DEVELOPING A FRAMEWORK FOR COPING WITH UNCONTROLLED URBAN SPRAWL OF WAR: A CASE STUDY FOR ENVIRONMENTALLY RESILIENT BENGHAZI CITY

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DEVELOPING A FRAMEWORK FOR COPING WITH UNCONTROLLED URBAN SPRAWL OF WAR: A CASE STUDY FOR ENVIRONMENTALLY RESILIENT BENGHAZI CITY

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ABSTRACT

DEVELOPING A FRAMEWORK FOR COPING WITH UNCONTROLLED URBAN SPRAWL OF WAR: A CASE STUDY FOR ENVIRONMENTALLY RESILIENT BENGHAZI CITY

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The environmental components of the green lands and the farms that are spread around Benghazi in a limited manner are among the most important resources for the city. These ecosystems were affected by the war that erupted after the Libyan uprising in 2011. This effect appeared in the spread of the phenomenon of urban sprawl as a result of the displacement of the population escaping from clashes and destroyed areas to the city periphery. The literature and studies reviewed dealt with the problem of urban sprawl in several dimensions, but they did not address the exacerbation of the problem of urban sprawl as a result of wars and civil conflicts, and its consequence in the environment. This research was directed at specific objectives in response to the risks that threaten the city's environmental resources, which were greatly affected by the spread of uncontrolled urban sprawl. The main aim of the research is to examine the case of Benghazi, and develop an environmentally resilient framework to cope with the uncontrolled urban sprawl resulting from the war.

This framework is investigating the reasons of urban sprawl problem and the relationship of civil war in the city with the spread of the phenomenon. The research also aims to assess the damage in the city's dimensions resulting from this war and from urban sprawl by focusing on the destruction in the environmental dimension. One of the aims of the research is also to investigate environmental vulnerability. The study

aims to define the city vision and objectives and propose a resilient action plan sensitive to urban sprawl and city environment to build and increase the city's adaptive capacity to cope with environmental vulnerability. This environmental resilience strategy plan will be a stage to may overcome the effects of war in urban dimensions of the city and reduce environmental vulnerabilities by suggesting an effective participation of the community and decision makers in preparing the action plan and assigning priority to proposed projects.

The study has a mixed research approach. Quantitative and qualitative techniques were used in a complementary manner. Quantitative data were collected from secondary data on the city and its environment, and analyzed using the results of remote sensing satellite imagery and Eight regions, Pearson's chi-square, and Urban Expansion Intensity Index techniques. Qualitative data were collected from the primary data through discussion groups and interviews and were analyzed using the SWOT analysis technique. The research used the quantitative data to understand the effects of war on the dimensions of the city, to define the problem of urban sprawl, and to understand its causes and effects. It has also been used to uncover the destruction of the environmental dimension within the framework of environmental vulnerability resulting from the uncontrolled urban sprawl. Qualitative data and their SWOT analysis were used to formulate the city vision that is sensitive to the environmental resilience and to prepare the initial environmental resilience action plan based on the goals of this vision. By synthesizing the analysis results of the primary and secondary data to understand where the city stands today, the study reached to a comprehensive evaluation of the second-generation plans in terms of evaluating the unimplemented stages, vacant areas within the plan boundary, decentralization possibilities in the plan, renewal possibilities in slum areas, and possible development areas according to the threshold analysis. The synthesis also formulated the environmental resilient vision “where the city should stand in the future" by proposing the action plan and presenting the environmental resilience strategies to increase the city's adaptive capacity to overcome environmental vulnerability and future developments, and propose projects with priorities to reach this aim.

The study concluded that the urban sprawl in Benghazi resulted from urbanization and war and environmental risks resulted from war, and urban sprawl. The study presented a deep understanding of the main issues affecting the increasing environmental

degradation and the spread of the problem of urban sprawl. The study showed the relationship between war and the urban sprawl in the city. The study concluded that traditional planning methods may not be beneficial in the special case of Benghazi, and that the use of environmental resilience strategies in planning may be useful to cope with environmental vulnerability, increasing the city's ability to adapt to future developments. The study formulated a framework model plan, including details of the actions within the strengths, weaknesses, opportunities and threat of the city.

The study concluded that these valuable information in policymaking and implementing an urban action plan based on resilience strategies may overcome urban and environmental problems that exist in other Libyan cities in the present and future. Although the results are relevant to the case of Benghazi and the resilience plan was built according to its specific conditions, it may be beneficial for planners and policy makers in other cities that have gone through or are experiencing similar conditions.

Keywords: Environmental resilience, Urban sprawl, War, Vulnerability, Benghazi, Building capacity

ÖZ

SAVAŞ KAYNAKLI KONTROLSÜZ KENTSEL YAYILMA İLE BAŞ ETMEK İÇİN BİR ÇERÇEVE GELİŞTİRMEK: ÇEVRESEL BAKIMDAN DAYANIKLI BİNGAZİ ŞEHRİ İÇİN VAKA ÇALIŞMASI

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Bingazi'nin çeşitli bölgelerine sınırlı bir biçimde yayılan yeşil alanlarve tarlalar ile çevresel bileşenleri, şehir için en önemli kaynaklardan biridir. Bu ekosistemler, 2011 yılındaki Libya ayaklanmasından sonra patlak veren savaştan etkilenmiştir. Bu etki, çatışmalardan ve yıkıma uğrayan alanlardan şehrin çevresine kaçan nüfusun yer değiştirmesi sonucu olarak kentsel yayılma problem ile ortaya çıkmıştır. Mevcut literatür, çarpık kentleşme sorununu çeşitli boyutlarda ele almıştır, ancak savaşların ve sivil çatışmaların bir sonucu olarak kentsel yayılma sorununun şiddetlenişine ve bu durumun çevrede yarattığı sonuçlara değinmemiştir. Bu araştırma, şehrin, kontrolsüz kentsel olarak yayılması sonucunda büyük ölçüde etkilenmiş olan çevresel kaynaklarını tehdit eden risklere odaklanmıştır. Araştırmanın temel amacı, Bingazi kentini inceleyerek savaş sonucunda ortaya çıkan kontrolsüz kentsel yayılma ile başa çıkmak için çevresel bakımdan dayanıklı bir çerçeve geliştirmektir.

Bu araştırma, kentsel yayılma sorununun nedenlerini ve şehirdeki iç savaşın bu problem ile ilişkisini araştırmaktadır. Araştırma aynı zamanda, şehrin çevresel boyuttaki yıkıma odaklanarak, savaştan ve kentsel yayılmadan kaynaklanan hasarı değerlendirmeyi amaçlamaktadır. Araştırmanın amaçlarından biri de çevresel kırılganlıkları araştırmaktır. Çalışma, şehir vizyonunu ve hedeflerini tanımlamayı ve kentsel yayılmaya ve kentin çevresel yapısına duyarlı ve dayanıklı eylem planları

önermeyi amaçlamaktadır. Şehrin çevresel kırılganlıkları ile başa çıkma kapasitesini artıran eylemler. Bu çevresel dayanıklılık strateji planı, eylem planının ve proje önceliklerinin hazırlanmasında toplumun ve karar vericilerin etkili katılımı sayesindesavaşınkent üzerindeki çevresel etkilerinin üstesinden gelmek ve çevresel kırılganlıkları azaltmak için bir başlangıç olacaktır.

