GREEN CORRIDOR ANALYSIS AS AN APPROACH FOR ENVIRONMENTAL SUSTAINABILITY IN JORDAN

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To my parents and those who have believed in me …

ABSTRACT

The expansion of huge urban areas leads to the loss of green spaces causing many environmental and economic problems. The infrastructure has been carried to the rural areas to deal with the needs of populations, reducing the green vegetation. This isolates one habitat from other habitat areas increasing fragmentation. A green corridor can connect one habitat to other areas of habitat. Thus, this thesis aims to analyze and provide a green corridor in four cities of Jordan. Through study some case studies, review of articles, researches, data collection, GIS, observations and maps derived from Jordanian ministries are used for the analysis of a green corridor in four cities in the northwest of Jordan. Therefore, this research provides a comprehensive planning of the biogeographical areas, ecotourism sites and variety of vegetation in the protected areas of namely, Ajloun Forest Reserve and Dibben Forest Reserve, to link them in the biodiversity and conservation regions of the Al-Salt and north Amman, after identifying these diverse areas of vegetation cover and wildlife in each governorate. In addition, the research discusses ecological, environmental and economic effects of applying a green corridor as a sustainable city approach in Jordan. In other words, the purpose of this study is to suggest a sustainable proposal by analyzing green area zones and green corridor axes to improve the nature and the environment in Jordan. This proposal adapts urban areas with the establishment of a green corridor connecting conservation areas in Jerash and Ajloun to Al-Salt and north of Amman. Such a green corridor can lead to an increase of local and international tourism that improves the economic strength and can increase the opportunities for citizens to live in a more ecological urban environment.

Keywords: Environmental sustainability; green corridor; connectivity; planning; Jordan

ÖZET

Büyük kentsel alanların genişlemesi, birçok çevresel ve ekonomik sorunlara neden olan yeşil alanların kaybına yol açmaktadır. Altyapı, yeşil bitki örtüsünü azaltarak nüfusun ihtiyaçlarını karşılamak için kırsal alanlara taşınmaktadır. Bu durum parçalanmaya neden olarak bir habitatı diğer habitat alanlarından ayırmaktadır. Yeşil koridor, bir habitat alanını diğer habitat alanlarına bağlayabilir. Bu kapsamda tez, analizler yaparak Ürdün'deki dört şehirde bir yeşil koridor önermeyi amaçlamaktadır. Vaka çalışmaları, makaleler, araştırmalar, veri toplama, GIS, gözlemler ve Ürdün bakanlıklarından elde edilen haritalar, Ürdün'ün kuzeybatısında dört şehirde bir yeşil koridorun analizinde kullanılmıştır. Bu araştırma, tespitler yaptıktan sonra, Ajloun Orman Rezervi ve Dibben Orman Rezervi'nin biyocoğrafik alanları, ekoturizm alanları ve korunan alanlarını, Al-Salt ve Kuzey Amman'ın biyolojik çeşitlilik ve koruma bölgelerine bağlayan kapsamlı bir planlamayı içermektedir. Ek olarak bu araştırma, yeşil bir koridor uygulaması aracılığıyla, Ürdün'de sürdürülebilir bir kent yaklaşımının ekolojik, çevresel ve ekonomik etkilerini değerlendirmektedir. Başka bir deyişle bu çalışmanın amacı, Ürdün'de doğayı ve çevreyi iyileştirmek için yeşil alan bölgelerini ve yeşil koridor akslarını analiz ederek sürdürülebilir bir öneri sunmaktır. Bu önerme, kentsel alanların, Jerash ve Ajloun'daki koruma alanlarını Al-Salt ve kuzey Amman'ın koruma alanlarına bağlayan yeşil bir koridora uyarlanmasını içermektedir. Böylesi yeşil bir koridor, ekonomiyi destekleyen yerel ve uluslararası turizmin artmasına ve vatandaşların daha ekolojik bir kentsel çevrede yaşama fırsatına kavuşmasına yardımcı olabilir.

Anahtar Kelimeler: Çevresel sürdürülebilirlik; yeşil koridor; bağlantı; planlama; Ürdün

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CHAPTER 1
INTRODUCTION

1.1 Overview

The idea of green corridor design emerged in the 1980s. The importance of the Green Corridor has become increasingly important in the protection of nature. Green corridor improves the types of wildlife in isolated areas and smallness. The basic rule of the Green Corridor is as follows: Getting connectivity of one habitat fragment from other areas of habitat which allows an exchange of individuals between natural living elements (Curci & Durdic, 2013).

Conservation area is defined as a territory or place of nature isolated and located away from human activities for the protection of animals and plants (Arpentieva, 2018). The conservation theory of nature supports the connection between isolated areas and increases the level of biodiversity in each separated region. The use of the green corridor was from nature requirements in the wildlife before more than eighty years this provided to enhance the natural biodiversity (Horskins et al., 2005).

With urbanization growth and urban development, the city is becoming an essential home for human; the city has become more influential than man's work on Earth. Because of this human growth, wildlife and natural resources have been threatened. Urban growth has changed the habitat of mosaics; this contributes to loss of biodiversity and vegetation within the city, and in green areas. The biodiversity system shows an important role in supporting human activities, natural life; enhance air quality and ecotourism benefits (Ratih & Febrianto, 2016).

The goals of nature conservation were applied by establishing protected areas; the International Union for Conservation of Nature (IUCN) recommends any country to have 10% of the area for protected areas and nature reserve zones (Ababneh & Rawashdeh, 2016). Jordan, as a Mediterranean country and a member in united nation, where desert represent the largest percentage of its area (~70%), desert percentage starts giving more concentration to nature reserves. This is clear through the increasing concentration in

establishing more and more protected areas. Moreover, whilst spatial planning using GIS had been used in many natural applications in Jordan (Haddad et al., 2013).

Cities in Jordan have experienced a population decrease in recent years. Urbanization is high in Jordan: in 1998, most of the population in Jordan was living in planned areas. On the other hand, that will expand in the future, which may probably reach more than 80% of the total population by the year 2010 to provide with the requirements of populations (Jaber & Probert, 2001).

Tukan (1995) describes the center of the cities in Jordan expands as large villages, usually the urbanization in the center of the city, affected by several social, political and economic factors. Toukan is a Jordanian architect describes the growth and urban development in Amman due to political and economic factors in the region lead to an explosion in the population density.

This thesis shall discuss and evaluate the green areas and zones in four cities in Jordan namely: Jarash, Ajloun, Al-Salt, and northern Amman. Results will enable us to obtain a green corridor design linking the four cities and improving the expected environmental image of the future by using GIS. Green corridors that provide habitat connections and movement routes through the urban environment, where these are linked to their wider surroundings, landscaping, tree and shrub planting and habitats such as woodlands, wetlands, heathland, and grassland, that can provide ecotourism benefits, healthy living spaces, improve fragmented sites of biodiversity. This thesis will identify locations of habitats and linking them with existing green open spaces along a green corridor is important to understand the integrity of the green infrastructure network.

1.2 Background and Research Problem

The scheme for sustainable urban development in Jordan is currently being considered through a national comprehensive plan for Jordan Behind the National Green Growth Plan. NGGO is an obvious vision for Jordan as a country with an expanding and sustainable economy that creates jobs, provides income for citizens, and is resilient to obstacles and instability in the region. Country`s economic provides opportunities for citizens as a decent

work with living requirements based on an environmentally sustainable economic growth model. Most of the Jordanian cities are exposing from urbanization growth which is due to increase immigration from neighboring countries as well as the urban migration patterns of citizens from outlying rural regions. Urban expansion in all directions has resulted in the destruction of vegetation and natural resources (Saleh & Alrawashdeh, 2007). One of the main problems for most urbanized countries and regions is the conversion of biodiversity into developed land covers, which is a direct result of urbanization (Makhamreh & Almanaseyha, 2011).

The huge urban areas have also expanded in loss of green spaces, minimization Open spaces and large separations between wetlands and the habitat of wildlife. Moreover, that isolates one habitat fragments from other areas of habitat. The infrastructure has been moved to the rural areas that were reducing the green vegetation to deal with the needs of populations.

The type of fuel used in Jordan and the industries has led to the rise of environmental pollution, which claims to be an awareness idea to reduce this situation. Jordan is a country rich in natural, cultural and historical and resources, with the increase in population was observed decrease in vegetation types, especially in the study area, which includes five major cities in Jordan, extending from the far north to the center of the capital Amman.

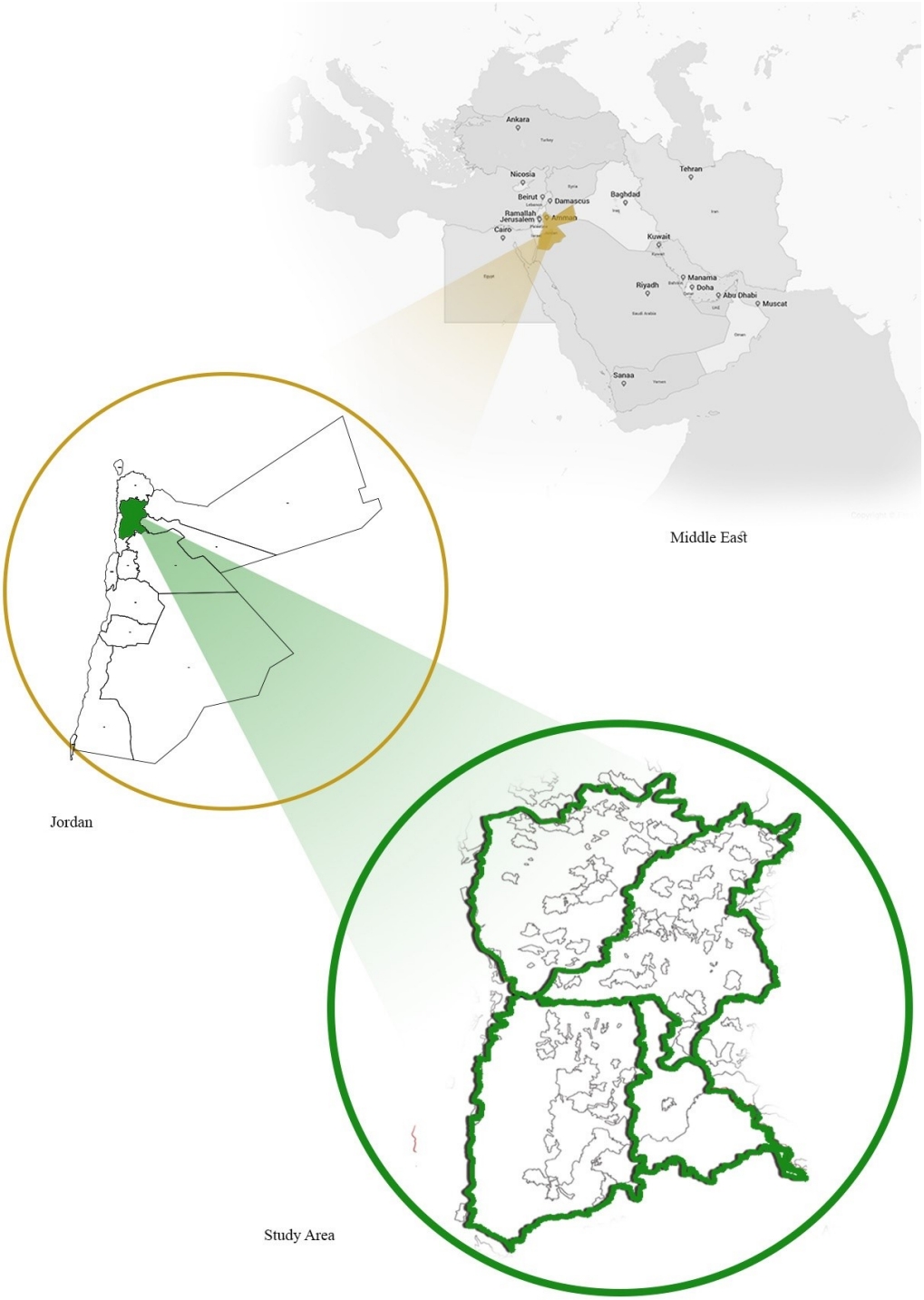

Figure1.1: The Hashemite Kingdome of Jordan, Study area, (MOMA; added by Author, 2018)

The location of Jordan (The Hashemite Kingdome of Jordan) in the middle east, Jordan is a Mediterranean country. The large percentage of Jordan is desert, according to Figure 1.1 the green area in Jordan map is mentioned in the study area, the study area is located in four cities in Jordan in the northwest namely: Ajloun, Jerash, Al-Salt and northern Amman.

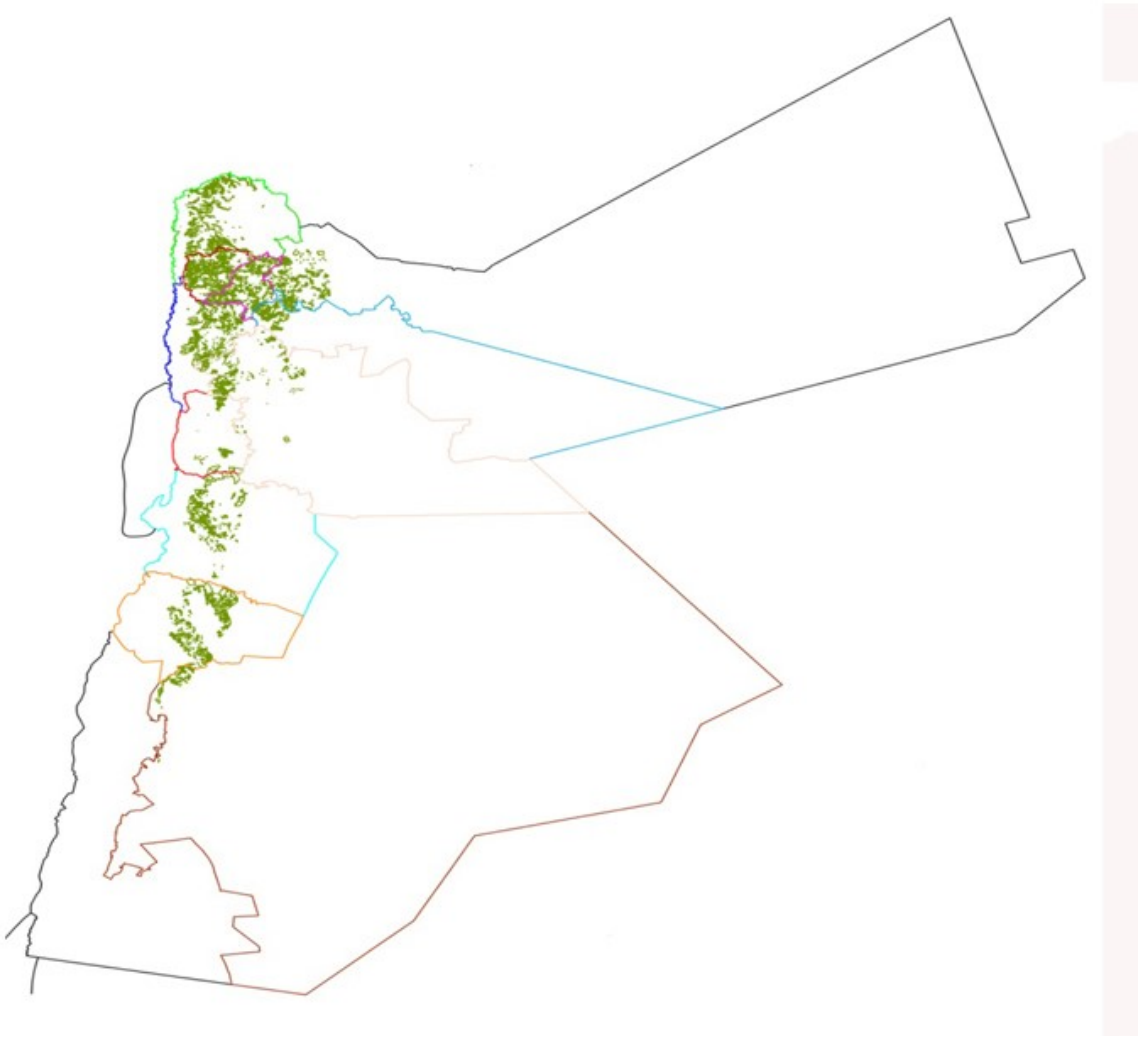

Figure 1.2: Tha Hashemite Kingdome of Jordan, Forest zoning in Jordan (MOA, 2018)

According to Figure 1.2, by distribution the forest zoning in Jordan the rich diversity in the northwest, geography and land cover hinder connectivity of green areas, there are isolated habitat patches along the study area. Our research to provide a connective green corridor proposal to enhance and improve the quality of urban life. Urbanization growth is playing as the main factor in the fragmentation of green areas, especially toward the rural areas to serve the population requirements.

1.3 Aim and Objectives

This research aims to analyze and provide a green corridor in four cities in Jordan. A green corridor is providing connectivity of one habitat fragment from other areas of habitat. Many benefits of designing a green corridor by supporting isolated patches. Providing

attractive places for tourism, increasing air quality and riparian habitat enhancement. The urbanization growth also expanded in loss of green spaces; there are many environmental and economic problems, reduction in the connectivity of wildlife which is decreasing numbers of birds. Green corridors try to solve them by providing the following objectives:

- Protecting the natural environment.
- Increasing the awareness of the local citizens to support wildlife by creating buffer zones along the green corridor.
- Reducing visual pollution by establishing a green corridor among the populated areas.

The development of forest areas in the four cities by providing integrated connectivity of green spaces least transformed by man, Green corridor creates links between the green areas of squares and playgrounds that provide all the services needed by humans in terms of visual, audio and sensory.

1.4 Scope and Research Structure

The study focuses on the applicant and analyzes a green corridor in four cities in the northwest of Jordan by overlying maps were derived from Jordanian ministries. Criteria have provided a deeper understanding for designing a green corridor which has supported from literature reviews to analyze and provide a useful design in four cities in the northwest of Jordan. That provides to reduce visual pollution by establishing a green corridor among the populated areas in four cities, by improving the expected environmental image of the future in Jordan.

1.5 Limitation of the Study

The research provides to analyze and provide a green corridor in four cities in the northwest of Jordan. Wildlife in Jordan is limited by creating nature reserves that minimize the interaction between human and wildlife in Jordan. In the study area has appeared various urban observations reflect low awareness of citizen, by providing a proposed analysis in the biodiversity areas. The limitation of the research is based on overlying maps by GIS within scientific criteria supported by literature reviews.

CHAPTER 2

LITERATURE REVIEW AND CASE STUDIES

2.1 What is a Green Corridor?

Green corridors planning as an approach to provide the continuity of urban green areas. There are many definitions that landscape designers describe as follows: Ndubisi et al. (1995) `s definition is "networks of linked landscape elements that provide ecological, recreational, and cultural benefits to the community ". Walker & Craighead (1997), describe green corridor as "avenues along which wide-ranging animals can travel, plants can propagate, genetic interchange can occur, populations can move in response to environmental changes and natural disasters, and threatened species can be replenished from other areas ". According to Hilty et al. (2006), another definition is "Corridor is any space, usually linear in shape that improves the ability of organisms to move among patches of their habitat". The green corridor is a link between vegetation and plants to provide and support the wildlife required elements, where we have observed the improvement of the environment along the green corridor.

2.2 Potential Benefits of the Green Corridor

Green corridor as a sustainable environment corridor enhances a high-quality life by providing the inhabitants a sense of the spaces by the interesting in nature (Aly & Amer, 2010). The green corridor can reflect the form of the city by drawing the outline of each governorate character that provides clear access to help people and transportation to get a full vision of the governorate accessibility (Hellmund & Smith, 2006). Corridors can decline urbanization and pollutions, and beneficial for the agriculture activities, for example, protect soil loss by the wind and torrential rains (Curcic & Durdic, 2013). Green connecting gives opportunities for citizens for pedestrians` movement with clear access and providing the highest quality of living requirements to relax, significant physical (Moseley et al., 2013). The green corridor provides Sustainable environment solutions while increasing the safety with friendly elements with nature and environment (Hunke & Prause., 2013).

Individuals can exchange between the patches to decrease population declines isolated patches and improve the wildlife at each small habitat (Fleury & Brown, 1997). The green network provides minimizing the health problems; attract tourism, social benefits by providing open areas for different activities, reducing the crime by offering areas for human activities (Eraghi et al., 2015).

