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Smart Land Cover-Based Solutions for Agricultural Decision-Making: The Western Slopes of Hebron Governorate Case

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Dedication

This work honors the search for knowledge and the people who have helped it grow.

To my instructors and mentors, whose strong leadership and keen observation laid the groundwork for a thorough investigation.

To my classmates and coworkers, who made each part of my study better by participating and working together.

To my family, for always being patient, supportive, and sure of how important scientific research is.

And to every researcher and scholar who is honestly and with purpose working to promote science, may this contribution be just one small step in the never-ending quest for knowledge.

Mohammed Sadeq AlAmleh

Declaration

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

Signed: ______________________________

Mohammed Sadeq Mohammed Alamleh

Date: 16 / 08 / 2025

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Mohammed Sadeq AlAmleh, 2025

Abstract

This study aimed to provide accurate information about land cover in the western slopes of Hebron Governorate (around 250,747 dunums), specifically in relation to agricultural lands. A descriptive analytical approach was used, and on-screen digitizing of the land covers was done using aerial photographs from the (GeoMoLG) platform using the (CORINE) land cover classification system and the latest version of ArcGIS Pro 3.5.

The results showed that 41% of the study area is agricultural, with olive groves being the most significant land type. The majority of artificial surfaces (81.2%) are urban fabric, with mines, dumping, and construction sites being the second largest. Forests and semi-natural areas make up 43.3% of the study area, with sparsely vegetated areas and coniferous forests representing the rest. The scarcity of open water bodies in the study area is seen as small agricultural pools.

The study concluded that there is mismanagement of land in the area, with industrial zones and urban sprawl on agricultural land, particularly permanent crops and non-irrigated arable lands. Olive groves are the most successful species for the region, economically viable, and deeply rooted in the history and legacy of the Palestinian people.

The study recommends reviewing industrial zones, haphazard trash dumps, urban and master plans and focusing on olive groves through rehabilitation initiatives, pruning campaigns, pest management, and enhancing production chain efficiency. It also recommends spatial analysis of land cover instead of agricultural census. A mobile application was developed to provide decision-makers with the study's results and findings.

In conclusion, comprehensive and periodic studies and analyses of land cover across other regions, including the West Bank and Gaza Strip, are necessary to generate reliable data and information for agricultural, urban, and industrial planning strategies.

Key words: Land Cover, CORINE, GIS, Western Slopes, On-screen digitizing.

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List of abbreviations

ARIJ	Applied Research Institute – Jerusalem
CORINE	Coordination of Information on the Environment
Dunum	1,000 square meters
GeoMoLG	Ministry of Local Government on-line GIS platform
GIS	Geographical Information Systems
GS	Gaza Strip
ha	Hectare
LRC	Land Research Center
MoA	Palestinian Ministry of Agriculture
NGO	Non-Governmental Organization
PCBS	Palestinian Central Bureau of Statistics
WB	West Bank

Chapter One

Introduction

1.1 General Introduction

Sustainable land management and agricultural development depend heavily on the availability of accurate, recent, and spatially referenced data on land cover (Al-Qawasmi, 2020; Mseden, 2021). In areas such as the western slopes of Hebron Governorate, an agriculturally significant region encompassing approximately 250,000 dunums, the absence of such data has impeded the ability of decision-makers to develop strategic plans aimed at protecting and enhancing agricultural productivity. This region, which is characterized by varied topography, microclimates, and fertile soils, has witnessed increasing pressures from urban sprawl, industrial encroachment, haphazard waste dumping, and Israeli settlement expansion, particularly in Area C, where Palestinian planning control is limited (Al- Dawda, 2018; Al-Ghababsha, 2023; Raddad, 2015).

The deterioration of agricultural land in the study area is largely attributed to weak land-use planning and a lack of integration between spatial data and development strategies. Traditional sources such as the agricultural census conducted by the Palestinian Central Bureau of Statistics (PCBS, 2021) rely on farmer-reported information and do not incorporate spatial analysis or field validation, thus limiting their usefulness for policy planning.

In response to these challenges, this study adopts a spatially analytical methodology that utilizes high-resolution aerial imagery (15 cm/pixel) from the GeoMoLG platform, integrated with Geographic Information Systems (GIS) and the Coordination of Information on the Environment (CORINE) Land Cover Classification System (European Environment Agency, 2019). Through on-screen digitization and field verification, the study classifies land cover with a focus on agricultural areas and their subtypes, such as permanent crops, arable lands, and heterogeneous cultivation patterns.

The results of this study are presented in the form of maps, statistical tables, and comparative analyses, providing a high level of precision that can directly support decision-making processes within the agricultural, urban, and environmental planning sectors. Furthermore, the study builds upon and expands previous local research (e.g., (ARIJ) Applied Research Institute - Jerusalem, 2010; Abu As'ad, 2020; Sadeh, 2021) by offering an updated and detailed spatial inventory of land cover, while also developing a mobile application ("Athro Deel") to ensure accessibility and utility for decision-makers and local institutions.

Table 1.1: Key stakeholders “decision-makers” and benefits from the study outcomes

Stakeholder	Benefit Aspects
Ministry of Agriculture (MoA)	• Reviewing and updating agricultural development plans and strategies for the western slopes of Hebron governorate • Optimization of agricultural and natural resource management
Ministry of Local Government (MoLG)	• Reviewing and updating the master plans of the Palestinian communities within the study area • Reviewing and updating national spatial plan • Monitoring of urban expansion
The Environment Quality Authority (EQA)	• Monitor environmental changes, assess ecosystem health, and support biodiversity conservation • Identification of environmentally sensitive areas, detection of land degradation and pollution hotspots and evaluation of climate change impacts
Ministry of Planning and International Cooperation	• Utilizing study outputs in evidence-based spatial planning, resource allocation, and sustainable development strategies • Identification of priority areas for infrastructure development and the formulation of policies that align with national development goals and international cooperation frameworks
Local Non-Governmental Organization (NGO’s)	• Enhance agricultural planning, promote sustainable land management practices, and support local farming communities • Identification of suitable areas for crop cultivation, monitoring of land-use changes affecting agricultural productivity, assessment of water and soil resource availability, and the design of community-based projects that strengthen food security and rural development
International NGO’s / Funders	• Prioritize funding for sustainable land management and conservation projects, and evaluate the environmental and socio-economic impacts of their interventions • Land cover provides reliable spatial data that support project design, monitoring, and evaluation, ensuring that resources are allocated efficiently to areas of greatest need
Researchers / Research Institutions	• Integrating study outputs into academic research, field studies, and educational programs. • The analysis provides high-resolution spatial data that support multidisciplinary studies in geography, environmental science, agriculture, and urban planning • Enhances research capacity, supports data-driven publications, and fosters collaboration between academia, decision-makers, and international institutions

Ultimately, this study contributes a robust methodological model for land cover analysis that can be replicated in other parts of the West Bank and Gaza Strip. It underscores the importance of integrating spatial technologies into national development frameworks, particularly in regions undergoing complex geopolitical and environmental transformations.

1.2 Study Problem

In regard to agriculture, the Hebron District is one of the most significant Palestinian regions because of its agricultural potential. With respect to the area of agricultural land, it comes second after the Jenin Governorate (Palestinian Central Bureau of Statistics – Agricultural Census 2021). This is the case because of the climatic and topological diversity of the governorate, in addition to the different soil types that are present there.

A majority of the western slopes of the governorate are characterized by mild topography, which makes possible the existence of large areas of agriculture. Most of the area consists of deep soil hills, which are ideal for the cultivation of trees for horticulture and/or fodder crops.

Regrettably, one of the primary causes of subpar agricultural land management techniques that result in the reduction of agricultural lands is the use of outdated and insufficient data on land cover and classification. The situation is further exacerbated by urban sprawl (Al-Dawda, 2018; Helal 2024), land fragmentation (An Noubani, 2017), climate change, and Israeli policies such as expansionist settler activity, land expropriation, house demolitions, agricultural access restrictions (especially in Area C), and various other forms of violence (Raddad, 2023).

These issues have led to a significant deterioration in agricultural land and an increase in land-use conflicts. A clear example of this is the presence of used car scrapyards within agricultural lands and factories built on farmland.

1.3 Study Justifications

The justifications for the study are as follows:

- The study is motivated by the absence of precise and current data on land cover, specifically agricultural lands, in the western slopes of Hebron Governorate.
- Lack of field verification for the recent agricultural census conducted by the PCBS and Palestinian Ministry of Agriculture (MoA) in 2021, which estimates agricultural areas based on farmer-reported information, without conducting spatial analyses.

1.4 Objectives

The general goal of this study is to provide accurate, updated and detailed information about the land cover in the western slopes of Hebron Governorate, contributing to the buildout of developmental plans for the area, particularly in relation to agricultural lands. The specific objectives of the study are as follows:

1. To identify, analyze, and classify the land cover, distribution, and percentages of different land cover types, including comparisons for each classification level, through conducting a land cover mapping for the study area using accurate aerial imagery from the year 2023.

2. To provide decision-makers with recent information about land patterns, areas, locations, and distributions of each agricultural subclass, which will assist them in updating and enhancing their development and planning strategies to achieve sustainable development for the area.

1.5 Study Importance

The importance of the study lies in its contribution to providing accurate information about the land cover of the study area for the year 2023, with a focus on agricultural aspects, which will significantly aid in the management of agricultural areas and facilitate decision-making processes related to all land cover classifications. Specifically, the study will contribute through:

1. Providing decision-makers with an up-to-date and accurate information base on land cover classifications, presented as statistical data and geographic distribution.

2. Creating maps for all land cover classifications at various levels and in different forms.

3. Linking the results to an interactive application, which will serve decision-makers in relevant ministries and institutions working in land development sectors.

1.6 Study Questions

The study aims to answer a set of questions, which can be summarized as follows:

1. Do decision-makers need detailed and accurate information about the land cover in the western slopes of Hebron Governorate?

2. How can land cover information be utilized to build comprehensive development plans for the western slopes of Hebron Governorate?

3. What is the best way to present land cover data and maps for maximum benefit?

1.7 Study Area

1.7.1 Spatial Boundaries:

The western slopes of Hebron Governorate are considered part of the western slopes of the West Bank, according to the West Bank Agro-Ecological Zones Map (LRC Geo-databases, 2025). This map classifies the West Bank into five zones according to location, rainfall, and altitude, as follows:

Table 1.2: West Bank agroecological zones classifications

Classification	Area – Dunums	Elevation - m
Jordan Valley - Jordan River Valley	732,040	-400 – 0
Eastern Slopes	1,386,557	0 – 600
Mountain Plateau	1,442,251	600 – 1,000
Western Slopes	1,215,066	300 – 600
Semi-Coastal Plain	883,566	50 – 300
Total Area	**5,659,480**	

Based on the previous table, the western slopes of Hebron Governorate (the study area) cover approximately 250,747 dunums; this area represents about 25% of the Hebron Governorate. The area extends from the village of Jabba in the north to the village of Al-Ramadin in the south, situated between latitudes 31°40'20" and 31°20'30", and longitudes 34°52'32" and 33°2'20". It is located about 8 km west of Hebron City.

This area was selected due to its high agricultural significance, featuring diverse land cover types. Additionally, it includes a considerable number of Palestinian communities (51 in total).

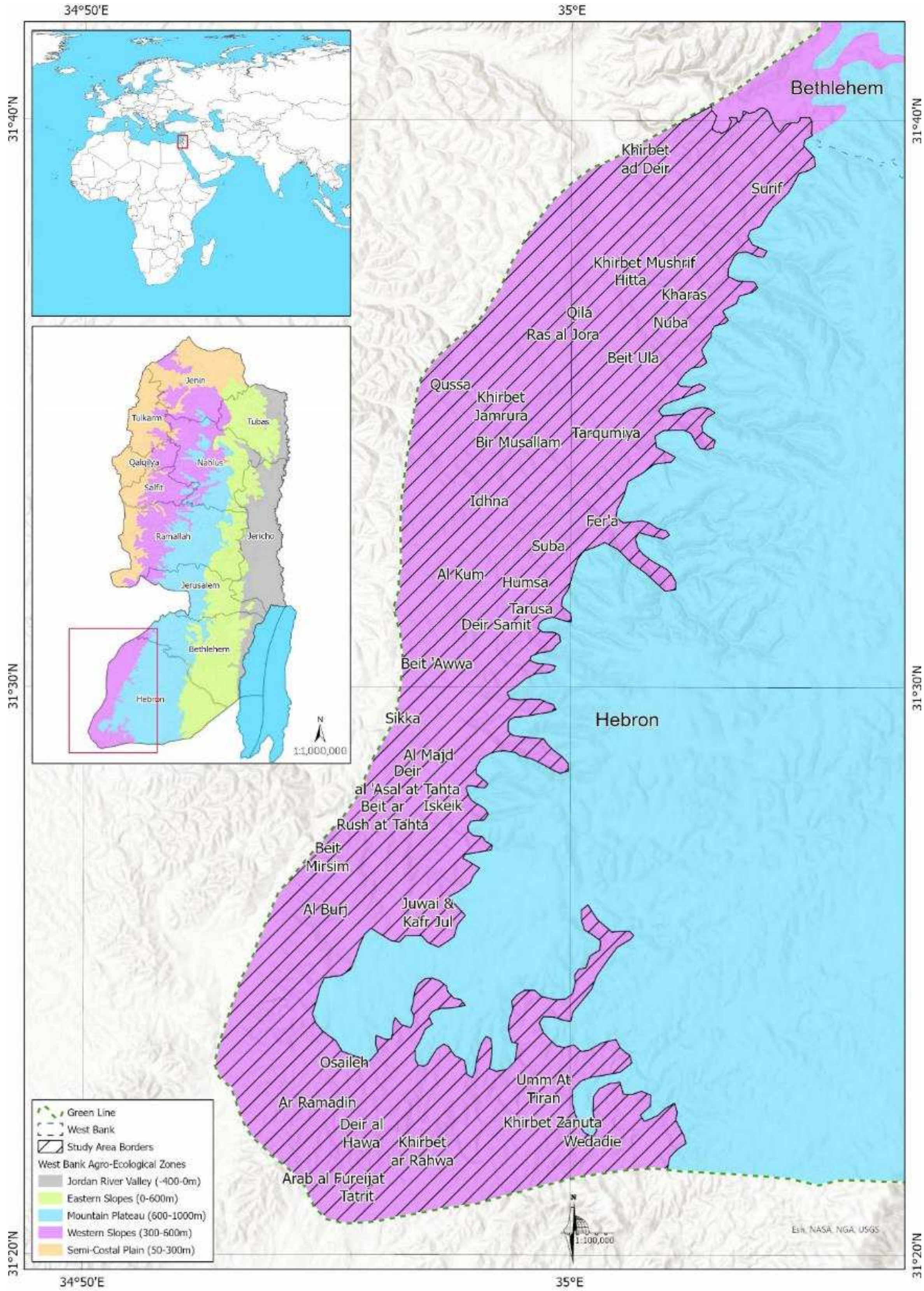

Figure 1.1: Map of the Study Area

1.7.2 Temporal Boundaries:

The study analyzes the land cover of the study area for the year 2023, based on aerial imagery. This year was selected for the following reasons:

1. Availability of high-resolution aerial imagery (15 cm/pixel) for 2023, accessible via the (GeoMoLG) Ministry of Local Government's online GIS platform and GIS software. These images enable visual interpretation and classification of most land covers.

2. No aerial images more recent than those from 2023 were available at the time of the study.

1.7.3 Communities within the Study Area:

There are 51 Palestinian communities within the study area; some of these communities are totally located in the study area, and some of them are partially. The following table shows these communities, areas, and the percentage of area within the study area:

Table 1.3.A: Palestinian communities within the study area

PCBS Code	Community Name	Total Area - Dunums	Inside Study Area - Dunums	Percentage
13502835	Beit A’wwa	8,513.6	8,513.6	100%
13502795	Al Muwarraq	667.4	667.4	100%
13503335	Ar Ramadin	14,499.0	14,499.0	100%
13503405	A’rab al Fureijat	5,453.1	5,453.1	100%
13503010	Beit ar Rush at Tahta	691.3	691.3	100%
13502765	Beit Maqdum	659.3	659.3	100%
13502925	Deir al 'Asal at Tahta	725.7	725.7	100%
13502770	El Kaum	1,406.7	1,406.7	100%
13502550	Hitta	5,637.0	5,637.0	100%
13502785	Humsa	1,637.3	1,637.3	100%
13502685	Idhna	23,258.6	23,258.6	100%
13502435	Khirbet ad Deir	1,008.6	1,008.6	100%
13503400	Khirbet ar Rahwa	9,888.5	9,888.5	100%
13502625	Khirbet Jamrura	3,749.7	3,749.7	100%
13502890	Tawas	1,234.7	1,234.7	100%
13503248	Kafr Jul	2,207.0	2,206.9	100%
13503090	Beit ar Rush al Fauqa	4,639.5	4,627.4	100%
13502970	Deir al 'Asal al Fauqa	2,957.6	2,897.3	98%
13502560	Kharas	6,850.5	6,666.9	97%
13502810	Deir Samit	7,049.1	6,808.3	97%
13502615	Beit Ula	19,843.0	19,111.8	96%
13502910	Al Majd	4,500.4	4,332.6	96%
13503170	Al Burj and Al Bira	7,395.7	7,108.3	96%
13502585	Nuba	6,156.7	5,908.0	96%
13502985	Iskeik	1,512.6	1,448.7	96%

Table 1.4.B: Palestinian communities within the study area

PCBS Code	Community Name	Total Area - Dunums	Inside Study Area - Dunums	Percentage
13503246	Iqtet	3,896.8	3,714.0	95%
13503075	Beit Mirsim	1,167.4	1,109.7	95%
13502730	Suba	3,148.9	2,899.3	92%
13502860	Sikka	1,284.1	1,177.8	92%
13503249	Abu Alhana	4,162.1	3,732.6	90%
13503375	Khirbet Zanuta	7,133.7	5,738.4	80%
13503324	Khirbet Alrthem	7,835.5	5,934.5	76%
13502450	Surif	29,860.6	22,099.8	74%
13502640	Tarqumiya	24,169.5	16,776.9	69%
13502800	Tarusa	536.5	349.5	65%
13503295	'Anab al Kabir	9,615.5	5,742.0	60%
13502870	Wadi 'Ubeid	4,451.7	2,404.2	54%
13503245	Adh Dhahiriya	46,013.2	22,427.7	49%
13503110	Wadi al Kilab	4,892.1	2,351.0	48%
13503235	Somara	2,509.8	1,023.2	41%
13502915	Marah al Baqqar	2,815.2	1,008.5	36%
13503285	Khirbet Shuweika	4,842.9	1,362.0	28%
13502950	As Sura	11,218.2	2,314.1	21%
13502895	Khursa	4,525.0	725.6	16%
13503145	Rabud	3,999.8	603.8	15%
13502750	Taffuh	12,111.9	1,487.0	12%
13502655	Beit Kahil	5,678.2	593.3	10%
13503270	Khirbet Deir Shams	4,872.9	475.9	10%
13502840	Dura	38,129.8	3,272.1	9%
13503320	As Samu'	41,088.7	866.0	2%
13502630	Halhul	36,305.1	411.8	1%
Total Area		**458,407.7**	**250,747.4**	**55%**

The above table showed that there are more than 31 Palestinian communities, 80% of whose areas are located within the study area.