Çalışma, karma bir araştırma yaklaşımına sahiptir. Nicel ve nitel teknikler, tamamlayıcı bir yaklaşımla kullanılmıştır. Nicel veriler, şehir ve çevresine ilişkin ikincil verilerden toplanmış ve sekiz bölgede uzaktan algılama uydu görüntüleme, Pearson Ki kare ve Kentsel Genişleme Yoğunluk İndeksi yöntemlerinin sonuçları kullanılarak analiz edilmiştir. Nitel veriler, tartışma grupları ve görüşmeler yoluyla birincil verilerden elde edilmiş ve SWOT analiz yöntemi kullanılarak değerlendirilmiştir. Araştırmada, kentüzerinde savaşın etkilerini anlamak, kentsel yayılma sorununu tanımlamak ve bunun nedenlerini ve etkilerini bilmek için nicel veriler kullanmıştır. Ayrıca, bu verilerin analiziyle kontrolsüz kentsel yayılmadan kaynaklanan çevresel kırılganlıklar çerçevesinde, çevresel boyuttaki yıkımı ortaya çıkarmak hedeflenmiştir. Nitel veriler üzerinde uygulananSWOT analizi, çevresel dayanıklılığa duyarlı şehir vizyonunu formüle etmek ve bu vizyonun sunduğu hedefler doğrultusunda başlangıç düzeyinde çevresel dayanıklılık eylem planını hazırlamak için kullanılmıştır. Çalışma, şehrin mevcut durumunu anlamak için birincil ve ikincil verilerin analiz sonuçlarını sentezleyerek; ikinci nesil planların kapsamlı bir değerlendirmesine ulaşmış, bu kapsamda planın uygulanmayan aşamalarını, plan sınırı dahilindeki boş alanları, plandaki merkezsizleşme olasılıklarını, gecekondu bölgelerindeki yenileme olanaklarını ve muhtemel gelişim alanlarını eşik analizine göre değerlendirmiştir Sentez sonucunda bir eylem planı önerilmiş, kentin çevresel kırılganlıklarını azaltacak ve gelecekteki gelişmeleri çözebilmedeki kapasitesini arttıracak,bu kapsamda önecelikli projeler önermek için çevresel dayanıklılık stratejileri sunacak, "şehrin gelecekte nasıl olması gerektiği"ne cevap veren çevresel dayanıklılık vizyonu formüle edilmiştir.

Çalışmanın bulguları, Bingazi'deki kentsel yayılmanın kentleşme ve savaştan kaynaklandığı; çevresel risklerin savaştan ve kentsel yayılmadan kaynaklandığını göstermektedir.Çalışma, artan çevresel bozulmayı ve kentsel yayılma sorununun artışını etkileyen temel konulara dair derin bir kavrayış sunmuş,şehirdeki savaş ile kentsel yayılma arasındaki ilişkiyi ortaya koymuştur. Çalışma, Bingazi vakası özelinde

geleneksel planlama yöntemlerinin yetersiz kalabileceği ve planlamada çevresel dayanıklılık stratejilerinin kullanımının, şehrin gelecekteki gelişmelere uyum sağlama becerisini artırmak suretiyle, çevresel kırılganlıklar ile başa çıkmak için faydalı olabileceği sonuçlarına ulaşmıştır. Çalışma; kentin güçlü ve zayıf yanları, fırsatları ve tehditleri çerçevesinde geliştirdiği eylemler ile Bengazi kenti için bir model önerisinde bulunmuştur.

Sonuç olarak, dayanıklılık stratejilerine dayalı bir kentsel eylem planının uygulanmasında ve politika geliştirilmesinde çalışmanın ulaştığı bilgilerin , bugün ve gelecekte, Libya'nın diğer şehirlerinde var olan kentsel ve çevresel sorunları azaltmakta kullanılabileceği düşünülmektedir. Sonuçlar Bingazi kentiyle ilgili olması ve geliştirilen dayanıklılık planı bu kentin koşullara göre inşa edilmiş olmasına karşın, benzer koşulların yaşandığı ve yaşanabileceği diğer kentlerdeki plancılar ve politika koyucular için fayda sağlayabilecektir.

Anahtar Sözcükler: Çevresel dayanıklılık, Kentsel yayılma, Savaş, Kırılganlık, Bingazi

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CHAPTER I

1. INTRODUCTION

1.1. Background

Urbanization in the world is increasing dramatically, and half of the world's population is living in cities. It is anticipated that their proportion will reach to 70% by 2050 (UN, 2014). With these developments in cities, they are also placing of struggles and conflicts. These interactions are accompanied by the problem of urban sprawl, which has affected the cities environmentally, socially and economically. Researchers and planners are trying to find solutions to address the causes and effects of urban sprawl (Habibi & Asadi, 2011; Karakayaci, 2016). Sprawl is a deprecatory term used to characterize urban development features that are often perceived as undesirable (Knaap, Talen, Olshansky, & Forrest, 2000). Urban sprawl results from a number of factors, including population growth, economic growth, weak planning policies, weak enforcement tools, reliance on private transport, and sometimes intra-urban conflicts that increase urban sprawl (Basudeb Bhatta, 2010; Karakayaci, 2016; Kaur, 2008). Urban sprawl in cities and urban areas is stemming from transforming innate stable case of rich and well-connected land cover to another stable case of high fragmentized and greatly reduced natural land cover (Huang, Wang, & Budd, 2009; Xi et al., 2012). Consequences of urban sprawl are many, including loss in open spaces, parks, farmland, and wildlife habitats, impacts on water quantity and quality, poor air quality, increase in the cost of services and infrastructure. All these risks result in an increase in environmental vulnerability (Habibi & Asadi, 2011; Vimal, Geniaux, Pluvinet, Napoleone, & Lepart, 2012; Wilson & Chakraborty, 2013).

Cities have complex interactions between social and technical elements, composed of a dynamic connection of social and physical networks. Resilience in urban planning for cities in the face of risks requires designing cities that combine characteristics that appear to be contradictory. These characteristics include efficiency and redundancy,

interdependence and diversity, flexibility and strength, autonomy and cooperation, adaptability and planning (Godschalk, 2003). The use of resilience policies in the planning process reduces vulnerabilities and control the problems resulting from urban sprawl and building the capacity of the city to meet future environmental challenges. This is the strategy to be tested and verified in this research.

A resilient city is an integrated adoptative to change networks of city inhabitants and physical systems. Physical systems include all city components of buildings, infrastructure, roads, energy and water networks, geology and topography of the city. The degree of resilience of a city depends on the ability of those component systems to survive and function in the face of disasters. Those physical systems act as the human body of the city. Developing countries and communities are those at risk the most and vulnerable to disasters, and, at the same time, urbanization brings about increased vulnerability (Lloyd-Jones, 2013; Smyth, 2014).

