations. It is negligible in case of forestry, (Burger and Kelting, 1999).
No significant difference were found in soil available Ca^{++}, P, Na^{+} and K^{+} (Table, 2).
Ammonium and nitrate concentration were significantly higher in the north (8.87 and 11.95 ppm) compared with the south facing slope aspect (5.14 and 3.53 ppm), respectively (table, 2).This is a primary limiting factor in many forests and consider as soil quality and nutrient availability indicator (Schoenholtz et al, 2000).

Our results are in agreement with the finding of Kutiel and Lavee (1999) on slope aspect effect on soil properties along aridity gradient in Israel, they concluded that differences between slopes in the semi-arid and arid zones were small and negligible when comparing some physical or chemical variables.

5.2. Slope gradient

The results showed that the slope gradient percentage was (46.0 and 39.2 %) for the (NFSA and SFSA) respectively which is considered as steep slope according to the US National Soil Survey Center, (2002). Slope gradient was regarded as the major factor influencing soil erosion and water runoff, and subsequently vegetation characteristics by (Fu et al, 2003). Understanding slope gradient and soil type will enhance our capability to predict forest dynamics and lead to more sound and effective management strategies.

5.3 Vegetation attributes

5.3.1 Plant biomass

The mean plant biomass for the north facing slope aspect (992.37 and 1105.15 kg/ha) were greater than the mean plant biomass for the south facing slope aspect (849.20 and 930.80kg/ha) during the years (2006-2007) accordingly (Figure, 4). There was no significant difference at $P \leq 0.05$, in the mean plant biomass when comparing between the years of study neither between the slope aspects. These results might be explained as a result of deficit in soil moisture and greater rate of evapo-transpiration process since the south facing slope aspect receive more solar radiation flux, which influence the water availability for plant species growth and nourishment (Qiu-Ju et al, 2006). In addition, the Ammonium and Nitrate concentration were significantly higher in the north (8.87 and 11.95 ppm) compared with south facing slope aspect (5.14 and 3.53 ppm), respectively (table, 2). This is considered as soil nutrient availability indicator, (Schoenholtz et al, 2000) which might be another reason of difference in plant biomass. In addition to the above mentioned reason, our findings show that soil moisture in the north facing slope aspect was greater than in the south facing slope aspect. This difference was reflected on higher plant biomass, despite the fact that difference was not significant. Gaps in trees due to tree cutting could be another reason for higher biomass since it gave more chance to plants to have enough light and reduce their competition for light.

5.3.2 Plant density

The results of statistical analysis in figure (5), showed no significant difference at ($P \leq 0.05$) in plant density between slope aspects in the study year 2006. But a significant difference at ($P \leq 0.05$) in plant density between slopes in the study year 2007. Also the comparison of the year 2006-2007 within the south facing slope aspect showed high significant difference at ($P \leq 0.015$). These results might be due to the slope aspect orientation, which influence the climatic factors such as rainfall events and temperature differences that are directly influence the water regime which is an important limiting factor and subsequently influence the plant density fluctuation. Grazing has the potential to impact every stage in a plant's life (Crawley, 1985), and thus influences where a plant can grow and its abundance and density. These results concur with the finding of Walton et al, (2005) and Sternberg et al, (2001). In addition, these results might be expected due to higher nutrient availability within the NFSA, which give more chance for plants to grow and reproduce.

5.3.3 Plant frequency.

Our results showed that the frequency percentage of each species is varied in between the slope aspects as well as in between the years of study. This variation might be due to the physiological requirements of each species also due to the variation in nutrient dynamics could have important implications for forest diversity and productivity in addition to variation in climatic factors such as rainfall events and intensity, the temperature differences that are due to the slope aspects which directly affect the evapo-transpiration processes, soil chemical and physical properties that directly influence the water and nutrient availability and subsequently the plant frequency. Grazing animals may also feed selectively on specific plant species or tissues, which can lead to increased mortality or slower growth rates of damaged individuals and subsequently affect the plant frequencies (Louda, 1995) These results comply the finding of Walton et al (2005) and Sternberg et al (2001). Many plant species were widely distributed in many places of the WAFR despite of the sensitivity of herbaceous vegetation to edaphic and micro environmental conditions. These phenomena could be due to their wide range of requirements, which enable them to survive and reproduce in different microhabitats.