2.3 The Design Standards for a Green Corridor

Currently, most of the new residential projects are combining with vegetation planting by creating natural ones or protecting natural areas toward the context (kirichenko-Babko et al., 2017). The main elements of the green corridor are a habitat, a conduit, a barrier of isolation patches and the source of the environment (Forman & Godron., 1986). There are four stages to design a green corridor, first one deeper understanding the context, second determining the objectives of the project, third determining diversity areas boundaries, fourth doing path designs or development green spaces, that scheme as an approach to provide a sustainable design with existing scientific factors (Hellmound, 1993). Green corridor connectivity usually be structurally and functionally, functionally is the behavioral response to the greening elements, structurally is the physical connectivity among greening elements (Goodwin, 2003). The sustainable cities try to protect green areas by providing an environmental comprehensive plan enhances the natural features.

The creation of green networks is important to preserve natural habitats as well as to improve the quality of the human environment and preserve the genetic variety. Table 2.1 shows the main elements should be taken to create an ideal green corridor include all nature factors.

In the urban context, the connectivity of green patches increases biodiversity, improves micro-climate and other ecological phenomena in the urban context (Pascual & Saura, 2006). The network connectivity mixes interactions between citizens and nature environmentally, physically, mentally (Jim & Chen, 2003). The green corridor provides a higher life quality and develops economic values such as urban planning quality and ecotourism potential. A deeper understanding of the connectivity of green spaces that could help to determine critical habitat patches to maintain the connectivity to improve

people's recreation (Pascual& Sauary, 2007). Green corridor shows the environmental nature of the inhabitants and reduces improves micro-climate and moisturizes the atmosphere, where it improves the economic strength and increases opportunities for citizens to get new opportunities.

Table 2.1: Main factors affecting wildlife movement in the environment (Aziz & Rasidi, 2014)

Category	Main Factors	Descriptions
Individual Factors	• Demographic	• Factors relating to species character and classification of animals
	• Ability/attitude to move and disperse	• Species/Individual preferences and ability to move and disperse from one patch to one patch
Physical Factors	• Design and quality of green corridors/ urban parks	• Provision of green corridors in between urban parks as habitat connectors for wildlife
	• Environmental factors/urban design/safety	• Elements of urban design and street design which influence choices of place for disperse activity (planting selection, arrangement and distribution)
	• Level of habitable (obtain food resources)	• Availability of environmental elements in providing food resources within the green corridors area to enable inhabitant
Social Factors	• Anthropogenic alteration/disturbances	• Human activities and interruption that impact on habitat loss and fragmentation of green space such as roads and traffic
	• Enemies/ Domestic animals	• Exposure to unfamiliar enemies involving domestic animals like cat and dog

2.4 The Relation between Green Corridors and Environmental Sustainability

Environmental sustainability`s definition is: " as meeting the resource and services needs of current and future generations without compromising the health of the ecosystems that provide them" (Morelli, 2011). Green areas are used for different activities for people with different ages, that a part of planning space in the cities with different types of plants, shrubs, trees and vegetation, that is comfortable, aesthetic, safety to make a social and local communicate through urban open spaces (Groenewegen et al., 2006). That is achieving sustainable urban planning by green areas through improves the air quality of life for citizens (Teimouri & Yigitcanlar, 2018). The green corridor provides many environmental benefits in open areas, ranging from protection, supporting environment

requirements and absorption of polluted gases. The green corridor reduces the energy costs which use in the adaptation by tempering temperatures in the external atmosphere (R.M et al., 2017).

Green connectivity is improving the level of sustainability for the residents, that linking is protecting and improving natural resources to increase the community with the environment (Eraghi et al., 2015). Management planning for green corridor provides natural and cultural green area structures reflect the need for all residents (Pena et al., 2010). Urban green is an essential factor of sustainability in cities, green network planning provides all the required for the high qualities of biodiversity (Shahani, 2012). According to Mensah et al. (2017), environmental sustainability defines as a concept of reservation elements of nature environment. The quality of the green spaces will be used to identify the city, which can improve the standard of living in the city (Rostami et al., 2013). Green spaces have economic and environmental importance, providing recreational space for citizens and tourists, which lead to job opportunities within the city (Abizadeh & Zali, 2013), See Figure 2.1.

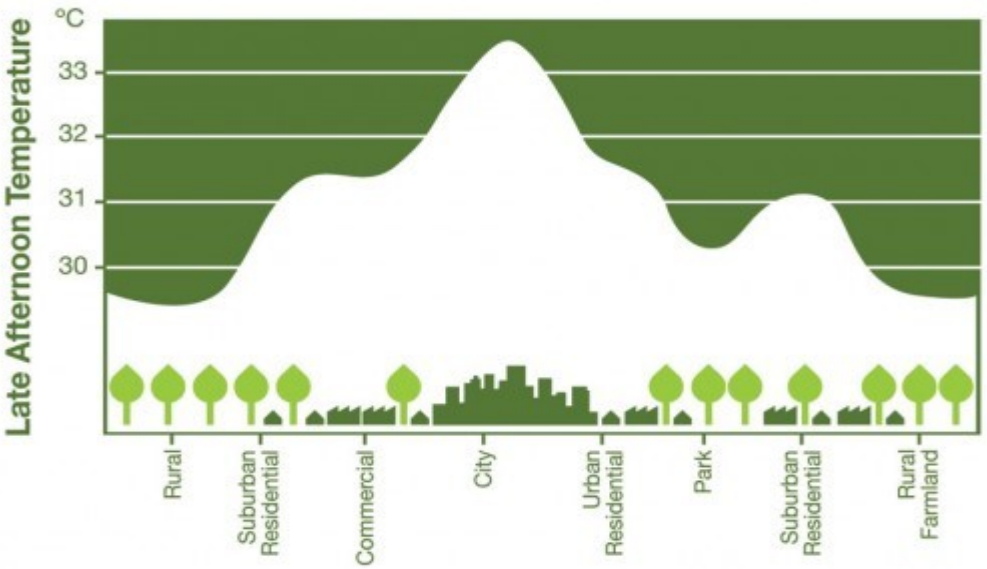

Figure2.1: green areas affect on the temperature in a city. Source: healthyurbanhabitat.com.au

The distribution green areas along stairs and pedestrian walkways in the center of a city that improves the quality of life living and among the residential areas. That can enhance people`s activities with a healthy and better living environment

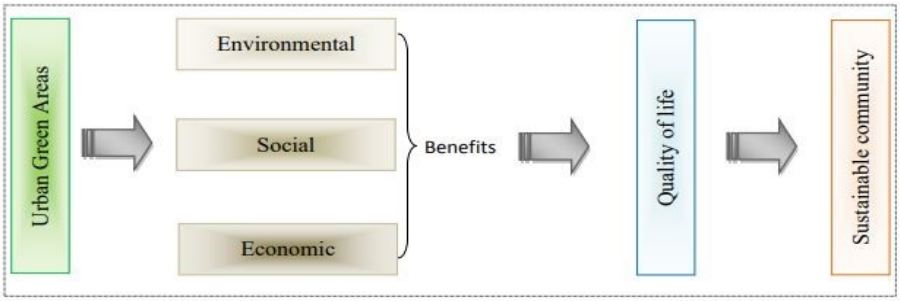

Figure2.2: The sustainable community (Elgizawy, 2014)

According to Figure 2.2, urban green areas as an important factor provide social, environmental and economic benefits to achieve the community for all human activates within nature features.

2.5 Case Studies from the Middle East, Africa and Asia

2.5.1 Egypt, Alexandria City

According to Cities Alliance (2007), the city of Alexandria is located on the Mediterranean Sea in the north of Egypt, which is characterized by high population density, Alexandria is a coastal city distinctive full of historical and archaeological sites. The expected future urban development of the city of Alexandria to extend to the areas surrounding the city towards the southeastern and western (Abdou Aziz, 2008).

Figure 2.3: The Alexandria city (Cities Alliance, 2007)

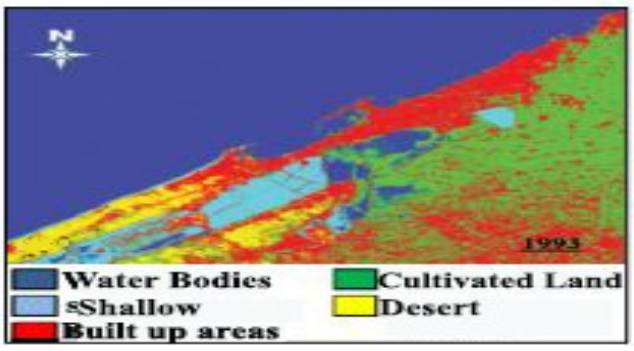

Figure 2.4: The expected future urban development of the city of Alexandria in 2055 (Abdou Aziz, 2008)

This case study shows how designers should deal with the urbanization growth, the growth extends toward the rural areas, Alexandria`s climate is the Mediterranean, the green network is including natural features, boundaries, and walkways. The opportunity in Alexandria network to try to deal with water features and green belt to a green network. If we compare it with the mentioned source in our thesis as a wetland source (Zarqa River in the study area) in the study region to support wildlife diversity.

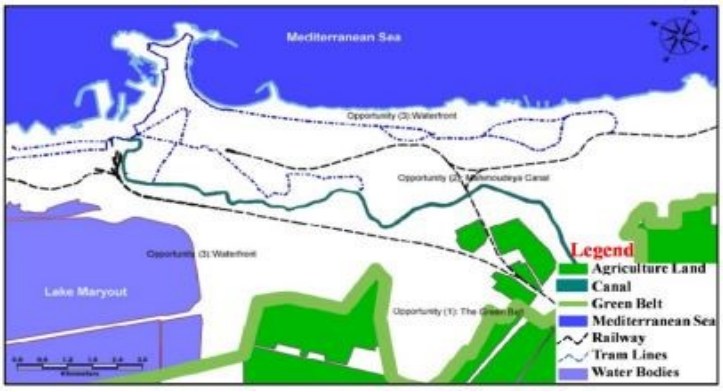

Figure 2.5: The Green connectivity of Alexandria city (Aly & Amer, 2010)

The distribution and creation of green corridors along the transportation lines is the main principle of nature corridors through places and stations, through the presentation of a comprehensive master plan passes through these stations through the channel; This leads to creating numerous of natural open spaces for citizens, improves the relationship between the local community and nature by providing green and open spaces to various human activities that will provide attractive places for tourism, the need for this green belt helps to link historical, archaeological and natural features that provide all the services needed by humans in terms of visual, audio and sensory. In addition, greenbelt redacts in the visual pollution that is exacerbated by decreasing green spaces (Aly & Amer, 2010).

2.5.2 Yesan County, The Republic of South Korea

Yesan is a territory located in South Chungcheong. This county is rich with diversity nature, biological and ecological resources. Yesan's connectivity works to provide valuable and important needs by improving biodiversity characteristics within cultural and social life. The results were gradual steps connecting these places through the use of layers to determine the boundaries of the most naturally, culturally and socially areas within this county (Orantes et al., 2012).

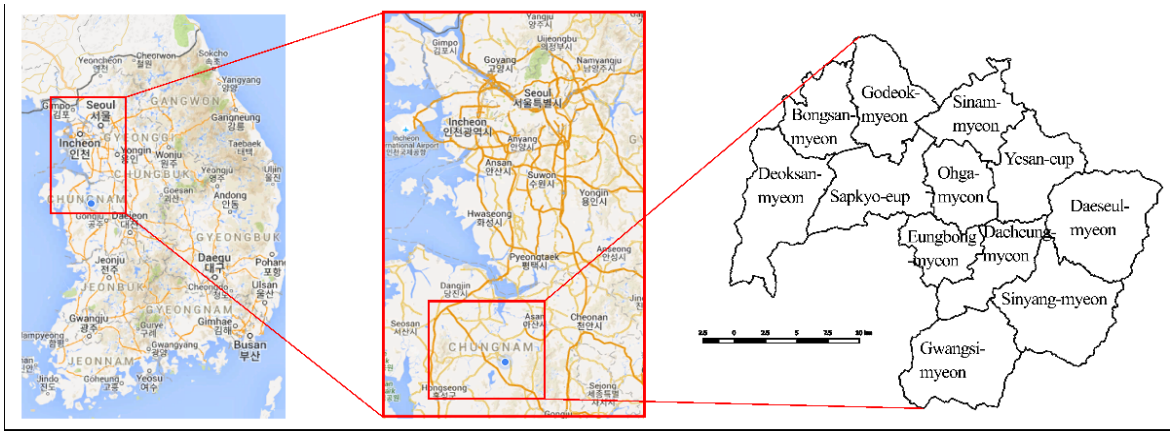

Figure 2.6: The county`s location in North Korea (Orantes et al., 2012)

Table 2.2 shows the challenges and barriers in Yesan County; we can see the slope as an opportunity to create connectivity in this county. Forest resources, lakes and several cultural and historical assets as an important element to support the connectivity. The topography in Jordan (study area) will provide enhance green connectivity in the four cities.

Table 2.2: Barriers and incentives for connectivity in Yesan county (Orantes et al., 2012)

Challenges and Opportunities	Physical	Socio-Cultural	Environmental
Connectivity challenges	• Infrequent public transportation	• Scarcity of green public spaces destined to promote social interaction within the core of the town	• Natural ecosystems interruption due to segregated development projects
	• Higher taxi prices compared to bigger cities (e.g., Seoul, Daegu Metropolitan city)	• Cultural/historical value assets not easily accessible from main town areas	• Disruption of high ecosystem value areas through agricultural practices and road construction
	• Lack of proper pedestrian roads between local towns/villages		• Disturbance in wildlife mobility areas (roadkill)
Opportunities	• Located less than 2 hours away from capital city, Seoul (bus, train)	• Existence of various cultural/historical assets	• Various natural assets classified as First-Degree Ecological Features
	• Express-ways, secondary, and tertiary roads connecting to surrounding areas	• Diverse touristic spots	• Natural scenery with high aesthetic value
	• Slope	• Considered a life-long education town	• One first-degree Provincial Stream (Sapgyo stream)
		• Large farming areas, which occupy approximately 21% of Yesan's territory	• 11 lakes and marsh reservoirs
		• Breathtaking views	• Forest resources represent 69.1% of Yesan's land

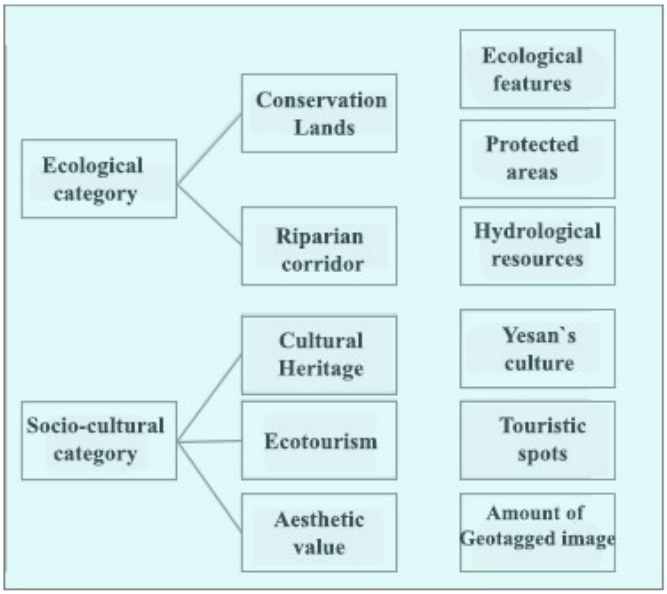

Figure 2.7: The categories for Yesan`s connectivity (Orantes et al., 2012)

According to Figure 2.7, the ecosystem category of this project plan includes the development of environmental value areas and the requirements for biogeographic life in this county. According to land use, the open green spaces are formatted by NLPU (National Land Planning and Utilization) in North Korea (Orantes et al., 2012).

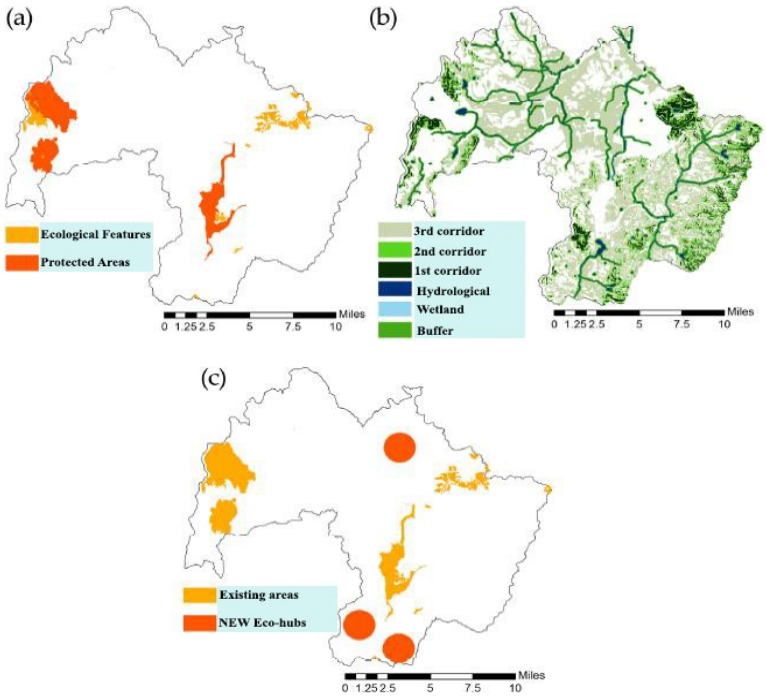

Figure 2.8: Yesan ecosystems hubs, (a) Ecological Features; (b) Green Corridors; (c) Existing areas (Ornates et al., 2012)

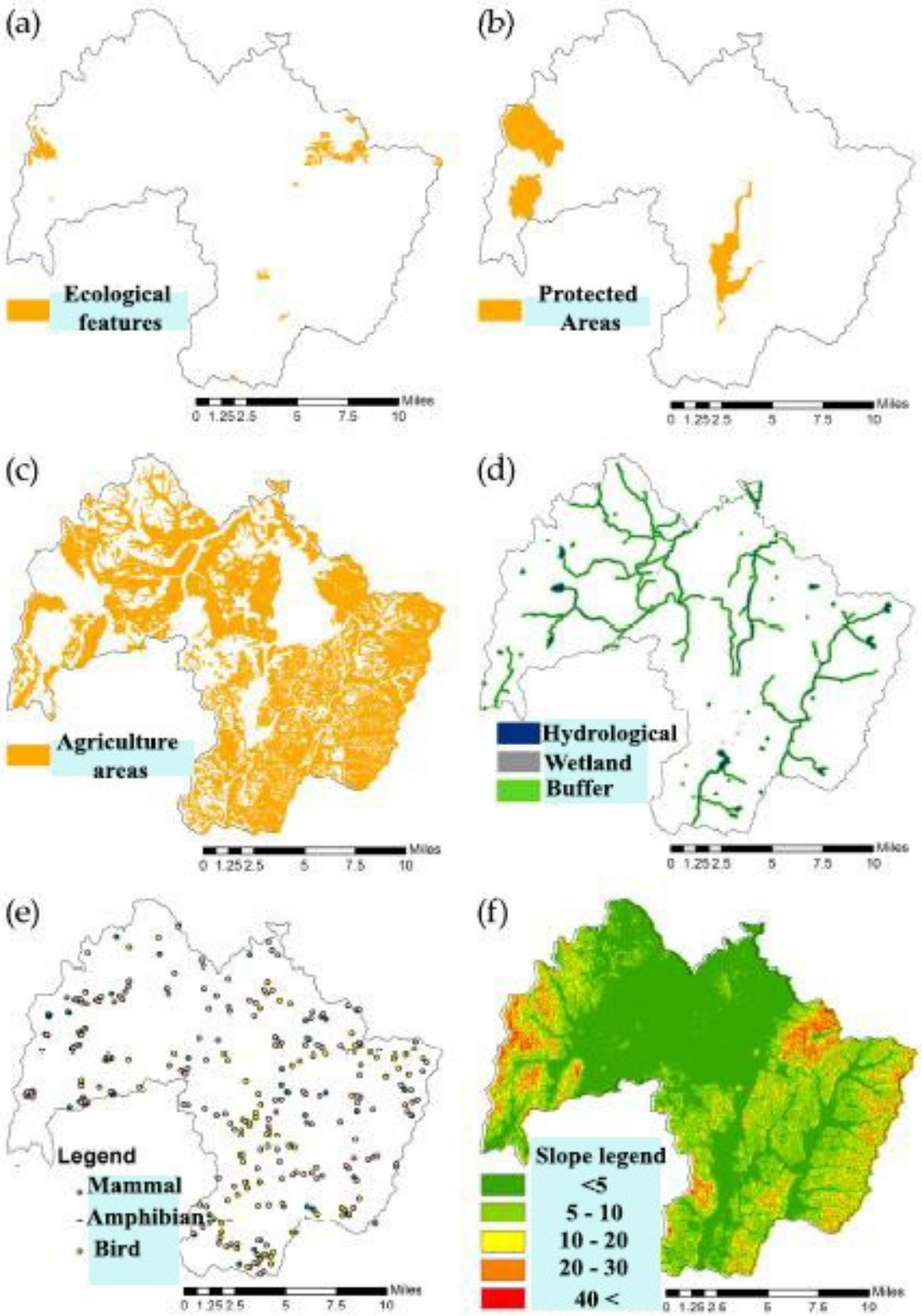

Figure 2.9: Yesan's characteristics: (a) ecological features,; (b) Protected Districts; (c) Forestry and agriculture areas; (d) Hydrological resources; (e) Roadkill information; and (f) Slope (Orantes et al., 2012)

Yesan`s urban planning ha divided into two categories, first section the natural Resources that provide Services for the ecosystem, the second section is the amenities that have to enhance and supporting as part of a green corridor in the county by integrating the Cultural places and important values of ecosystem spaces (Orantes et al., 2012).