Environment resilience is the ability of any urban environment system to absorb and recover quickly from the impact of any plausible disaster. The city stakeholders, by their decisions and responses, have to ensure 1) reduction in loss of life, 2) reduction in loss and damage to assets, 3) continuity of functions of the city and its environment. Their resilience framework will be an array intersecting between plausibly disasters that may affect the city and common features of any human settlement (Eraydin & Tasan-Kok, 2013; Meerow, Newell, & Stults, 2016).

1.2. Problem Statement

As a result of dynamic interactions between the socio-economic and biophysical operation occurring on multiple scales, urban ecosystems change over time and place. The environmental resilience of urban ecosystems is affected by these interactions (Alberti & Marzluff, 2004). The issues that limit urban resilience on a large scale are loss of limited agriculture lands, fragmentation of natural habitats, changing energy flows, nutrient cycling and disruption of hydrological and air systems. Urban form and land use distribution as alternative urban patterns cause many effects on the dynamics of ecosystems and their environmental resilience. Urban ecological processes with local interactions and multiple feedback mechanisms among human decisions resulted in urban sprawl. Urban sprawl causes loss of agricultural land, pollution due to traffic congestion, loss of energy from transportation and impacts on the hydrological

environment (Alberti & Marzluff, 2004). Using practices of resilience strategies in city development can support increasing the capacity of ecosystems in and around these cities to provide better services and to accommodate a balanced urban growth (ICLEI, 2013; Schewenius, McPhearson, & Elmqvist, 2014).

In Libya, where most of the land of the country consists of deserts, arable lands are limited, and these lands are only 1.03% of the total country land. Ecosystems and climate change have a major impact on people's lives so that a high priority is given to urban planning (Attwairi, 2015). This situation has led to a greater concentration of population in the urban centers of coastal areas and pressure on rural/agriculture lands, resulting in inequalities in services and population between urban and rural regions. This disparity has become a source of concern for the state in general and for planners about the management of urban growth in particular (AlEmara, 2009).

The city of Benghazi faced many political conflicts after the uprising against Gadhafi's regime in 2011. These conflicts turned into a civil war within the city, and seem to have ended by the end of 2017. As a result of this war, many buildings were destroyed in city districts and the city center. This resulted in the displacement of the inhabitants of these districts, and because of the absence of the State, those people were left without shelter. Most of them went to the city periphery to settle there, causing a significant increase in urban sprawl, which in turn caused the destruction of the limited environment around the city of Benghazi and increased its vulnerabilities.

The problems in the city, especially the planning problems that affect the city environment, increased after the events and the war in 2011. Uncontrolled urban sprawl is a natural and unavoidable outcome of a chaotic situation determined by the civil war. It is not exclusively a consequence of an enforcement failure in urban management under ordinary circumstances. Bankoff, Grewe, Brady, and Oslund (2004) pointed to a variety of indirect effects of war and military on the environment and forests, such as the impact of wars on timber prices, land use and ecological change.

Nowadays, "Government" and "Citizens" seem to be two highly polarized, disassociated and detached entities in Benghazi. Their repel lies in the inaccessibility in local food and labor markets. The government is weak in recreating local markets (commodities, goods and services), whilst the people are poorly served by the

government and socio-economically discriminated from urban habitats. Urban sprawl is a factual consequence of such a discrimination and isolation, where people seek alternative locations for their existence and subsistence. This vital combat of people cannot be managed by traditional control mechanisms, but by functional instruments, which strengthen the government economically and increase its service capability for its citizens.

The lack of substantial government services to local people, particularly in food supply and employment besides other basic needs (health, education, social security, etc.), urge the local people to perpetuate their subsistence in agricultural urban fringes and peripheries depending on their own shelters and gardens for the sake of security and nourishment. Regretfully, these vital needs cannot be provided by the government under current conditions. The current governmental system is unfortunately not in the position to overcome such an urban sprawl problem by the aid of enforcement instruments of urban management directly. This problem could be solved by the aid of multiplier effects of some prime urban management instruments indirectly. This instrument will be developed through the understanding of environmental resiliency.

Realization of a suitable approach will certainly not to be limited to urban inhabitants in Benghazi, but also be extended to comprise suburban and sprawl areas as well. Linkages between the urban center of Benghazi and urban sprawl in its peripheries can avail to provide a fundamental basis for successive management and incremental control of such an adverse situation.

1.3. Objectives and Justification of the Study

This study attempts to develop resiliency environment framework strategies to the planning problems in Benghazi City struggling with the problem of urban sprawl. The expected outcomes of the study include strategies to meet the requirements of the inhabitants and government of the city, and develop a resilience vision for the development of the city. After identifying the main causes and environmental impacts of the uncontrolled urban sprawl in the city, resilience solutions will be designed. The road map/strategies will be developed to reduce these environmental effects, and control the phenomenon of sprawl for Benghazi City.

When the situation in the city is in chaos, uncertainty, increased vulnerabilities and all risks will be the outcome of the civil war. It is inadequate and abstract to deal with

those problems and situation normally. It requires an abnormal solution to deal with these problems and reduce their impact. Resilience-thinking planning as an action-oriented solution can be implemented in the planning process of Benghazi City. The research was formulated according to this framework. It follows an action research that reveals actions to be implemented in the comprehensive process. To do this, the study starts with SWOT analysis, then it determines the vision of the city. Then, it presents strategies and projects to be applied to achieve this vision with the participation of stakeholders and within a specific timetable. These action packages should be in line with the strategy of preserving the environment and reducing urban sprawl.

Agricultural lands and ecological assets around Benghazi will be unsustainably endangered and ruined. It seems that traditional solutions and direct actions relying on regulations and enforcements do not allow the city to handle this problem. Currently, reigning extraordinary conditions in Libya in general and in Benghazi in particular require the development of an alternative combat strategy. The study starts with the integration of opinion leaders' proposals along with resilience thinking to define the alternative combat strategy for rationalizing the urban services and connectedly reactivating the urban functions in Benghazi. It can be an effective strategy, which is expected to incorporate the sprawl in the peripheries into the urban system based on extended linkages and catchment actions.

There is a limited number of researches about Benghazi City and its planning system. The few existing studies do not review the planning problems of the city and do not discuss the problem of urban sprawl. There is no recent study to discuss the problems of urban planning or urban sprawl after the war in 2011. Therefore, this study seeks to fill in the knowledge gap in this subject, in addition to the researcher's desire to provide assistance to develop strategies for urban sprawl and reducing its impact on the city and its environment. This will be done by answering the following research questions:

- **What is the environmentally resilient framework for the City of Benghazi to cope with the uncontrolled urban sprawl resulting from the war?**
    I. What are the reasons and consequences of urban sprawl in Benghazi?

II. How did the war influence urban sprawl in Benghazi? And what is the relationship between urban sprawl and environmental vulnerabilities in the city?
III. What is the methodology to develop a framework for environmental resilience in Benghazi in order to cope with urban sprawl?
IV. What are the environmental resilience strategies to cope with the environmental vulnerabilities of urban sprawl as a part of the city vision?
V. What are the action plan and projects for environmental resilience and for capacity building to overcome future environmental vulnerabilities in Benghazi?