5.3.4 Botanical composition.

A total of 109 plant species were identified during the course of the study and this number considered large within such small area. These results might be due to the geographical location of the study site as well as due to topographic, slope aspect; elevation level and climatic variations that have an important influence on plant diversity and distributions. These results comply with the conclusions and finding of Mata-Gonzalez et al, (2002). This result also in consistence with Danin et al, (1975), they reported that the semi –arid region of Palestine inhabitant by a mixture of flora more than one phyto-geographic region.
Under similar environmental conditions flora of Mediterranean, Irano-Turanian and Saharo-Arabia were observed by Ariza (2004) at Yatteir Forest, Species like *Poa bulbosa*, *Trifolium spp, Anthemis palaestina* and *Medicago spp*, are will

known for their ability to grow in dry, shallow and stony soils, and in poor habitats, like the case of WAFR. These finding are in consistence with Danin.et.al, (1975) and Ariza, (2004). These finding show to which extent this forest is important as a gene pool and as a plant genetic resource that conserve and protect a huge number of plant species

5.3.5 Life form

The relative density of herbaceous annual plants in the north facing slope aspect was greater than the relative density of herbaceous annual plants in the south facing slope aspect during the study year 2006 and the opposite happened in the year 2007. Annuals are able to show one or more way of adaptation towards water shortages and drought tolerance like passing drought periods as dormant seed, (Crawley, 1986). These results might be also as a reflection of significantly higher Ammonium and Nitrate concentration in the north (8.87 and 11.95 ppm) compared with (5.14 and 3.53 ppm), respectively as well as to the difference in soil water content which is higher in value but not significant in the north vs south facing slope aspects.

In the year 2006, the relative density of herbaceous perennials plants in the south facing slope aspect was greater than the relative density of herbaceous perennials plant of the north slope aspect, and the opposite happened in the year 2007 (Table, 5).These results might be because of climatic variable variations, precipitations; wind directions and solar radiation flux. The favorable abiotic conditions in north-facing aspect enhanced the dominance of certain species, perennial in particular, which have a competitive advantage over annuals. However, south-facing aspect provides more difficult conditions, such as high temperatures, low soil moisture content, and extreme climatic fluctuations. Thus, source of organic matter mainly vegetation and the decomposing factors, i.e.

microorganisms, which interact with climatic conditions are the main elements that affected the quantity of organic matter (Al-Seikh, 2006). Soil water contents and litter accumulation may influence seed germination because it can modify the spectral composition of light reaching the seeds, (Facelli and Pickett, 1991) thus inducing a differential germination, (Roy & Soni´e, 1992) which may affect species composition and the dominancy of species life form groups. The soil seed bank of species is usually large in patches dominated by shrubs, and population dynamics after catastrophic events is largely dominated by factors controlling seed germination of shrubs (Francisco & Lozano, 1997).

Our results are in agreement with the finding of Sternberg et al, (2001).They found that when the resources levels are too low for most plants to utilize, mortality takes place in annual species and perennial plant growth is restricted (Henkin et al, 1998).In the Mediterranean basin such phenomenon occurs first in south facing slopes, then in the south and between the wet and dry seasons create transition periods during which available soil water and resources can be erratic and varies from year to year, (Hiernaux and Gerard, 1999).

5.3.6. Similarity.

The results showed fair similarity in between the slope aspects, with a value of 39 %. These findings strengthening our results of botanical composition and life form groups that differ when comparing the NFSA and SFSA aspects. This phenomenon might be explained because of slope aspects, which influence the micro-environment suitable for each species to grow and germinate in a particular slope aspect. According to Sternberg et al, (2001) slope aspect has significant effect on composition, structure, density and similarity of the plant communities developing at both slope aspects. These results in agreement with other results in the neighboring Israel in which species composition, richness and similarity differed between north and south facing slopes, (Kutiel, 1992); (Kadmon and Harari,1999) .

5.3.7. Diversity index and Species richness

Shannon- Weiner diversity index showed that the north facing slope aspect has higher diversity index vs. the south facing slope aspect (Table, 7). The species richness in the north facing slope aspect was higher than the species richness in the south facing slope aspect, (47 species per 7.5 m^2 and 34 species per 7.5 m^2) accordingly for the year 2006, and (34 species per 7.5 m^2 and 32 species per 7.5 m^2) accordingly for the year 2007 (table, 8). This is probably due to the fact that north facing slope aspects usually provide more suitable niche for many plant species to grow and reproduce. The position in the transition region from a Mediterranean region to semi-arid regions, and species from both regions can find suitable niches. This result agrees with Kutiel et al, (1999) and Al-Joaba, (2006) they found that species richness and species diversity reach their maximum values at the intermediate zone along with the climatic transect.

5.3.8. Tree canopy cover and density

The results show that slope aspect has no significant effect on the tree canopy, when comparing the north and south facing slope aspects. These results might be because this forest is considered as a mixed one (Man made and natural), this might be also due to the difference in planting times. The average diameter at breast height (DBH) (83.63 and 52.38 cm) was significantly greater at $P<0.05$ for the north vs. south facing, (figure, 6). This difference might be due to the difference in the available biotic and abiotic component in between the two slope aspects. In addition our findings show that soil moisture and Nitrate were greater within the (NFSA) than in (SFSA), due to these facts, the growth of trees and their

DBH in the (NFSA) could be more than in (SFSA). These results agree with finding of Walton et al (2005) and Sternberg et al, (2001).