According to Figure 2.10, the final green infrastructure network by combining ecosystem and Culture value and interconnecting between roads, water bodies, and wetlands.

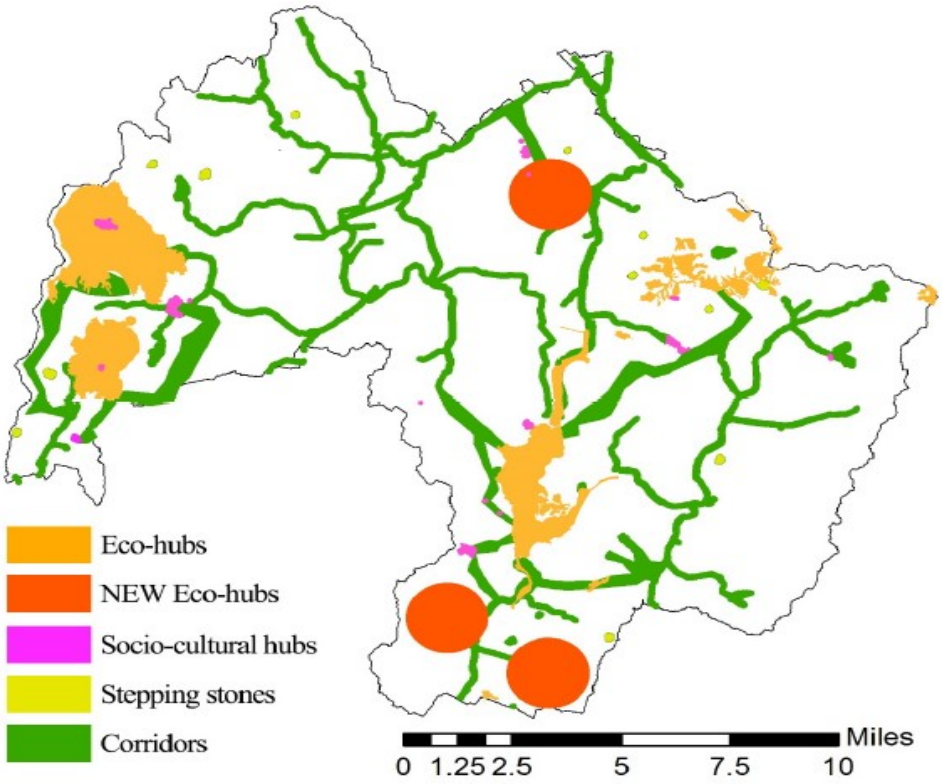

Figure 2.10: Yesan's corridor (Orantes et al., 2012)

The county green corridor gives a clear conception for the designers and architects to provide comprehensive planning of the city, this scheme works on the integration between the environment and humanitarian activities (Orantes et al., 2012).

This case study shows the importance of the slope and forests, where it serves as an opportunity for the success of the Green Corridor, the criteria used in the design to find the supporting elements of the green path as, slope, lakes, forest resources.

2.5.3 Tanzania

Nyanganje Corridor is located in Tanzania; the rich of biodiversity allows creating a green corridor. The goal of this project to conserve elephant migrations, Nyanganje Corridor includes more than 110 square kilometers. Ruipa Corridor is located in Tanzania, therefore, covers an integrated mosaic of land covers and protected areas, and also covers two governate districts, Ruipa Corridor includes 25 square kilometers, is situated close to the Ruipa river, This corridor offers a link between the diverse landscape of lakes, vegetation and fields (Jones et al., 2012).

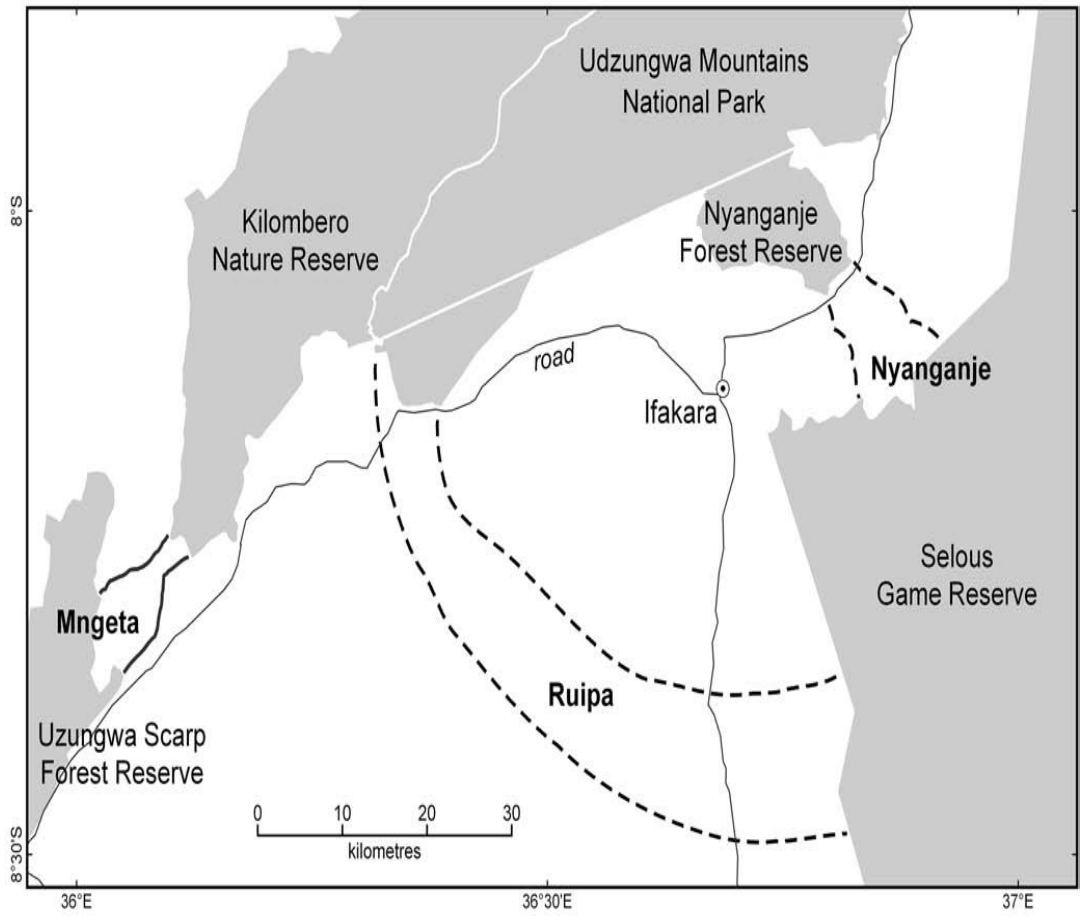

Figure 2.11: The Nyanganje and Ruipa Corridors (Rovero, 2012)

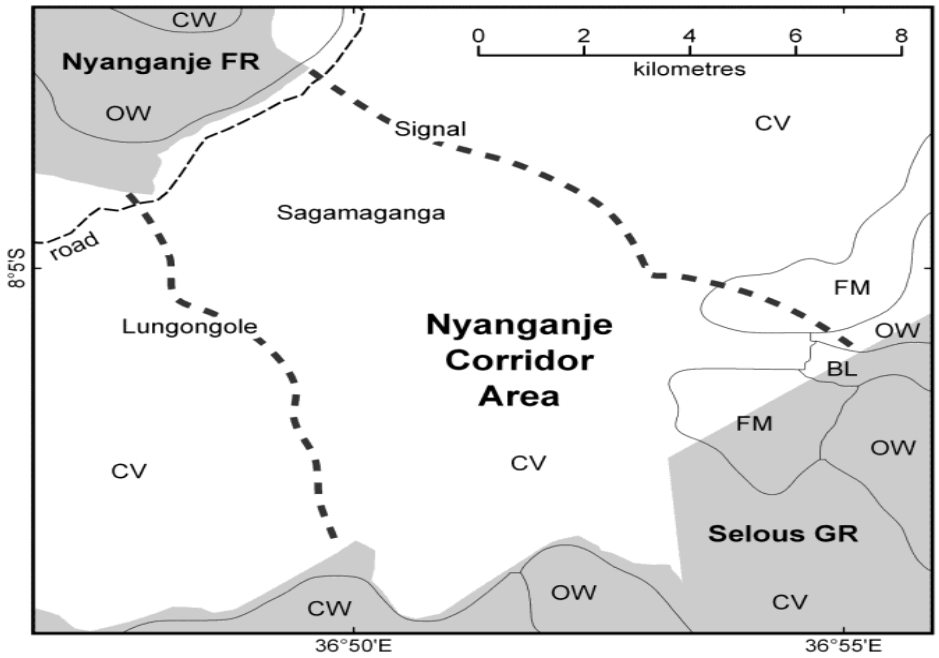

Figure 2.12: Nyanganje Corridor Area (Jones et al., 2012)

Nyanganje Corridor and Ruipa corridor are a pattern of an integrated mosaic of land cover and protected areas, small lakes, devastating Pastures, and colored swamp. Corridors conservation will require a real and clear interaction of land cover designing and biodiversity requirements among the public and private landowners (Jones et al., 2012).

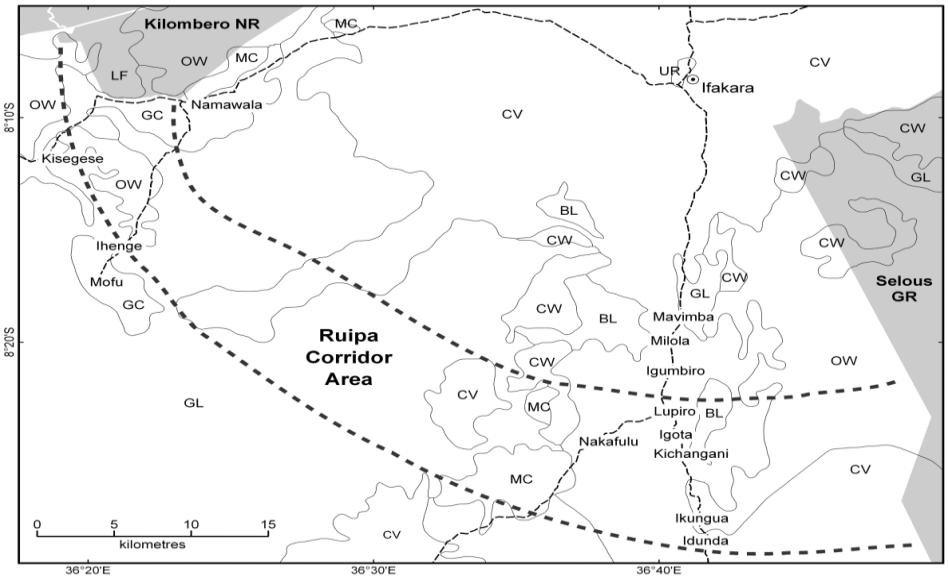

Figure 2.13: Ruipa Corridor Area in Tanzania (Jones et al., 2012)

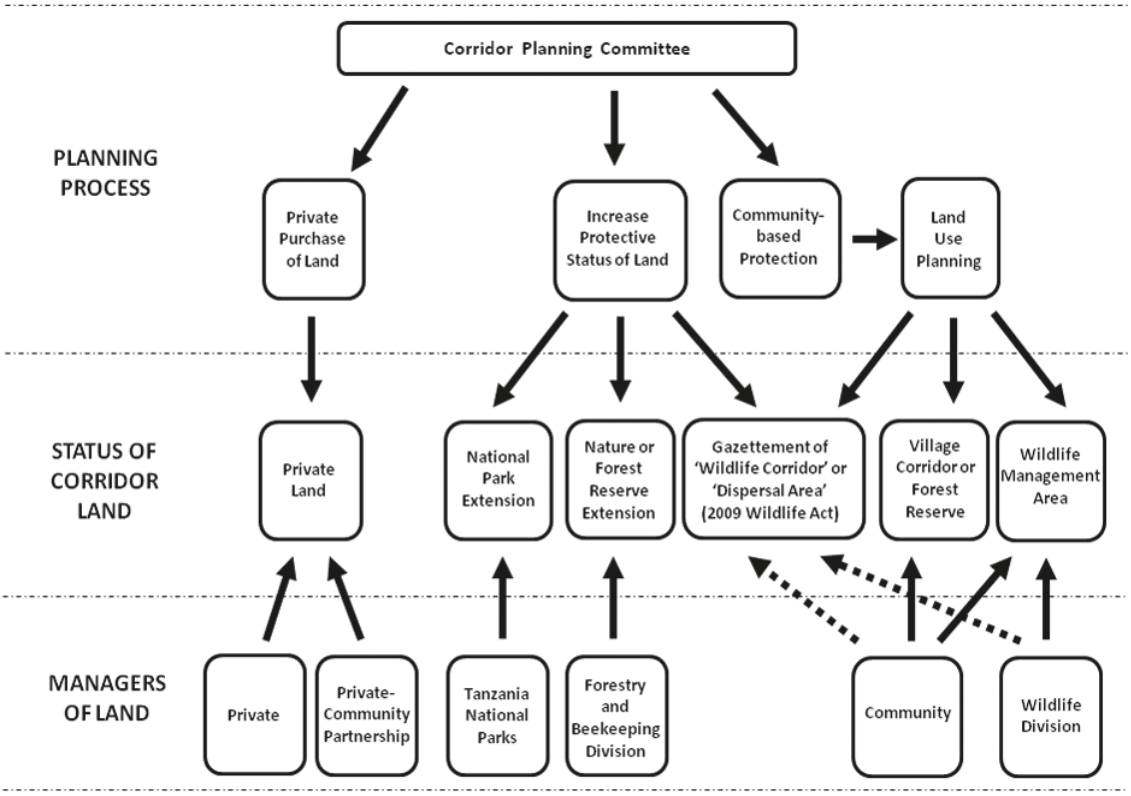

Figure 2.14: Scheme for corridors conservation in Tanzania (Jones et al., 2012)

Figure 2.14 shows the scheme of factors should be taken to conserve corridors, green corridor`s conservation is starting with the extension of nature or forest reserve by increasing the protective status of the land. Protected areas in the study area in Jordan have chosen as an extension of nature and biodiversity sources. This case study shows the importance of forests extension, where it considers as an opportunity for the success of the Green Corridor, the criteria used in the design to find the supporting elements of the green corridor by improving the protective index and The need of government`s attention.

2.5.4 India

The Kanha-Pench corridor is one of the most important green corridors in India and decreases tiger dispersal between Kanha and Pench Tiger Reserves, the corridor complex hovers around 120 tigers creating a healthy metapopulation of tigers in central India, along with other wildlife diversity. Landscape planning also provides diverse land cover, vegetation protection regimes, and traditional inhabitants communities (Srivastava & Tyagi, 2016).

Figures (2.15, 2.16) show two popular green corridors in India, these examples present to analyze several obstacles of green conservation and management. The solutions of green corridor`s barriers should be valuable and meaningful by involving a clear framework for decision-maker for corridor conservation.

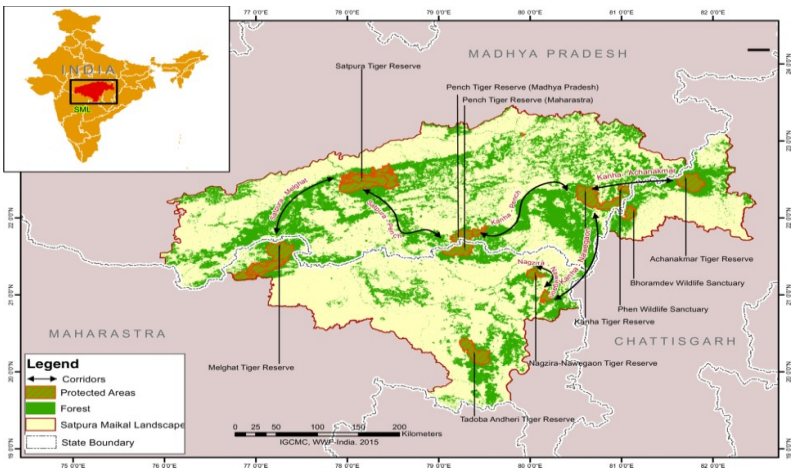

Figure 2.15: Kanha Pench corridor (Srivastava & Tyagi, 2016)

Kaziranga National Park, there are more than 2400 elephants this landscape is connected with the isolated patches through four corridors, which are facing various developmental and anthropogenic pressures by providing all services needed for human and wildlife diversity (Srivastava & Tyagi, 2016). This case study shows the importance of a clear framework, where it provides an opportunity for the success of the Green Corridor, the criteria used in the design to find solutions of the green path barriers.

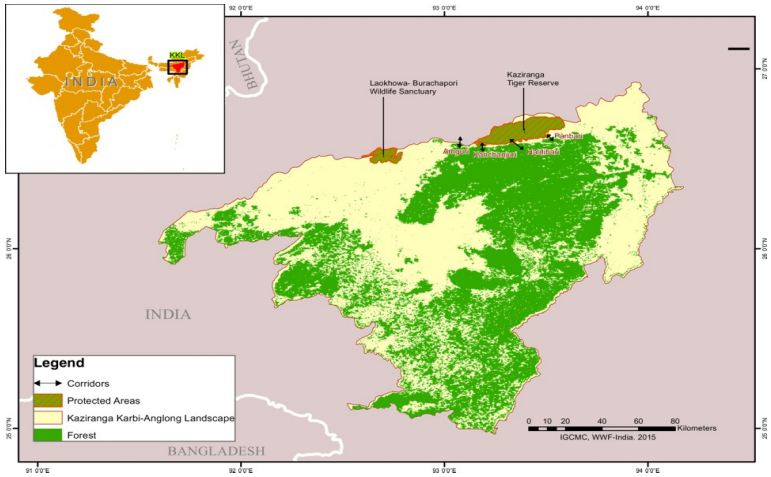

Figure 2.16: Kaziranga – KarbiAnglong Landscape (Srivastava & Tyagi, 2016)

CHAPTER 3

GREEN CORRIDORS AS AN ENVIRONMENTAL SUSTAINABILITY APPROACH IN JORDAN

3.1 Urban Green Corridor in the Global Context

The principle of a green corridor will not enable since human existence is effective. So, in an urban context, the principle of an urban corridor provides and contributes to the reduction in visual pollution of urban air quality. Numerous Problems have appeared in the global context such as visual pollution, The acute shortage of services needed, and the temperature is minimized by the effect of protecting the natural environment.in addition, improving the quality of air life, urban green corridors provide suitable conditions to wildlife corridors, in the other hand, support the increase of biodiversity, the free exchange of individuals between natural elements, water infiltration (Rocha & Ramos, 2012).

Economic activities in most countries are within the center of cities. cities create opportunities and activities themselves. Most of the technological investigations occurred in the cities and therefore, all are parallel with the quality of the environment. In addition, industrial growth has led to environmental problems which threaten Health and public safety; Researchers believe it can be a disincentive to economic growth and quality of lifestyle (Eraghi et al., 2015).

3.2 Barriers on Green Corridor`s Connectivity

According to McDonald et al. (2009), the obvious effects of urbanization on biodiversity are complicated, consisting of the disappearance of isolated areas and habitat patches, exacerbating visual pollution by decreasing green spaces. According to Elmqvist et al. (2013), the largest effect of urbanization growth on wildlife diversity system is the reduction in the connectivity of wildlife patches that have been located near expanding urban areas, that don't allow an exchange of individuals between a habitat fragments from other areas of habitat.