This research aims to study the problem of urban sprawl in Benghazi City, which is of a special nature, given the city had suffered from the war between 2011 and 2017. This war led to the destruction of a large part of its neighborhoods, and increased the rate of urban sprawl significantly in the city periphery. The main aim is to develop an environmentally resilient framework that will increase the capacity of the city and the planning system to cope with the urban sprawl problem and its negative effect on the city environment. The study also attempts to formulate a plan of actions sensitive to this framework to achieve the objectives of the city vision.

In the pursuit of its aims, the study is using a quantitative and qualitative mixed approach to achieve its aim. Quantitative data were collected from secondary data on the city and its environment, and analyzed using the results of remote sensing satellite imagery. Qualitative data were collected from the primary data through discussion groups and interviews, and analyzed using the SWOT analysis technique. Then, quantitative and qualitative data analyses were synthesized to develop the environmentally resilient framework for the city according to the vision and objectives, and to suggest strategies and an action plan to reach these goals.

1.1. Scope and Structure of the Thesis

This study was framed to reach to a resilience strategy for Benghazi to reduce the environmental risks and vulnerabilities resulting from urban sprawl. This phenomenon has spread significantly in the city outskirts, agricultural and green areas as a consequence of the civil war in the city.

This thesis includes ten chapters. The first chapter consists of an introduction which presents the theoretical background of the thesis. This includes the problem statement, objectives and justifications of the study, presentation of the research question and the secondary questions that the research aims to answer. In this chapter, the scope and structure of the thesis are presented.

Chapter Two reviews and analyzes the literature on resilience, defines the resilience concept and how to construct it in a specific planning system, how to measure the system's resilience to withstand a threat or problem. The chapter also explores the environmental resilience strategies and the benefits it may add to urban planning to make it more resilient. The chapter also discusses urban vulnerability types and their indicators in cities.

Reviewing and analyzing the previous studies on urban sprawl to identify reasons and consequences and to present the experiences of other countries to identify the source and development of urban sprawl is conducted. And how the sprawl changes the macroform of cities to see how the environment is affected. The policies and strategies adopted by these countries to contain and limit the effects of urban sprawl on the environment will also be reviewed. This will be done in the third chapter of this study.

Chapter Four presents the contextual setting of the Benghazi City and a review of the history of its urban plans. The pre-war situation of the city will also be presented. This includes a review of all city dimensions including population, economic, social, environmental and spatial dimensions. The destruction of the city as a result of the war in these dimensions will be demonstrated. The chapter also reviews the individual reactions of the city's resilience to war disturbance. The fifth chapter displays the research methodology by reviewing methods including data collection methods and tools as well as methods and tools for data analysis.

Chapter Six shows the analysis of secondary data. The chapter reviews environmental vulnerability and urban sprawl in the city before the war and in the case of no-war, and analyzes these cases by using remote sensing data and its applications.

Chapter Seven reviews the analysis of the primary data collected from discussion groups and interviews, and analyzes them using SWOT.

Chapter Eight synthesizes the primary and secondary data analysis and SWOT analysis for the environmental resilience strategies to overcome future urban sprawl in Benghazi City.

Chapter Nine proposes the action plan and strategies for environmental resilience to achieve the vision for Benghazi. In the last chapter, a comprehensive summary of the research objectives and procedures will be reviewed. This chapter also presents the main conclusions and contributions of the study. Recommendations for future studies are also proposed in this chapter depending on the study findings and limitations.

CHAPTER II

2. CONCEPT OF URBAN SPRAWL

This chapter will review and analyse the previous studies on urban sprawl. It will start with term definitions and dimensions; identify the causes and effects, and present the experiences of other countries. The chapter will then show how sprawl changes the macroform of cities to demonstrate how the environment is affected, and review the policies and strategies adopted by these countries to contain and limit the effects of urban sprawl on the environment.

2.1. Definitions and Reasons of Urban Sprawl

Various definitions of the urban sprawl will be reviewed, and reasons and effects of urban sprawl will be discussed in this section.

2.1.1. Definitions of Urban Sprawl

Urban sprawl is a complex phenomenon and has contradictory definitions (Clifton, Ewing, Knaap, & Song, 2008; Galster et al., 2001). It is a result of socio-economic and political development under particular conditions, and it has greatly become a main issue for many cities, even though a common consensus concerning the definition and effects of urban sprawl could not be achieved (Angel, Parent, & Civco, 2007; Johnson, 2001; Sarvestani, Ibrahim, & Kanaroglou, 2011). Galster et al. (2001) found in their literature review that the sprawl can simultaneously or alternatively refer to: (i) certain patterns of land-use; (ii) processes of land development; (iii) causes of particular land-use behaviors; and (iv) consequences of land-use behaviors. They presented various sprawl definitions from varied perspectives.

Land use and land cover changes have been a key subject for the discussion of global warming and climate change by several decades. Expansion in urban land is one of the most frequent figure forms of land-use change/land cover (Alphan, Doygun, & Unlukaplan, 2009; Gillies, Box, Symanzik, & Rodemaker, 2003). With the rapid

growth of urbanization; urban land use, land cover changes and urban sprawl are among the main topics for the study on changes dynamic of the urban land use (Dewan & Yamaguchi, 2009; Grimm et al., 2008).

There is a consensus that urban sprawl is an uncontrolled, scattered suburban development that increases traffic problem, reduces resources, and demolishes open space, although this is still being debated. (Peiser, 2001). Change in land use and land cover is the direct implication of urban sprawl, as the sprawl increases the build-up and paved areas (Sudhira & Ramachandra, 2007). The definition of sprawl relies on the viewpoint of who gives the definition, and this is because sprawl is discounted by some and demonized by others (Barnes, Morgan III, Roberge, & Lowe, 2001). Some researchers concentrated on describing urban sprawl rather than defining it (Galster et al., 2001; E. H. Wilson, Hurd, Civco, Prisloe, & Arnold, 2003). Researchers such as E. H. Wilson et al. (2003) stated that, without a general and common definition, modeling and quantification of urban sprawl are highly difficult. Modeling urban growth rather than urban sprawl gives us the ability to measure and quantify the area of land that has changed for urban use (Angel et al., 2007).

The urban sprawl should be properly described in order to achieve an overall understanding of the causes and effects of sprawl. However, as it is associated with poor land use planning and economic performance (Pendall, 1999), urban sprawl is often assessed mainly on socio-economic indicators such as population growth, mobility costs, employment shifts, changes in city revenues and commercial developments. Political conditions, shifts and conflicts may also cause unplanned urban expansion in urban areas (Brueckner, 2000; Dericioglu, 2018; Lucy & Phillips, 2001).

The way in which growth takes place in and near urban areas is a prominent subject for policymakers and the public to discuss the future of cities. This encouraged researchers to look beyond disciplinary and political boundaries, and seek knowledge about the causes and consequences of different development patterns. While these global issues are emerging, the local concept of sprawl is not. In case of developed country, the term typically depict pictures of low population, private car dependency, and mostly monotonous residential development along the city periphery. However, this description is not useful in developing countries where urbanization has different

motives and appears in a different form. This poses another challenge for the generalization of research results (Wilson & Chakraborty, 2013).