1.8 Study Area Climate

The majority of the study area falls within an arid zone due to low and/or intermittent rainfall and high average annual temperature (LRC Geo-databases, 2025). Specifically:

- Seventy-seven percent of the study area is classified as arid (dry) regions.
- Nine-point four percent falls within a semi-arid zone.
- Twelve-point three percent of the area is classified as highly arid, located in the southern parts of Hebron Governorate, near the city of Adh Dhahriyah.
- Only 1.2% of the study area is classified as semi-humid, located in the northernmost part near the town of Surif.

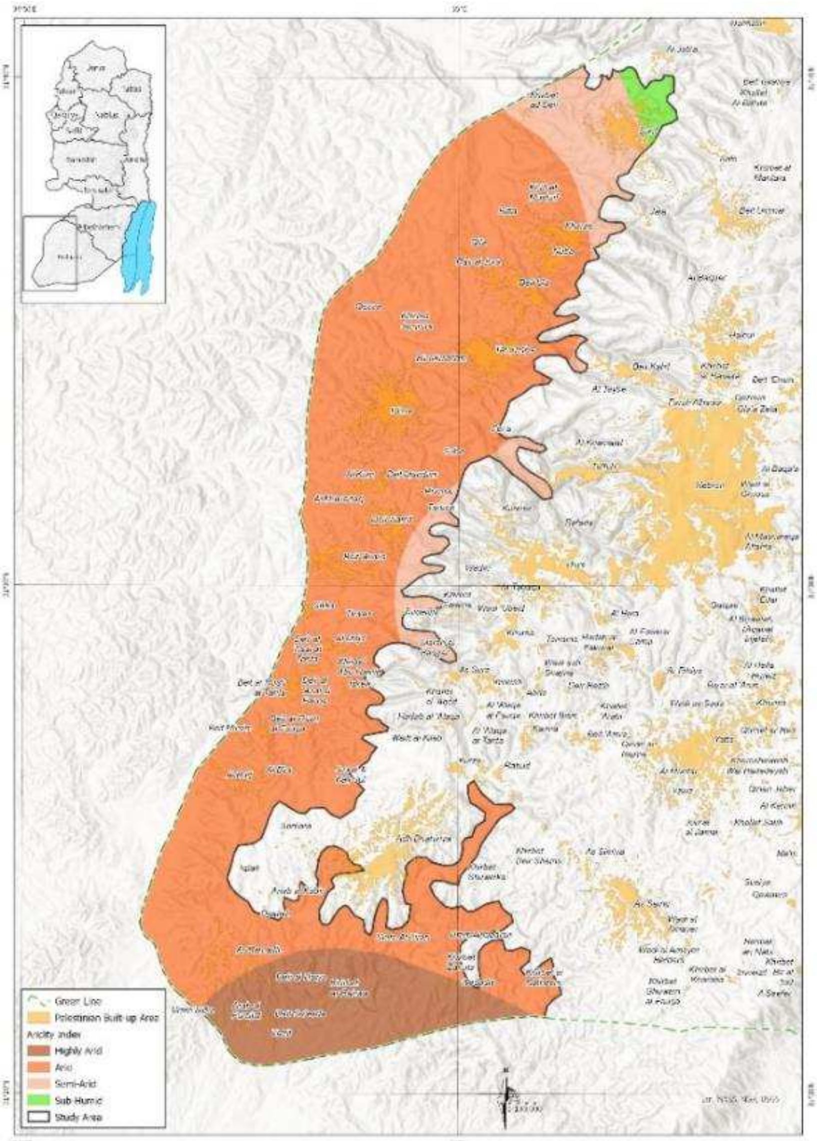

Figure 1.2: Climate Classifications of the Study Area

1.9 Study Area Annual Rainfall

From Map No. (3) (LRC Geo-database, 2025), the majority of the study area falls within an annual rainfall range of 400–450 mm, covering approximately 36.6% of the study area. This pattern is followed by the 350–400 mm rainfall range, which covers about 25% of the area.

However, rainfall in Palestine has shown significant variability recently, fluctuating both annually and regionally (Shadeed, 2012). This instability has serious consequences for:

- The agricultural sector and biodiversity.
- Increased risks of drought and desertification.
- Negative impacts on groundwater reserves (Environmental Education Center, 2023).

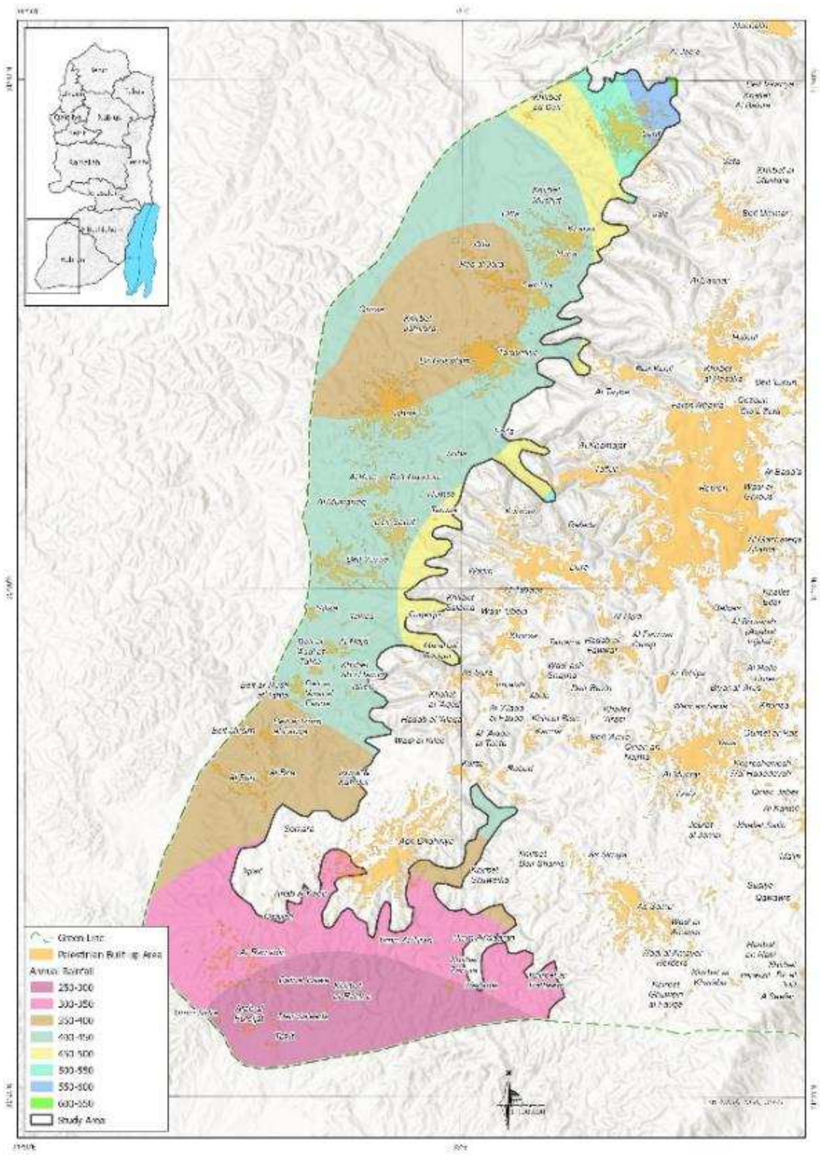

Figure 1.3: Annual rainfall rate in the study area

1.10 Study Outputs

The study's outputs were diverse, aiming to present the data and results in the best possible way to meet the needs of stakeholders and researchers. These outputs included the following:

1. **Study Report**: This is a comprehensive report that thoroughly explains the study problem, its objectives, and its significance. It also details the methodology used for collecting and analyzing the results, presents the main findings, offers commentary on those findings, and provides a set of recommendations for decision-makers.

2. **Mobile Application**: A mobile app was developed for both Android and Apple iOS devices. The app was designed and developed in collaboration with a specialized programmer. It includes detailed data that make it easier for decision-makers and researchers to access and utilize the study’s results.

These outputs aim to ensure that the study's findings are accessible and beneficial to a wide audience, supporting informed decision-making and further research.

Figure 1.4: Mobile application home screen

Chapter Two

Literature Review

2.1 Theoretical Framework

2.1.1 Land Cover Maps:

Land cover maps are maps that document all the types of cover on the Earth's surface, including agricultural, industrial, water bodies, open areas, and other land uses. Land cover can be identified through aerial imagery or satellite images, providing valuable data to assist managers and decision-makers in gaining a deeper understanding of the current state of land. They also help in evaluating past decisions and offer insights into the potential impacts of decisions before they are implemented (Pulighe, 2023).

Land cover maps can be used to better understand the effects of natural phenomena and human activities on the natural landscape. These maps enable the monitoring of population growth, decline in agricultural lands, and the impact of climate change on agricultural lands and water bodies, as well as the prediction and evaluation of floods and storms. Additionally, they play a critical role in setting development priorities and creating protection plans for agricultural lands, natural reserves, and forests.

2.1.2 CORINE Land Cover Classification System:

In the early 1980s, the European Commission launched the CORINE program (European Environment Agency, 2019), which was developed to standardize methodology for producing maps of land cover, biodiversity, and air quality across Europe. This initiative was in response to the need for comprehensive, detailed, and coordinated datasets concerning land cover and land use in Europe. At that time, national land cover maps were often inconsistent and non-comparable across borders, making it impossible to monitor the European environment at a continental level.

The CORINE system has undergone several updates, with major revisions in 2000, 2006, and 2012, and the most recent update was released on June 10, 2019. The system relies on visual interpretation to identify and classify land cover types recorded in aerial imagery or satellite images. It involves determining and assessing these land cover types to create accurate and consistent maps that can be used for environmental monitoring and planning.

2.1.3 Definition of Hierarchical Land Cover Categories:

The CORINE system (Kosztra B., 2019) divides land cover into five main land cover classes (Industrial Areas, Agricultural Areas, Forest and Semi-Natural Areas, Wetlands, and Water Bodies) (Kosztra, 2019). Each class is classified according to three levels, with each level further detailed into several groups in a specific order. This classification system was utilized in the study because it is the most widely used in Palestine (most, if not all, previous land cover maps were prepared using it), and it is also easy and convenient to apply in the study area. Below are the key classifications of the CORINE system:

Class 1: Artificial Areas:

Class 1.1 Urban Fabric: Areas primarily occupied by residential buildings and structures used for administrative/public facilities, including the surrounding areas (associated land, nearby road networks, parking lots).

Class 1.2 Industrial, Commercial, and Transport Units: Areas mainly occupied by industrial activities such as manufacturing, trade, financial services, and infrastructure for transport, including road traffic, rail networks, airport facilities, and river and sea port installations, along with the associated lands and access infrastructure. This also includes industrial livestock facilities.

Class 1.3 Mining, Dump and Construction Sites: Industrial areas primarily occupied by extraction activities, construction sites, industrial waste disposal, and associated land areas.

Class 1.4 Artificial Non-Agricultural Vegetated Areas: Areas created for recreational use, including urban green parks, sports facilities, and leisure areas.

Class 2: Agricultural Areas:

Class 2.1 Arable Land: Land subjected to crop rotation systems, used for annual crops that are harvested every year, as well as fallow land-both rainfed or irrigated. This category includes land used for water-intensive crops, such as rice fields.

Class 2.2 Permanent Crops: Land occupied by permanent crops that are not subject to a crop rotation system. This includes crops grown for fruit production, such as orchards (e.g., apple, olive), and vineyards or shrub plantations (e.g., vineyards, berry bushes).

Class 2.3 Pastures: Land used permanently (for at least 5 years) for the production of fodder. This category includes both natural or cultivated grass species, pasture meadows, and mechanically harvested hayfields.

Class 2.4 Heterogeneous Agricultural Areas: Areas where annual crops are mixed with permanent crops on the same piece of land, or where annual crops are grown under forest trees, or areas where annual crops, meadows, and/or permanent crops are adjacent to each other. It also includes landscapes where crops and pastures are closely intertwined with natural vegetation or natural areas.

Class 3: Forest and Semi-Natural Areas:

Class 3.1 Forests: Areas covered by forests and wooded lands, characterized by vegetation consisting of native or non-native coniferous trees and/or broadleaf trees that can be utilized for the production of timber or other forest products.

Class 3.2 Shrubs and/or Herbaceous vegetation associations: Areas with moderate shrublands, such as Atlantic meadows and Alpine mountain shrublands, subalpine shrub communities, long grasslands, hedgerows, and dwarf conifer vegetation.

Class 3.3 Open Spaces with Littile or No Vegetation: Natural areas covered by sparse vegetation or no vegetation, including rocky areas with few or no plants on steep slopes, rock pavements, limestone pavements with plant communities colonizing these surfaces, as well as snow, permanent glaciers, inland sand dunes, and coastal sand dunes.

Class 4: Wetlands:

Class 4.1 Inland Wetlands: Areas that are flooded or exposed to flooding for most of the year, typically with freshwater or slightly saline or stagnant waters, and characterized by a distinct vegetation cover, including low shrubs, semi-vegetative species, or herbaceous plants.

Class 4.2 Coastal Wetlands: Areas that are inundated by high tide waves at some point in the annual tidal cycle. This includes salt meadows, salt marsh grasslands, whether transitional or non-transitional to other communities, and vegetated areas that exhibit varying levels of salinity and moisture.

Class 5: Water Bodies:

Class 5.1 Inland Waters: Natural lakes, ponds, and swamps that contain freshwater, as well as flowing waters from all rivers and streams. This also includes human-made freshwater bodies such as reservoirs and canals.

Class 5.2 Marine Waters: Offshore and continental shelf waters, as well as bays, narrow channels, including marine lakes, sea lakes, gulf areas, and estuaries.

2.2 Previous Studies

To understand and take a clear picture of the reality of the land cover mapping in the Palestinian territories and other areas, many related studies that intersect with the title and objectives of this research were reviewed. These studies were divided into two categories:

1. **Local Studies**: This category includes studies that are relevant to the subject and objectives of the study at the local Palestinian level. These studies offer insights into similar land cover classifications, agricultural practices, and environmental factors specific to the Palestinian context.

2. **Global Studies**: This category includes studies that are similar in topic and title to the study but focus on areas outside of Palestine. These studies provide a broader perspective on land cover classification, land use changes, and environmental challenges in different regions, offering comparative data and methodologies that can inform the current research.

By reviewing both local and global studies, the research can draw on existing knowledge and best practices, providing a solid foundation for analyzing land cover and related issues in the study area.

2.1.4 Local Studies:

1. **Applied Research Institute – Jerusalem ARIJ (2010)**, "*West Bank and Gaza Strip Land Cover Analyses for the years 2006 and 2010*", Unpublished study.

The GIS department on (ARIJ) conduct a land cover analyses for the West Bank (WB) and Gaza Strip (GS), for the years 2006 and 2010, they utilized the CORINE land cover classification system for the level II, and they only classified the urban areas at the level III. On-screen digitizing for 50 cm pixel size aerial photographs and satellite images were utilized for the years 2006 and 2010 in order to prepare the land cover analyses. They also use random points for field verifications. The analyses and maps were prepared on scale 1 to 5,000.