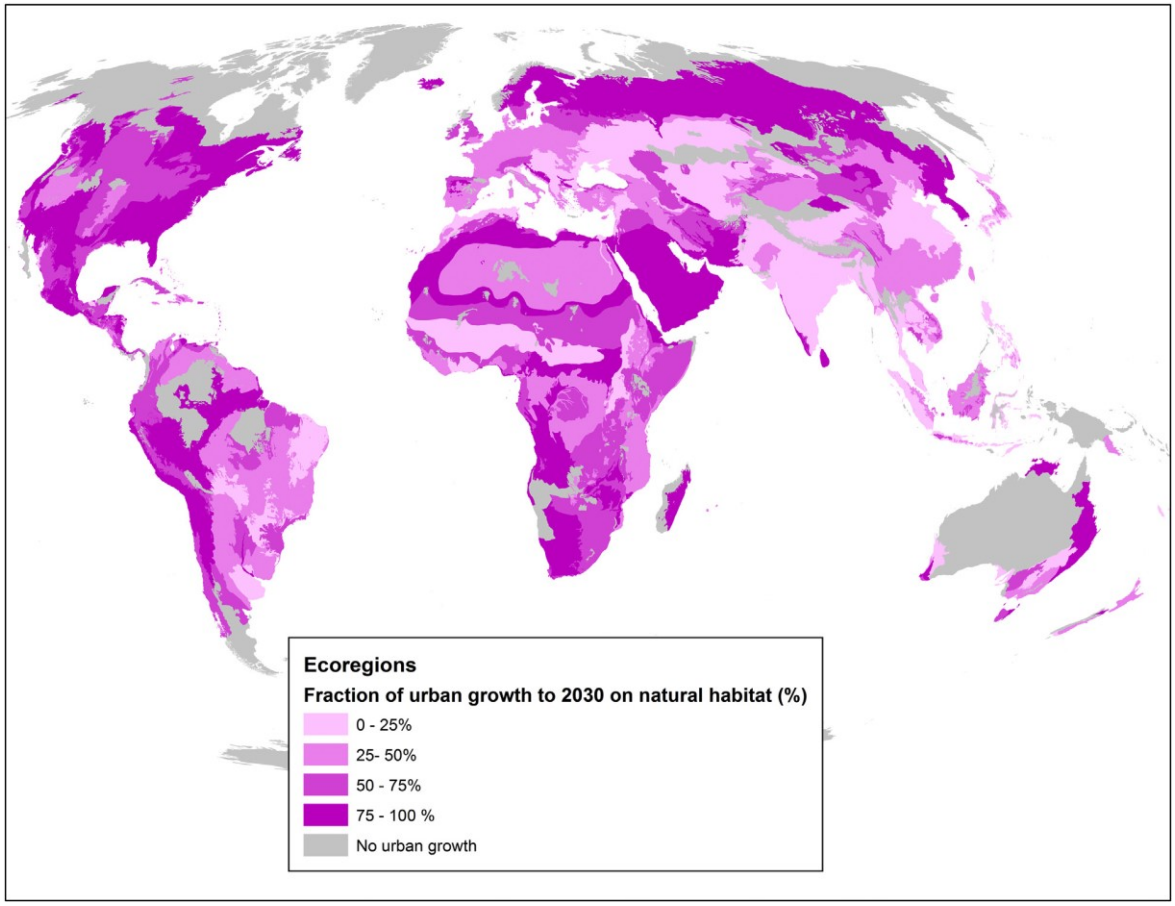

Figure 3.1: Urbanization growth percentage on natural habitat after a decade (McDonald et al., 2018)

According to Noss (1993), the obstacles in a connective path in a matrix are occurred by roads and transport corridors, one habitat fragment from other areas of a habitat that appeared in fragmentation phenomena. Because of this, green areas are separated into smaller areas that architects planners must consider and provide accurate solutions for cities.

Figure 3.1 shows the urbanization growth in the global context. According to the concept to create a green network, urbanization elements are serious obstacles to connectivity and exacerbate to isolate green patch; therefore, they should be avoided in the creation of green corridors (Li et al., 2015).

One the most problem has faced in the wildlife conservation in loss of numbers of wildlife individuals, Table 3.1 shows how the roads have decreased numbers of individuals namely: Black bear, Panthers, and Marsh rabbits. The traffic stream in Jordan threats many types of the individual when animals attempt to crossroads.

Table 3.1: Roads have decreased numbers of wildlife individuals (Harris & Scheck, 1991)

Reason	Example
Roads natural migration routes and death results When animals attempt to cross the traffic stream	Black bear on US
Roads provide a deceptively easy movement Opportunity and animals intermingle with traffic	Panthers and bears in wetlands
Roads bisect established ranges	Panthers in Big Cypress National Reserve
New food resources made	Marsh rabbits
New habitat is attractive as an ecological trap	Cattle egret, marsh rabbit
New environment serves	Florida mouse, love bugs

Generally, the barriers and any obstacles should be as miniature as possible to increase in the connectivity of wildlife which is linking one of habitat fragment from other areas of habitat through provides an integrated framework of a connective corridor (Fleury & Brown, 1997).

3.3 History, Culture and Economy in Jordan

Jordan located in the southwest part of Asia Continental. People from different cultures have come to this region in a continuous way; Jordan had various civilizations and nations migrations which were built on them civilizations committees at that time. As were built rooted kingdoms in various locations: Napatiens on the southern part, Ammonites in the middle, and Gileadians and Ghassanid in the north, and the expansion of the Romans, Byzantines impact then on the land of Jordan in 63 AD, the region stayed under the control of Romanian during the four hundred years, until the presence of Muslims, that end to the Byzantine existence by Arabs and Muslims who were came from the south. Still, Jordan had been a representation of Various Islamic Rules Systems (Ghraybeh, 2014).

Jordan Emirate appeared in 1921 and Prince Abdullah manages this region, and Hashemite Family ruled Jordan until this moment. The populations' citizens from different cultures have come to this region in a continuous way; Jordan had various civilizations and nations migrations, which gave Jordan its contemporary personality. In addition, an important factor gave country special socialization identical in making Jordanians like Bedouins in their Habits and traditions upon its regional site and its short distance from the south where many Bedouin Arab Tribes came from there and settled on Jordan area (Gharaybeh, 2014).

3.4 Geography and Climate of Jordan

According to Freiwana & Kadioglu (2008), the county of Jordan is divided into a desert Lands towards the east and Mountain Highland areas in the west according to the biogeographic nature. The huge Rift Valley Determines the eastern and western banks of the Jordan River, with more than 70% Stable Jordanian population living in that region (CIA, 2016). The Characteristics of the soil and the shortage of water resources, as well as variable rainfall, in addition, reduce the capacities and possibilities of majority land covers and other natural factors (FAO, 1992). The climate of the study area shows a sharp difference in temperature in the two main seasons and temperature average from 31.5 °C in the summer to 5.7 °C in the winter.

According to Figure 3.3, The maps show the highest annual rainfall in the northwest of Jordan that supports wildlife and the environment diversity, Designing a green corridor in this area encourages to between the isolated patches, in addition increasing the vegetation in the northwest reduces the highest annual water evaporation, Figure 3.2 shows the annual evaporation in Jordan.

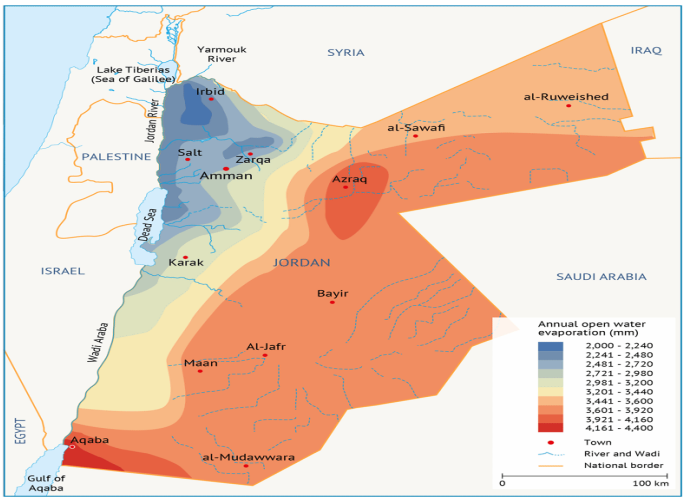

Figure 3.2: Annual open water evaporation. Source: ww.water.fanack.com/jordan/geography-climate-population/ frank

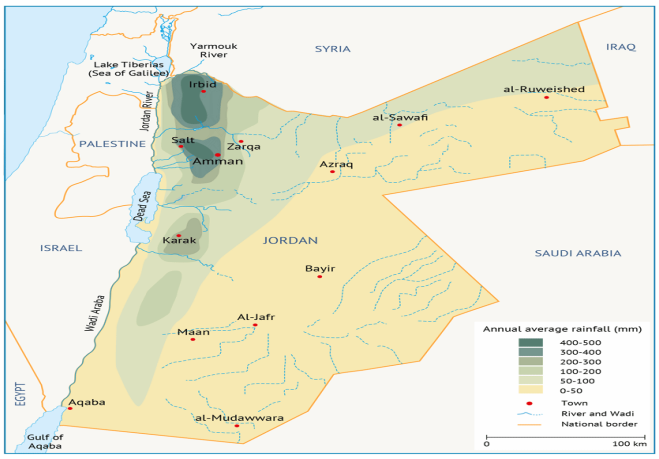

Figure 3.3: Annual average rainfall and precipitation. Source: www.water.fanack.com/jordan/geography-climate-population/ frank

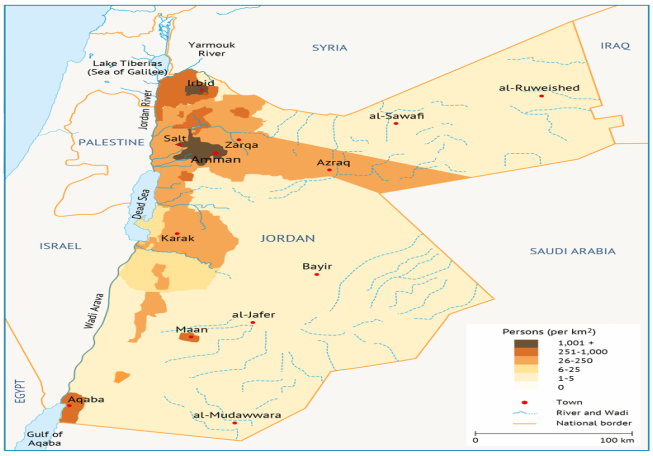

Figure 3.4: Population density in Jordan. Source: www.water.fanack.com/jordan/geography-climate-population/ frank

Figure 3.5: Ajloun map by Google Earth and GIS program

3.5 Study Region of the Research

3.5.1 Ajloun City

In the northwest region of Jordan Ajloun is located at a distance less than 80 kilometers from the capital of Jordan. It's one of the smallest Jordanian governorates. It's reaching 1200 m height above sea level, topography covered with diversity plants, featured weather during the whole year, unique mountains, valleys with streams, Unique archaeological sites, areas for climbing and various activities. That makes Ajloun an important place for tourism at both local and regional levels. This Provides a quiet and beautiful area of visitors activities, see Figure 3.6 (Al-Kheder et al., 2016).

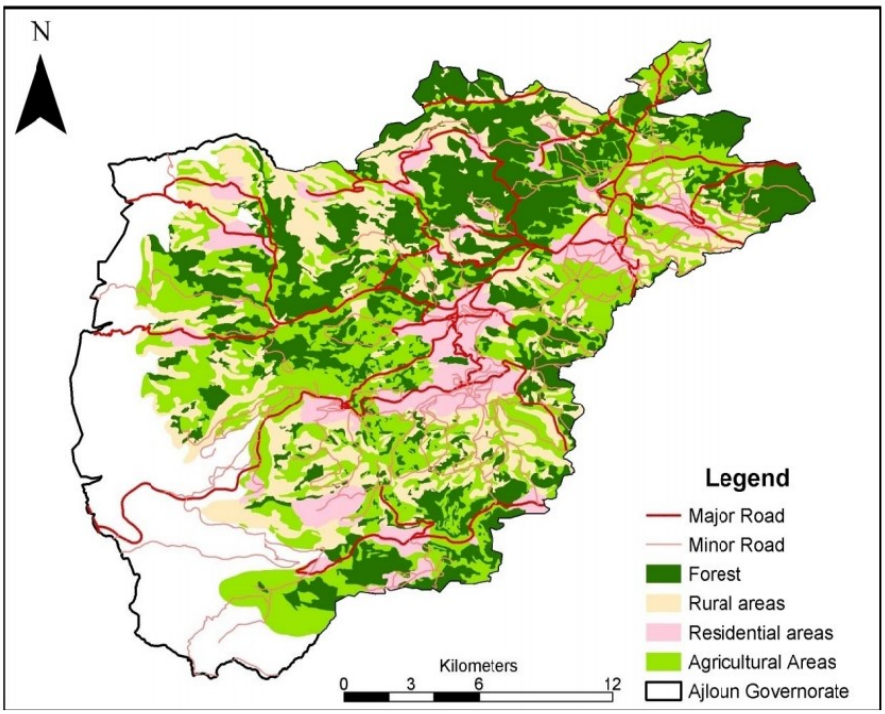

Figure 3.6: GIS land cover map for Ajloun (Al-Kkader et al., 2016)

Figure 3.7 shows the topography of Ajloun, Ajloun has a unique mountainous topography which impacts the infrastructure services, such as roads, municipality boundaries, and other aspects. The contour lines were converted into TIN surface to provide a deeper understanding of the topography of Ajloun (Al-Kheder et al., 2016).

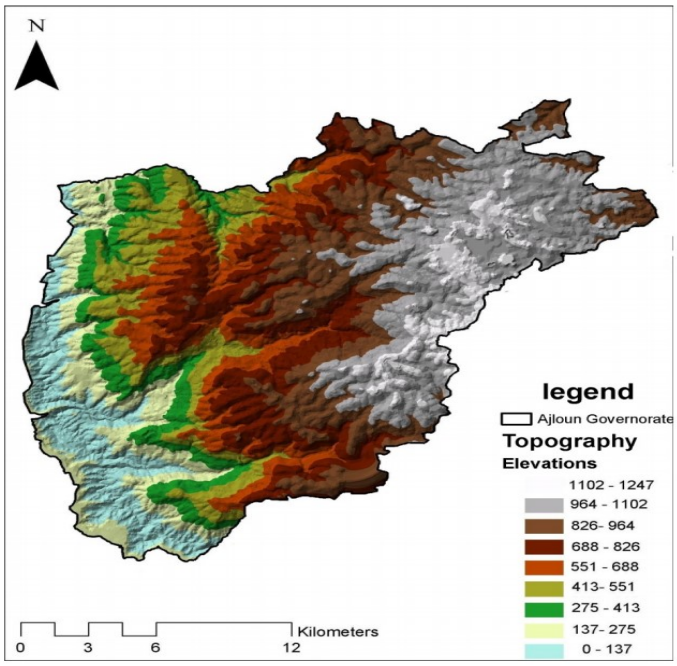

Figure 3.7: Topography of Ajloun city (Al-Kkader et al., 2016)

Different sites have limited accessibility; this includes problems related to the road network, transportation safety, and land cover violations. GIS is a very important tool in providing better understanding. The road network in Ajloun is poorly model missing the minimum infrastructure criteria. The roads are missing pedestrian services, creates obstructions in pedestrian movement in the city. Finally, there are obstructions need to develop a pedestrian movement system for all minor road networks to assess the pedestrian conditions in the city, Figure 3.8 presents a proposed parking extension (Al-Kheder et al., 2016).

Figure 3.8: Proposed parking extension (Al-Khader et al., 2016)

The land cover obstructions in Ajloun came mainly from nearby construction project by laws number 21 and 23 for the years 1988 and 2002. The priority plan is needed to begin solving the main problems under the available budget constraints and urgently needed to evaluate the projects and their effectiveness in enhancing local institutions (Al-Kheder et al., 2016).

Ajloun Forest Reserve (see Figure 3.9) is a nature reserve situated within the Ajloun Governorate. Managed by RSCN (Royal Society for Conservation of Nature). Ajloun Forest Reserve Established in 1987, the area about 12 square kilometers. There is the availability of plant diversity from trees such as trees Maple, butcher, wild olive, oak and pine (RSCN, 2018).

Figure 3.9: Ajloun Forest Reserve (RSCN, 2018)

Figure 3.10: Wildlife diversity in Ajloun Forest, A)Beech Marten, B)Red Fox, C)Golden Jackal, D)Striped Hyena, E)Caucasian Squirrel, F)Indian Crested Porcupine (RSCN, 2018)

Figure 3.11: Ajloun Landmark by Google Earth

Figure 3.12: Jerash map by Google Earth and GIS

3.5.2 Jerash City

Jerash is one of the best examples in the Middle East of Roman city; it is considered as one of the three great classical city sites in the Near East. Jerash city was a mega city during the Roman and Byzantine period and this indicated by the construction of impressive historical and archeological sites. Landscape planning in history represent the "combined works of nature and man, they are illustrative of the evolution of human societies and settlements over time". Jerash area has seen enormous development over the past 50 years, especially in the modern city of Jerash. It has many changes related to tourism development, commercial development, population growth, infrastructure, and increased utilization of natural resources". Due to the importance of the cultural landscape of Jerash and because of the rapid development in tourism and commercial sectors, there is a necessity to protect this unique cultural landscape, The cultural landscape concept belonging, outstanding, locality, meaning, and singularity of place. So we have to protect the cultural landscape from the impacts of modern urbanization. The Jerash city lands were used in and around the archaeological sites with uncontrolled urbanization which modified the harmonious development from 1992 until 2016, see in Table 3.2, which show the percentage of land use changes during the period between 1992 and 2016 (Al-Saad, 2017).

Table 3.2: The land cover changes from 1992 to 2016 (Al-Saad, 2017)

Year	Density Population	Agricultural Land	Commercial	Unused Spaces	Public Spaces
1992	14.9%	19.4%	2.5%	14.2%	3.8%
2000	30.8%	8.2%	3.6%	2.3%	4.4%
2007	31.4%	9.2%	3.6%	1.4%	4.4%
2016	31.9%	9.4%	3.6%	1.8%	4.7%

The new developments in the landscape one of the impact of modern urbanization on the world heritage, providing varied services for tourists and visitors, adapting historic sites to suit the vital commercial spaces around the city (Lennon, 2003).

Modern urbanization impact the integrity of World Heritage cultural landscapes stem from the developments in the landscape, commercial activities, housing, infrastructure, Amman -Irbid road and the buffer zones around the city.in the center of the Jerash are the

commercial activities, and the commercial development is adapting the continuing growth toward the main road. The center of Jerash is expanding in its buildings towards the east and northeast though there is some expansion toward the Mafraq highway. After the increasing in Jerash population numbers, the random construction and haphazard building appeared as houses and buildings these buildings caused filling all the gaps in the downtown area. The construction of new buildings distorts the quality of the setting of the archaeological remains. There are a lot of problems of the population growth and housing are the concentration of the workplace in the center of the city, the migration from the villages to the city which is adding pressure on the services, random construction. The ancient terraces have been damaged; this way causes harmful impacts, including erosion, damage to vegetation and water pollution. The geographical situation and its accessibility affect on the growth of the city and its economic power. Establishment of new services and infrastructures in the heritage sites detract from the original monuments. Any infrastructure services need to be carefully planned to protect the site. The impacts of transportation infrastructure; Jerash municipality created Southward prolongation of the market street by the demolition of a solidcluster of an ancient building**,** Destruction of variety of ancient buildings, Demolition of the southeastern corner tower of the Ancient town, views of the North Gate location obscured by infrastructure cables (Al-Saad, 2017).

The main urban transport service in Jerash city is Amman-Irbid road. This road has contributed to the population growth and as a result, put development pressure on the land between the older parts of modern Jerash. The main road separates the Heritage Site from the modern city. Creating buffer zones require producing modern base maps of the Jerash area to be used in GIS modeling. That limits urbanization activities and protects the integrity of the site from different impacts of urbanization activities in the modern city of Jerash for preventing the impacts of modern urbanization (Al-Saad, 2017).