This study tries to conduct an analysis of the reviewed literature around a comparison of research methods employed and of the findings with respect to four categories of the environmental effects of urban sprawl: effects on land, air, energy and water. Environmental outputs are considered to be one of the dimensions of sprawl. It should be emphasized that, if considered in a comprehensive manner, it can provide a framework for bridging growth characteristics across national contexts and reducing the need for a definition of sprawl that operates everywhere. Among the studies analyzed, urban sprawl is generally conceived as the result of unplanned, inappropriate or non-existent planning (Abelairas-Etxebarria & Astorkiza, 2012; La Greca, Barbarossa, Ignaccolo, Inturri, & Martinico, 2011; Paül & Tonts, 2005) or alternatively, as a result of wealthy families and commercial investors exercising their local preferences in an open free market. This hypothesis is supported by the availability of good transport infrastructure and relatively cheap private transport (McEldowney, Ryley, Scott, & Smyth, 2005).

Another more common approach for determining urban sprawl is to focus on its physical features as a particular pattern of development, whereas there is some difference in the specific criteria used. Many articles rely on a group of descriptors such as low-density, scattered, discontinuous, uncontrolled, leap-frog, and single land use (Galster et al., 2001; Sarvestani et al., 2011). In other situations, urban sprawl is defined in less specific terms, and is understood to occur when the rate of urbanization exceeds the population growth rate (Bart, 2010; Frenkel, 2004), or as simple as a low-density housing development (Brody, Gunn, Peacock, & Highfield, 2011; Garcia & Riera, 2003). However, there are also limitations on the multi-dimensional definitions of urban sprawl based on physical diagnosis. Most of the studies from developing country contexts focus on low-density housing development as the main characteristic of sprawl, while rapid urbanization, which may, in fact, be higher in density, is the most common concern. Pucher, Peng, Mittal, Zhu, and Korattyswaroopam (2007) stated that cities in India are increasingly being ringed by unplanned, accidental sprawl, although the density in those cities is higher compared to most suburbs in the U.S..

The third and final approach, which is the most common to determine the urban sprawl among the studies examined, is to focus on the dynamic aspects and an explicit understanding of sprawl as a process (Barredo & Demicheli, 2003; Fazal, 2001; Haase & Nuissl, 2007; Xi et al., 2012). Land use change is the main concern of these studies, and this justifies the increasing use of scenario analysis and remote sensing (Dewan & Yamaguchi, 2009; Sarvestani et al., 2011; Sudhira & Ramachandra, 2007). Sprawl is controlling different actions (before and after), indicators (metrics) and monitoring (detection change) and to notarize and analyze the situation. Whereas the physical characteristics of sprawl vary from one location to another, the concept of sprawl is mainly about change and commonly includes a landscape shift. Haase and Nuissl (2007) stated that the environmental aspect of urban sprawl is linked to the level of the social relation. The sprawl resistance in Leipzig, Germany has emerged from some anxieties that extend beyond its environmental consequences (Haase & Nuissl, 2007).

Besides its social and environmental impact on rural and urban inhabitants, sprawl creates a huge burden on governments as well. It may cause different serious socio-economic events such as financial unbalance between societies and economic bias (Karakayaci, 2016). Some studies asserted that the sprawl has an effect in decreasing open spaces and amenities, increasing the costs of public services and taxation, and causing traffic problem (Wu, 2006). Despite that, some studies advocate that the emerging of urban sprawl was due to the desire of people to live in a vast area, large homes and their preferences such as tendency to comfort, and it has emerged within an ordinary developing process between urban and agricultural utilization (Brueckner, 2000; Henderson & Mitra, 1996).

The negative connotation of the term "urban sprawl" appears in most debates related and in many definitions (for example, sprawl is an indiscriminate random growth characterized by inadequate access to basic land uses such as housing, employment and common services such as schools, hospitals and public transit) (Bullard, Johnson, & Torres, 2000). However, it is a useful term, because, unlike the more neutral terms such as counter-urbanization or urban deconcentration, it indicates differences in the patterns of land use and neighborhoods in the suburbs. Urban sprawl is more than just a relatively low-density living outside the political boundaries of the city and thus generally not the same of suburbs (Jaret, Adelman, & Reid, 2006).

From all the above, discussions and definitions of urban sprawl were in terms of uncontrolled and undesirable sprawl, low density of sprawl areas and lack of basic urban services and facilities. Uncertainty is increasing significantly in the areas of unplanned expansion, where it is difficult to know the nature of land use and the direction of future development and other inquiries that are left without a certain answer that increase uncertainty.

2.1.2. Reasons of Urban Sprawl

There are different factors that cause urban sprawl either according to the level of development in countries or society structure. In America, for example, the demand for a large detached home with a garden that is in contact with the nature, introverted lifestyle (Brueckner, 2000) and racism are the main causes of urban sprawl (Nechyba & Walsh, 2004). In a report prepared by the European Commission, the causes of urban sprawl in Europe were grouped under seven headings (EEA, 2006) (see Table 2.1):

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Table 2.1. Urban Sprawl Causing variables of factor groups – Adopted from EEA (2006) and (Bruegmann, 2006)

Macro-economic variables	Economic growth
	Globalization
	Integration
Micro-economic variables	Rising living standards
	Price of land
	Availability of cheap agricultural land
	Competition between municipalities
Demographic variables	Population growth
	Increase in household formation
Housing preferences	More space per person
	Housing preferences
Inner city problems	Poor air quality
	Noise
	Small apartments
	Unsafe environments
	Social problems
	Lack of green open space
	Poor quality of school
Transportation	Private car ownership
	Availability of roads
	Low cost of fuel
	Poor public transport
Regulatory frameworks	Weak land use planning and planning policy
	Failure or Poor enforcement of existing plans and planning policy
	Lack of horizontal and vertical coordination and collaboration
Political and war conflict	Political conflicts and Civil war

Bhatta (2010) emphasizes that one other reason of urban sprawl is the government policies that give the estimates for urban development. Low agricultural land prices cause intense demand of sectors such as residential, manufacturing, business and construction. Preference of these sectors in agricultural land instead of plots as establishment places both causes urban sprawl and inefficient use of resources due to non-agricultural use of agricultural land (EEA, 2006). The impact of urban sprawl consumes countless natural resources in the name of urban growth due to settlement, commercial and industrial areas approaching the natural and protected areas, and increases air pollution which deals serious damage to the ecosystem (EEA, 2006; Karakayaci, 2016; Wu, 2006). However, meeting the needs of people who suffer from lack of housing within the boundaries of the urban fabric of the city were difficult due to many reasons, such as high prices of land and property, searching for safety and security and escaping from civil wars. Therefore, appropriate solutions should be put

in place to restrict and control urban sprawl in cities. These solutions take into consideration the current and future conditions of the city and its resources, as well as the citizens' needs (Brueckner, 2000; Henderson & Mitra, 1996).