2. **Sahar Abidin's Study (2018):** " *Evaluation of the Effect of Surface Runoff on the Urban Growth in the Natural Area of Hebron's Basins Using Geographic Information Systems (GIS) between 2001 and 2014* "

The study aimed to evaluate the impact of surface runoff networks on urban growth in the natural watersheds of Hebron city. The research focused on understanding the runoff network using the ArcGIS program, studying urban growth patterns over four periods (2001, 2007, 2010, and 2014), identifying areas of urban expansion, and linking the runoff network to urban growth locations, particularly in areas of valleys and floodwater channels.

The study used a descriptive-analytical methodology as well as a historical cartographic approach to achieve its objectives. Aerial imagery from 2001, 2007, 2010, and 2014 was employed to monitor urban expansion and correlate it with the surface runoff network.

Key findings included a steady increase in population growth during the study period. Areas where the runoff network intersected with urban areas were identified. The study also noted that the absence of an urban master plan was a key factor preventing the municipality from stopping construction in valley areas, which should have been considered agricultural zones. The study recommended that the surface runoff network should be taken into account in urban planning to reduce the impact of runoff on urban areas. Additionally, the establishment of an urban master plan for Hebron city, including land use plans, was emphasized. It also suggested improving cooperation between residents and governmental agencies to minimize runoff impacts in residential areas prone to flooding. Finally, the study called for specialized committees to monitor areas affected by runoff and to establish water drainage systems compatible with the urban master plan and runoff networks in future plans.

3. **Mishal Al-Douda's Study (2018):** "*Analysis and Evaluation of Land Uses in Hebron Governorate and their Planning Strategies*"

This study focused on Hebron Governorate, highlighting the chaotic planning of land uses and the overlap of various land uses in the region. The research analyzed land use plans for Hebron Governorate over three periods: 1997, 2006, and 2010. The results revealed discrepancies between the official land use plans and the actual situation on the ground, as well as differences in land use patterns over the three periods.

The study used a descriptive, analytical, and historical methodology, relying on available information regarding land uses in Hebron Governorate. Interviews, field surveys, and site visits were conducted to gather data.

The study's results pointed to several negative aspects of overlapping land uses and the lack of comprehensive master plans that organize land uses in the governorate. The most important recommendation of the study was the urgent need to develop an urban master plan for the governorate to regulate land uses and propose future land use categories for the coming years.

4. **Bayan Al-Qawasmi's Study (2020):** " *Agricultural Land Use Change in the Mountain Hebron from 2000 to 2018: The Case of Hebron, Halhul, and Sa'ir*"

This study focused on understanding the changes in agricultural land uses in Mount Hebron, specifically in the city of Hebron and the towns of Halhul and Sa'ir, between 2000 and 2018. The main objective was to monitor the changes in land area and types based on aerial photographs from both years, while also assessing the impacts of urban growth, economic activities, and Israeli occupation policies on agricultural lands. The study also examined the role of natural factors (such as topography and rainfall) on agricultural land uses and their distribution.

Additionally, the study explored the reasons behind farmers abandoning agriculture and leaving their land, correlating these reasons with various socio-economic factors such as gender, education level, household income, age, and farming experience.

The study used a spatial analytical methodology, analyzing aerial images with GIS software to classify and calculate agricultural land areas and examining the different factors (urbanization, settlement, and natural conditions) affecting agriculture. The researcher also applied quantitative (statistical) analysis, utilizing SPSS to analyze a survey conducted with 67 farmers in the study area, using a snowball sampling method.

The study concluded that there was a decrease in the area of vineyards in Hebron, Halhul, and Sa'ir, while olive tree cultivation increased. When comparing the 2018 results with data from the Ministry of Agriculture, the study found significant discrepancies, largely due to differences in classification methods. The study also provided statistical data on agricultural land areas in 2000, which was not previously available at the community level.

Furthermore, the study highlighted the relationship between rainfall and topography on agricultural distribution. It was found that agricultural areas, especially olive groves, expanded in areas with 400 mm of rainfall and slopes of 0-13 degrees, where the soil's ability to absorb water and its fertility were optimal. The study also indicated that increased slope caused a decrease in agricultural areas due to soil erosion. The encroachment of urban expansion on high- and medium-value agricultural land was also evident.

The study noted that Israeli policies, particularly the restrictions within 1500 meters of Israeli settlements and areas classified under Oslo's accord (A) and (B) zones, pushed Palestinians to expand urban growth on the agricultural lands.

The study recommended conducting additional research to assess agricultural changes in other parts of Hebron Governorate to provide a more comprehensive picture of agricultural changes in the region. It also urged the Ministry of Agriculture to reconsider the methods used for delineating and classifying agricultural lands and recommended that relevant authorities take measures to prevent construction on high-value agricultural lands.

5. **Amal Abu As'ad's Study (2020):** "*The Role of Water Harvesting Projects in the Vegetation Cover: A Field Study from the Viewpoint of Beneficiaries in Hebron Governorate*"

This study aimed to explore the role of rainwater harvesting projects in the vegetation cover of Hebron Governorate between 2011 and 2019, focusing on the effectiveness of the projects, the sustainability of the techniques used, the satisfaction of the beneficiaries, and the impact on soil moisture retention and agricultural crops.

The researcher used the descriptive methodology, be conducting a survey on 120 beneficiaries of rainwater harvesting projects in Hebron Governorate, who were selected randomly. The collected data were analyzed using SPSS software.

The study found a positive correlation between all aspects of the research. It revealed that the sustainability of rainwater harvesting techniques, the effectiveness of the projects, beneficiary satisfaction, soil moisture retention, and the improvement in agricultural crops were all high.

The study provided a set of recommendations, focusing on the following:

- The need to utilize stone terraces in rainwater harvesting projects to improve efficiency.

- The necessity to expand rainwater harvesting projects in semi-arid areas and areas classified as C (according to the Oslo Accords).

- The importance of conducting applied studies on the relationship between harvesting techniques and supplemental irrigation in rainfed agriculture.

- The need to conduct studies on traditional rainwater harvesting techniques to preserve and promote Palestinian agricultural heritage.

This study highlights the potential of rainwater harvesting as an effective tool for improving agricultural sustainability and vegetation cover in dry areas.

6. **Lana Sadeh Study (2021):** "*Modeling of Land Use in Support of Urban Agriculture in Hebron City using the integration between the multi-criteria evaluation (MCE) and Geographic information systems Technique*"

The study aimed to aimed to explore the concept of urban agriculture, its types, and its environmental, economic, and social significance.

The study sought to develop a suitability map divided into three levels: highly suitable, moderately suitable, and least suitable for urban agriculture in Hebron City. This was achieved by employing the Delphi method to identify factors influencing agriculture in Hebron, followed by the Analytic Hierarchy Process (AHP) to determine the weight of each factor through pairwise comparisons. Subsequently, Multi-Criteria Evaluation (MCE) was used to make decisions based on these comparisons.

Using GIS, the study represented the factors, applied the calculated weights, and integrated them to generate the suitability map.

The study recommended establishing guidance offices to support modern agriculture, enacting and updating laws to align with the city's evolving needs, incorporating urban agriculture into urban planning, and providing financial support from governments to promote urban agriculture.

7. **Ayah Helal and Zahraa Zawawi Study (2024):** *"Land Cover and Surface Temperature in the West Bank, Palestine"*

The research article examines rapid urban transformation and land cover changes in the 10 major cities (Ramallah and Al-Bireh, Jenin, Qalqilya, Salfit, Tubas, Jericho, Bethlehem, Tulkarm, and Hebron) of the West Bank, Palestine, from 1995 to 2021. It analyzes how the expansion of built-up areas and changes in soil type affect Land Surface Temperature (LST). Using a remote sensing–based methodological framework, the research finds an inverse relationship between built-up area increase and LST, with built-up areas having lower LST compared to surrounding open spaces due to differences in land cover and soil types.

2.1.5 Global Studies:

1. **Wang, C., and others Study (2015)**: *"High-Precision Land-Cover-Land-Use GIS Mapping and Land Availability and Suitability Analysis for Grass Biomass Production in the Aroostook River Valley, Maine, USA"*

The study conducted high-precision land-cover/land-use mapping in four townships of Maine's Aroostook River Valley – USA, using on-screen digitization and direct interpretation of very high spatial resolution satellite multispectral imagery (15–60 cm) and high spatial resolution LiDAR data (2 m) and the field mapping method. It produced the region's first detailed land-use maps and provided accurate area estimates, particularly for grasslands (fallow land, pasture, hay fields). Findings show that 7,594 hectares of fallow land (25% of open land) exist, with 4,870 hectares in plots larger than 4 hectares. Soil analysis indicates most grassland (85%) lies on prime or important farmland, while only 4.9% is on poorly drained soils. The study concludes that the valley has significant underutilized land suitable for sustainable grass biomass production.

2. **Keelin Denver Haynes Study (2020*): "Modeling Land Cover / Land Use Change: A Case Study of a Dynamic Agricultural Landscape in Southern Vietnam"***

The study analyzes land-cover and land-use changes in Vietnam's Mekong Delta provinces of An Giang and Dong Thap, focusing on the transition from traditional rice farming to more profitable activities like fruit orchards, aquaculture, and medicinal plants. Using high-resolution satellite data, fieldwork, and the Land Change Modeler, the research models past changes (2019) and predicts future trends up to 2027 under various scenarios. It also considers historical, cultural, and policy influences, combining quantitative remote sensing with qualitative interviews to capture local and global drivers of change. The study highlights the need to understand environmental, social, and economic interactions to create policies that protect rural livelihoods and food security.

3. **Nadia Mseden Study (2021):** *"Land Cover changing and land uses in Busayra district period between (2000-2018) by using geographical information systems (GIS)"*

The study aimed to identify and analyze changes in land use in the Busayra District / Jordan through satellite imagery processed using ArcMap 10.3. The study adopted both historical and analytical methodologies to achieve its objectives.

The findings revealed five main types of land cover and land use in the study area: urban development, Dana Biosphere Reserve, mining, agricultural land, and rangelands. The study quantified the changes in each land use type over the study period, showing a decline in fertile agricultural lands due to urban expansion.

Additionally, the study highlighted the importance of investing in urban and agricultural projects within the rangeland areas, which make up the majority of the study region. It also recommended directing urban expansion towards the eastern areas due to the declining vegetation cover and desertification caused by climate change.

Moreover, the study emphasized the importance of utilizing GIS applications for monitoring land cover and land use changes.

4. **Zaid Bani Khaled Study (2022):** "*Analysis of the change in Land Use Patterns in Mafraq City during the period (1975-2015) Using GIS and Remote Sensing"*

The study aimed to analyze land use changes in Mafraq City / Jordan over a 40-year period (1975-2015), focusing on six land use categories: Agricultural lands, Urban areas, Unused lands, Barren lands, Limestone areas and Basalt rock areas.

The study assessed the extent of change in these land use types within the study area. The research applied a descriptive-analytical approach by processing Landsat satellite images captured in May of 1979, 1995, and 2015. GIS and remote sensing techniques were used to classify and quantify land use changes over time.

The findings revealed significant chang**es** in land use and land cover in the study area, with a notable decline in agricultural lands and a considerable expansion of built-up areas over the years.

The study recommended limiting unplanned urban expansion at the expense of fertile agricultural land and emphasized the need to develop a digital database for land use and land cover to support future scientific research.

This study underscores the impact of urbanization on agricultural lands and highlights the importance of sustainable land management strategies in Mafraq City.

5. **Alaa Al-Shbool Study (2022):** *"Determining Optimal Land Use in Ramtha District Using Spatial Suitability Analysis Model and Medium-Resolution Satellite Images"*

The study aimed to identify the optimal land use in Ramtha District / Jordan by analyzing natural and human characteristics, including: Soil types, Geology, Water resources, Road networks, Population distribution, Basic services and Climatic data.

The study adopted a descriptive-analytical approach to examine natural and human characteristics, including soil layers, geology, valleys, water resources, roads, population clusters, essential services, and climatic data. It utilized both qualitative and quantitative methods alongside GIS tools.

Due to the district has suffered from the absence of a scientific methodology in land organization or the issuing permits for different land uses, the study conducted a spatial suitability evaluation to guide future expansion. This was achieved by analyzing the impact of various spatial criteria using Spatial Analyst GIS tool and assigning weights to influential factors based on their relative importance through the Analytic Hierarchy Process (AHP).

The study concluded that highly suitable agricultural lands have declined, while the outskirts of Ramtha City, away from the central urban core, were found to be the most suitable for residential use.

The study recommended strict enforcement of laws and regulations to protect land use and prevent encroachments, particularly on agricultural lands.

6. **Ahmad Al-Sharafat Study (2022)**: *"Using Geographic Information Systems (GIS) and Remote Sensing to Select the Most Suitable Landfill Sites in Irbid Governorate"*

The study aimed to identify the most suitable locations for landfills in Irbid Governorate, northwest Jordan, using GIS and remote sensing.

The study was based on several criteria, including groundwater depth, slope, soil texture, geology, and land cover, while also considering factors such as proximity to valleys, residential areas, earth cracks, roads, and international borders.

The study employed the Weighted Linear Combination (WLC) technique to produce a criteria-based suitability map, where each criterion was ranked and weighted before being combined. Additionally, the Boolean logic approach was used to create buffer zones around restrictive factors.

The findings classified the study area into five suitability levels: unsuitable areas, low-suitability areas, moderate-suitability areas, high-suitability areas, and very high-suitability areas. The study also determined the area and percentage of each suitability level in relation to the total study area.

7. **Ahmad Al-Ghababsha Study (2023)**: "*Monitoring Land Degradation and Land Cover Classification in Eastern Jordan Using GIS and Remote Sensing in the Period 1998 through 2020"*

The study aimed to observe and track land degradation in Western Jordan, where the average annual rainfall ranges between 200-600 mm, over the period 1998-2020 using GIS and remote sensing techniques.

The study area was divided into three zones to analyze the relationship between climatic gradients and land degradation levels. The study extracted the Normalized Difference Vegetation Index (NDVI) and Surface Albedo from satellite imagery. Additionally, a land cover map was generated using the Support Vector Machine (SVM) algorithm.

To highlight the impact of quarrying, the study utilized high-resolution imagery from Google Earth Pro to assess the environmental damage caused by quarries and to monitor the impact of deforestation in three forests within the study area.

The results showed a general decline in NDVI values and a notable increase in Surface Albedo, indicating that land degradation intensifies as rainfall decreases. The study also found that most quarries are located on arable lands, rainfed agricultural lands, and open rangelands, posing a threat to their sustainability. Furthermore, the results highlighted that deforestation poses a significant environmental risk to the three monitored forests in the study area.

8. **Neamat Karimi and others Study (2025)**: *"An advanced high-resolution land use/land cover dataset for Iran (ILULC-2022) by focusing on agricultural areas based on remote sensing data"*

The study introduces ILULC-2022, the first high-resolution Land Use/Land Cover (LULC) dataset for Iran, focusing heavily on agricultural areas. Using a two-level Object-Based Image Analysis–Decision Tree (OBIA-DT) model, the research integrates high-resolution

Google Earth images for segmentation and multi-temporal Sentinel-2 imagery for classification.

> **Level 1**: Produces a general agricultural land map without distinguishing irrigation type.
>
> **Level 2**: Differentiates croplands into irrigated and rainfed, with five irrigated subtypes.

Field data (~52,000 points) were used to train and validate the model, achieving 85–97% accuracy across varying climates.

Findings estimate Iran's agricultural land at 20.9 ± 2.1 million ha (13% of total area), split almost evenly between irrigated and rainfed lands, with most in moderate-to-humid basins. ILULC-2022 aims to serve as a benchmark dataset for monitoring land cover changes and guiding sustainable development, water management, and agricultural planning in Iran.

2.3 Previous Studies Review

Upon reviewing the previous studies, it is evident that most of the research related to tracking and studying land cover changes, especially regarding agricultural cover, primarily focuses on demonstrating the variation and changes in the areas and percentages of agricultural lands and land use. These studies often highlight the decline of agricultural cover due to the unregulated urban expansion and other changes, while providing general suggestions for the organization and management of these lands. It is worthy to indicate that, most of these studies utilize high resolution satellite images and remote sensing in analyzing and mapping land cover.

Due to lack and high price of detailed high-resolution satellite images, and in most cases, it is unavailable, so, remote sensing with available low-resolution satellite images, will not reflect a detailed land cover for the study area, therefore, this research will utilize on-screen digitizing using available high resolution aerial photos to map the land cover of the study area.

This study, however, will focus on how to **utilize the knowledge of the areas and percentages of various land covers** in a way that benefits decision-makers and managers involved in the agricultural lands' development in the Palestinian agricultural directorates. As well as, it will support Palestinian civil institutions working in the field of land development and reclamation programs in drawing up future development plans, outlining development prospects, and determining priorities. This will be done by leveraging the study's results to shape and implement their development programs and projects.

Additionally, funding agencies will benefit from the study's results in defining their funding programs and prioritizing financial allocations, both in terms of the programs and the required funding amounts.

For researchers, this study will serve as an essential reference for building and executing deeper studies in areas not covered in this research and also offering a foundation for further exploration in related fields.

Chapter Three

Materials and Methods

3.1 Study Methodology (Methods and Tools)

The methodology outlines the approach followed by the researcher to answer the study's questions, achieve its objectives, and derive the expected results in the quickest and most effective way. Below is a description of the methodologies and tools used in the preparation of the study:

3.1.1 Descriptive Method:

This method was used to **describe the study area and its characteristics**, as well as to describe the different classifications of land cover, particularly the **agricultural cover**. The method also includes an explanation of the factors affecting the increase or decline in land cover, such as population growth and the impact of Israeli measures on limiting and developing agricultural land cover.