The tree density were (2.27/100 m^2 and 1.93 tree/100 m^2) which equivalent to (227/ha and 193/ha) for the north and south facing slopes aspect respectively (appendix B table, 2). These results also may be because this forest is considered as a mixed one, (Man made and natural), so human interventions and restocking process dates along with the favorable environment might be increase the survivability rate of the sowed seedlings and makes the difference in DBH too. In addition to the surrounding villagers negative impacts, tree cutting and collection. The gaps due to tree cutting in between trees reduce their competition for resources and light

Figure 8: Tree cutting in WAFR.

Chapter Six: Recommendations

6.1 Recommendations

Development of a consistent management action plan and/or strategy to protect the existing forest areas in the West Bank in general and WAFR in particular is highly recommended, strictly from an ecological point view.

These activities might include enforcement of the existing regulations for forest and environmental control measures such as eco-tourism regulations, non-timber forest products regulations. In addition, the institutional and financial aspects have to be re-evaluated**.**

Based on two years of investigations results of this study we strongly recommend the following activities to be executed.

1. Further scientific studies on the Palestinian forested area are strongly recommended.
2. Enforcement of the available strategies and action plans by the respected Authorities or Ministries to protect this site as source of plant genetic resource is strongly recommended.
3. Afforestation campaign to increase the density of trees and re-stocking the cleared areas of WAFR is recommended.

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Appendix

Appendix A. Table (1) Frequency percentage of plant species identified in the north and south facing slope aspects of Wadi Alquf, 2006-2007

Number	2006				2007			
	North facing slope aspect		**South facing slope aspect**		**North facing slope aspect**		**South facing slope aspect**	
	Scientific Name	**Frequency %**	**Scientific Name**	**Frequency %**	**Scientific Name**	**Frequency %**	**Scientific Name**	**Frequency %**
1	*Ononis sicula*	11.11	*Ononis sicula*	22.22	*Ononis sicula*	20.00	*Ononis sicula*	6.67
2	*Echinops polyceras*	3.70	*Aegilops geniculata*	11.11	*Bromus fasciculatus*	60.00	*Aegilops geniculata*	46.67
3	*Aegilops geniculata*	3.70	*Atractylis cancellata*	3.70	*Crocus hermoneus*	20.00	*Bromus fasciculatus*	33.33
4	*Minuartia decipiens*	14.81	*Bromus fasciculatus*	11.11	*Plantago afra*	6.67	*Plantago afra*	20.00
5	*Anthemis palaestina*	18.52	*Plantago afra*	7.41	*Stipa capensis*	6.67	*Stipa capensis*	26.67
6	*Bromus fasciculatus*	74.07	*Stipa capensis*	3.70	*Trifolium purpureum*	13.33	*Trifolium purpureum*	20.00
7	*Crocus hermoneus*	14.81	*Allium Sp*	3.70	*Allium Sp*	13.33	*Allium Sp*	6.67
8	*Plantago afra*	29.63	*Teucrium capitatum*	11.11	*Alcea digitata*	6.67	*Onobrychis caput-galli*	6.67
9	*Trifolium purpureum*	29.63	*Onobrychis caput-galli*	11.11	*Notobasis syriaca*	13.33	*Teucrium capitatum*	13.33
10	*Allium Sp*	33.33	*Cicer judaicum*	3.70	*Medicago scutellata*	13.33	*Cicer judaicum*	13.33
11	*Alcea digitata*	3.70	*Tragopogon coelesyriacus*	11.11	*Brachypodium distachyon*	53.33	*Lactuca sp*	20.00
12	*Lactuca sp*	3.70	*Brachypodium distachyon*	85.19	*Biscutella didyma*	20.00	*Medicago scutellata*	6.67

Continue Appendix A, Table (1)