Figure 3.13: Jerash landmark by Google Earth

The Wildlife Diversity in Dibben Nature Reserve

Managed by the Royal Society for the Conservation of Nature, Dibben Nature Reserve Established in 2004 (see Figure 3.14), the area about 8.5 square kilometers, It hosts at least 17 threatened species Extinction at the local level such as the Persian squirrel. There is the availability of plant diversity from trees such as trees Maple, butcher, wild olive, oak and pine (RSCN, 2018).

Figure 3.14: Dibben Nature Reserve (RSCN, 2018)

Figure 3.15: Wildlife diversity in Dibeen Forest, A)Persian Squirrel, B)Syrian Woodpecker, C)Palestine Sunbird, D)Blue Tit, E)Wrens, F)Tawny Owl(RSCN, 2018)

Figure 3.16: Al-Salt Map by Google Earth and GIS

3.5.3 Al-Salt City

Jordan is a historical place; there are many buildings with different architectural heritage. Many different cultures, periods passed Jordan is starting from the pre-historic civilization; Nabataea, Greek, Roman, Byzantine, Islamic and contemporary periods. All these periods have many cultures which show different resources for history, tourism and, historical heritage. As-Salt city one of The historic cities full of rich architectural traditions, craft skills, design, urbanization, various arcs, key bow and decoration (Sqour &Tarad, 2015).

The culture affects on the spaces and dimensions of buildings to identify the identity of the place and the history, the identity of the building reflects the culture of people to design their houses to get the best design. Al salt city is located on the western mountains of Jordan overlooking to Jordan River. the population around 115, 000 inhabitants, Salt above sea level around 800-1120 meters, the urban planning of the city involve many factors, natural, social, cultural, materials of construction are stone materials and especially yellow stone. The climate in Al-Salt is mild compared to the Jordan desert. The Culture of Al-Salt city one the important elements plays and draws the outline of the building design, materials of the building, windows, doors, entrances, traditional architecture (Almatarnh, 2013).

The study of architecture is important to show the historical and traditional buildings in this city are interested in green spaces by having courtyards inside houses and gardens in the outside. That concept shows to increase air quality and provides all services needed by humans in terms of visual (Alsubeh, 2013).

Figure 3.17: Al-Salt city on the map of Jordan.Source:www.lonelyplanet.com/maps/middle-east/jordan/

Cultural and social heritage of the houses in As-Salt show the importance of them to design the houses there, the urban planning designed by the social activities, begging with shops in the center of the city, the city affected by different periods, Greece, Roman, Byzantines, Islamic, to the Ottoman (Alsubeh, 2013). Traditional style Most of the old buildings of As-Salt were built using Yellowstone, using of arched window detailed in the façade, the contemporary architecture constructed less than 50 years ago, using the white stone with different scale (50 -25 – 12.5 cm). The old buildings were built of yellow stone from local resources local techniques and (tiles) from Germany and some artists from Lebanon (Fakhouri & Haddad, 2017). Figure 3.18 shows land cover changes in Al-salt City, the residential urbanization growth is increasing in Al-Salt city that threats the green open spaces to deal with urbanization requirements.

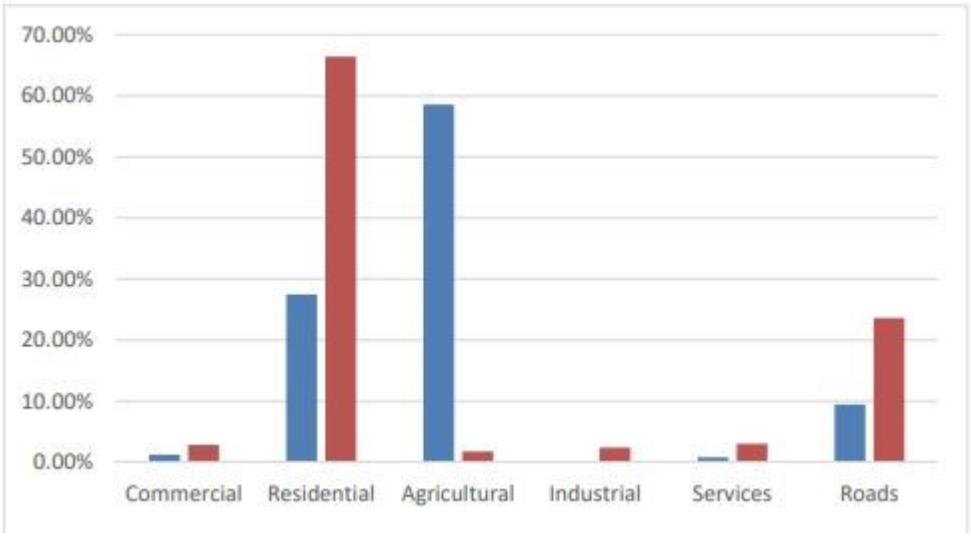

Figure 3.18: land cover changes in Al-Salt city (Qtiashat et al., 2018)

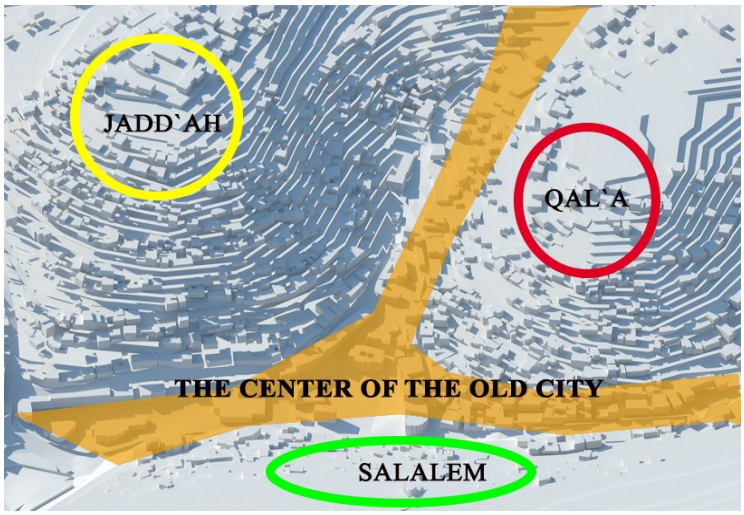

Figure 3.19: Al-Salt topography model with three hills to create the center of the old city (Fakhouri & Haddad, 2017; added by Author, 2018)

According to Figure 3.19, Al-Salt is characterized by the geographical sloping terrain. Three major mountains compose the ancient city of Al-Salt; one of the mountains (SALALEM) was built in modern times from the White Stone with a clear vision shows an increase in the height of buildings. Al-Salt's climate is hot in the summer and cold in the winter as a Mediterranean country (Almatarnh, 2013).

The forest zoning in Al-Salt city is presented in Zay area (see Figure 3.20), Zay is a village in Jordan. It is one of the most beautiful natural resorts in Jordan and a district of Al-Salt city, Zay forests famous for pine, cypress, olives, and grapes, dominated by mountainous nature and perennials trees. To the west we can see the Jordan Valley from Zay`s mountains, most of the visitors to the forests of Zay are Jordanian citizens (personal communication, January 2019).

Figure 3.20: Zay Forest in Al-Salt city (Author, 2019)

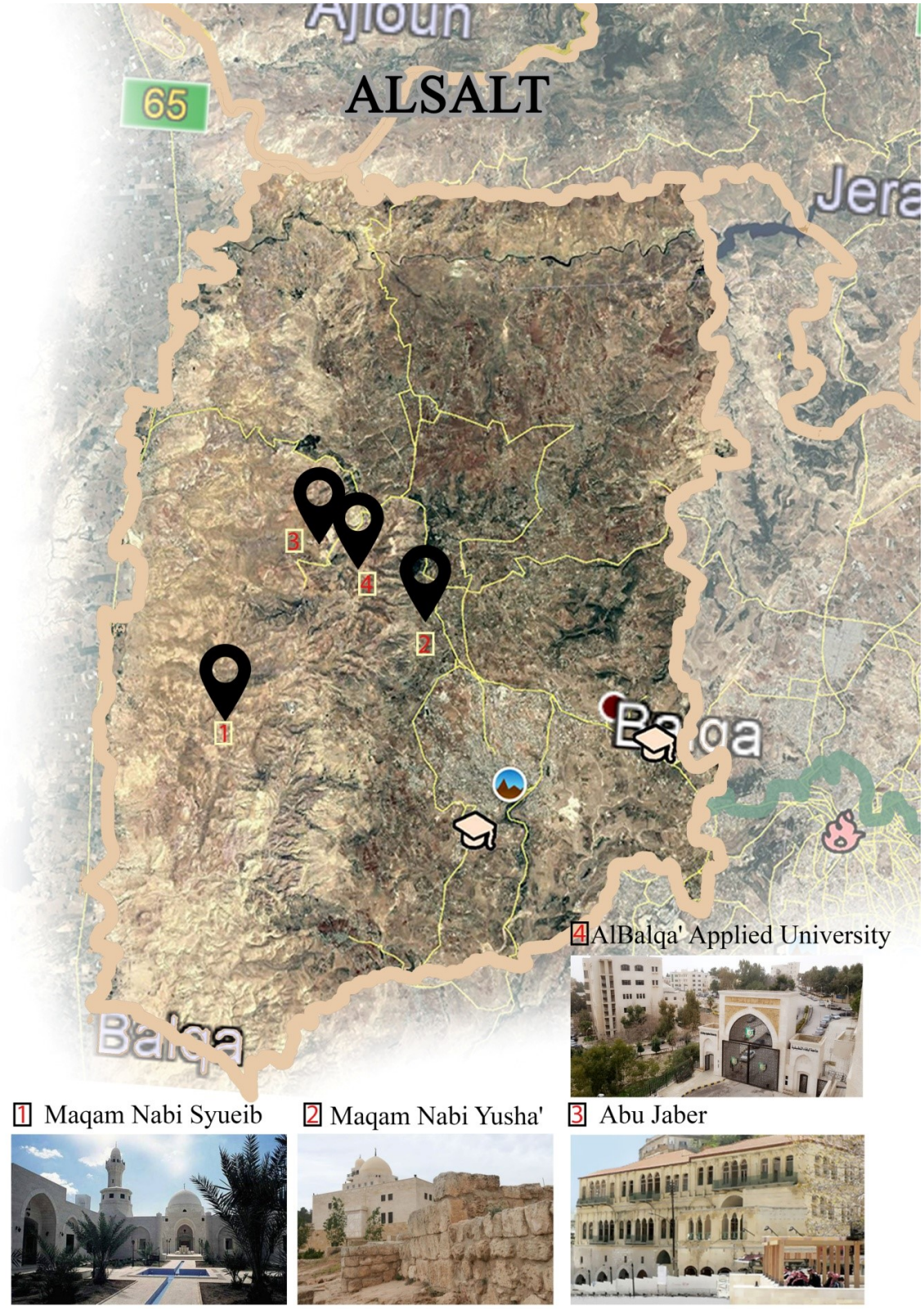

Figure 3.21: Al-Salt Landmark by Google Earth

Figure3.22: North Amman map by Google Earth and GIS

3.5.4 Amman

Amman is the Capital of Jordan. Seven major mountains compose the ancient city of Amman (Raselain) there is Greater Amman Municipality located, to the west of Amman is Al-Salt where a major road (Alsarou Street) links them (Potter et al., 2008).

The topography of Amman illustrates the shape of the city and Transport network within the city so that has planned each district, the names of each district have attributed to the name of the mountain where it is located (Al-Azhari & Al-Najjar, 2012).

Geologically, the urban planning of Amman involves many factors, natural, social, cultural, materials of construction are stone materials and especially from limestone. Climatically, is mild compared to the desert shows a Sharp difference in temperature in the two main seasons which is relatively dry in the summer (Potter et al., 2008).

According to Figure 3.23 shows the changes in land cover in loss of open spaces and increasing in the Built up area, this Figure shows decreasing rained farming area in Amman city.

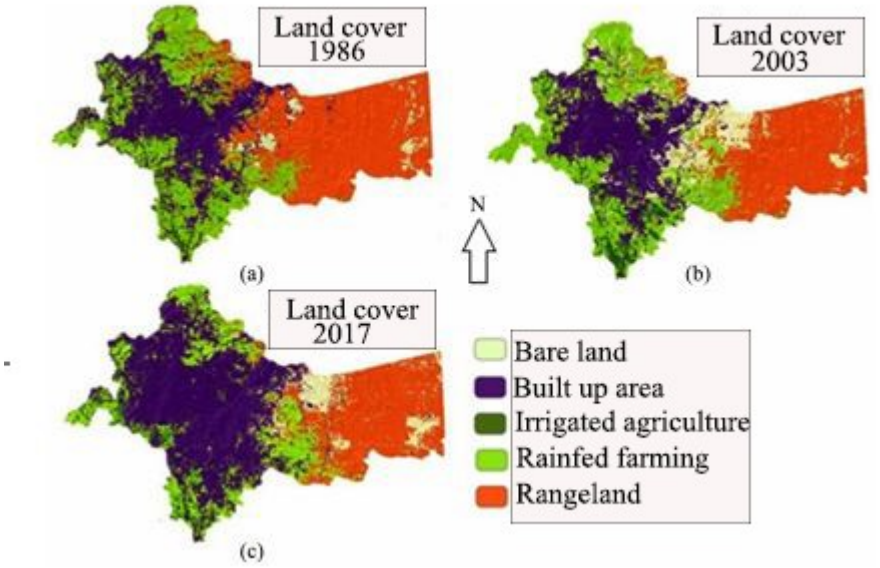

Figure 3.23: Amman Land cover; (a) 1986; (b) 2003; (c) 2017 (Farhan & Al-Shawarmeh, 2019)

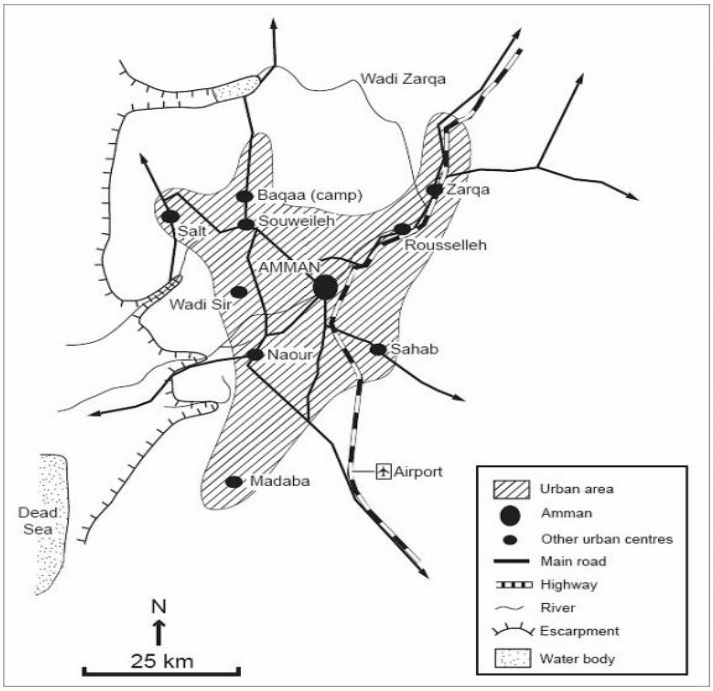

Figure 3.24: Amman: general location map (Lavergne, 2004)

More than 30% of Jordan's population lives in Amman. According to the topography of the city the development began from several decades to deal with slopes and valley as a critical node for citizens, that urban development increases extended to the middle of the sloping and flat areas (Potter et al., 2008)**.**

The capital city`s population began in the early part of the last century clearly because of crises and successive migrations From neighboring countries. that leads to transforming Amman from a small village to a large city with visual pollution. The population has exceeded two million people in recent years (DOS, 2010).

Figure 3.25 shows Amman`s population from the beginning of the last century, the residential urbanization growth is increasing in Amman city that threats the green open spaces to deal with urbanization requirements.

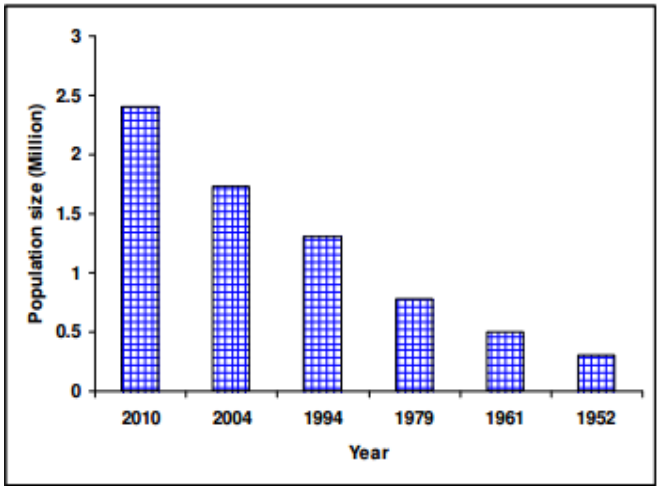

Figure 3.25: Amman`s population from the beginning of the last century (Almakhamreha & Almanasyeha, 2011)

Congestion that word characterizes the urban transport system of Amman. Amman has reflecting uncontrolled comprehensive growth. Most people in Amman do not use public transport where is the transportation system is random and unorganized. Moreover, Most people use cars or taxi, so sometimes the streets in Amman during working hours are semi-closed or traffic is very slow, That leads to destruct of public transportation Public transport due to delays in employees arrival time to their works. (Al-Asad, 2004).

Alhummar forest (see Figure 3.26) is located to the west of the Capital of Jordan, A mountainous area filled with pine trees, that forest the King of Jordan and his family are living. Alhummar is a beautiful and quiet area with landscapes related to Al-Fuhais city, west of Balqa Governorate, and we can see Al-Salt`s mountains (Personal communications, 2018).

Figure 3.26: Alhummer Forest (Author, 2018)

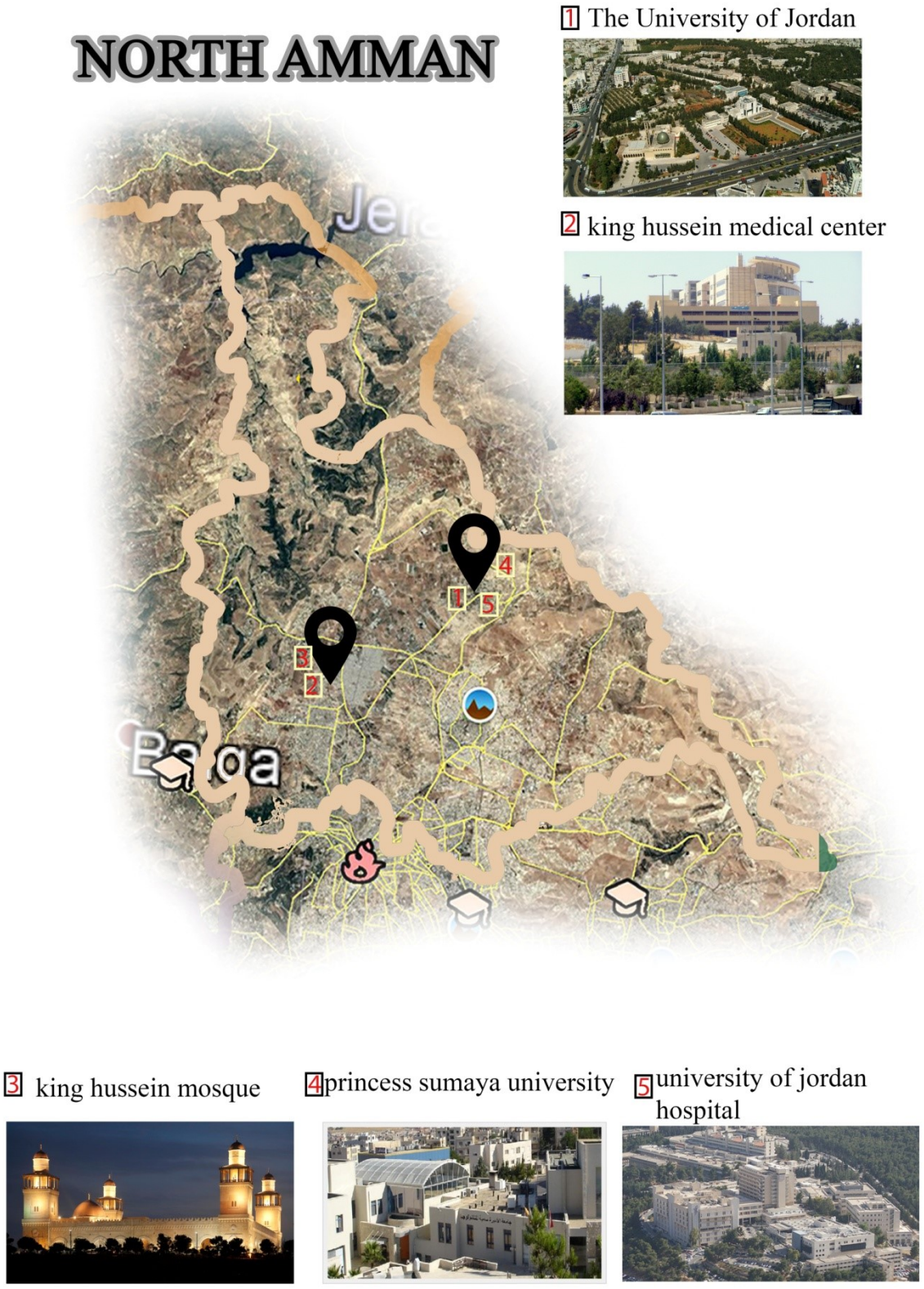

Figure 3.27: North Amman Landmark by Google Earth

3.6 Urban Planning Governance in Jordan

Figure 3.28: Greater Amman Municipality (GAM, 2018)

Greater Amman Municipality

The greater Amman municipality focuses on providing high-quality municipal services on different factors, economically, socially and environmentally. Amman Municipality is responsible for green open spaces to provide all the services needed by humans in terms of visual and attractive places for tourism (GAM, 2018).