Additionally, the descriptive method involved providing descriptions of other **information layers**, including:

- **Geopolitical layers**, such as the division of areas within the study area according to the Oslo accord, bypass roads, the annexation and expansion wall and Israeli settlements.

- **Topographic layers**, such as the slope and elevation maps of the study area, as well as the distribution of rainfall and temperature.

This comprehensive description helps in understanding the broader context in which land cover changes occur in the region.

3.1.2 Spatial Analytical Method:

This method was used to **observe, delineate, and classify the various land cover types** in the study area on a scale of (1:1,000) using on-screen digitizing for high land cover accuracy and data precision (Wang, 2015), relying on aerial imagery available on GeoMoLG, which can be accessed in ArcGIS Pro via server connection, eliminating the need to download the images onto a computer. These aerial images are characterized by their **high resolution (15 cm/pixel) for the year 2023**, and they cover the entire study area.

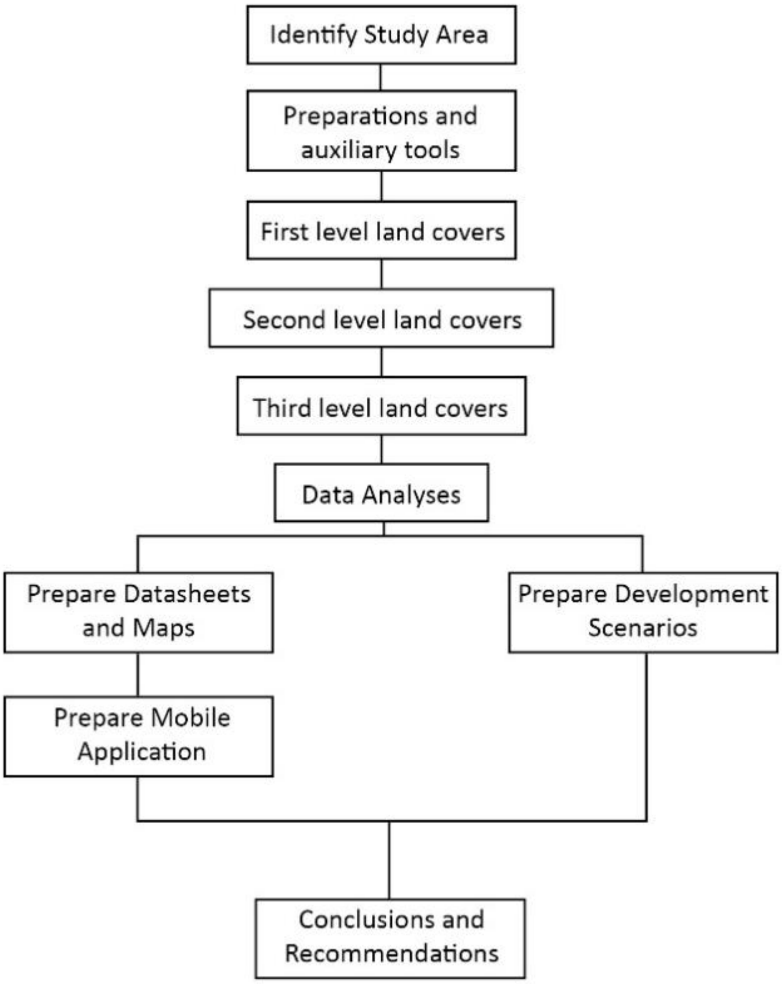

Figure 3.5: Approach of the study

The **ArcGIS Pro 3.5** program was used for **observing, analyzing, and on-screen delineating land cover types**, as well as for processing and analyzing the images in the following manner:

Figure 3.6: An aerial photo from the study area on scale (1:1,000)

Geo-Database Creation

A Geographical Database (Geo-Database) was created to store all the data that would be used in the preparation of the study. This includes data such as: Study boundaries, geopolitical layers (such as road networks, boundaries of Palestinian communities, Israeli settlements, and the separation wall) and other data that will be generated to achieve the study's objectives.

The Palestinian coordinate system (Palestine_1923_Palestine_Grid) was used for this geodatabase, ensuring that all geographic data stored in it can be converted into any other coordinate system as needed for further analysis or comparison.

Classification System

The CORINE system (Coordination of Information on the Environment) (Kosztra B., 2019) was utilized for land cover classification, which classify the land into 44 different categories. A modification and adaptation of the system was made to suit the Palestinian context, especially for land cover types that are not defined in the original system. Examples include: Israeli settlements, Israeli military bases, bypass roads, and the wall.

The **CORINE system** classifies land cover into three main levels:

1. **Level 1** classifies land cover into five major categories:
   - Artificial surfaces
   - Agricultural areas
   - Forests
   - Semi-natural areas
   - Wetlands and water bodies

2. **Level 2** provides sub-categorization for each of the major land cover types, offering more detailed classifications.

3. **Level 3** provides further refinement, breaking down each sub-category into even more specific land cover types.

This hierarchical structure allows for comprehensive and detailed mapping of land cover, which is crucial for accurate analysis and decision-making in land management.

Digitization, Classification and Verification

The **digitization and classification** of land cover were carried out through visual (on-screen) interpretation of the entire study area using the tools available in **ArcGIS Pro 3.5**. To ensure the accuracy of the digitization and classification, **field verification** was applied. The process involved converting the main classification file (polygons) of the agricultural areas into a point file (points), agricultural areas land cover polygons were considered as the study population which equal to 7,967 polygons (García-Álvarez, 2022).

The sample size was calculated using Yamane's formula (Chaokromthong, 2021; Yamane, 1967): $n = N / (1 + N * e^2)$. Where (n) is the sample size, (N) is the population size (which equal to 7,967 points), and (e) is the margin of error (set at 0.05). Plugging in these values, the resulting sample size (n) is 381. So, the total number of points were numbered, and a random selection of 381 samples were taken using (Me-Excel) program to be verified in the field.

Each sample point was verified in the field through printed maps provided to LRC field workers and officers, and the necessary adjustments were made based on the results of the field verification. This approach ensured the accuracy and reliability of the classification and digitization process, thus improving the quality and accuracy of the study's findings.

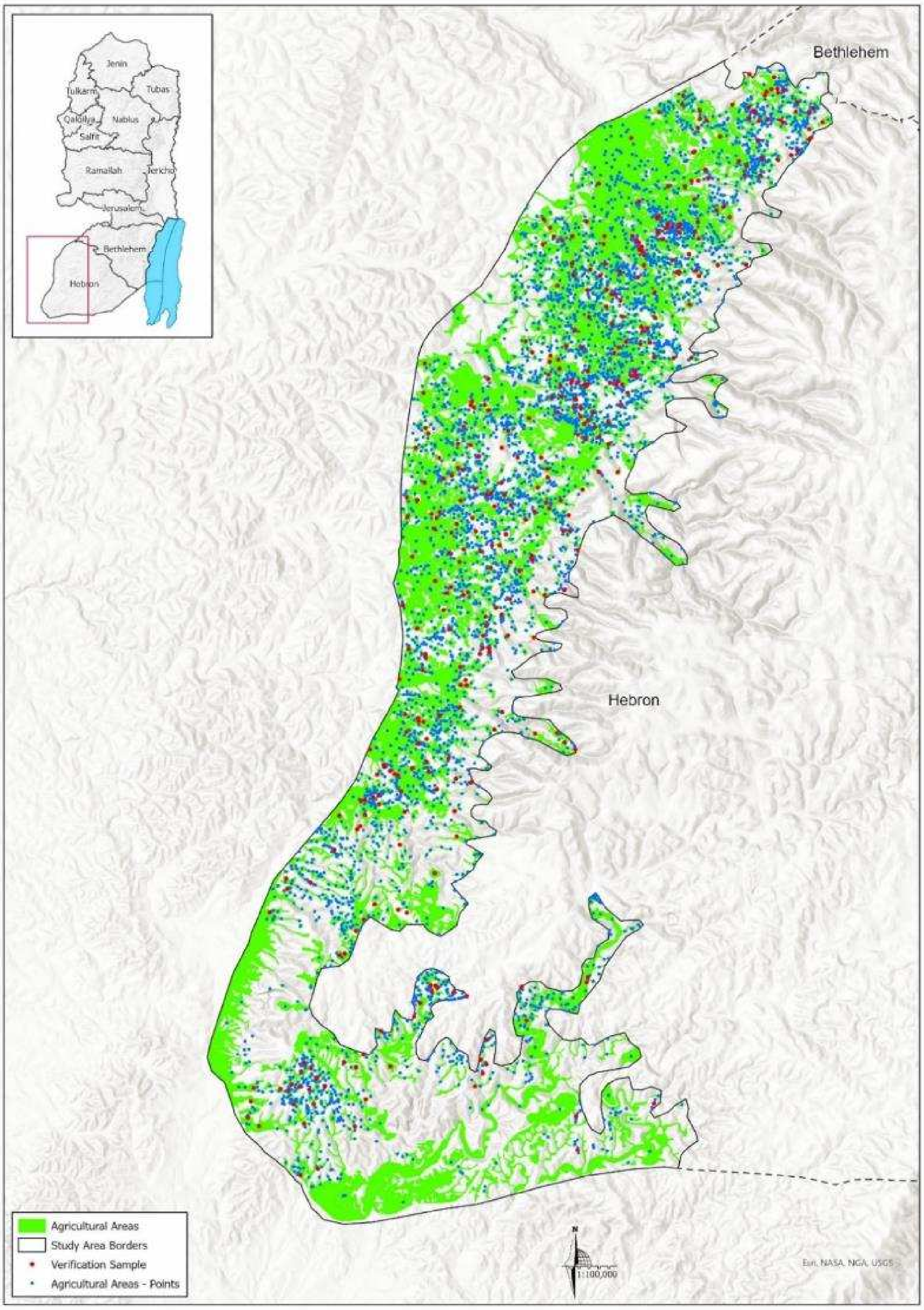

Figure 3.7: Field Verification samples location

Data Analyses

The tools available in **ArcGIS Pro 3.5** were used to **calculate the areas** of different land cover classifications and convert them into dunums. The areas for each main classification were also calculated based on the primary levels. Additionally, summary reports and percentages were generated using these tools.

From another hand, the land cover layer was intersected with other geo-political layers, which include: communities' boundaries, Oslo accords geo-political classification (A, B, C), seam zone, 100 meters eastern the wall buffer zone, 100 meters on either side of the bypass roads buffer zone, 500 meters around the Israeli colonies buffer zone and 500 meters around the Israeli military bases buffer zone.

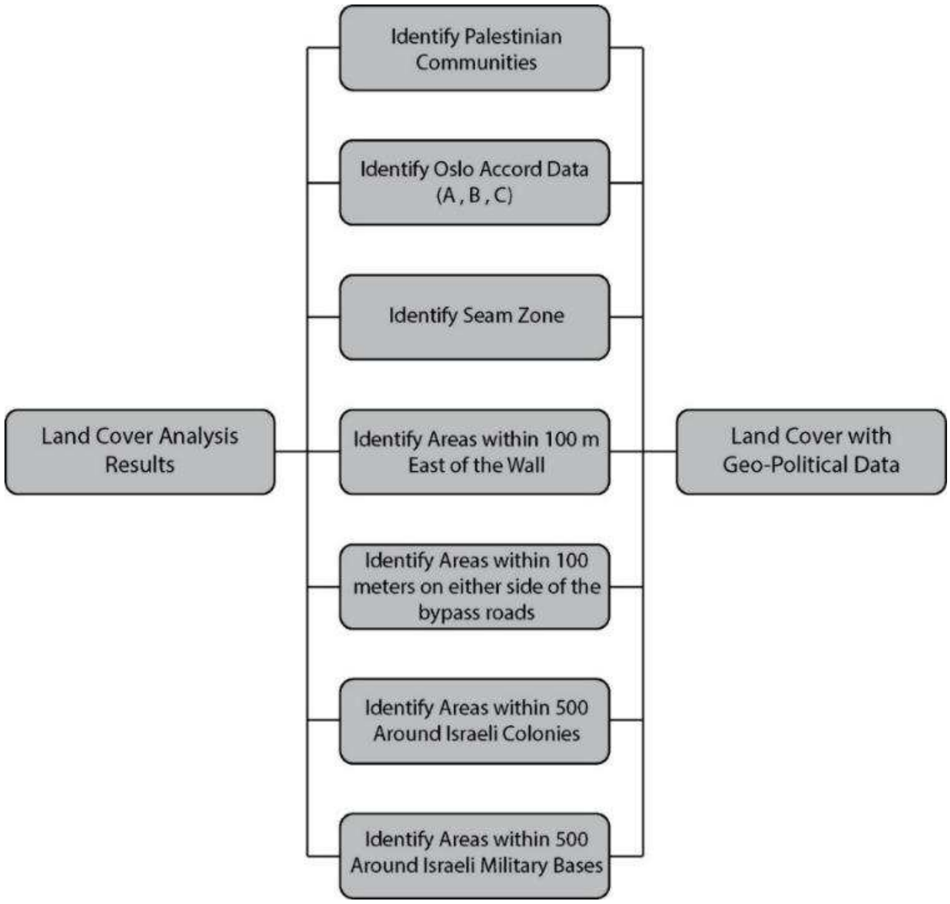

Figure 3.8: Land cover geo-political identification spatial analysis

To further analyze the results, the data was exported and analyzed using MS-Excel, allowing for a deeper analysis of the land cover distribution and its implications. This combination of GIS and spreadsheet tools provided a comprehensive approach for processing, analyzing, and reporting the study's findings.

3.1.3 Comparisons with Other Studies:

To enrich study results and findings, and to show the extent of variations and changes in land cover for the study area, comparisons were made with the finding of two studies: (ARIJ, 2010) land cover analyses for West Bank and Gaza strip, and PCBS agricultural census 2021. In 2010, ARIJ conducted a land cover analyses for West Bank and Gaza strip (unpublished study). The results of the land cover analysis for the study area have been obtained from ARIJ as GIS data. By utilizing (ArcGIS Pro 3.5) and (MS-Excel 2019), all totals for the second level of classification were made using (Pivotable) tool, and a comparison were done with study findings.

A further comparison was conducted using the 2021 agricultural census from PCBS. The raw data, which accessible on the PCBS website in (SPSS) format, was converted into a spreadsheet file. MS Excel 2019 was utilized to filter Hebron governorate data, and all Palestinian communities intersecting with the study area were selected in order to calculate the totals of the land tenures in the study area according to PCBS classifications. Data adaptation was done to fit it with study classification and to make the comparison with the study findings.

3.2 Developing a Mobile Application

One of the main outputs of the study is to develop a mobile application for both Android and iOS. The mobile application was named (Athro Deel) which is a Syriac word, The Syriac language has a special religious significance in Christianity, because Jesus Christ (a Palestinian Prophet) spoke Aramaic, which is considered the mother tongue of Syriac language (Al- Mawsili, 1876). Athro Deel in Syriac language means (Mawtini مَوّطِني) in Arabic or "my homeland" in English.

The application was developed by hiring a dedicated programmer, he utilizes (Flutter) for developing the application, (Flutter) is an open-source framework for building beautiful, natively compiled, multi-platform applications from a single codebase.

There are three versions of the mobile application:

1. **Free version**: In the free version of the application, which lasts for one month from the date of downloading the app and does not require creating an account in the application's database, users will be able to create all types of queries. However, the results will be limited to the first 100 data records. This is intended to familiarize users with the program, how to use it, and the format of the outputs the application provides, serving as an incentive to subscribe to the paid version.

   Users of the free version will not be able to export data, whether statistical tables, summaries, or charts—these will be for display purposes only. They will also not be able to update the application in the future to access new features and updates (such as the second release, which allows users to view query results as interactive maps).

2. **Personal version**: It is a full version of the application, allowing the user to make full use of the data and build queries freely without any restrictions. All result data will be displayed in the form of tables, charts, and summaries, and the user will be able to export the data as Excel tables and/or PDF files.

To subscribe to the application, the user must create an account in the application's database using an email address or mobile phone number, which will serve as the username for the application. When logging into the app for the first time from the user's device, activation will be required on that device only. This means that if the account is stolen by someone else, they will not be able to use it if it is already activated on the original owner's device. This measure is designed to prevent the account from being used on more than one device, increase security, and prevent identity theft.

The account will be offered at a nominal price not exceeding USD 24 per year for annual subscriptions or USD 3 per month for monthly subscriptions. Payment will be made electronically using local bank e-cards. The subscription will be renewed automatically before the end of the subscription period, and the user can cancel the subscription at any time. However, the subscription fee is non-refundable, and upon cancellation, the user will revert to the benefits of the free subscription.

3. **Corporate version**: It is a version that includes all the features of the paid personal version but is designed for ministries, institutions, and associations. It is initially installed by the system administrator (IT administrator) of the institution, who, through the application's interface, can activate multiple devices in the database, up to a maximum of 10 devices per institution, by generating a unique code for each device. This code is then used to activate the application when it is first run-on other devices.

   The subscription fee for this type of account will be USD 100 per year for an annual subscription or USD 15 per month for a monthly subscription. Payment will be made electronically using local bank e-cards. The subscription will be renewed automatically before the end of the subscription period, and the institution's system administrator (IT administrator) can cancel the subscription at any time. However, the subscription fee is non-refundable, and upon cancellation, all users will revert to the benefits of the free subscription.