13	*Brachypodium distachyon*	88.89	*Coridothymus capitatus*	22.22	*Lomelosia palaestina*	13.33	*Brachypodium distachyon*	93.33
14	*Biscutella didyma*	14.81	*Lathyrus cicera*	3.70	*Hedypnois cretica*	73.33	*Andropogon distachyos*	6.67
15	*Hedypnois cretica*	59.26	*Piptatherum miliaceum*	74.07	*Lagoecia cuminoides*	20.00	*Piptatherum miliaceum*	46.67
16	*Lolium sp*	14.81	*Micromeria fruticosa*	18.52	*Lolium sp*	53.33	*Micromeria fruticosa*	20.00
17	*Andropogon distachyos*	18.52	*Picnomon acarna*	14.81	*Andropogon distachyos*	40.00	*Avena serilis*	20.00
18	*Micromeria fruticosa*	3.70	*Carlina curetum*	29.63	*Micromeria fruticosa*	6.67	*Carlina curetum*	13.33
19	*Carlina curetum*	7.41	*Avena serilis*	3.70	*Hordeum spontaneum*	6.67	*Phagnalon rupestre*	13.33
20	*Avena serilis*	40.74	*Phagnalon rupestre*	51.85	*Adonis palaestina*	6.67	*Scorpiurus muricatus*	6.67
21	*Crepis aspera*	11.11	*Micromeria sinaica*	3.70	*Avena serilis*	20.00	*Asphodelus aestivus*	13.33
22	*Micromeria sinaica*	44.44	*Helianthemum salicifolium*	7.41	*Crepis aspera*	60.00	*Phalaris sp*	20.00
23	*Helianthemum salicifolium*	11.11	*Anagallis arvensis*	29.63	*Micromeria sinaica*	53.33	*Trifolium campestre*	**33.33**
24	*Scorpiurus muricatus*	7.41	*Asphodelus aestivus*	14.81	*Mercurialis annue*	13.33	*Cyclamen persicum*	6.67
25	*Mercurialis annue*	3.70	*Phalaris sp*	7.41	*Anagallis arvensis*	33.33	*Linum strictum*	6.67
26	*Anagallis arvensis*	33.33	*Urospermum picroides*	14.81	*Phalaris sp*	46.67	*Kickxia judaica*	6.67
27	*Cynosurus coloratus*	33.33	*Carthamus tenuis*	3.70	*Trifolium campestre*	73.33	*Lagoecia cuminoides*	6.67
28	*Phalaris sp*	22.22	*Kickxia judaica*	14.81	*Cyclamen persicum*	6.67	*Torilis tenella*	6.67
29	*Urospermum picroides*	22.22	*Sinapis arvensis*	18.52	*Nigella arvensis*	6.67	*Sinapis arvensis*	13.33

Continue Appendix A, Table (1)

30	*Trifolium resupinatum*	3.70	*Torilis tenella*	11.11	*Carthamus tenuis*	6.67	*Lotus corniculatus*	13.33
31	*Trifolium campestre*	77.78	*Lotus corniculatus*	3.70	*Linum strictum*	20.00	*Sarcopoterium spinosum*	20.00
32	*Nigella arvensis*	11.11	*Sarcopoterium spinosum*	29.63	*Torilis tenella*	73.33	*Helianthemum lippii*	20.00
33	*Eryngium creticum*	3.70	*Helianthemum lippii*	3.70	*Lotus corniculatus*	26.67		
34	*Linum strictum*	14.81			*Cichorium endivia*	6.67		
35	*Coronilla scorpioides*	3.70			*Sarcopoterium spinosum*	26.67		
36	*Cistus incanus*	18.52			*Poa bulbosa*	26.67		
37	*Lagoecia cuminoides*	51.85						
38	*Sinapis arvensis*	7.41						
39	*Torilis tenella*	74.07						
40	*Salvia hierosolymitana*	3.70						
41	*Lotus corniculatus*	7.41						
42	*Erodium gruinum*	11.11						
43	*Cichorium endivia*	3.70						
44	*Sarcopoterium spinosum*	59.26						
45	*Poa bulbosa*	11.11						

Table (2) Plant density/m²in the north and south facing slope aspects for the years 2006-2007

	2006				2007			
	North facing		South facing		North facing		South facing	
Num	Scientific Name	Density/ m²	Scientific Name	Density/ m²	Scientific Name	Density/ m²	Scientific Name	Density/ m²
1	*Ononis sicula*	0.89	*Ononis sicula*	1.63	*Ononis sicula*	2.40	*Ononis sicula*	1.07
2	*Echinops polyceras*	0.15	*Aegilops geniculata*	4.30	*Bromus fasciculatus*	60.53	*Aegilops geniculata*	15.7
3	*Aegilops geniculata*	0.15	*Atractylis cancellata*	0.15	*Crocus hermoneus*	1.33	*Bromus fasciculatus*	5.07
4	*Minuartia decipiens*	0.74	*Bromus fasciculatus*	1.48	*Plantago afra*	1.33	*Plantago afra*	8.8
5	*Anthemis palaestina*	1.63	*Plantago afra*	0.30	*Stipa capensis*	1.33	*Stipa capensis*	5.33
6	*Bromus fasciculatus*	48.44	*Stipa capensis*	0.30	*Trifolium purpureum*	2.13	*Trifolium purpureum*	1.33
7	*Crocus hermoneus*	0.74	*Allium Sp*	0.44	*Allium Sp*	0.80	*Allium Sp*	0.27
8	*Plantago afra*	2.22	*Teucrium capitatum*	1.19	*Alcea digitata*	0.27	*Onobrychis caput-galli*	0.53
9	*Trifolium purpureum*	2.96	*Onobrychis caput-galli*	0.59	*Notobasis syriaca*	2.93	*Teucrium capitatum*	0.53
10	*Allium Sp*	2.07	*Cicer judaicum*	0.59	*Medicago scutellata*	3.73	*Cicer judaicum*	0.53
11	*Alcea digitata*	0.15	*Tragopogon coelesyriacus*	0.44	*Brachypodium distachyon*	34.13	*Lactuca sp*	1.6