According to Simpon (2002), GAM is responsible to increase air quality by providing the green areas of squares and playground that act to reduce in visual pollution, moreover at the same time enhance the local economic development process.

Amman considered as the largest municipality in Jordan, Where most of the towers, hotels and commercial establishments, according to the citizens and investors in different sectors, all need services from all the life activities. The infrastructure works to change and increase the efficiency of production of life requirements, through the economic development process. All of these factors achieved through the various departments of

Greater Amman Municipality, the services it provides, which serves civil society institutions (Shaqrah, 2014).

Ministry Of Municipals Affairs

Established in 1965 under the name of the interior ministry of Municipal Rural and environmental affairs. The current name was in 2002 as the Ministry of Municipal and Rural Affairs. MOMA is responsible to make sure that the actions from the local organizations in line with the current laws and regulations, providing urban studies with the comprehensive planning for the region (MOMA, 2018).

Figure 3.29: Ministry of Municipals Affairs (MOMA, 2018)

3.7 National Green Growth Plan for Jordan

The concept of National green growth plan for Jordan is to focus on alternative energy sources that are friendly with the environment And increase awareness of the use of solar energy. The project starts from the capital towards Aqaba city in the south. The long term needs to reduce using fuels to provide friendly energy with the environment, such as solar technologies for cooling and heating the houses. The vision of the National Green Growth Plan to provide a sustainable economy, jobs, reducing the cost of electric bills for citizens, reducing pollutions. That provides decent work and living conditions based on an environmentally sustainable economic growth model. The smart urban planning aims to transform the country's planning areas into friendly zones that are comfortable for residents and visitors that provide all the services needed by humans, rural flexibility planning creating an improved urban space for living requirements. Figure 3.32 shows the mainstream of the National Green Growth of Jordan (MOE, 2018).

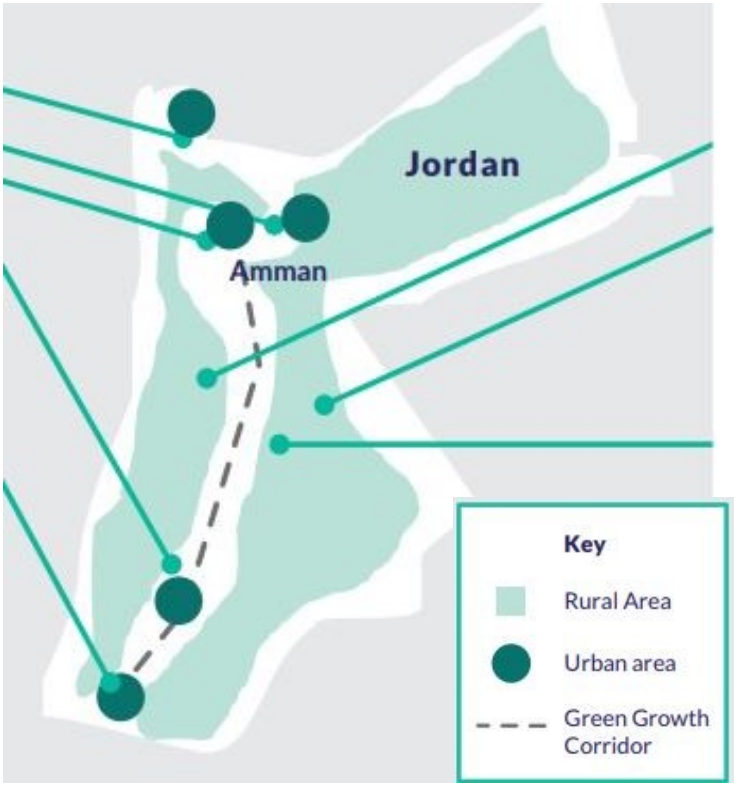

Figure 3.30: General urban plan of National Green Growth of Jordan (MOE, 2018)

CHAPTER 4
THE RESEARCH METHODOLOGY

4.1 Research strategy

Research strategy analyzes a green path (corridor) connects vegetation and biodiversity`s region to allow the animals and birds to move freely especially from the north of the study area (Ajloun and Jerash) towards Al-salt and Amman , the green corridor will connect the mountains in Ajloun (Ajloun Forest Reserve) toward Jerash (Dibben Forest Reserve) to reach Zarqa River (king Talal Dam) , that is the lowest district in the study area, that area is warm in the winter because it is low that provides a safe and suitable environment for animals and birds there is a low rainfall and less prone to storms and extreme winds in winter. Green corridor Allow the animals and birds to move from the protected areas through the green corridor and get the terrain natures mountain slopes, peaks, hills, rivers, and low areas. The .green corridor will provide access to natural green space for local residents and improve existing green spaces and lifestyle.

4.2 Research Methodology

Urbanization growth has become represented many environmental problems as a source for visual pollution that affects negatively for human activates and ecotourism. Protected areas in Jordan as attractive places for truism. Land-cover planning is being played as an important factor to enhance the protected areas and forest zones in Jordan. This thesis aims to analyze a green corridor proposal between the forest and protected areas, they are located in four cities in Jordan, green connectivity shows comprehensive planning of the representativeness of biogeographically areas, ecotourism and variety of vegetation in the protected areas namely, Ajloun Forest Reserve and Dibben Forest Reserve, and in the biodiversity regions in the Al-Salt and North. In order to meet the objectives of the thesis, the author has shown qualitative research methods under four sections. The first section concentrated on data collection from literature reviews; analyze maps (water resources, vegetation cover, forest areas, and riverbeds) which were collected from local governmental offices. According to existing forests and riverbeds, i provide a green corridor proposal between the four cities in order to create green corridor for wildlife and

sustainable environment for living organisms including humans by the following spatial criteria:

- The green corridor should be closed to a wetland area to support the wildlife (Zarqa River as an example in the study area) (Aziz & Rasidi, 2014).
- The green corridor should be closed to wildlife diversity zones as a protected area (Ajloun forest reserve and Dibben forest reserve) and natural features (Zay forest and Alhummer)
- The green corridor should be passing different elevations gradient (200m – 1200m) to provide comfortable sustainable places for visitors (Eraghi et al., 2015). The slope should be smoothed lees than 10% and the steeper decrease in the number of green spaces (Davies et al., 2008). Green corridor reduces the sharp difference in temperature during the four seasons in Jordan (31.5 C^o – 5.7 C^o) (Odeh et al., 2017; Freiwana & Kadioglum, 2008).
- The green corridor should be away from highways by creating buffer zones along the path to protect the wildlife and provides safe places for visitors (Alexandre et al., 2010)
- The green corridor should be designed according to the topography and contour lines to be parallel with urbanization growth directions most of the cities in Jordan characterized by topography (Fakhouri & Haddad, 2017).
- The wider green corridor is better for wildlife there is no scientific data to determine a green width (Peng et al., 2017).
- The green corridor should be tried to separate the populated areas to provide open spaces for citizens.
- The need of government`s attention (Orantes et al., 2017).

While the second section concentrated on analyze the data from the first point, by using Google earth and GIS and putting all information on map according to the upper criteria to meet the objectives by providing green corridor proposal, is another method used to provide representativeness of the vegetation's locations, particularly in the Al-Salt and Amman. In addition, the study was supported by personal communications with the municipality of each city and urban observations of visiting on January – march, 2019.

4.3 Study Area

The green corridor has been starting to take as a sustainable approach in the last years. Green corridor improves the urban environment planning within the framework of biodiversity and ecotourism. The study area is located in four cities in Jordan in the northwest namely: Ajloun is one of the smallest Jordanian governorates (Ajloun Forest Reserve), Jearsh is considered one of the three great classical city sites in the Near East (Dibben Nature Reserve), Al-Salt is one of the historic cities full of rich architectural traditions with 115,000 inhabitants (Zay Forest), Amman is the capital of Jordan and seven major mountains compose the ancient city of Amman (Alhummer Forest). The study area has an extent of approximately 1,500 square kilometers.

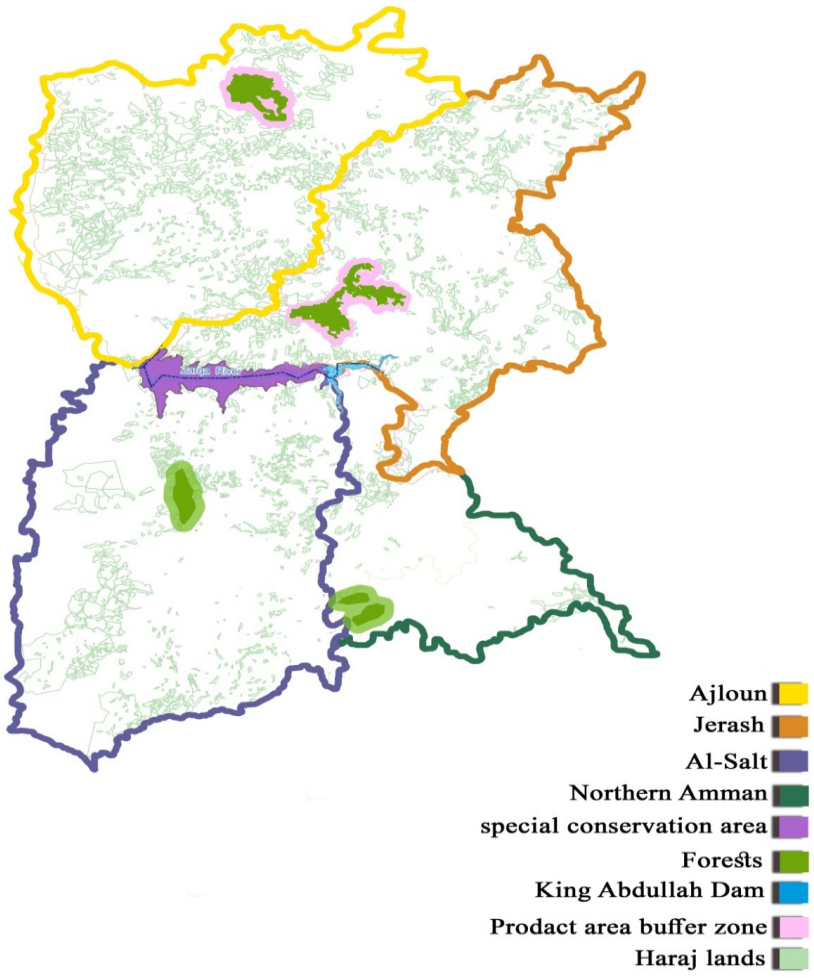

Figure 4.1: The rich of natural diversity, Forest Zoning and Water Resources of the study area (Ministry of Municipal Affairs, drawn by the Author, 2018)

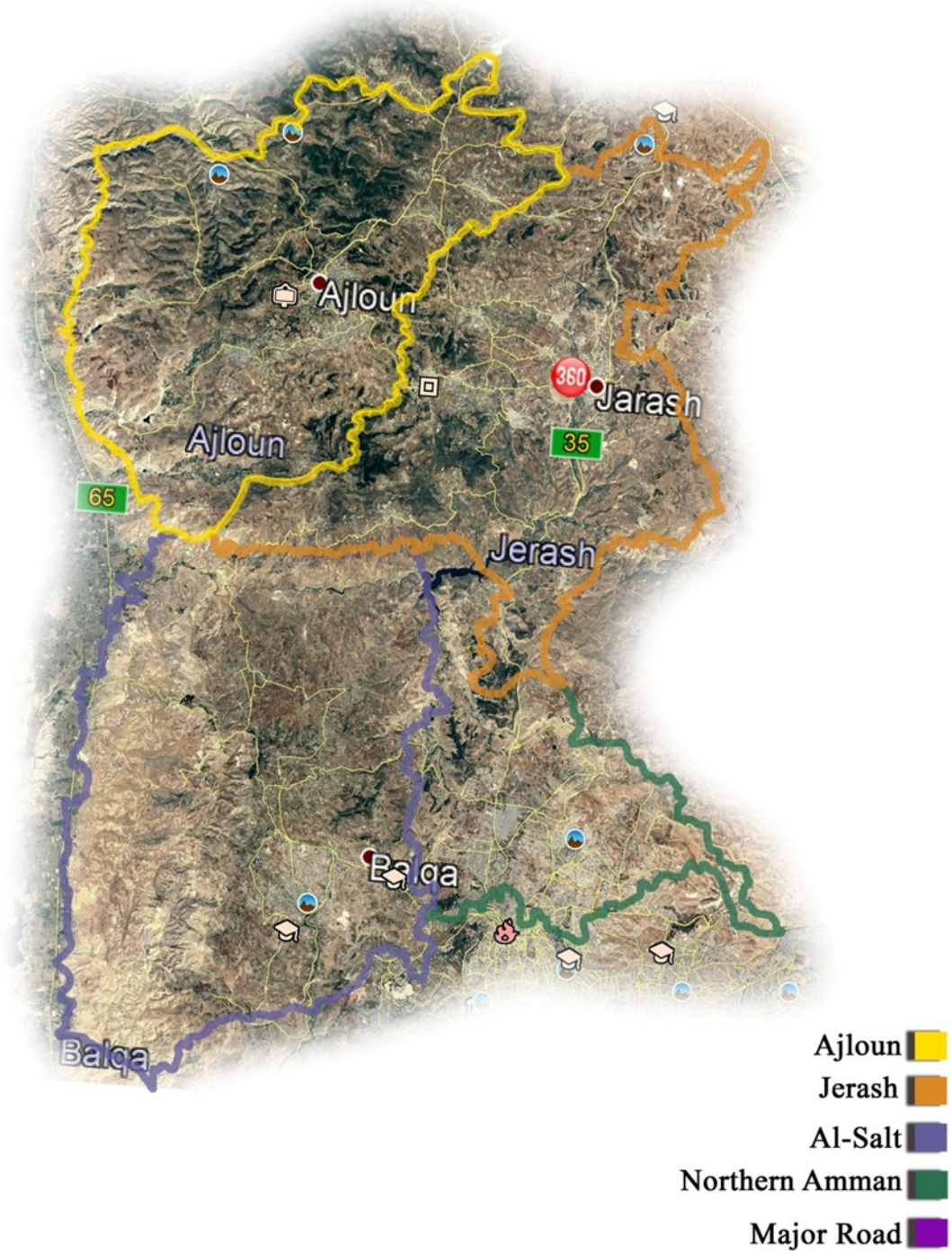

Figure 4.2: Study Area (Ministry of Municipal Affairs, drawn by Author, 2018)

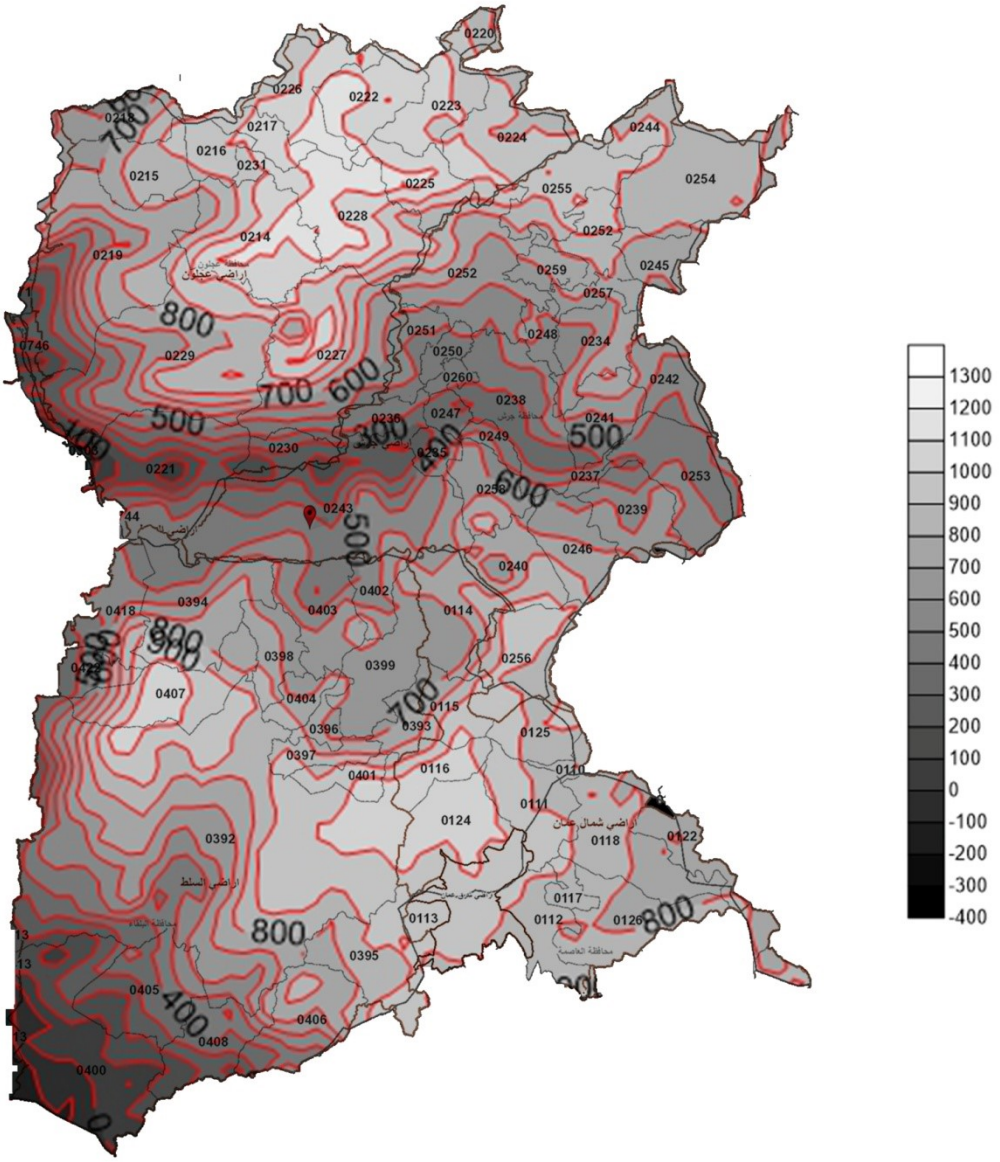

Figure 4.3: Study Area Contour by Google Earth (Author, 2018)