Table 3.5: Advantages and limitations of the "Athro Deel" application versions

Feature	Free	Personal	Corporate
Paid subscription	✗	✓	✓
Available for a limited time	✓	✗	✗
The user can build queries freely and easily	✓	✓	✓
Query output is limited to the first 100 records	✓	✗	✗
Query results can be exported as tables, graphs, and summaries	✗	✓	✓
It is renewed periodically	✗	✓	✓
A master account is required to activate the on users' devices.	✗	✗	✓
It can be updated with newer versions	✗	✓	✓
For ministries, institutions and associations	✗	✗	✓

Chapter Four

Results and Discussion

4.1 First Level Results

In this stage of classification, the study area classified to four main classes: Agricultural Areas, Artificial Surfaces, Forests and Semi-natural Areas and Water Bodies. The analyses of the study area land cover showed that about 41% of the total area is agricultural areas, artificial surfaces and forests and semi-natural areas represent about 16% and 43% of the study area respectively. This confirms that most of the study area is utilized and/or can be utilized for agricultural purposes. The below figure shows the areas distribution according to land cover analysis – level I.

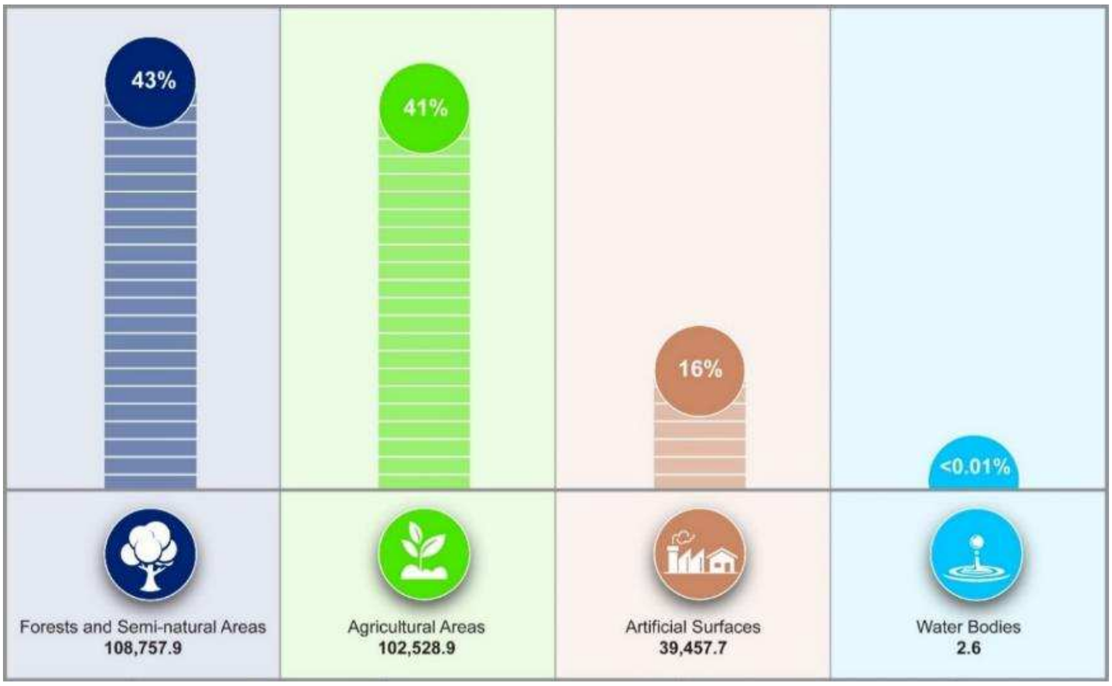

Figure 4.9: Land Cover - Level I (Areas & Percentages)

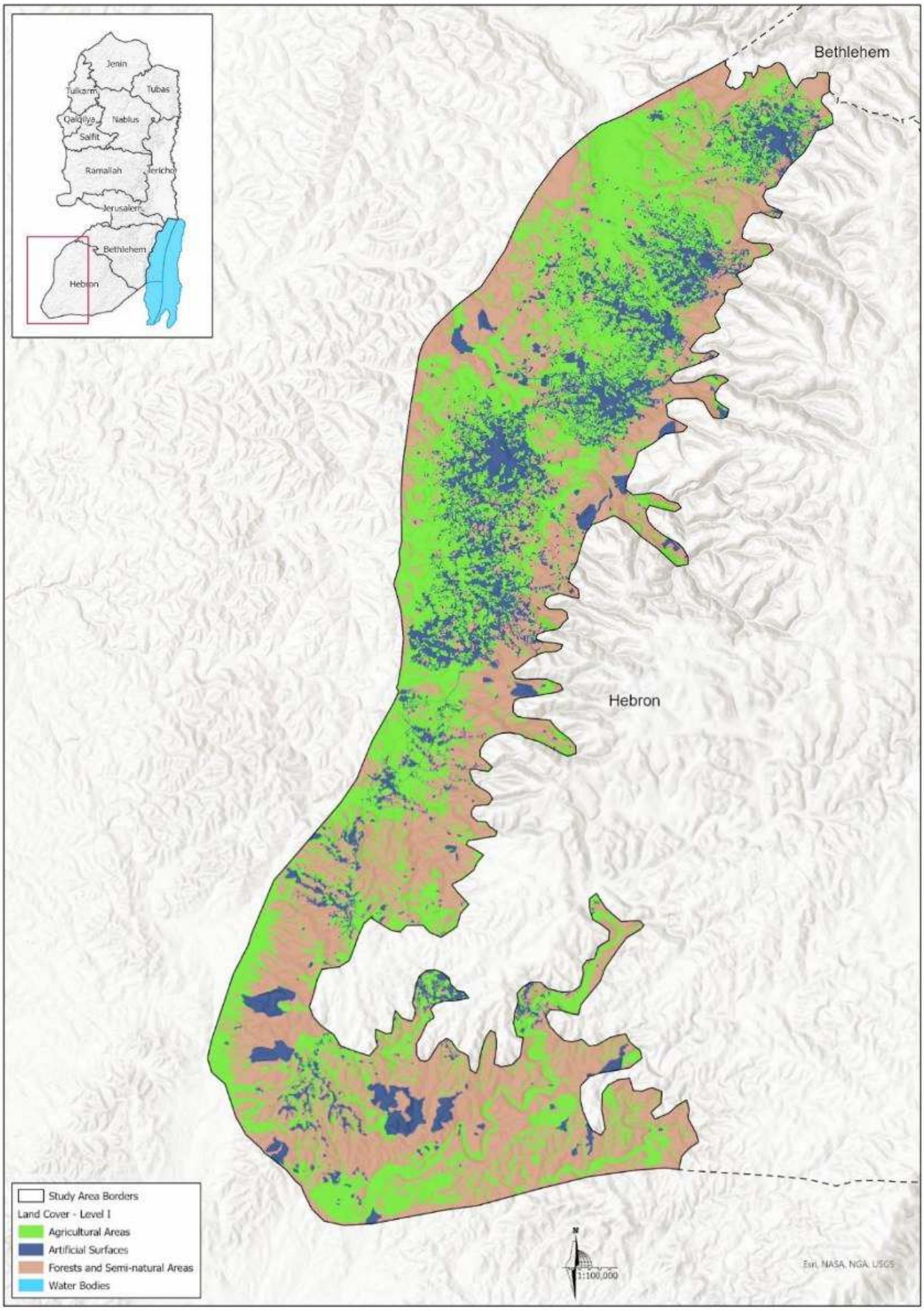

Figure 4.10: Study Land Cover Map - Level I

4.2 Second Level Results

In this stage of classification, each one of the four main classes (level I classification) were divided to its main sub-classes, for example: Agricultural areas were divided to: permanent crops, arable land and heterogeneous agricultural areas. The following figure, illustrate the second level of land cover classification for the study area:

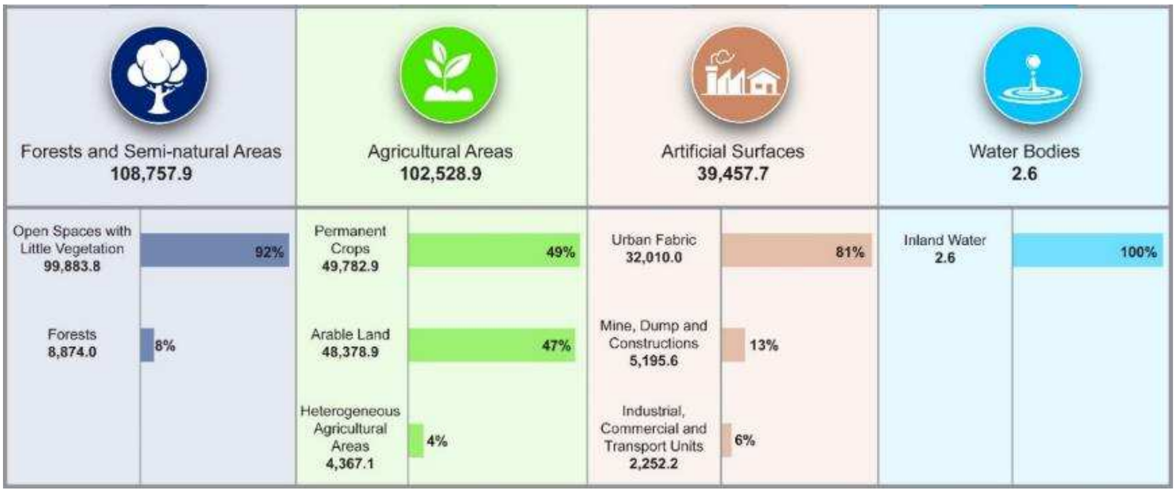

Figure 4.11: Land Cover - Level II (Areas & Percentages)

The above table and figure illustrate that, most of the agricultural areas (49%) are permanently utilized and are not subject to a crop rotation system (e.g., olive groves and vineyards), the dominant landform of these areas are slopes, hills and hill-crests. Arable land which subjected to crop rotation systems and used for annual crops that are harvested every year such as: rainfed field crops (cereals, legumes and rainfed vegetables) represent about (47%) of the agricultural areas, most of these areas are plains and valleys. The rest of the agricultural areas, which represent about (4%) were utilized heterogeneous agriculture (Areas where annual crops are mixed with permanent crops on the same piece of land), this is familiar in Palestinian cultural and due to land fragmentation, so, Palestinian farmers tend to plants many varieties on the same plot of land.

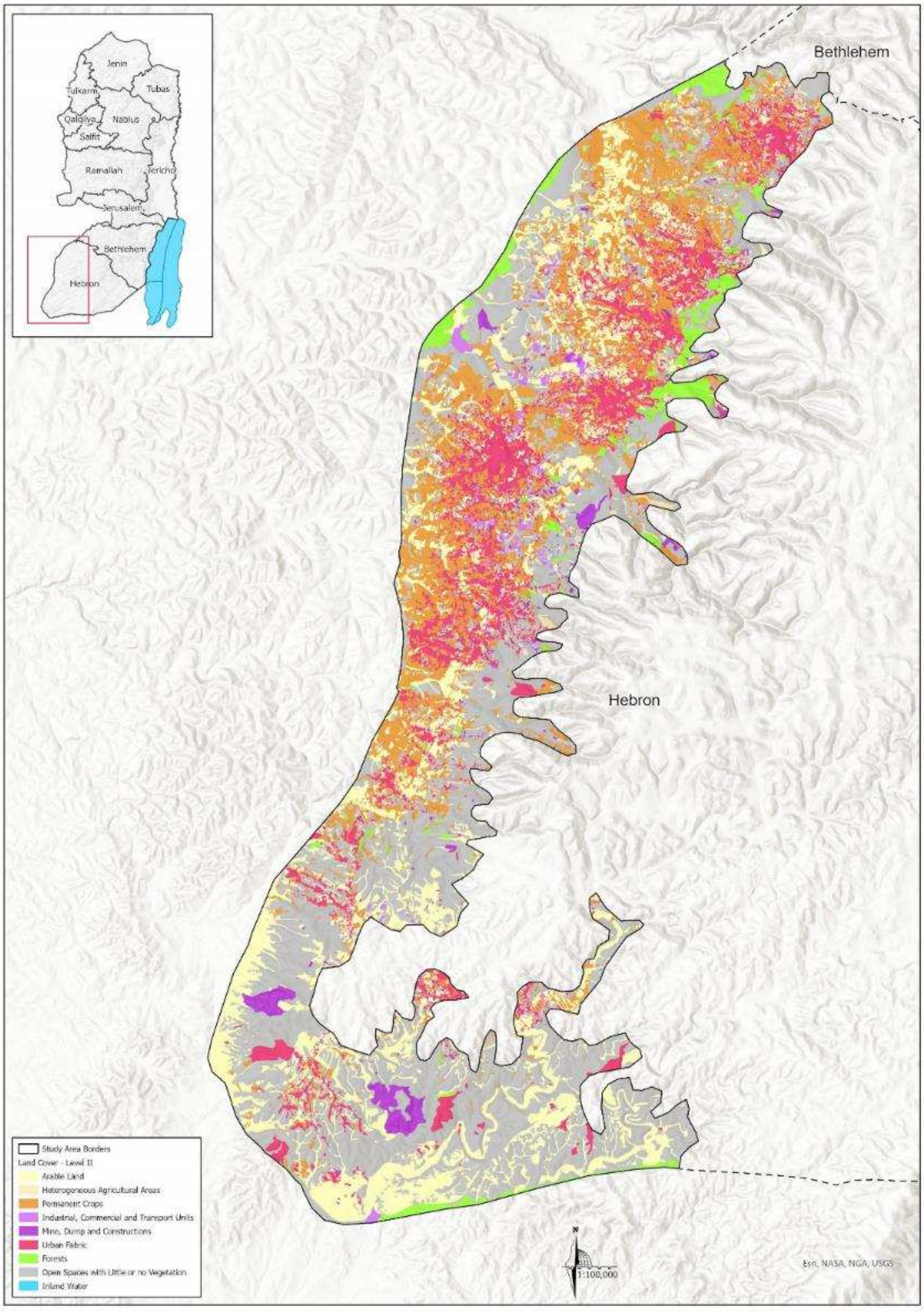

Figure 4.12: Study Land Cover Map - Level II

4.3 Third Level Results

This is the final stage of classifications, each level II class were divided to its sub-classes, for example: Arable lands were divided to: non-irrigated arable land, permanent irrigated land and green houses. The areas and percentages for each final class shown in the following table.

Table 4.6: Study area land cover - Level III

Land Cover	Area - Dunums	%
Agricultural Areas	**102,528.9**	**40.9%**
Arable Land	**48,378.9**	**47.2%**
Non-irrigated Arable Land	47,575.5	98.3%
Permanently Irrigated Land	445.3	0.9%
Green Houses	358.0	0.7%
Heterogeneous Agricultural Areas	**4,367.1**	**4.3%**
Complex Cultivation Patterns	4,367.1	100.0%
Permanent Crops	**49,782.9**	**48.6%**
Olive Groves	49,647.5	99.7%
Vineyards	135.5	0.3%
Artificial Surfaces	**39,401.1**	**15.7%**
Industrial, Commercial and Transport Units	**2,252.2**	**5.7%**
Industrial or Commercial Units	1,807.4	80.3%
Port Areas	444.8	19.7%
Mine, Dump and Constructions	**5,138.9**	**13.0%**
Construction Sites	3,587.9	69.8%
Dump Sites	95.9	1.9%
Mineral Extraction Site	1,455.2	28.3%
Urban Fabric	**32,010.0**	**81.2%**
Continuous Urban Fabric	29,130.9	91.0%
Discontinuous Urban Fabric	289.2	0.9%
Israeli Colonies	2,589.9	8.1%
Forests and Semi-natural Areas	**108,814.5**	**43.4%**
Forests	**8,874.0**	**8.2%**
Coniferous Forest	8,874.0	100.0%
Open Spaces with Little or no Vegetation	**99,940.5**	**91.8%**
Sparsely Vegetated Area	99,940.5	100.0%
Water Bodies	**2.6**	**< 0.01%**
Inland Water	**2.6**	**100.0%**
Water Bodies - Agricultural Pool	2.6	100.0%
Total Area	**250,747.1**	**100.0%**