Continue Appendix A, Table (2)

12	*Lactuca sp*	0.15	*Brachypodium distachyon*	97.04	*Biscutella didyma*	4.27	*Medicago scutellata*	0.27
13	*Brachypodium distachyon*	47.11	*Coridothymus capitatus*	1.48	*Lomelosia palaestina*	0.53	*Brachypodium distachyon*	163
14	*Biscutella didyma*	0.89	*Lathyrus cicera*	0.30	*Hedypnois cretica*	17.60	*Andropogon distachyos*	1.87
15	*Hedypnois cretica*	14.67	*Piptatherum miliaceum*	4.74	*Lagoecia cuminoides*	18.40	*Piptatherum miliaceum*	3.2
16	*Lolium sp*	12.15	*Micromeria fruticosa*	1.19	*Lolium sp*	10.40	*Micromeria fruticosa*	1.33
17	*Andropogon distachyos*	1.04	*Picnomon acarna*	0.59	*Andropogon distachyos*	5.60	*Avena serilis*	4.53
18	*Micromeria fruticosa*	0.15	*Carlina curetum*	1.48	*Micromeria fruticosa*	0.27	*Carlina curetum*	0.53
19	*Carlina curetum*	0.59	*Avena serilis*	0.30	*Hordeum spontaneum*	5.33	*Phagnalon rupestre*	0.53
20	*Avena serilis*	8.44	*Phagnalon rupestre*	2.67	*Adonis palaestina*	0.27	*Scorpiurus muricatus*	0.27
21	*Crepis aspera*	0.59	*Micromeria sinaica*	0.15	*Avena serilis*	2.40	*Asphodelus aestivus*	0.53
22	*Micromeria sinaica*	6.81	*Helianthemum salicifolium*	0.74	*Crepis aspera*	24.53	*Phalaris sp*	4.53
23	*Helianthemum salicifolium*	1.19	*Anagallis arvensis*	2.81	*Micromeria sinaica*	12.53	*Trifolium campestre*	2.4
24	*Scorpiurus muricatus*	0.44	*Asphodelus aestivus*	0.74	*Mercurialis annue*	5.07	*Cyclamen persicum*	0.27
25	*Mercurialis annue*	0.30	*Phalaris sp*	0.30	*Anagallis arvensis*	8.80	*Linum strictum*	0.53
26	*Anagallis arvensis*	1.63	*Urospermum picroides*	0.59	*Phalaris sp*	16.53	*Kickxia judaica*	0.27

Continue Appendix A, Table (2)

27	*Cynosurus coloratus*	9.78	*Carthamus tenuis*	0.15	*Trifolium campestre*	16.27	*Lagoecia cuminoides*	0.53
28	*Phalaris sp*	7.70	*Kickxia judaica*	0.74	*Cyclamen persicum*	0.27	*Torilis tenella*	2.67
29	*Urospermum picroides*	1.48	*Sinapis arvensis*	1.33	*Nigella arvensis*	2.67	*Sinapis arvensis*	1.33
30	*Trifolium resupinatum*	0.44	*Torilis tenella*	1.48	*Carthamus tenuis*	0.80	*Lotus corniculatus*	0.8
31	*Trifolium campestre*	22.07	*Lotus corniculatus*	0.30	*Linum strictum*	1.33	*Sarcopoterium spinosum*	1.07
32	*Nigella arvensis*	1.04	*Sarcopoterium spinosum*	1.19	*Torilis tenella*	61.60	*Helianthemum lippii*	1.6
33	*Eryngium creticum*	0.15	*Helianthemum lippii*	0.30	*Lotus corniculatus*	2.13		
34	*Linum strictum*	1.78			*Cichorium endivia*	0.27		
35	*Coronilla scorpioides*	0.89			*Sarcopoterium spinosum*	1.07		
36	*Cistus incanus*	0.74			*Poa bulbosa*	8.80		
37	*Lagoecia cuminoides*	11.85						
38	*Sinapis arvensis*	0.30						
39	*Torilis tenella*	33.48						
40	*Salvia hierosolymitana*	0.44						
41	*Lotus corniculatus*	0.30						

Continue Appendix A, Table (2)

42	*Erodium gruinum*	0.59
43	*Cichorium endivia*	0.44
44	*Sarcopoterium spinosum*	3.56
45	*Poa bulbosa*	1.78

Table (3) List of identified plant species, their kinds and climate distribution, found in the north and south facing slope aspects of Wadi Alquf during the years of study 2006-2007