Rapid urbanization led to unplanned expansion of cities, which subsequently led to a number of other negative consequences, such as informal urban growth and urban sprawl. Due to economic, environmental and political considerations, these negative externalities have prevailed in many developing countries. Most of the cities in developing countries grow horizontally, because the population is spread to unplanned areas on the margins of cities, at the expense of areas devoted to agriculture and conservation of the environment (Lowton, 1997).

People who are forced to find shelter on the outskirts of large cities usually build their houses with any building materials they can afford, such as trees, clay bricks, or cement in some cases with their own labor force. These houses often lack the basic facilities and services, where they are scattered and disorganized with narrow, twisted and unpaved roads. There is virtually no health, education, environmental, security or other basic urban services in these areas (Redman & Jones, 2005).

2.1.4. Wars as a Reason of Urban Sprawl

As industry and mining formed the cities of the world in the 19th century, wars in the 20th century also shaped the new urban features of the world. Over the decades, world wars have greatly influenced the growth patterns of the world's regions. Wars have created many problems that planners have tried to find solutions and proposals to overcome war effects (Abbott, 1976; Lotchin, 1979). The World War II was not the only main factor in growing urban areas in America, Europe and other countries, but it was certainly a major factor. The wars in America crystallized the existing tendencies and identified a new agenda of developers and planners. In Germany, the war changed the shape of the cities, and the capital of Berlin was completely divided (Nash, 1985). The war crisis has removed much of the ideological opposition against planning in the West. This opposition was against the idea of decentralization adopted by a group of new planners. Beginning in 1945, modern planners in America adopted a pragmatic approach to planning. The vision changed from broad social planning and plans involving utopian communities to plans focusing on practical issues such as turning military industries into peaceful ones, recruiting, improving housing and

accommodating immigrants to cities in the West during the World War II (Nash, 1990; Scott, 1969).

Wars result in two major demographic changes in cities. Firstly, they increase the mortality rate, and may influence the fertility and natural growth rate in a city (Coale, 1989; Webb, 1963). Secondly, they may lead to the movement of population from unstable and insecure areas to the safer regions (Albuja & Ceballos, 2010; Marion & Maurice, 2010). During the World War II, cities such as London and Berlin experienced large amounts of population loss which cannot be compared to the population encountered in current wars (Glaeser & Gyourko, 2005; Glaeser & Shapiro, 2002). Wars negatively influence the economic structure in cities in accordance with growth, production, consumption and distribution. According to Collier (1999), GDP per capita falls at an annual rate of 2.2 percent during civil wars compared to peace situation. This percentage increases to more than 35% if the war continues for 15 years (Collier, 1999). The reason of this decline is the reduction in production due to gradual loss of capital as a result of destruction, repairment and replacement (Collier & Hoeffler, 2002). Civil wars affect the growth of sectors cumulatively such as manufacturing, construction, transportation, distribution and financing sectors (Collier & Sambanis, 2005).

Wars lead to devastation in the socio-cultural structure (Khan, 2013), as a result of various problems including unemployment, poverty, epidemics, a weakened sense of community, and damage in infrastructure and building stock (Baddeley, 2011; Barth, Li, McCarthy, Phumiwasana, & Yago, 2006). Public health is another main issue associated with war, where health care is decreasing in times of war (Toole & Waldman, 1993). Wars also generate multiple health hazards (Levy & Sidel, 2007). Wars create pressure on spatial development and the macroform of the cities (Glaeser & Shapiro, 2002). The urban structure becomes more fragile and vulnerable (Sampaio, 2016). War increases urban problems such as increased pollution and destroyed urban services (Richardson, 2002).

2.2. The Root and Theories of Urban Sprawl

To further explore the roots and the theoretical background of urban sprawl, this chapter examines urban growth and sprawl theories, including location theory, center periphery theory, dependency theory and urban bias theory.

Studies about how regions evolved into urban areas and and about spatial form developments in the cities with a focus on the process of transformation, began to spread from the beginning of this century by urban and geographical economists (Adams, 2005; Batty, 1991; Blumenfeld, 1954; Burgess, 1927; Hoyt, 1939; Muth, 1961). These studies have produced a number of theories indicating that the economy and industrial attractions have the greatest impact on spatial development.

These theories include the concentric zone (Burgess, 1927), the sector (Hoyt, 1939), and the multiple models of nuclei (C. D. Harris & Ullman, 1945) that present sectoral competencies and rent contests, which can form urban spaces in several forms (Losch, 1954). These theories of growth pole (Perroux, 1950) have contributed to an understanding of the changing urban forms that are being driven towards development. As the city continues to capitalize on economic performance in terms of size and impact of agglomeration, it continues to grow economically as well as converting lands into built-up areas (Muth, 1961).

There are two types of spatial development variation: expansion development from the core and dispersion development from the core (see Figure 2.1). These agglomerations or clusters are spread in both development types around the urban centers. These agglomerations also have three types of development; over agglomeration (high centralization), diseconomies and sprawl (decentralization) (Dericioglu, 2018). This controlled sprawl can be seen in the emergence of satellite cities that refers particularly to smaller urban areas which are situated slightly near to but are mainly independent of larger urban core areas (Haseeb, 2017). Uncontrolled urban sprawl refers to the unplanned spreading of urban development in the city periphery (Adaku, 2014).

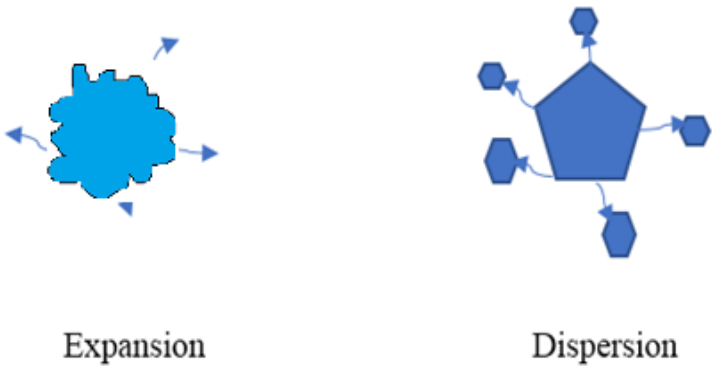


Figure 2.1. Spatial development variation (Source: Author)

2.2.1. Location Theory

Location theory tries to find an explanation of the distribution of space activities and functions (Capello, 2011). Its goal is to identify the factors affecting the location of individual activities. It attempts to find out how to allocate different parts of land between different types of production, and the division of the functions in space (Alonso, 1964; Hoover, 1936; Losch, 1954). Location options are explained by looking only at the major economic forces that drive site operations, and ignoring the geographic feature of concentration of activities, agglomeration economies, which cause activities concentration, and transport costs, which spread activities in space.

As urban productivity is considered to be higher than rural productivity, it has increased the migration from rural to urban areas and to more productive cities. Newcomers to urban areas have become settled in the cities. This influx contributed to the expansion of cities, and caused over crowdedness and urban congestion (J. R. Harris & Todaro, 1970). As a result of this, the spread of urbanization, which may be poorly planned or uncontrolled, has increased (see Figure 2.2) (Adaku, 2014; Galster et al., 2001; Karakayaci, 2016).