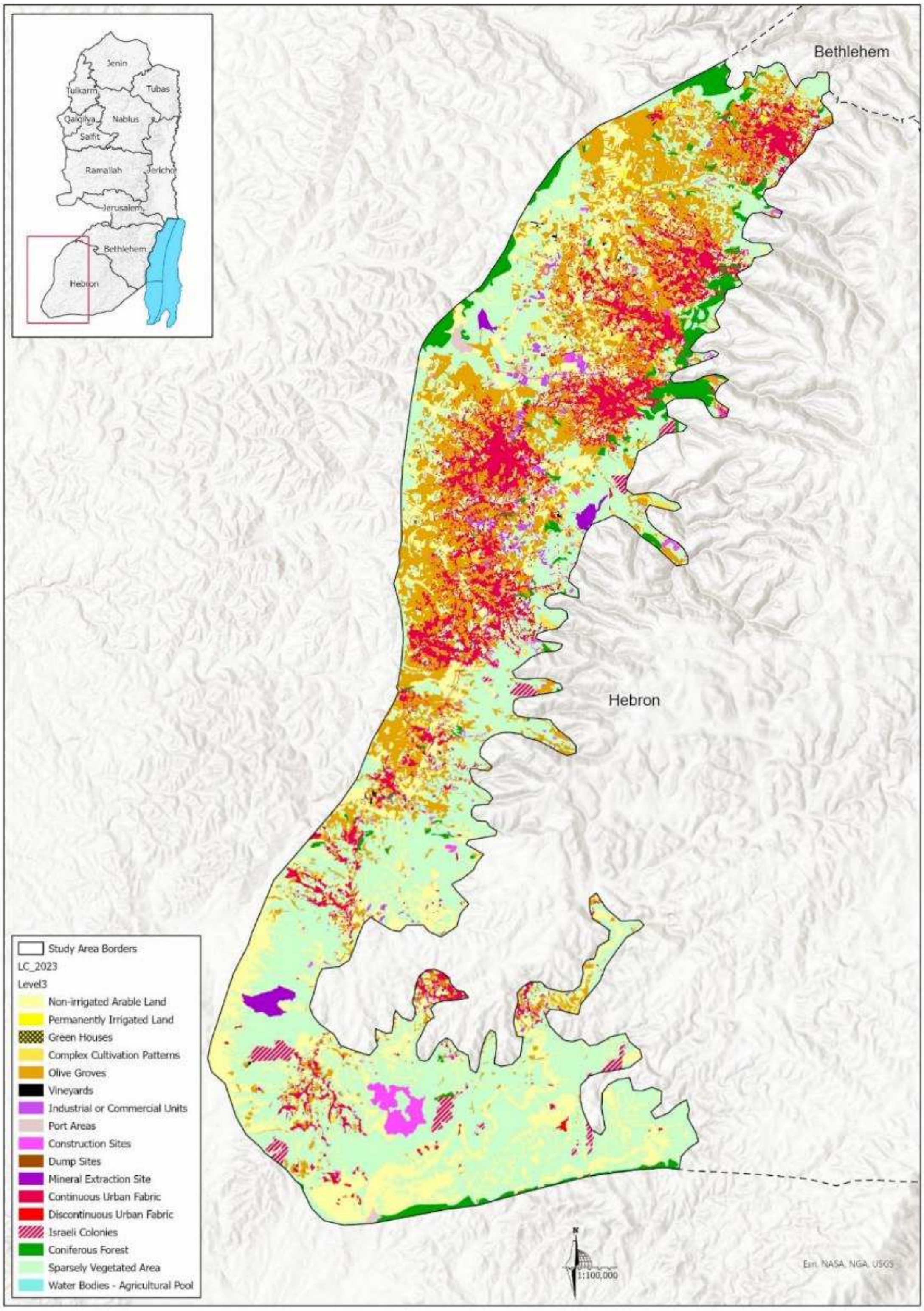

Figure 4.13: Study Land Cover Map - Level III

4.4 Agricultural Areas Classes and Sub-Classes

Within next pages, the researcher will try to review and discuss the land cover analysis related to each of the third level classes, with more focusing on the agricultural aspects - the study main subject.

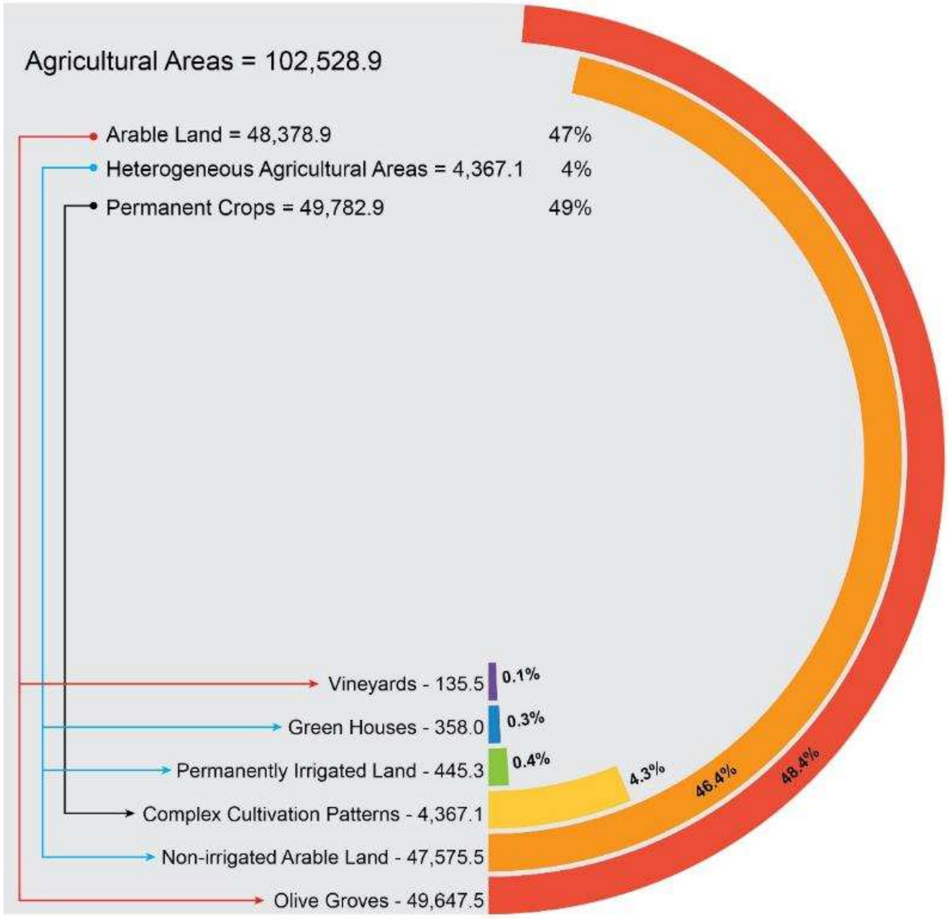

Figure 4.14: Agricultural areas classes and sub-classes in the study area

4.4.1 Arable Lands Sub-Classes:

Table 4.7: The arable lands in the study area

Land Cover - Arable Land	Area - Dunums	%
Non-irrigated Arable Land	47,575.5	98.3%
Permanently Irrigated Land	445.3	0.9%
Green Houses	358.0	0.7%
Total Area	**48,378.9**	**100%**

The results of the study shows that most of the arable lands (98.3%) are utilized as non-irrigated lands, these lands are utilized in rainfed agriculture (cereals, legumes and rainfed vegetables), the dominant of these areas are plain and valleys.

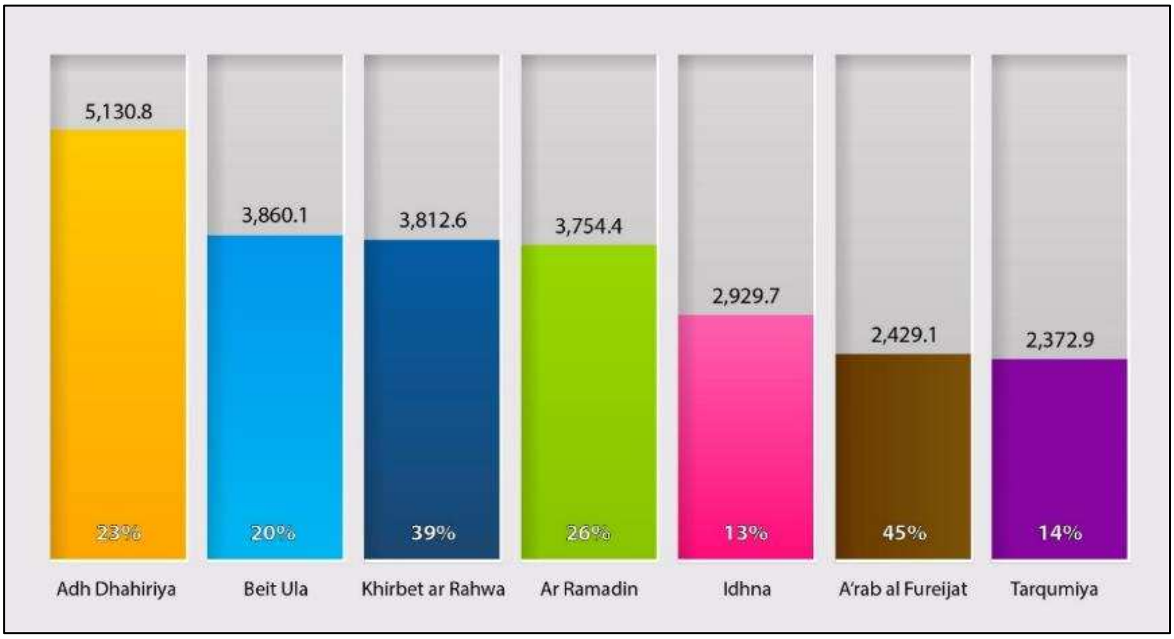

Figure 4.15: Communities with more than (2,000 dunums) of non-irrigated arable land

* Percentage represents the area of non-irrigated arable land to community area in the study area

The above chart shows that Palestinian communities with large areas of plans and valleys are utilized in rainfed agriculture. The top area come in Adh Dhahiriya with a total of 5,130 dunums, were A'rab al Fureijat (45%) of its area utilized in non-irrigated arable land due to dominant landform "plains".

Due to shortage of allocated water for agriculture and the scarcity of permanent water resources, the irrigated lands are very few in the study area, these areas limited to about 800 dunums, which represent not more than (1.7%) of the arable lands – (0. 8%) of the agricultural areas.

Permanent Crops Sub-Classes:

Table 4.8: Permanent crops in the study area

Land Cover - Permanent Crops	Area - Dunums	%
Olive Groves	49,647.5	99.7%
Vineyards	135.5	0.3%
Total Area	**49,782.9**	**100%**

Olive groves were representing most of the permanent crop in the study area (99.7%), and it is also representing the dominant vegetation cover (48% of the agricultural areas and 20% of the study area), this result is consistent with the results of (Bayan Al-Qawasmi's, 2020) study, so, due to low and fluctuation in rainfall rates, the high aridity index in the study area, as well as the dominant slopes are moderate in the study area (hills), this will increase the soil ability to absorb water, which make it more appropriate for such cultivations "Olive groves" instead of vineyards, which need high percentage of rainfall as well as more chilling hours are required, so the vineyards represent not more than (0.3%) of the permanent crops in the study area. From another land, the symbolism of the olive as well as olive oil for Palestinian people and also it does not require much care and agricultural practices, making olive groves one of the most widespread crops in the study area (Shadeed, 2022).

Regarding the geographical distribution of olive groves, the study results show that, most of the olive groves are located in: Surif, Idhna, Beit Ula, Tarqumiya, Beit A'wwa, Deir Samit and Kharas. Surif comes at the top with a total of 8,170 dunums, which represent around (37%) of the town total area within study area. From another hand, (39%) of Beit A'wwa town area located within the study area, are planted with olive. The table below show the top communities within the study area which planted with olive groves.

Figure 4.16 : A photo of Olive Groves and plains to the west of Nuba village

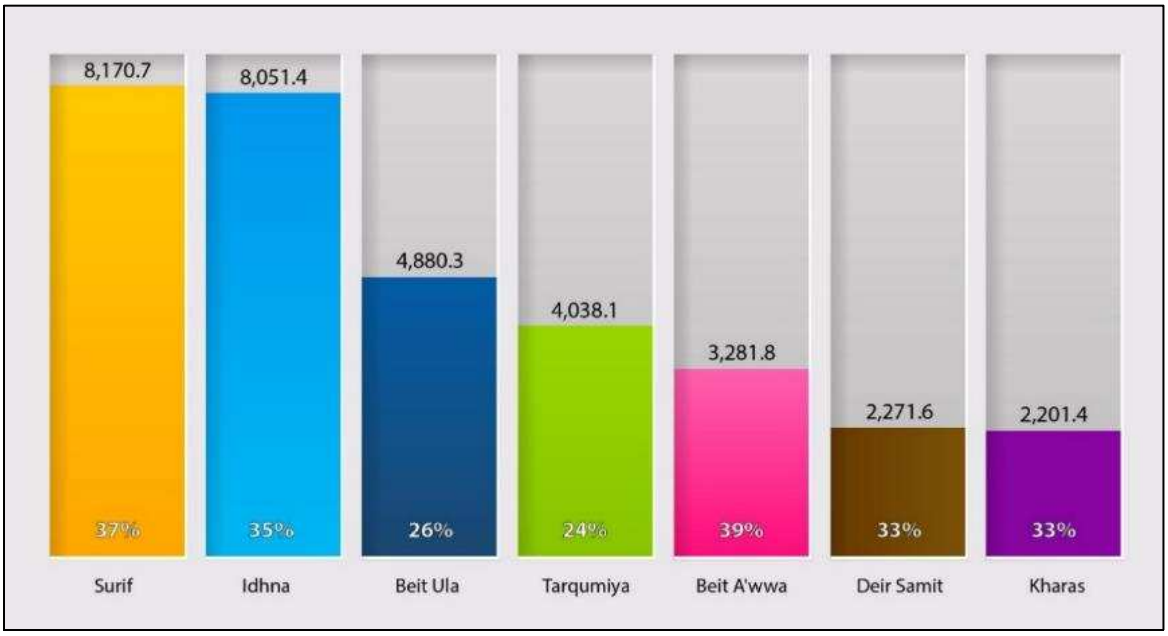

Figure 4.17: Communities with more than (2,000 dunums) of olive groves

* Percentage represents the area of olive groves to community area in the study area

4.4.2 Heterogeneous Agricultural Areas Sub-Classes:

Complex cultivation patterns are the dominant vegetation cover in the heterogeneous agricultural areas; so, due to land fragmentation, which none as the division of agricultural land into smaller, scattered plots often resulting from inheritance, increasing urbanization, and other socio-economic factors (Ghadeer Al Nubani, 2017), agricultural lands became economically infeasible, so farmers forced to cultivate it intensively with multiple varieties. Complex cultivation patterns represent about (4.3%) of the agricultural areas in the study area and it is worthy to indicate that, most of these areas are closed or inside urban fabrics "*built-up areas*". Study results shows that, most (43%) of heterogenous agricultural areas are located in Surif, Idhna and Beit Ula with a total of 766.5, 566 and 560 dunums respectively.

Figure 4.18: A photo of heterogeneous agricultural in the study area

4.5 Artificial Surfaces – Classes and Sub-Classes

Urban fabric founded as the dominant sub-class of the artificial surfaces in the study area, were more than (81%) of the artificial surfaces classified as urban fabric (around 13% of the study area), these areas classified to three subclasses: Palestinian continuous fabric "dominant subclass" (Palestinian communities' built-up areas), Palestinian discontinuous fabric and Israeli colonies.

The study results show that, around (29,420 dunums) classified as Palestinian urban fabric, (7,536 dunums) which represent around (25.6%) of the urban fabric are outside of the Palestinian communities' master plan and most of it are inside the agricultural lands, see map 7. In general, this occurred due to land fragmentation, mismanagement of agricultural lands as well as the lack of master plans expansion plans, this fact is consistent with many previous studies like: (Abidin's, Sahar (2018); Al-Qawasmi's, Bayan (2020) and (Mseden, Nadia (2021)), which indicated that urban expansion is often at the expense of agricultural land, without prior planning and outside the master plans.

Figure 4.19: A photo of urban expansion on agricultural areas

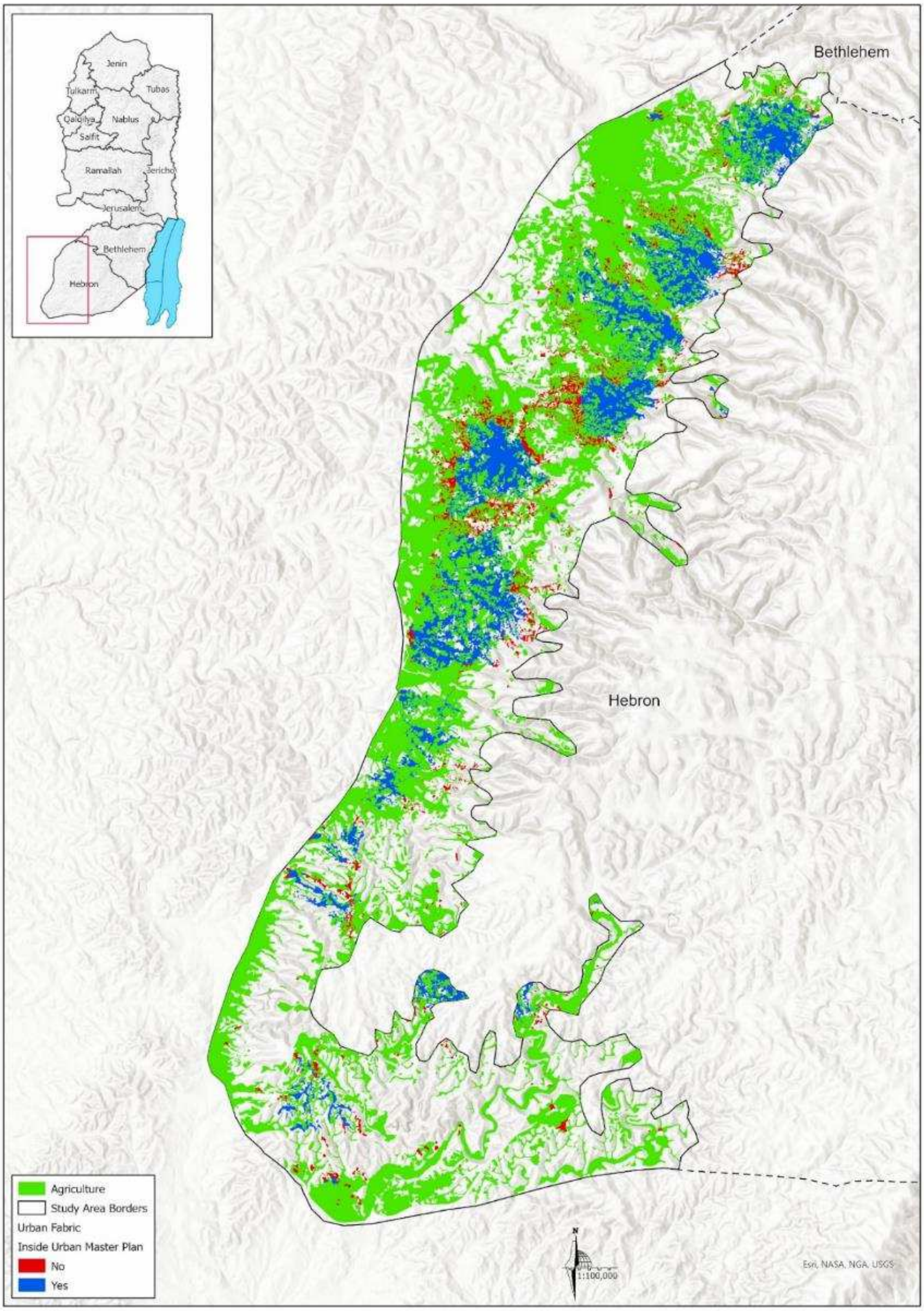

Figure 4.20: Urban fabric expansion inside agricultural lands

4.5.1 Industrial or Commercial Units in the study area:

The study results show that, around (1,807 dunums) are classified as industrial or commercial units, unfortunately, around (66.6%) of it are inside agricultural areas, which means that it is outside communities master plans. Moreover, most of the industrial or commercial units which located inside communities' master plan, are located in areas which are not classified as industrial areas, this result can be seen clearly in the northern entrance of Idhna town as well as in the plain area of Tarqumiya town which is adjacent to the road leading to Tarqumiya crossing point, this plain area is distinctive by its fertility and has been, over the years, considered the town's rain-fed vegetable basket. The map below illustrates this result clearly.