	Arabic Name	**Scientific Name**	**Common name**	**Life form**	**Climate**
			Forbs		
1	شقائق النعمان	*Adonis palaestina*	Palestine pheasnt's eye	Geophyte, Perennial	M
2	ختمية	*Alcea digitata* *	Degitate hollyhock	Hemicryptophyte, perennial	M
3	ثوم	*Allium Sp**	Garlic	Therophyte, annual	M.I
4	عين جمل	*Anagallis arvensis**	Pimpernel	Therophyte, annual	E.M.I
5	حمحم ازرق	*Anchusa azurea*	large blue alkanet	Hemicryptophyte, perennial	E.M.I
6	اقحوان	*Anthemis palaestina*	Palestine Chamomile	Therophyte, annual	M
7	لوف	*Arum palaestinum*	Palestine arum	Geophyte, Perennial	M
8	غيصلان	*Asphodelus aestivus**	Asphodel	Therophyte, annual	SA.S
9	ام خرس	*Atractylis cancellata**	Distaff thistle	Therophyte, annual	M
10	شوك غزال	*Atractylis comosa**	Distaff thistle	Therophyte, annual	M
11	رغيف راعي	*Biscutella didyma**	Brillenschote	Therophyte, annual	M.I
12	شوك حمار	*Carlina curetum*	Carline thistle	Hemicryptophyte, perennial	M

Continue Appendix A, Table (3)

13	قوص	*Carthamus tenuis**	Safflower	Therophyte, annual	M
14	مرار بنفسجي	*Centaurea eryngioides*	Cornflower	Hemicryptophyte, Perennial	I
15	قرينه زهرية	*Chorispora purpurascens*	Ram's horn	Therophyte,annual	M.I
16	حمص بري	*Cicer judaicum*	Judean chick pea	Therophyte, annual	M
17	مديك	*Cichorium endivia*	Dwarf chicory	Therophyte, annual	M.I
18	علك	*Cichorium pumilum*	Endive	Therophyt,annual	M.I
19	مدادة	*Convolvulus tricolor*		chamaephyte,semi-shrub	M.I
20	كورنيلا–خويتمه	*Coronilla scorpioides*	Scorpion vetch	Therophyte, annual	M
21	صفيرة	*Crepis aspera*	Hawks beard	Therophyte, annual	M
22	بلابوس	*Crocus hermoneus*	Hermon crocus	Geophyte	I
23	صليصله متفرعة	*Crucianella macrostachya*	Common crosswort	Therophyt,annual	M
24	قرن غزال	*Cyclamen persicum**	Persian cyclamen	Geophyte, Perennial	M
25	صبورة جبل	*Dactylis glomerata*		hemicryptophyte,perrenial	E.M.I
26	قرنفل بري	*Dianthus strictus*	Carnation	Hemicryptophyte,perrenial	M
27	قوص	*Echinops adenocaulos*	Globe thistle	Hemicryptophyte, perennial	M

Continue Appendix A, Table (3)

28	ارث/شوكة جمل	*Echinops polyceras*	Globe thistle	Hemicryptophyte, perennial	I
29	مسلة عجوز	*Erodium gruinum*	Stroks bill	Therophyte, annual	M
30	قرصعنة	*Eryngium creticum*	Syrian eryngo	Hemicryptophyte, perennial	M
31	قطينة	*Evax contracta*	Cudweed	Therophyte,annual	M
32	عكوب	*Gundelia tournefortii*	Gundelia	Hemicryptophyte, perennial	I
33	رويس جبل	*Hedypnois cretica*	Hedypnois	Therophyte, annual	M
34	عدسية	*Helianthemum salicifolium*	Willow-leaved rock rose	Therophyte, annual	E.M.I
35	دم المسيح(الغزال)	*Helichrysum sanguineum*	Red everlasting	Hemicryptophyte, perennial	M
36	خس بري	*Lactuca sp**	Lettuce	Therophyte, annual	I
37	سعيسعة	*Lathyrus cicera*	Vetchling	Therophyte, annual	M
38	كتان قائم	*Linum strictum*	Upright yellow flax	Therophyte, annual	M
39	ركيبة	*Lomelosia palaestina*	Scabious	Therophyte, annual	M.I
40	لوتوس-رجل .	*Lotus corniculatus*	Common bird's foot trefoil	Hemicryptophyte, Perennial	M
41	دريهمة	*Malabaila secaul*	Arabian hartwort	Hemicryptophyte, perennial	I
42	دحريجة	*Medicago scutellata**	Medic	therophyt,annual	M

Continue Appendix A, Table (3)