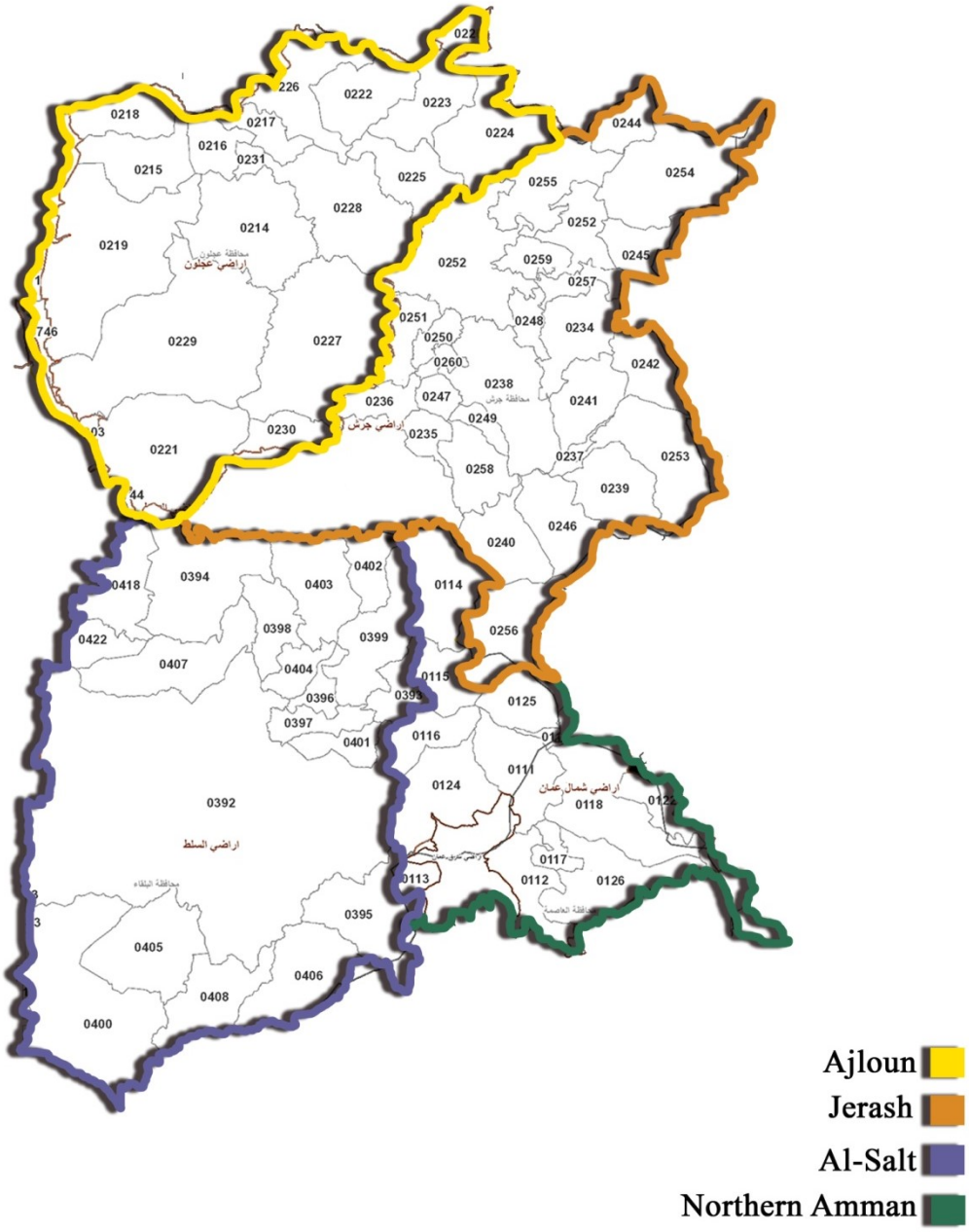

Figure 4.4: Sector (Ministry of Municipal Affairs, drawn by Author, 2018)

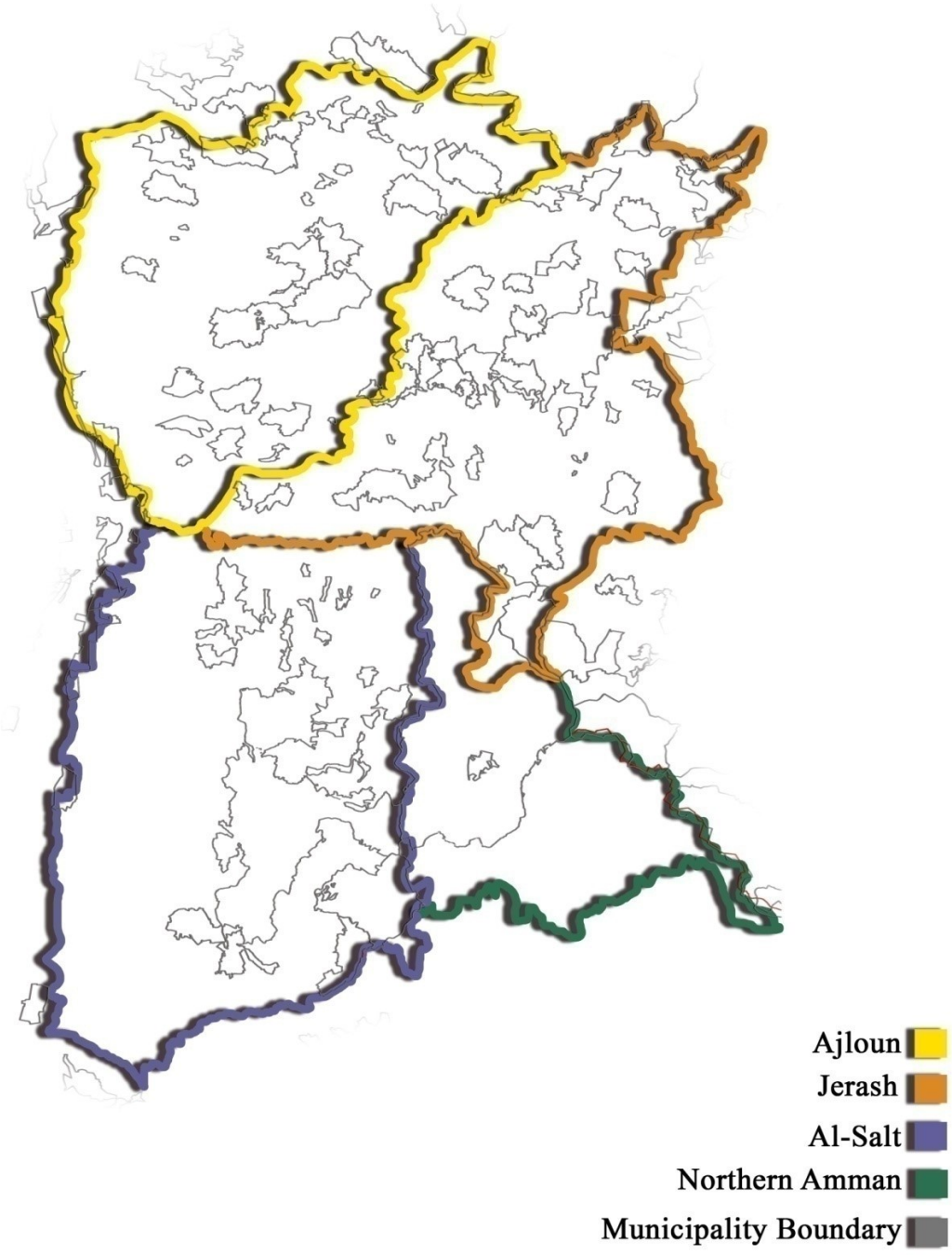

Figure 4.5: Municipality boundaries (Ministry of Municipal Affairs, drawn by Author, 2018)

Figure 4.6: Roads (Ministry of Municipal Affairs, drawn by Author, 2018)

4.4 Study Area`s Problems

The research problem is presented a growth of the population and urban extension towards the vegetation has resulted in negative impacts with random directions on the natural environment which has appeared in fragmentation for greenery systems, reducing the patches area, losing the verity of biodiversity, isolated area of habitat that decreases species of biodiversity. Royal Society for the conservation of Nature has managed the reserves (protected areas). Most of the study area`s problems area happening away from protected areas (Ajloun Forest Reserve and Dibben Nature Reserve). Protected areas in Jordan is managed and controlled by the Royal Society for Conservation of Nature, that makes a barrier of interaction between the wildlife and local residents for the conservation of nature. According to Figure 4.7 shows the Hunting the birds.

Figure 4.7: Hunting the birds (Author, 2018)

Figure 4.8 shows Cutting trees to create and expand new roads that reflect no comprehensive plan of each governorate to protect natural features. When The Municipality of each district cuts trees to create new service roads that reduce the humble awareness of citizens that has appeared in cutting trees to heat the houses and cutting of trees for to construct new commercial buildings (see figure 4.9).

Figure 4.8: Cutting trees to create and expand new roads (Author, 2018)

Figure 4.9: Cutting trees to heat the houses (Author, 2018)

Figure 4.10 shows local citizens throw the trash after leaving the place and finishing their trip that Destructs of the wild and natural life. The non-connectivity and local communities between the rich biodiversity areas lead to reduce residents' awareness to reserve nature and the protected areas, leaving the trash led to disappearing of wildlife appearances. All these factors have negatively impacted the natural environment life.

Figure 4.10: Throwing the trash (Author, 2018)

Figure 4.11: Cutting of trees to construct new commercial buildings (Author, 2019)

Figure 4.12: Cutting of trees to construct new commercial buildings (Author, 2019)

Figures (4.11, 4.12) show cutting trees to construct new commercial buildings, in Jordan the owner of commercial land is looking to build a building for economic issues to increase the incomes from lodgers, owners prefer to move the trees from the front of their buildings.

One the most problem has been facing in the wildlife conservation in Jordan is losing of numbers of wildlife individuals; Figure 4.13 shows how the roads have decreased numbers of individuals. The green corridor should be away from highways by creating buffer zones along the path to protect the wildlife and provides safe places for visitors. In the other hand, grazing affect; is popular phenomena in Jordan especially on vegetation at open spaces, see Figure 4.14.

Figure 4.13: Run over the animals on the roads (Author, 2019)

Figure 4.14: Grazing affect (Author, 2018)

4.5 Data Analysis

The study area is 1,520 square kilometers, the maps were derived from the Ministry of Agriculture and Ministry of Municipality Affairs; these maps were updated by Google Earth. The analyze approach including two sections by overlaying in GIS. The first section is concentrated on data collection from literature reviews, urban observations, maps were obtained from different ministries of each city. While the second section is concentrated on the application and analyze the data. Special criteria has used to analyze a green corridor proposal containing the following: a wetland area to support the wildlife, wildlife diversity zones as a protected area, passing different elevations gradient with smooth slope, creating buffer zones along the path to protect the wildlife, green corridor is parallel with topography lines, providing open spaces by separating the populated areas.

4.6 The History of Urban Green Development in Jordan

In fact, the history of Jordan within the preservation of the surroundings, vegetation, and life was created by the institution of natural reserves and so animals cannot move from one protected to another biodiversity area through the green path as a result of there aren't any inexperienced corridors that enable them to maneuver simply and safely. The Ajloun Forest Reserve could be a nature reserve situated within the Ajloun Governorate in north-west Jordan. Established by the honorary society For The Conservation Of Nature in 1988 within the space around the village. Dibeen Forest Managed by the Royal Society for the Conservation of Nature, Dibben Nature Reserve Established in 2004, consist of 8.5 square kilometers. This Reserve could be a nature reserve situated within the north-west of Jordan, The forest is understood because of the driest places within the region and ranges over sixty metric linear units and is dynamic in altitude of 500m to 1000m on top of water level. The rock inside the reserve could be a mixture of sedimentary rock and chalky sedimentary rock that has been shaped into steep slopes. Alhummar could be a high mountain space with pine forests. It's one among the best areas of the capital of Jordan. It's situated to the west of the Jordanian capital, a beautiful and quiet area with landscapes related to Al-Fuhais city, wherever King Abdullah II and his family live. Zay, it's one among the mountainous forest areas with dense pine forests in Jordan, To the west,

we can see the Jordan Valley from Zay`s mountains. Zay situated to the north of the governorate of Balqa.

4.7 Trees and Plants Proposed for the Corridor

Selecting trees for urban planting should be according to survival needs. We can choose beautiful trees that can bear difficult conditions such as hardwoods and with a good survivability (Ware, 1994). In addition, the author has concentrated to show the proposed natural types of trees and shrubs they are suitable with Jordan`s climate, to design the green corridor. See Figure 4.15

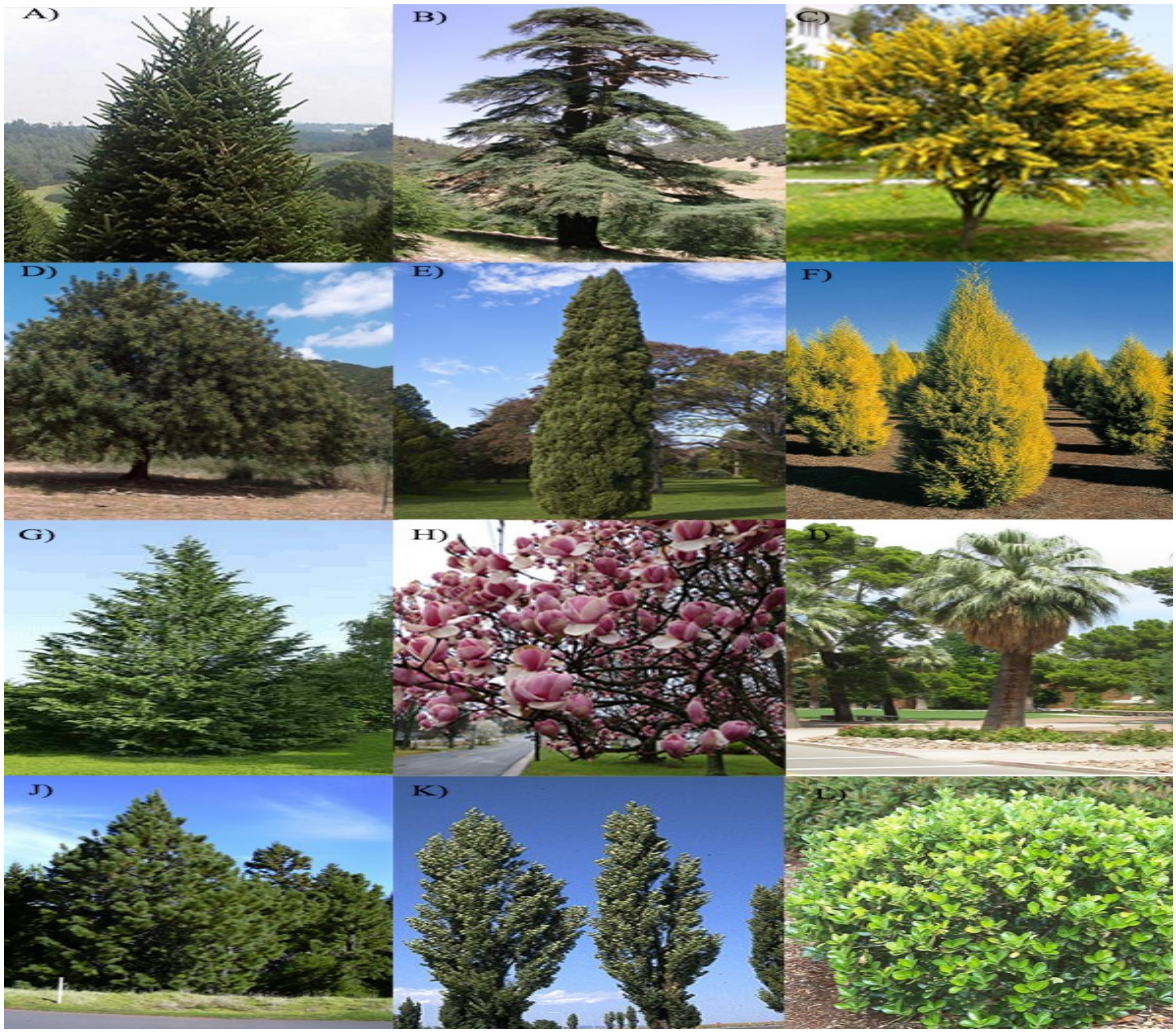

Figure 4.15: Trees and shrubs, A) Abies Fraseri, B) Cedrus Atlantica, C) Acacia cyanophylla, D) Ceratonia Siliqua, E) Cupressus Sempervirens, F) Cupressus Macrocarpa, G) Cupressocyparis Leylandii, H) Magnolia grandiflora, I) Washingtonia Filifera, J) Pinus Spp, K) Populus Nigra, L) Euonymus japonicu.(National Agricultural Research center, 2018)

The requirements of wildlife need biodiversity space to adapt to the new environment of built-up areas by human activities that are different from their natural habitat. In order to protect their species by providing adaptable areas and wildlife environment, they have to move and disperse from the habitat area to the other patches. There are many distinctive behaviors in animal's movement among the urban wildlife, first one the long-distance movement by a single individual, second periodic movement by a single animal, punctuated by pauses and gene flow through a reproduction resident by a green corridor (Aziz & Rasidi, 2014).

According to Jorgensen (1986), urban forestry: is defined as "the management of trees for their present and potential contributions to the physiological, sociological and economic well-being of urban society". According to Doick et al., (2016), another definition for urban forest: is "all the trees in the urban realm – in public and private spaces, along linear routes and waterways, and in amenity areas. It contributes to green infrastructure and the wider urban ecosystem".

The increasing concern for the quality of life in urban areas has led to a growing awareness among arboriculturists of the functional value of urban trees (Johnston, 1983). Urban trees have a significant impact on improving climatic conditions. For this reason, it is preferable to choose urban trees to reduce urban growth effects (Akay & Onder, 2016). Urban trees provide benefits for environmental aspects as air, soil, water, and temperature. Furthermore, urban trees have social benefits improving the welfare of the population and increasing the price of real estates (Frigeri et al., 2017).

4.8 Corridors` Connectivity Proposal

Design green corridor should concentrate to have a wetland as a water resource. Moreover, to determine the various terrains elevations location as a diverse environment for wildlife requirements during the four seasons. The concept in the analyzing green corridor is connecting the highest areas(1200m-1000m) to lower areas(1000m-700m) down to Zarqa river (400m-200m) as a water resource, thus obtain a suitable and gradual topographic design to enhance and facilitate. Special criteria has used to analyze a green corridor proposal containing the following: a wetland area to support the wildlife, wildlife diversity zones as a protected area, passing different elevations gradient with smooth slope, creating buffer zones along the path to protect the wildlife, green corridor is parallel with topography lines, providing open spaces by separating the populated areas. A deeper understanding of the relations between contour lines and elevations location as a diver's environment. Moreover, to determine the various terrains, for wildlife requirements during the four seasons, see Figure 4.16.

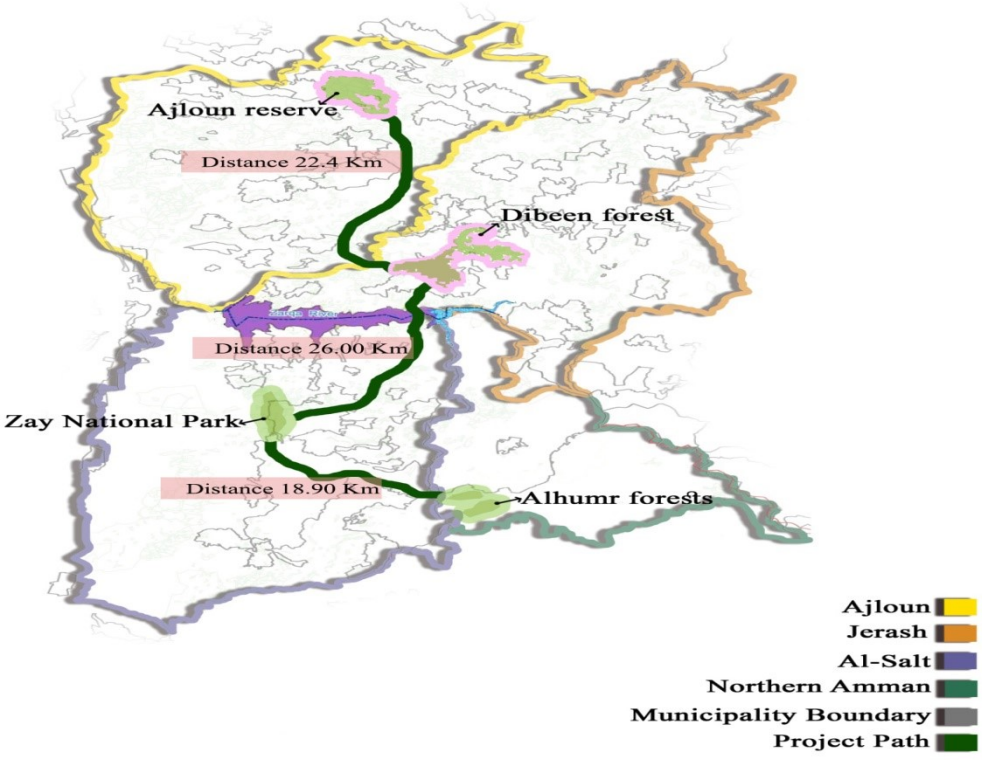

Figure 4.16: Green corridor path with distances (ministry of municipals affairs, 2018, drawn and added by Author, 2019)

CHAPTER 5
RESULTS, DISCUSSION AND CONCLUSION

5.1 Results

The green corridor has designed by a deeper understanding of the relations between contour lines and biodiversity`s requirements. The green corridor provides connectivity of one habit fragment from other areas of habitats and allows an exchange of individuals between natural living elements. Conservation of the natural open areas along the green corridor that promotes biodiversity and be home to a diverse mix of habitats and wildlife and creates new green spaces for multi-functional residents and promote healthy lifestyles. The process of linking the rich green areas with protected areas of study area increases and allows breeding for many birds and animals within the varied environmental landscape. When the green path passes through the low areas (Zarqa river) that provides a comfortable zone for wildlife`s requirements in the cold days, where is less prone to extreme winds as it represents warmer region than mountain areas.