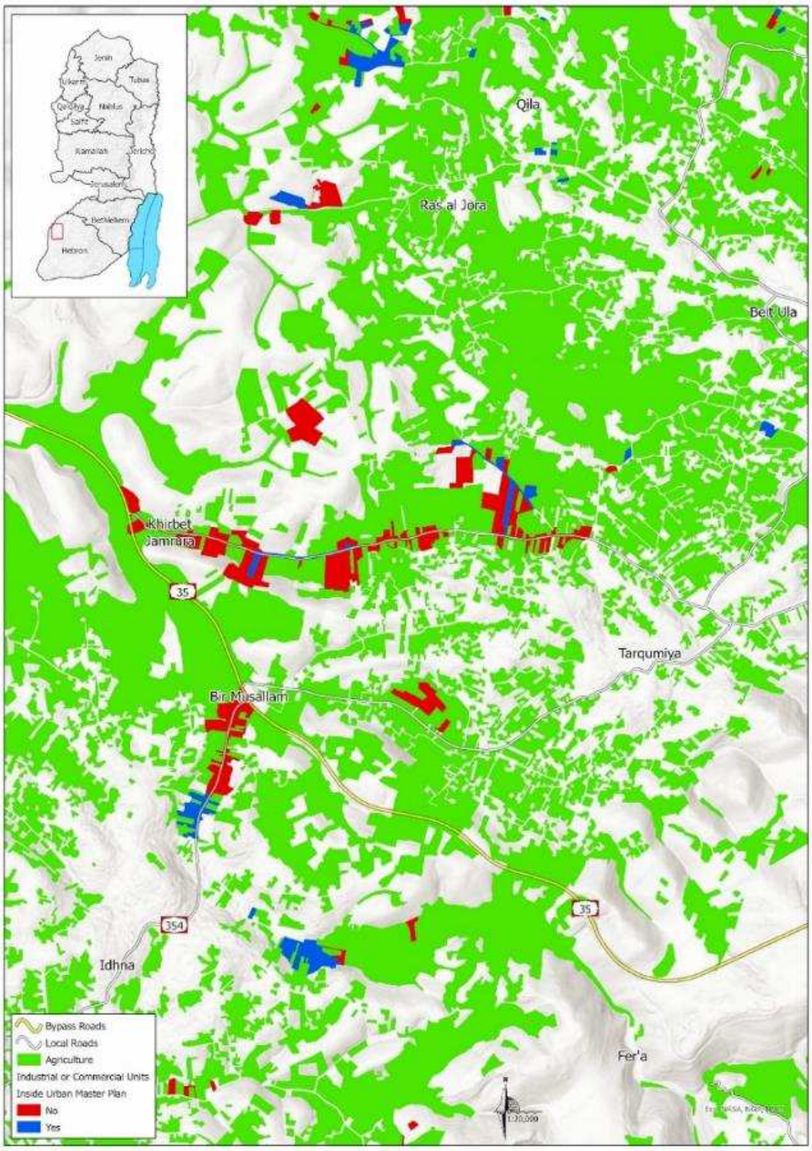

Figure 4.21: Industrial units inside agricultural lands (Idhna and Tarqumiya case)

4.6 Forests and Semi-natural Areas in the study area

A study showed that the majority of forested and semi-natural areas are classified as sparsely vegetated areas (open spaces), with an estimated area of approximately (99,940 dunums), equivalent to (92%) of the total open spaces and around (40%) of the study area. These areas are generally characterized by little or no vegetation cover (wild species), an abundance of surface rock out-crop and shallow soil depth.

The area of coniferous forests in the study area amounted to about (8,874 dunums), or about (8%) of the area of forests and semi-natural areas. These are coniferous forests that were planted during the Jordanian era, as was the case in Wadi Al-Qaf forest, as well as those planted by the Israeli occupation authorities in the areas adjacent to the Green Line west of the towns of Tarqumiya, Beit Ula, Nuba, Kharas, and Surif.

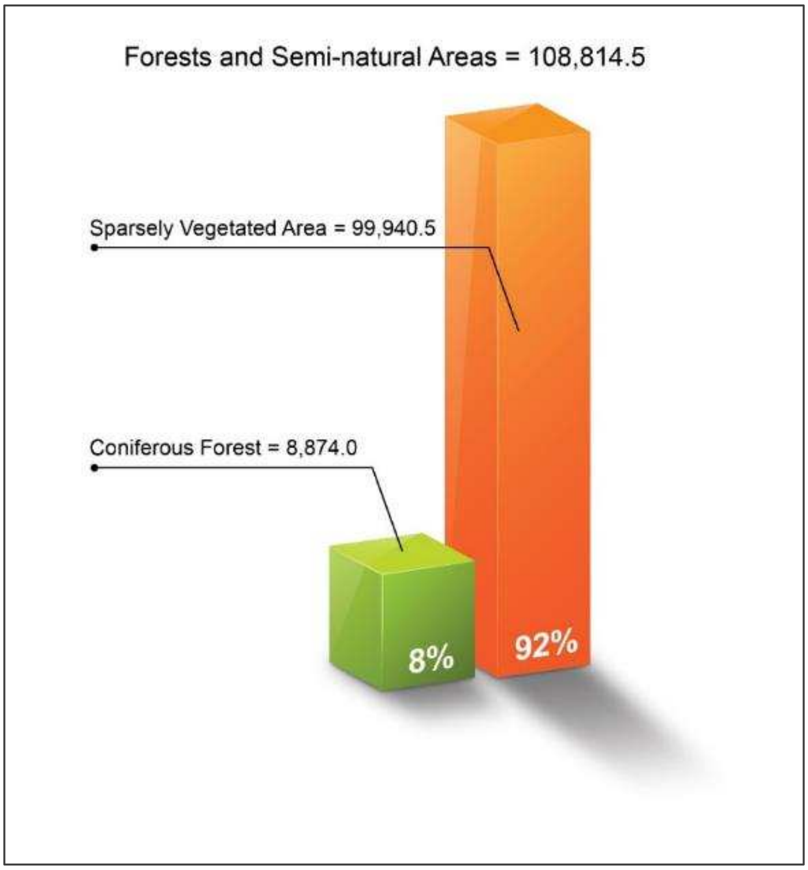

Figure 4.22: Forests and Semi-natural areas in the study area

4.7 Land Cover Comparisons

The researcher conducted the following comparisons to enhance the study and contrast the findings with earlier assessments of the land cover in the studied area, these comparisons were made with (ARIJ – 2010) land cover and with agricultural Census (2021).

4.7.1 Study Results vs. ARIJ (2010) Land Cover:

After investigating (ARIJ, 2010) land cover and summarize the results of the land cover for level II subclasses, a comparison was made with main findings of the study for the same level. The following table illustrate the comparison results:

Table 4.9: (ARIJ) Land Cover (2010) vs. Study Land Cover (2023)

Land Cover - Class II	(ARIJ) Land Cover (2010) - Dunums	Study Land Cover (2023) - Dunums	Variance	Variance %
Arable land	57,993.70	48,378.90	-9,614.80	-17%
Open spaces with little or no vegetation	105,446.90	99,940.50	-5,506.40	-5%
Permanent crops	54,913.10	49,782.90	-5,130.20	-9%
Heterogeneous agricultural areas	4,618.70	4,367.10	-251.6	-5%
Inland water	1.3	2.6	1.3	100%
Industrial, commercial and transport unit	603	2,252.20	1,649.20	274%
Forests	6,308.20	8,874.00	2,565.80	41%
Mine, dump and construction sites	1,654.80	5,138.90	3,484.10	211%
Urban fabric	19,207.50	32,010.00	12,802.50	67%
Total Area	**250,747.1**	**250,747.1**		

As table (8) illustrates, there are noticeable variances in the areas of land cover generally and agricultural cover specifically, and it is clear that there is a notable reduction in agricultural areas, especially in arable land, permanent crops as well as in heterogeneous agricultural areas, and also a reduction in open spaces and areas with little or no vegetation. In contrast, it is clear that a steady increase in artificial surfaces, especially in industrial, commercial and transport unit, mine, dump and construction sites, as well as in urban fabrics.

These combined facts, and the conclusions of previous studies (Abidin's, Sahar (2018), Al-Douda's, Mishal (2018) and (Al-Qawasmi's, Bayan (2020)), confirm that urban and industrial expansion occurs primarily at the expense of agricultural land, and secondarily at the expense of open spaces, which is often the result of outdated urban master plans as well as weak agricultural land development and planning strategies stemming from inadequate information on land cover and classification, and this, confirm the study problem statement. In summary, the area of (arable land, open spaces with little or no vegetation, permanent crops, and heterogeneous agricultural areas) decreased by a total of (20,503 dunums) while the area of (urban fabric, mine, dump and construction sites, forests, industrial, commercial and transport unit, and inland water) increased by the same total amount. The figure below, illustrate the comparison between (ARIJ - 2010) land cover subclasses areas (Level II) and study land cover subclasses for the same level.

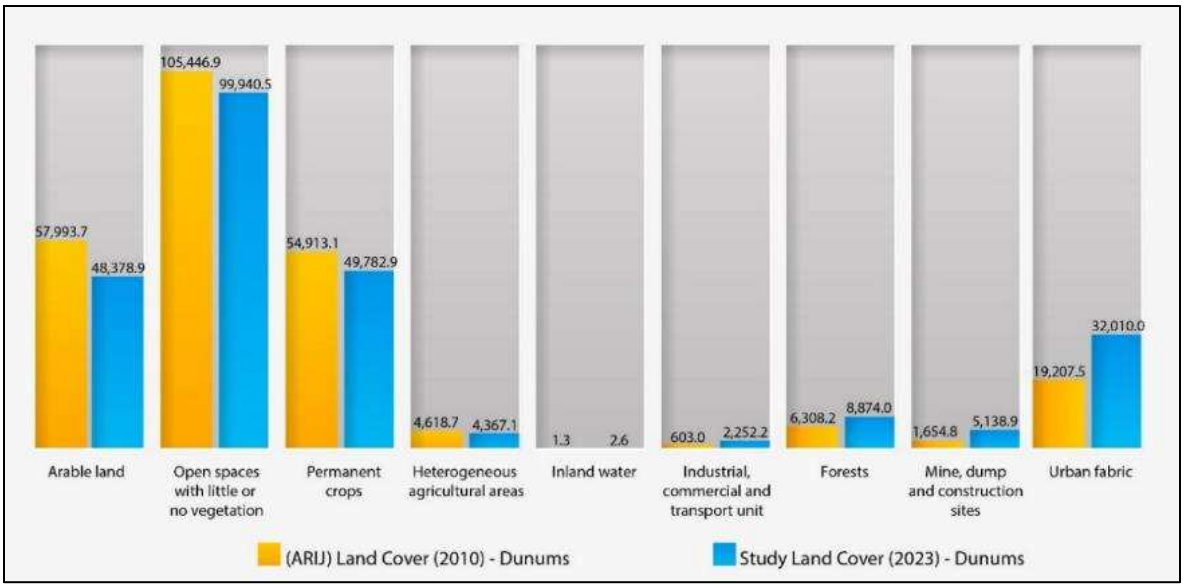

Figure 4.23: (ARIJ) Land Cover (2010) vs. Study Land Cover (2023)

4.7.2 Study Results vs. Agricultural Census (2021):

The following comparison table illustrate the findings of the main classes of the agricultural lands in the study area with the totals of the land tenure calculated from agricultural census (2021) for the Palestinian communities located in the study area:

Table 4.10: PCBS Agricultural Census (2021) vs. Study Land Cover (2023)

Land Cover Class	Agricultural Census (2021) Area – Dunums	Study Results (2023) Area – Dunums	Variance	Variance %
Arable Land	29,196.4	48,378.9	19,182.50	66%
Permanent Crops	47,969.4	54,150.0	6,180.60	13%
Forests	383.6	8,874.0	8,490.40	2,213%
Greenhouses	604.0	358.0	-246.00	-41%

As shown in the above table, there are a hug variation in most of the agricultural land cover subclasses, there are many reasons for these variations, which can be summarized in the following points:

1. The areas of the farmers' lands as pear in the agricultural census are calculated based on land tenure of the farmers, which based on data collected via questionnaires, so, the credibility of the provided data is depending on the farmers' truthfulness.

2. The agricultural census mentioned that, areas that have not been cultivated or serviced (ploughed, pruned, sprayed, etc.) for 5 years or more are not counted as part of the cultivated land area.

3. The agricultural census mentioned that, the cultivated area may be larger than the total area planted with horticultural trees, vegetables, and field crops due to scattered plantings of permanent crops that have been intensified based on standard areas by type.

4. The cultivated area may be smaller than the whole area designated for orchard trees, vegetables, and field crops due to the successive planting of temporary crops in the same location across several seasons.

5. Concerning the forest areas, the agricultural census focuses on man-made forests planted by the farmers themselves, so, the forests which located in state or public lands, are not calculated in the forests' grand total.

6. It is clear that, the area of greenhouses has drastically diminished due to the lack of sustainable water sources, reduced and fluctuating rainfall, decreased water supply from Israel in recent years, and rising production input costs.

Based on the above points, and in order to achieve a comprehensive understanding of agricultural land, its distribution, and usage changes, it is essential to perform a periodic vegetation cover survey (Land cover analyses) instead of depending just on agricultural censuses; this is definitely, contingent upon the availability of historical data, available budgets, expansion of the study area, as well as the requisite level of precision.

4.8 Study Main Results

The researcher came to the following results after studying and examining the land cover in the study area:

4.8.1 Agricultural Areas:

1. The total area of the study area is (250,747 dunums), (41%) of which is agricultural areas.

2. Permanent crops are the most common cover in agricultural lands with a total of (49,782.9 dunums), (48,378.9 dunums) is arable land, and the rest of the agricultural areas is classified as heterogeneous agricultural areas with a total of (4,367 dunums).

3. Olive groves cover most of the permanent crops with a total of (49,647.5 dunums).

4. The vineyards do not cover large areas in the study area, as they do not exceed (135.5 dunums).

5. Most of the arable lands are classified as non-irrigated arable lands with a total of (47,575.5 dunums).

6. The total area of permanent irrigated land is about (803.3 dunums), where most of it is greenhouses which represent about 44.6% of the permanent irrigated lands.

7. Complex cultivation patterns (mixed agricultural practices), which is considered as heterogeneous agricultural areas, represent about (4.3%) of the agricultural lands with a total of (4,367 dunums).

4.8.2 Forests and Semi-natural Areas:

1. The total area of the forests and semi-natural areas was about (108,814.5 dunums) which equivalent to approximately (43.3%) of the study area.

2. Forests and semi-natural areas were the dominant land cover in the study with a total of (108,814.5 dunums) which represents about (43.4%) of the study area.

3. Sparsely vegetated areas (open spaces with little or no vegetation cover) is the common land cover in the forests and semi-natural areas with a total (99,940.5 dunums) which represent around (40%) of the study area.

4. Coniferous forest represents about (8.2%) of the forests and semi-natural areas with a total of (8,874 dunums).

Artificial Surfaces:

1. The total area of the artificial surfaces was about (39,401 dunums) which equivalent to approximately (15.7%) of the study area.

2. The urban fabric covered most of the artificial surface with a total of (32,010 dunums), equivalent to approximately (12.7%) of the study area.