43	عصى هرمز	*Mercurialis annua**	French mercury	Therophyte, annual	M.E
44	ابو حربية	*Minuartia decipiens*	sandwort	Therophyte, annual	M.I
45	أجراس بيت لحم	*Molucella laevis*	Smooth molucca blam	Therophyte, annual	M
46	قزحة	*Nigella arvensis*	Field fennel flower	Therophyte, annual	E.M.I
47	خرفيش الجمال	*Notobasis syriaca**	Syrian thistle	Therophyte, annual	M
48	جريس	*Onobrychis caput-galli*	Meddick vetch	Therophyte, annual	M
49	أونيون–وسبة	*Ononis sicula**	Persian rest harrow	Therophyte, annual	M.I.SA
50	بخور مريم	*Pallenis spinosa**	Starwort	Hemicryptophyte, perennial	M
51	رجل حمامه	*Paronychia argentea*	silvery whitlow wort	Hemicryptophyte, perennial	M
52	شوك فار	*Picnomon acarna*	Yellow cnicus	Therophyte, annual	M.I
53	بلانتاغو	*Plantago afra**	Fleawort	Therophyte, annual	M.I
54	رويس	*Rhagadiolus stellatus*	Star hawkbit	Therophyte, annual	M.I
55	لسان ثور	*Salvia hierosolymitana**	Jerusalem sage	Hemicryptophyte, perennial	M
56	ابرة الراعي	*Scandix pecten-veneris**	Shepherd's needle	Therophyte, annual	E.M.I
57	عنجد	*Scorpiurus muricatus**	Caterpillar plant	Therophyte, annual	M

Continue Appendix A, Table (3)

58	لفيته	*Sinapis arvensis**	Charlock	Therophyte, annual	M
59	علك خيل	*Sonchus oleraceus*	Common sow thistle	Therophyte, annual	E.M.I
60	طرخشفون	*Taraxacum officinale*	Common Dandelion	Hemicryptophyte, perennial	M
61	رباط	*Tolpis virgata*	Rushhawk weed	Hemicryptophyte, perennial	M
62	لزيقة	*Torilis tenella*	Many rayed bur parsly	Therophyte, annual	M.I
63	ذيل فرس	*Tragopogon coelesyriacus*	Long beaked goat's beard	Hemicryptophyte, perennial	M.I
64	قرط اصفر	*Trifolium campestre*	Hop clover	Therophyte, annual	M
65	قرط بنفسجي	*Trifolium resupinatum*	Pink clover	Therophyte, annual	M.I
66	برسيم خشن	*Trifolium scabrum*	Rough trefoil	Therophyte, annual	M
67	حلبة برية	*Trigonella berythea*	Beirut fenugreek	Therophyte, annual	SA
68	نفل (حواجه)	*Trigonella stellata*	Star fenugreek	Therophyte, annual	SA
69	بصيل	*Urginea maritima*	sea squill	Geophyte	SA
70	قضيد	*Urospermum picroides*	Prickly cupped goat's beard	Therophyte, annual	M.I
71	فلينه قاسية الوبر	*Valantia hispida**	Bristly crosswort	Therophyte, annual	M

Continue Appendix A, Table (3)

			Grasses		
72	شعير ابليس	*Aegilops geniculata**	Goat grass	Therophyte, annual	M
73	سنام شعبتين	*Andropogon distachyos**	Two-spinked beardgrass	Hemicryptophyte, Perennial	SA
74	شوفان	*Avena sterilis**	Animated oat	Therophyte, annual	M.I
75	دنبان	*Brachypodium distachyon**	Purple false brome	Therophyte, annual	M.I
76	قصفة	*Briza minor*	Quaking grass	Therophyte, annual	M
77	ترغول حزمي	*Bromus fasciculatus*	Fascicled brome	Therophyte, annual	M
78	عريف المروج	*Cynosurus coloratus**		therophyte,annual	M.I
79	سبيلية	*Gastridium scabrum*	Nit grass	Therophyte, annual	M
80	شعير بري	*Hordeum spontaneum*	Wild barley	Therophyte, annual	M.I
81	ريشة كروية	*Lagoecia cuminoides**	False cumin	Therophyte, annual	M
82	مشعرية	*Lamarckia aurea*	Golden top grass	Therophyte,annual	M.I
83	ربيان جبلي	*Leontodon tuberosus*	Bulbous dandelion	Hemicryptophyte, perennial	M
84	زوان	*Lolium sp*	Rey grass	Therophyte, annual	M.I.SA
85	فلارس	*Phalaris sp**	Canary grass	Therophyte, annual	M

Continue Appendix A, Table (3)