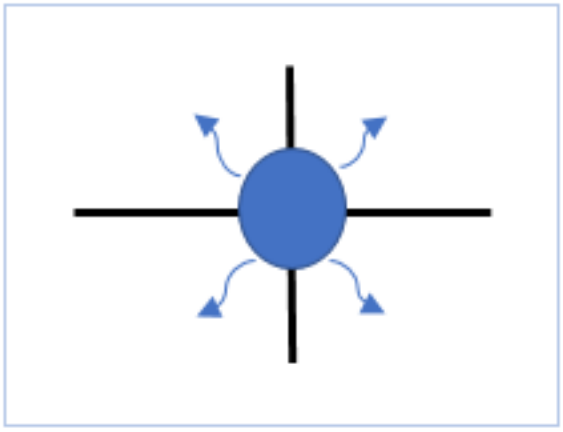


Figure 2.2. Schematic diagram showing diseconomies and external economics affecting location theory (Source: Author)

2.2.2. Center Periphery Theory

This theory was proposed by John Friedman and supplemented by some regional theorists. It assumes that relations between central and peripheral regions are the real engines of development at the regional level (Antonescu, 2014). It describes how economical, political and cultural power is spatially distributed between dominant

center regions and semi-peripheral and peripheral areas (Stadel, 2009; Weinand, 1973).

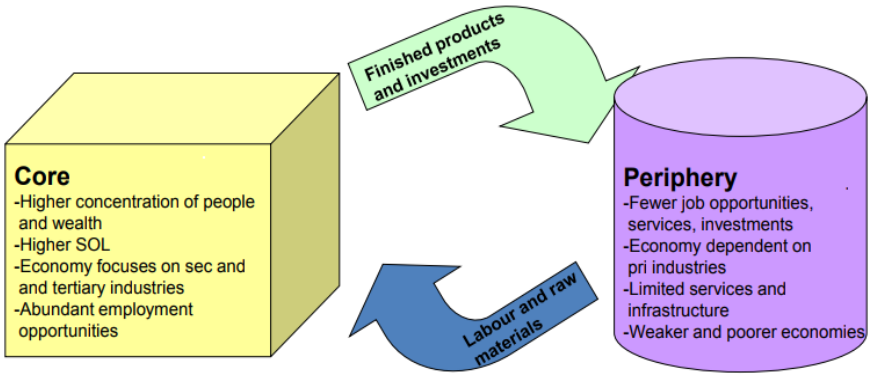


Figure 2.3. Relation between core and periphery; SOL: Standard of living (Source: Author)

The upward transitional area can be seen as the semi-periphery. Resource frontier is peripheral, but endowed with resources. Downward transitional area can be seen as the periphery suffering from backwash effects of development in the center. Advantages to the periphery are called the spread effect. The center's growth has a positive effect on the periphery; thus, products will be provided by the periphery to the center. Negative externalities like congestion and over crowdedness will affect the center and as result of that, companies will be located in the periphery (see Figure 2.3) (Raagmaa, 2003).

The center's growth has also negative effects to the periphery, known as Backwash Effects. It is characterized by capital outflow, migration of the population with a good economic situation from the periphery to the center and inability of the periphery companies to compete with core companies (see Figure 2.4) (Raagmaa, 2003).

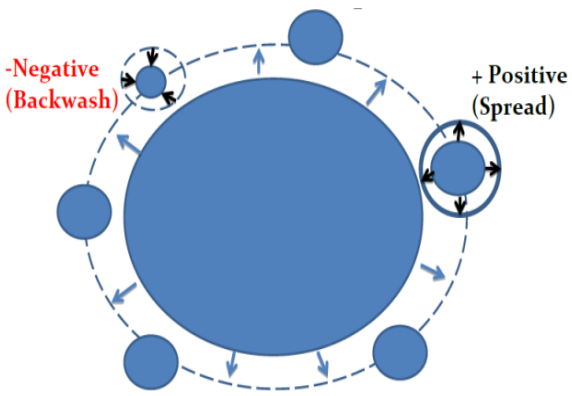


Figure 2.4. Backwash Effects and spread effect of core and periphery (Source: Author)

2.2.3. Urban Bias Theory

The bias theory seeks to explain the urban process development in both developed and developing countries. It is useful to interpret urban development in developing countries in particular. This approach relates to changing the development process from an economic perspective to a political one. Urban policies in urban centers are more attractive at the expense of rural areas, where most necessary facilities are located in city centers. Usually in developing countries, a large proportion of citizens live in rural areas, but facilities are concentrated in urban centers only (Tettey, 2005).

Those who live in urban areas benefit more from the high standard of living as a result of these policies. Rural areas have a lower standard of living, causing a difference between urban and rural areas. As a result, rural areas become push centers and urban areas are centers of attraction to the rural population (Tettey, 2005; Willis, 1994).

As a summary of these theoretical approaches concerning the development of the urban areas, the developing societies gain more socio-economic development that leads to ignoring the rural areas. Dependency theory illustrates the distorted way of economic development in developing countries as a result of external political, economic and cultural influences, particularly at the level of national development policy. It occurs politically, economically and culturally, particularly at the regional development policy level. It also shows changes in the structure of urban areas in several countries. These changes are mainly concentrated on the transition from the pre-capitalist era to adaptation to capitalism. Dependency theory in the urban context shows the importance of external economic and political forces as essential forces for the formation of urban areas (Santos, 1979).

In contrast, urban bias theory places the concept of urban development, which was previously based on the economic concept, into a political concept. Attention is given to urban areas only by governments, and rural areas are neglected in whole or in part. This has increased migration from the countryside to urban centers for better services and life (Anthony, 2005). As some researchers have mentioned, urban development in many African countries occurred without industrialization (Jedwab, Gollin, & Vollrath, 2014).

2.2.4. Measurement of Urban Sprawl

Three main types of urban patterns can be identified for any monocentric or polycentric urban region (Pozoukidou & Ntriankos, 2017; Yue, Liu, & Fan, 2013) (see Figure 2.5)

Linear development: Development is parallel and along major transport lines. While development takes place in the lands adjacent to the main roads, areas not accessible by roads tend to remain green, awaiting conversion to urban land uses, when the value of land increases and infrastructure stretches from major roads.

Peripheral accumulation: Expansion of the urban fabric takes place in the margin and next to existing urban development. It happens when there is a growing urban population and a lack of land supply. This consumptive urban land use is supported by the gradual extension of basic urban infrastructure such as water supply network, sanitation system, energy network and roads.

Leap-frog development: Occurs in the case of discontinuity with the existing urban fabric with the use of disintegrating land in urban areas. It interspersed with green areas and characterized by the uncontrolled development of new urban centers.