3. Mine, dump and construction sites come in the second place of the dominant land cover of the artificial surfaces with a total of (5,138.9 dunums).

4. Industrial, commercial and transportation units occupy the third share of artificial surfaces, with a total area of (2,252 dunums), representing (5.7%) of the artificial surfaces area.

4.8.3 Water Bodies:

1. Water bodies (inland water) whose area does not exceed (2.6 dunums), knows as "man-made agricultural pools", which filled from harvested rainfall and/or from water network.

4.8.4 Mobile Application Outputs:

In the first release of the mobile application, all study results were inserted in the application database. Expected users will be able to build queries in the application according to the following levels:

1. **Land Cover Level**: the user can build a query for such land cover class, for example: agricultural lands, artificial surfaces, forests and semi-natural lands… etc. as well as for any farther sub-classes. The user also will have the possibility to build complex (advanced filtering) query of combinations using (and, or) in the query syntax.

2. **Community Level**: in this form of queries, the user can build a query about land covers at community level, for example: the total areas of all land covers in Beit Ula, or Surif. As well as make comparison of land cover totals between to maximum of five different communities.

3. **Geo-Political Level**: the user can build a query regarding any land cover within geo-political zones, like: agricultural lands behind the wall (seam zone), or closed to Israeli colonies, bypass roads or green line (armistice line), as well as the distribution of different land covers according to Oslo accord (area A, B and C). Combination will also be possible.

4. **Advanced Level**: here the user can build a query in complex syntax. Where he/she can build the query using all above levels in one time, so the query will be like: what is the total area of the olive groves in area C and behind the wall in Surif town in 2023.

In the second release of the application, which assumed to be ready by the first quarter of 2026, a website will be developed, so the users of the website and mobile application will be able not just to view the results of inquiries in form of tables, charts, and totals, but also will be able to view the results on maps, so the distribution and location of the land cover will be shown in the queried extent.

Figure 4.24: Mobile application query builder interface

Chapter Five

Conclusions and Recommendations

5.1 Conclusions

This study explored the land cover in the study area, aiming to provide a comprehensive understanding of agricultural lands, areas, distribution, and the impact of other land cover. Through detailed data analysis and evaluation, several key findings emerged that contribute to enriching current knowledge and offer practical applications for decision-makers, practitioners, and researchers. This final section presents the main conclusions drawn from the research, highlighting the most important findings and their broader significance. These conclusions can be summarized in the following points:

1. The overlap of industrial zones and urban sprawl on agricultural land signifies a deficiency in updating urban planning and the inadequate formulation of master plans for Palestinian communities within the study area, this fact was corroborated by the studies conducted by (Abidin's, Sahar (2018)), (Al-Douda's, Mishal (2018) and (Al-Qawasmi's, Bayan (2020)).

2. The land cover assessment of the study area indicated that the olive groves is the most successful and appropriate species for the region, were study results shows that around (48%) of the agricultural areas are planted with olive trees, this result is consistence with (Al-Qawasmi's, Bayan (2020)) study results, as well as the reduction of land cultivated with vineyards.

3. The extensive olive orchards in the study area suggest that this variety is the most appropriate for the region, economically viable, and deeply rooted in history and legacy of the people.

4. The uncontrolled spread of urban fabrics and industrial zones was one of the main causes of the loss in permanent crops, non-irrigated arable land in particular, and arable land in general, this is clearly seen in Tarqumiya northern plains as well as in the entrance of Idhna.

5. Uncontrolled haphazard trash dumps (junk cars) growth at the expense of agricultural fields as well as residential areas - particularly the plain areas - are one of the main threats to agricultural lands, soil, water resources and distorting the landscape, this is clearly seen in Tarqumiya, Beit Ula, Idhna, Adh Dhahiriya and Kharas communities.

6. The expansions of mineral extraction sites (Israeli quarries) and Israeli colonies on expense of agricultural areas and open spaces, indicates the absence of clear strategy to address these challenges, and the lack of interest of Palestinian farmers in objecting to and confronting these expansions.

7. Land fragmentation in the study area is one of the main factors contributing to the prevalence of mixed cropping systems (Complex cultivation patterns). Where small-scale farmers seek to maximize the utilization of their limited landholdings by cultivating multiple varieties of fruit trees, aiming to meet their subsistence needs and achieve the highest possible productivity.

8. The hug variation in areas of different land covers between study results and agricultural census (2021) highlight the need for updated land cover analyses for all West Bank, and not relying on agricultural censuses in building development strategies and plans.

9. The noticeable changes in different land cover areas as peer in study results comparison with ARIJ land cover analyses (2010), highlight the need for periodical land cover analyses, which will help decision-makers in formulating development strategies and response plans.

5.2 Recommendations

In light of the study's main conclusions and analyses, a number of tactical and strategic recommendations to guide future actions and decision-making were proposed. These suggestions are intended to help develop evidence-based policies, improve the efficacy of existing practices, and address the issues that have been identified. This section attempts to inform stakeholders, including decision-makers, practitioners, and researchers, on the best course of action going forward and contribute to sustainable solutions by converting the research findings into practical steps:

5.2.1 Recommendations for Governmental bodies:

1. There is an urgent necessity to develop and implement strict policies and laws as well as assess and analyze the urban and master plans for Palestinian communities within the study area to curtail the encroachment of residential and industrial zones on agricultural lands.

2. It is imperative to reclassify lands based on their agricultural value and the national spatial plan, enforce strict regulations to prevent encroachments, and establish effective mechanisms for implementing these laws to safeguard agricultural lands from various forms of infringement, including unplanned urban expansion, industrial activities, and other inappropriate uses.

3. Focusing intently on olive groves via rehabilitation and development initiatives and projects by pruning campaigns, pest management, and enhancing production chain efficiency, as well as affording more efficient and appropriate varieties for the region.

4. Relying on spatial analysis of land cover rather than agricultural census is preferred because the results are highly precise and can be used to inform future development plans.

5. Adopting the scenarios presented by the study regarding olive groves, arable lands, and open spaces in future development plans.

5.2.2 Recommendations for Local and International NGO's:

1. There is an urgent need to support smallholder farmers and those owning fragmented land parcels through targeted extension programs, introducing high-yielding and climate-resilient fruit tree varieties. These programs should focus on best practices for managing mixed cropping systems. Such interventions aim to enhance land productivity and contribute more effectively to achieving food security.

2. Special attention should be given to the plains, arable lands, and olive groves by implementing water harvesting projects and securing water sources to support irrigated agriculture, which can play a vital role in ensuring food security for the region and surrounding areas.

3. Addressing the presence of haphazard trash dumps (junk cars) within residential areas and agricultural lands is essential. These sites should be reorganized and properly managed to preserve soil quality, protect water resources, and maintain the overall natural landscape.

4. It is essential to provide high priority in future planning to vast areas of open spaces and semi-natural lands, focusing on their optimal utilization and protection from various encroachments, particularly Israeli-related ones. Additionally, securing funding and developing clear, targeted developmental plans for these lands is crucial.

5.2.3 Recommendations for Researchers:

1. It is essential to conduct comprehensive and periodic studies and analyses of land cover across other regions, including the entirety of the West Bank and Gaza Strip, and consider the results of this study. Such efforts are crucial for generating reliable data and information that can serve as a foundation for the development of agricultural, urban, and industrial planning strategies.

2. Sharing and uploading land cover analysis data for other areas or similar studies to the mobile application's database in order to maximize benefits and disseminate information to stakeholders, including decision-makers and researchers.

5.3 Development Scenarios

5.3.1 Olive Groves Development:

Olive groves represent both a cultural heritage and an economic backbone for the region, contributing to food security, rural livelihoods, and landscape stability. As shown in the study results, many of these groves are under pressure from urban expansion, climate change, and inadequate management practices. Developing a sustainable scenario ensures their preservation, productivity, and long-term profitability.

Goals:

1. Increase olive productivity while maintaining ecological balance.
2. Improve farmers' income through value-added olive and olive oil products.
3. Protect groves from degradation, pests, and climate-induced stresses.
4. Enhance market access for olive products domestically, regionally and internationally.

Strategic Actions

1. Agronomic Development

- Introduce modern irrigation systems (drip irrigation, rainwater harvesting) to optimize water use, especially for treated gray-water.
- Apply soil fertility management through organic compost and green manure.
- Select and plant drought-resistant and high-yield olive cultivars.
- Implement integrated pest management to reduce chemical pesticide use.

2. Technological Integration

- Use remote sensing and GIS for monitoring grove health and productivity trends.
- Apply precision agriculture tools (soil moisture sensors, smart irrigation controllers).

3. Capacity Development

- Provide training workshops for farmers on modern cultivation, pruning, and post-harvest handling.
- Support youth and women's involvement in olive-based agribusiness.

4. **Value Chain Enhancement**

- Establish local olive oil pressing and bottling facilities with quality certification.
- Promote organic certification and geographical indication (GI) labeling to increase market value.
- Develop branding and marketing strategies for export to niche markets.

5. **Environmental and Cultural Preservation**

- Protect ancient olive trees as cultural and tourism assets.
- Land rehabilitation and maintain terraced landscapes to prevent soil erosion and enhance water retention.

6. **Implementation Timeline:**

Table 5.11: Olive groves development phases

Phase	Timeframe	Key Activities
Short-term	1 – 2 years	Water harvesting projects, farmer training, pest control program initiation
Medium-term	3 – 5 years	Expansion of modern irrigation, olive oil processing facilities, branding and export strategies
Long-term	6 – 10 years	Full integration of precision agriculture, GI-certified international exports, eco-tourism development

7. **Expected Outcomes**

- **Economic**: Increase farmer income by 30 – 40% within 5 years.
- **Environmental**: Reduced soil erosion and improved biodiversity in groves.
- **Social**: Increased youth engagement in agriculture and local employment opportunities.

Table 5.12: Olive groves estimated annual production quantities (Olive and Oil)

Rainfall (mm)	Area - Dunums	Olive Qty. - Ton	Oil Qty. - Ton
< 300	308	141	31
300 - 400	14,886	8,187	1,786
401 - 500	32,617	21,951	4,762
501 - 600	1,829	1,570	337
> 600	8	10	2
Total Area	**49,647**	**31,858**	**6,918**

Quantities calculated based on LRC unpublished study on West Bank olive production (2024).

From the above table, it is clear that most of the olive groves are located in areas with annual rainfall ranges (401 – 500 and 300 – 400 mm), which recommended as the most suitable for olive (Shadeed, 2022), this also indicate that areas with less than 300 mm of annual rainfall, could be cultivated with olive groves and increase the production by applying supplementary irrigation.

5.3.2 Arable Lands Development:

Arable lands form the foundation of agricultural production and food security. These lands face challenges from urban encroachment, soil degradation, water scarcity, and climate variability. A sustainable development approach can increase productivity, maintain soil health, and support rural economies.

Goals

- Enhance crop productivity through improved agronomic and technological practices.
- Maintain soil health and fertility over the long term.
- Optimize water use efficiency in cultivation.
- Integrate climate-smart agricultural methods to reduce vulnerability.
- Increase farmers' profitability and market competitiveness.

Strategic Actions

1. Land Management and Agronomic Practices

- Apply crop rotation and diversification to maintain soil fertility and reduce pest pressure.
- Encourage conservation tillage to minimize soil erosion.
- Use green manures and organic compost to improve soil structure.
- Introduce drought-tolerant and high-yield varieties suitable for local conditions.

2. Water Management

- Implement efficient irrigation systems (drip, subsurface).
- Establish rainwater harvesting and on-farm water storage facilities.
- Promote deficit irrigation strategies during water shortages.

3. **Technological Integration**

- Deploy GIS and remote sensing to monitor land use changes.
- Utilize precision agriculture tools such as soil moisture sensors.

4. **Capacity Development and Farmer Support**

- Provide continuous training programs on modern farming techniques.
- Facilitate access to microfinance and agricultural insurance schemes.
- Support farmer cooperatives.

5. **Value Chain and Market Access**

- Improve post-harvest handling and storage facilities to reduce losses.
- Promote contract farming with reliable buyers.
- Establish local and regional marketplaces for farm produce.

6. **Environmental and Policy Measures**

- Enforce land-use zoning to protect arable lands from urbanization.
- Introduce incentives for sustainable farming and penalties for land degradation.
- Integrate arable land conservation into national food security strategies.
- Applying conservation agriculture to maintain minimum of soil disturbance, encourages permanent plant cover and preserves species diversity through seed rotation.

7. **Implementation Timeline**

Table 13: Arable lands development phases

Phase	Timeframe	Key Activities
Short-term	1–2 years	Farmer training, soil testing, initial irrigation upgrades, policy enforcement
Medium-term	3–5 years	Expansion of precision agriculture, value chain development, market linkage programs
Long-term	6–10 years	Full integration of climate-smart agriculture, export-oriented crop production, conservation agriculture

8. Expected Outcomes

- **Economic**: 25 – 35% increase in average yields and farmer incomes.
- **Environmental**: Improved soil organic matter and reduced erosion.
- **Social**: Strengthened rural livelihoods and increased youth engagement in agriculture.

Table 5.14: Field crops - Areas and productivity (MoA, 2021)

Year	Cultivated Area - Dunums	Production - Ton			
		Cereals	Dunum Average	Straw (Hay)	Dunum Average
2018 - 2019	310,235	75,490	0.243	635,224	2.048
2019 - 2020	283,896	62,741	0.221	72,238	0.254

According to MoA report on its achievements for 2019-2020, the production fluctuation between the two seasons is due to climate change and the farmers' adoption of agricultural rotation for rainfed crops.

Based on the above table, the averages for production regarding arable lands in the study area are calculated, and so, the estimated production as peer in Table 15.

Table 5.15: Arable lands estimated seasonal production

Land Cover	Area – Dunums	Production - Ton	
		Cereals	Straw (Hey)
Arable Lands	48,379	11,272	57,619

The above table shows that, the estimated produced cereals can feed at least 30,883 head of animal for one year (1 kg for each animal head per day), and the estimated produced hey, feed at least 52,620 head of animal for one year (3 kg for each animal head per day), or the same amount of animal head (30,883), considering that 5.11 kg for each animal head per day.

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Smart Land Cover-Based Solutions for Agricultural Decision-Making: The Western Slopes of Hebron Governorate Case

حلول ذكية معتمدة على تحليل الغطاء الأرضي لدعم اتخاذ القرارات الزراعية: دراسة حالة المنحدرات الغربية لمحافظة الخليل

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ملخص:

هدفت هذه الدراسة إلى تزويد صنّاع القرار والباحثين بمعلومات دقيقة ومفصلة حول الغطاء الأرضي في المنحدرات الغربية لمحافظة الخليل (بمساحة تبلغ 250,747 دونم)، وبالتركيز على الأراضي الزراعية. تم اعتماد المنهج الوصفي التحليلي في معالجة الصور الجوية المتوفرة على منصة (GeoMoLG) والترسيم اليدوي (on-screen digitizing) للغطاءات الأرضية باستخدام نظام تصنيف (CORINE)، وباستخدام النسخة الأحدث من برنامج (ArcGIS Pro 3.5).

أظهرت نتائج الدراسة أن (41%) من منطقة الدراسة تصنف أراضي زراعية، حيث تعد بساتين الزيتون النوع الأكثر انتشاراً. الغالبية العظمى من الأسطح الاصطناعية (81.2%) هي نسيج حضري، مع كون المناجم مكبات النفايات ومواقع البناء هي الثانية من حيث المساحة. تشكل الغابات والمناطق شبه الطبيعية (43.3%) من منطقة الدراسة، حيث تمثل المناطق ذات الغطاء النباتي النادر والغابات الصنوبرية الباقي. كما أظهرت الدراسة ندرة المسطحات المائية المفتوحة في منطقة الدراسة، كما هو الحال في معظم مناطق الضفة الغربية، حيث تظهر فقط على شكل برك زراعية.

خلصت الدراسة إلى أن هناك سوء إدارة للأراضي في المنطقة، ويظهر ذلك في التداخل الواضح بين المناطق الصناعية والزحف العمراني على حساب الأراضي الزراعية، والانتشار العشوائي وغير المنظم لمكبات النفايات (بما في ذلك السيارات الخردة) على حساب الحقول الزراعية والمناطق السكنية.

توصي الدراسة بمراجعة المناطق الصناعية، ومكبات النفايات العشوائية، والمخططات الهيكلية والعمرانية، والتركيز على بساتين الزيتون من خلال ومشاريع التأهيل والتطوير، وحملات التقليم، ومكافحة الآفات، وتعزيز كفاءة سلسلة الإنتاج. كما توصي الدراسة بالاعتماد على التحليل المكاني للغطاء

الأرضي بدلاً من التعداد الزراعي. تم تطوير تطبيق موبايل لتزويد صانعي القرار بنتائج الدراسة بطريقة بسيطة وسهلة وتفاعلية.

ختاماً، ولتوفير بيانات موثوقة يمكن أن تشكل أساساً لوضع استراتيجيات فعالة للتخطيط الزراعي والعمراني والصناعي، لا بد من إجراء دراسات شاملة ودورية للغطاء الأرضي في مناطق أخرى، بما يشمل كامل الضفة الغربية وقطاع غزة، والاستفادة من منهجية ونتائج هذه الدراسة والبناء عليها.

كلمات مفتاحية: الغطاء الأرضي، نظام (CORINE)، المنحدرات الغربية، الترسيم اليدوي على الشاشة.