86	سنام	*Piptatherum miliaceum*	Rice millet	Hemicryptophyte, Perennial	M
87	نزعة	*Poa bulbosa**	Bulbous meadow	Hemicryptophyte, perennial	E.M.I
88	ذيل الثعلب	*Polypogon monspeliensis*	Annual beardgrass	Therophyte, annual	M.I.SA
89	بهمة	*Stipa capensis**	Twisted awned sper grass	Therophyte, annual	I.SA
90	برسيم بري	*Trifolium purpureum**	purple clover	Therophyte, annual	M
Shrubs					
91	شعيط–عجرم	*Asparagus aphyllus**	Prickly asparagus	Geophyte	M
92	بلوته	*Ballota undulata*	Common ballota	chamaephyte,semi-shrub	M
93	لبيد احمر	*Cistus creticus**	Soft-hairy rockrose	Chamaephyte, semi shrub	M
94	زحيف	*Coridothymus capitatus*	Cone head thyme	Chamaephyte,semi-shrub	M
95	ورد شمس	*Helianthemum lippii*	Sun rosse	Chamaephyte, semi shrub	SA.S
96	كيكسيا مصرية	*kickxia aegyptiace*	Egyptian toadflax	Chamaephyte,semi-shrub	SA
97	كيكسيا لسان السبع	*Kickxia judaica*	Toadflax	Chamaephyte, semi shrub	SA
98	زعتر	*Majorna syriaca*	Wild marjoram	Chamaephyte,semi-shrub	M
99	شاي عراق	*Micromeria fruticosa**	Thyme leaved savory	Chamaephyte, semi shrub	M

Continue Appendix A, Table (3)

100	صليصلة	*Micromeria sinaica**	Savory	Chamaephyte, semi shrub	SA
101	صوفان	*Phagnalon rupestre*	African fleabane	Chamaephyte, semi shrub	M.I
102	دبيقة	*Rubia tenuifolia*	Narrow leaved madder	phanerophyte	M
103	خويخة	*salvia dominica*	Dominica sage	Chamaephyte, semi shrub	M
104	نتش	*Sarcopoterium spinosum**	Thorny burnet	Chamaephyte, semi shrub	M
105	جعدة	*Teucrium capitatum*	Cat thyme	Chamaephyte, semi-shrub	M.I
106	كمندرة–جعدة مشرفه	*Teucrium divaricatum**	Germander	Chamaephyte, semi shrub	M
107	كتيله	*Varthemia iphionoides**	Common varthemia	Chamaephyte, semi shrub	M
108	السرو	*Cupressus sempervirens**	Funeral cypress		M
109	صنوبر حلبي	*Pinus halepensis**	Allepo-Pine	Tree	M

Scientific names with *, are common to both slope aspects

Climate distribution

M: Mediterranean, I: Irano-Turanian, S.A Saharo-arabian, E: Euro-siberian

الملخص

الخصائص النباتية في محمية غابة وادي القف

تهدف الدراسة إلى بحث الخصائص النباتية في محمية غابة وادي القف: الأشجار، الغطاء النبـــاتي الأرضـــي، وبعض صفات التربة الفيزيائية والكيميائية، وتأثير اتجاه الميل (شمالي أو جنوبي) على خـــصائص النباتـــات والتربة.بحثت الدراسة تأثير الميل على الخصائص النباتية كالتكوين و البناء النباتي،الكتلة الحيوية النباتية، كثاقة المجتمعات النباتية، مساحة الجزء المتغصن لأشجار الغابة، محيط أشجار الغابة على مستوى الصدر.

تم اختيار منطقتين ممثلتين عشوائيا ضمن محمية غابة وادي القف،الأول فيه اتجاه الميل شمالي والثاني فيه اتجاه الميل جنوبي.أظهرت نتائج البحث أن لإتجاه الميل تأثير ذو دلالة إحصائية معنوي على الخـــصائص النباتيـــة، كالتكوين والبناء، الكتلة الحيوية النباتية، كثاقة المجتمعات النباتية، الى جانب بعض صفات التربـــة الفيزيائيـــة والكيميائية.كانت البنية النباتية في الميل الشمالى مختلفة عنها في الميل الجنوبي وكذلك الحـــال عنـــد مقارنـــة السنوات المختلفة. يعتقد بأن السبب وراء هذا الإختلاف هو الإختلاف في الموارد المتوفره للنباتات فـــي كـــلا الميلين، هذا الى جانب الحقيقة العلمية المعروفة وهي ان الميل الجنوبي يتعرض لأضعاف ما يتعرض له الميل الشمالي من أشعة الشمس، مما يجعل الميل الجنوبي أكثر جفافا ودفئا، وبالتالي يزيد من عمليات التبخر والنـــتح ومعدل درجات الحرارة اليومي في موسم الصيف حيث الجفاف وقلة المياه.يتمتع الميل الـــشمالي بـــوفرة فـــي الموارد مثل، رطوبة التربة، وظهر هذا جليا في نتائجنا حيث كانت رطوبة التربة في الميل الشمالي اعلى منها في الميل الجنوبي وكذلك الحال تركيز الأمونيا والنترات والتوصيل الكهربائي وبدلالة إحصائية معنوية.

إن نتائج هذا البحث تتفق مع نتائج الكثير من الدراسات والأبحاث المحلية والإقليمية والدولية.