The analyzing aims to adapt to the green corridor to urban areas, the establishment of green corridor network between rich diversity areas. This green corridor shows the environmental nature of the inhabitants and reduces the high temperature in the summer and moisturizes the atmosphere, which leads to expansion of local and external tourism, which improves the economic strength and increases the number of opportunities for citizens.

Figure 5.1 shows the green corridor is passing different elevations gradient (200m – 1200m) to provide comfortable sustainable places for visitors (Eraghi et al., 2015). The slope should be smoothed lees than 10% and the steeper decrease in the number of green spaces (Davies et al., 2008). That reduces the sharp difference in temperature during the four seasons in Jordan (31.5 C^o – 5.7 C^o) (Odeh et al., 2017; Freiwana & Kadioglum, 2008).

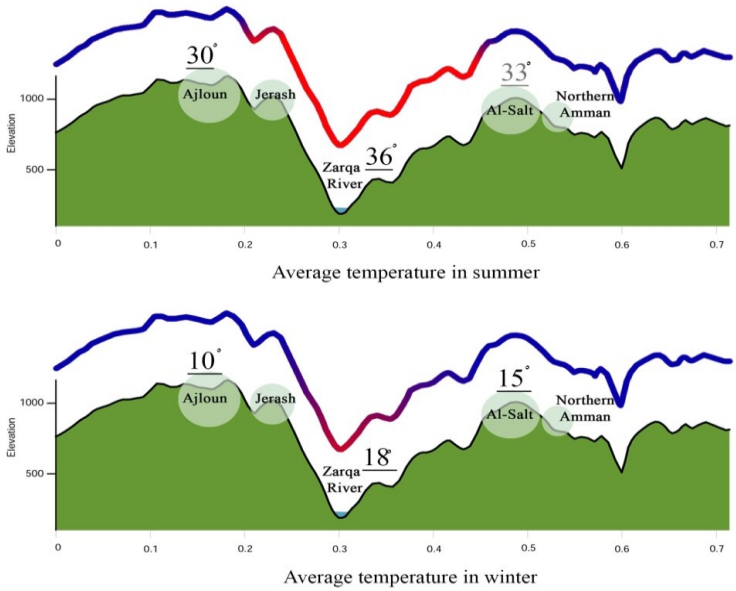

Figure 5.1: Average Temperature (Author, 2019)

The green corridor should be away from highways by creating buffer zones along the path to protect the wildlife and provides safe places for visitors (Alexandre et al., 2010). According to Figure 5.2, designing buffer zones along the green corridor as open spaces provide a vital area for all services needed by humans, attractive places for tourism, increase air quality, protect the natural environment, and enhance awareness of humans to protect wildlife.

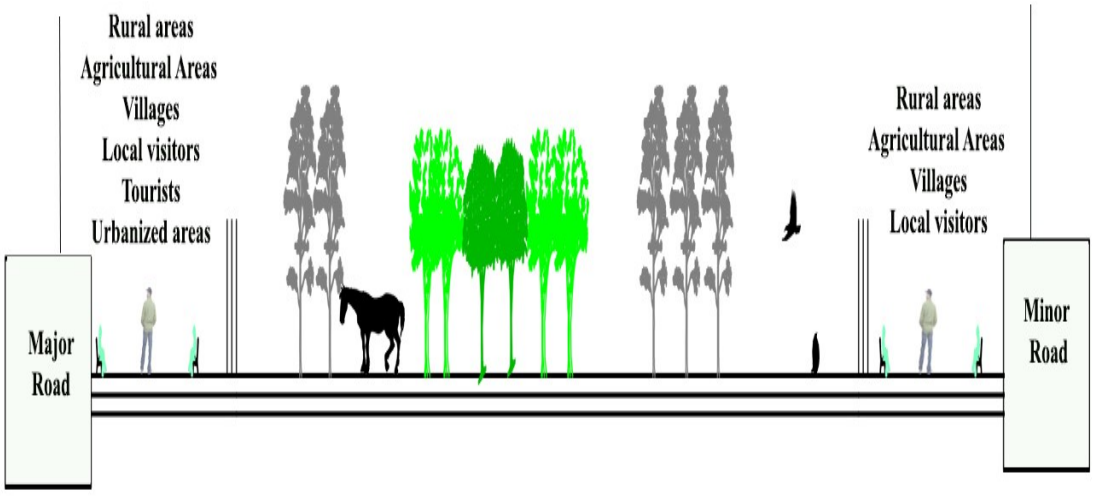

Figure 5.2: Detailed section views of the green corridor (Author, 2019)

Figure 5.3 shows green corridor`s topography should be designed according to the topography and contour lines to be parallel with urbanization growth directions most of the cities in Jordan characterized by topography (Fakhouri & Haddad, 2017).

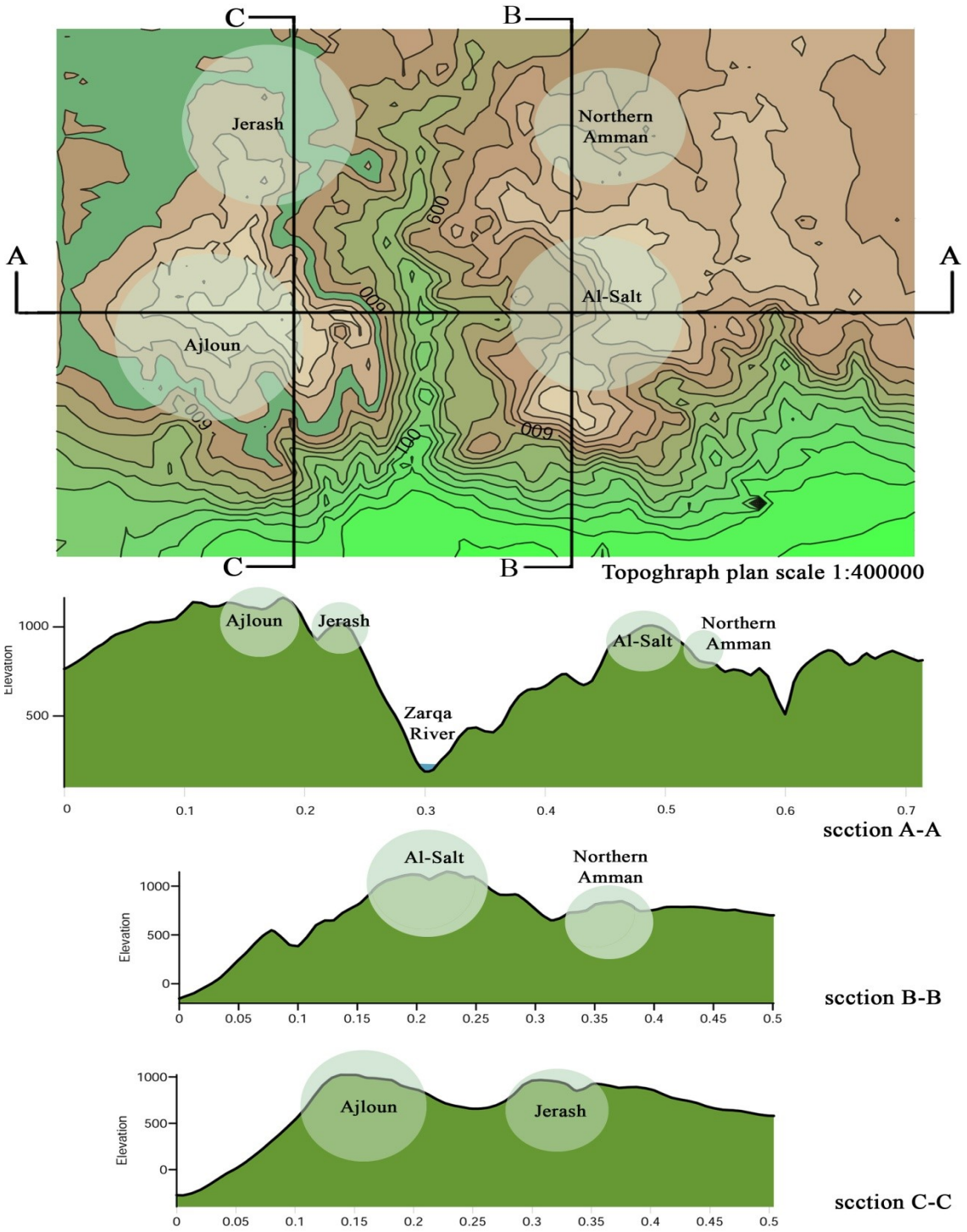

Figure 5.3: Section views of topography (Author, 2019)

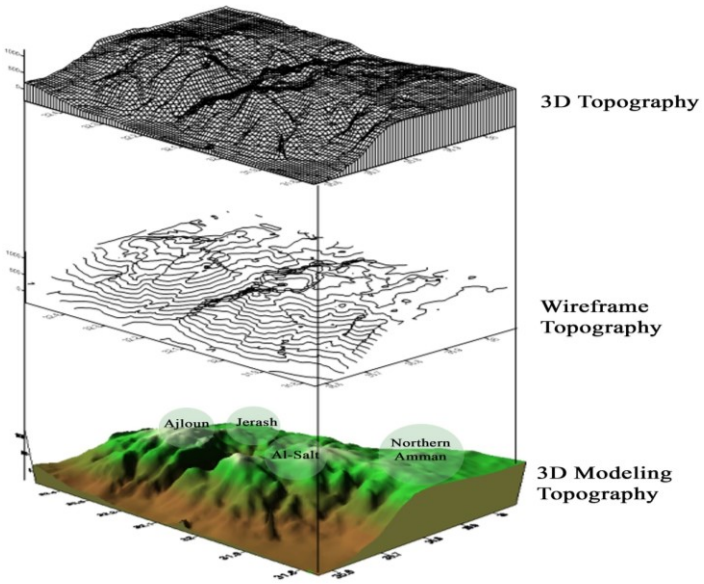

Figure 5.4: 3D Topography (Author, 2019)

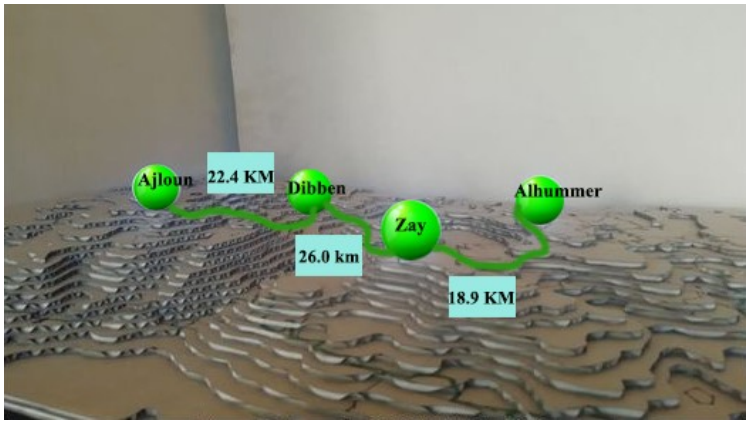

Figure 5.5: Topography 3D Model (Author, 2019)

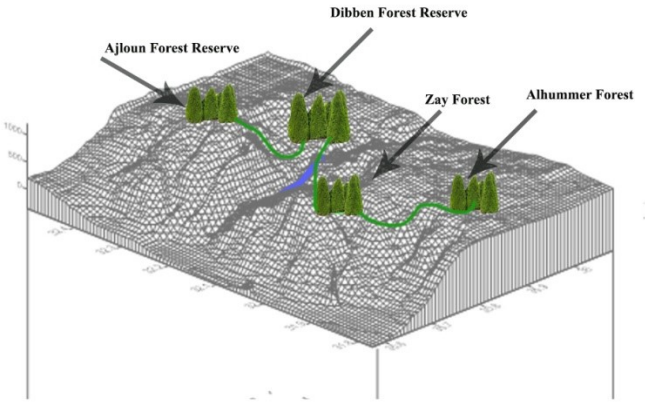

Figure 5.6: Green corridor with the topography of the study area (Author, 2019)

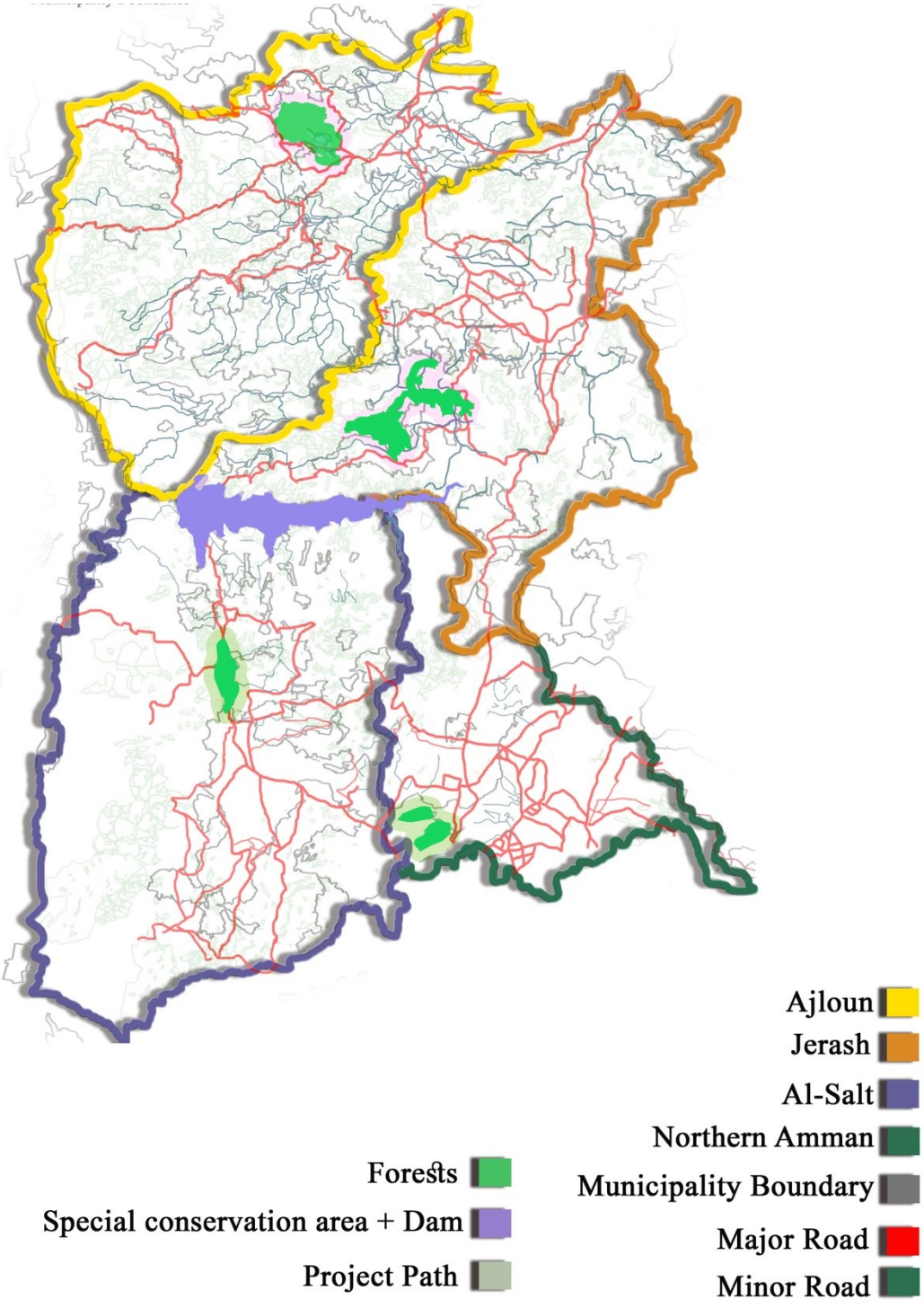

Figure 5.7: Land cover for Green corridor (Author, 2019)

5.2 Discussion and Conclusion

The higher elevations have been shown a sharp difference in temperature less than lower elevation (Zhao et al., 2019). Jordan weather is dry hot and dry in summer and cold in the winter. The green corridor provides suitable places for different types of wildlife.

There is a need to increase the number of green spaces in Jordan of human activities. The problem of shortage of green areas is facing the people and where the design and urban expansion infringes on these green spaces. Especially within the city centers, there is a severe shortage of green areas within these cities. Figure 5.8 shows The importance of topography for wildlife and diversification of plant species, through the slope can obtain different areas of temperature at the same moment, this provides suitable areaas for wildlife during hot and cold days. The green corridor design works to increase the green spaces around the cities and separates densely populated areas. This corridor passes through mountains, peaks, hills, and valleys, the network between the protected areas and the rich diversity forest in Al-Salt and Amman allows an exchange of individuals between natural living elements. The green corridor provides an environment suitable for the residents during the winter and summer, as the passage of the green corridor in the mountain areas provides tourist areas with mild temperature in the summer.

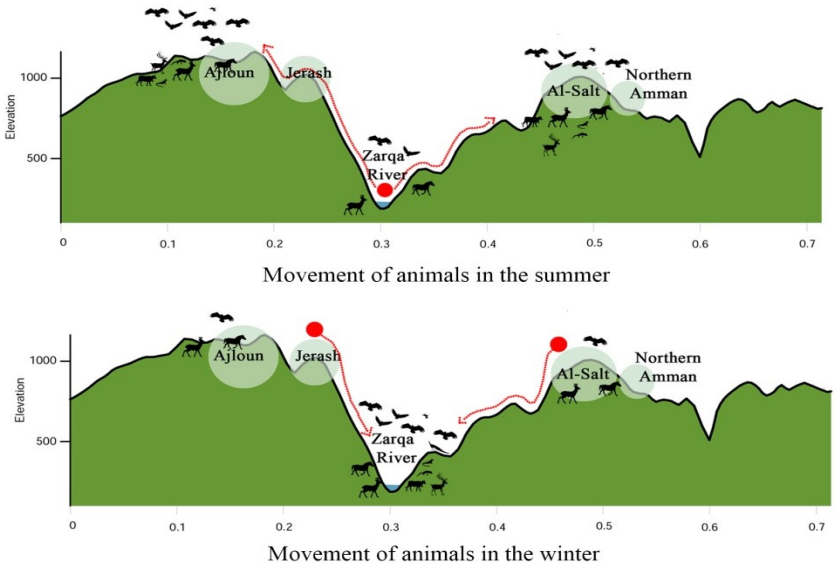

Figure 5.8: Movement of animals (Author, 2019)

Planning and evaluating the advantages of corridors for biodiversity conservation is difficult, in the fact there are numerous impacts design of corridors depending on the plant's type, corridor length, and geographical location. Use of corridors changes particularly between species allows an exchange of individuals between natural living elements.

The researchers and interested have been shown the importance of green corridor to support wildlife and to provide nature requirements, the greater amount of natural or semi-natural habitat like a river, lake, would have greater quantities numerous of nature elements. These species are represented in natural elements trees, shrubs, grass, animals, birds, in the green corridor is effective because of their requirements and developmental needs.

The green corridors offer opportunities for citizens, shelter, food, attractive places and protection which allow the biodiversity of wildlife to survive and exchange from one habitat (green space) to another. Human activities have affected the wildlife by reducing the humble awareness of citizens has appeared in hunting and cutting trees to heat the houses and cutting of trees to construct new commercial buildings.

The framework of design green corridors has been very important for planners and decision-makers. In the future, the need of government`s attention to analyze a green corridor to connect all cities in Jordan to meet the needs of population inflation. The coordination of citizens and biodiversity within the same matrix needs to additionally analyze given deeper attention on the green areas. The importance of the green corridor is to improve species richness at patch and landscape scales and can help keep up maintain ecosystem processes such as reproduction, Enable the exchange of individuals between wildlife natural living elements, and reduction in visual pollution.

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