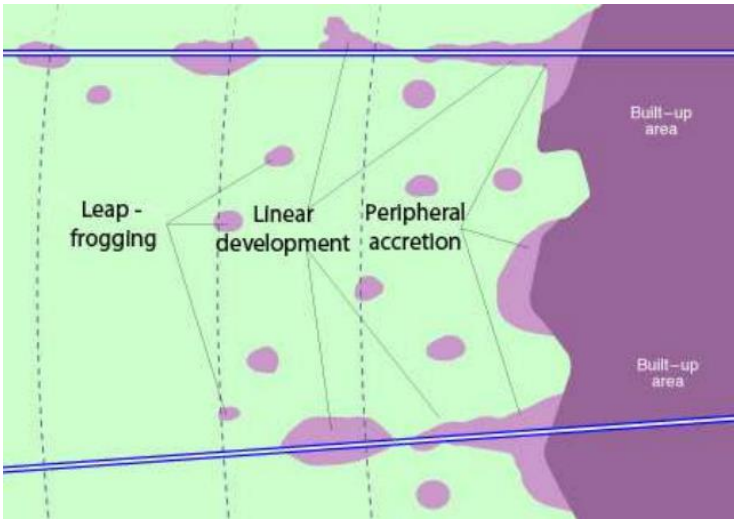


Figure 2.5. Types of urban sprawl's spatial pattern (Source:Pozoukidou & Ntriankos, 2017)

The type of urban sprawl should be defined in order to be understood and measured. In many studies, several quantitative methods have been mentioned to measure the phenomenon of urban sprawl and determine its spatial patterns, as well as differences with respect to the area under study. While case studies of the United States focus on

single-family housing units, road network indicators and intersectoral densities (Ewing & Cervero, 2010; Holcombe & Williams, 2010), European case studies focus more on land use, mixing and penetration of the ground cover (Arribas-Bel, Nijkamp, & Scholten, 2011). In particular studies, a combination of indicators is merged in a measured index, in order to obtain a more combined technique (Frenkel & Ashkenazi, 2008; Jiang, Liu, Yuan, & Zhang, 2007; Sudhira, Ramachandra, & Jagadish, 2004).

The indicators system was created by completing three sub-steps: the first step is to determine the existence and degree of urban sprawl. The second step is to determine whether the selection specified in the previous step of urban sprawl gives the properties of the sprawl. The final step refers to the spatial pattern and extension properties. The indicators were selected based on two criteria: their ease of calculation and the characteristics of the sprawl they are trying to measure.

In terms of calculation, remote sensing of satellite images are used to calculate all indicators. In terms of the characteristics of the sprawl they are trying to measure, they can be classified in two categories. Land cover is the first category, consisting of indicators that measure the penetration of the land cover and the degree of urban sprawl. Geometry is what makes up the second category. These indicators have emerged in the fractal geometry that attempts to determine the characteristics of the spatial imprint and the geometry of the urban fabric.

2.3. Consequence of Urban Sprawl on the Environment

There are grave consequences of urban sprawl on the lives of the citizens and the city, that many of the inhabitants realize less explicitly (Kaur, 2008). Some problems connected with urban sprawl are listed in Table 2.2.

Table 2.2 summarizes the consequences of urban sprawl in cities. Urban sprawl could cause many problems. Some can be mentioned such the absence of enjoyable, attractive green areas which are vanishing and being replaced by buildings and useless landscape. Large spaces of the land are being enveloped by roads and concrete. Unplanned developments can often lead to burdening of road capacities, power lines, etc. Towns that were planned for small groups of people are often forced to cater to the sprawled communities. It results in overcrowding of services and infrastructure, leading to traffic congestions, intermittent water supply, pressure on sewerage system, etc.

Table 2.2. *Some problems connected with urban sprawl (Adopted from Kaur,2008)*

Absence of open space, forests, valuable agricultural lands
Overcrowding of services and infrastructure.
losing of small towns and settlements
Increasing urban pollution
Environmental degradation
Major dependence on private vehicles

Small towns and settlements located near the big city are lumped into the city's urban population, if the distance between the two is not far. These settlements have, however, not really disappeared, but have been swallowed by the advance of urban sprawl and lost their unique identity.

Construction site erosion, fuel spills, oil leaks, paint spills, lawn chemicals, pet wastes contribute to water pollution. This also leads to soil contamination. Also, the increased use of motor vehicles releases chemicals and particulates like hydrocarbons, carbon monoxide and nitrogen oxides, leading to air pollution and smog. The suburbs on new urban lands add to the deterioration of the environment through depletion of resources (air, water and soil). There are impacts on vegetation and habitation. Several species of animals and plants are becoming extinct, impacting on the precious environmental resources. It also creates a threat to water quantity and quality.

Land use change in urban areas is seen as an essential element of global environmental change (Turner, Lambin, & Reenberg, 2007). Giving the increasing importance of urban areas to global environmental change vulnerabilities is important. There is an urgent need to understand how urban areas are evolving, how and where they may develop in the future (Sarvestani et al., 2011). To know the difference between urban growth and urban sprawl is quite difficult, since both are referred to as urban development. Inquiries such as the extent to which development should be extended and the level of density and its shape are to be called urban growth or urban sprawl remain unsolved (Bekele, 2005).

Continuing with the same categorization of Johnson (2001), four main categories of environmental impacts referring to urban sprawl are considered to be; Air, Energy, Land, and Water.

2.3.1. Impact of Urban Sprawl on Land

Losses of greenbelts and farmlands, forests and open spaces are the main common points handled by researchers to demonstrate the impact of urban sprawl from a land use perspective (Frenkel, 2004; Xi et al., 2012). In the research presented by Frenkel (2004), it is claimed that using a combination of quantitative models and scenarios, the effectiveness of focused growth management policies was found to be better than current policies in maintaining greenbelts, open spaces and agricultural lands (Frenkel, 2004). Sprawl has also been related to habitat loss (Dumas, Jappiot, & Tatoni, 2008; Huang et al., 2009; Robinson, Newell, & Marzluff, 2005).

Fewer articles from developing countries focusing on land resources were noted. One of these studies showed that the external growth of cities is a threat to agricultural lands along the fringe in China's cities (Xi et al., 2012; Xu, 2004). Another study in India documents similar patterns of losses of major agricultural lands around the cities north of India (Fazal, 2001). Sarvestani et al. (2011) utilized GIS and remote sensing to spatial dispersion measuring for the Iranian city of Shiraz (Sarvestani et al., 2011). In general, the literature dealing with the effects of land resources from both developed and developing countries is comparable in their methodologies with GIS and remote sensing (Dumas et al., 2008; Fazal, 2001; Huang et al., 2009; Paül & Tonts, 2005; Pauleit, Ennos, & Golding, 2005; Robinson et al., 2005; Sarvestani et al., 2011; Vimal et al., 2012; Xi et al., 2012).

2.3.2. The Impact of Urban Sprawl on Air

The relationship between transportation and air pollution is what most studies have focused on in this category. Vehicles have long been regarded as major contributors to urban air quality issues (Willens, 1970), and studies have shown that there is a link between urban crawling and low air quality. Stone Jr. et al. (2007) examined the relationship between sprawling development and four pollutants in eleven cities in the midwestern part of United States. The results of their study indicated that compact development could significantly reduce emissions of pollutants at the regional level. It will only happen in the long run, when supplemented with growth controls, vehicle inhibiting barriers and technological emission controls (Stone Jr, Mednick, Holloway, & Spak, 2007).

Another study on the effect of urban crawling on air quality in the Ruhr region of Germany shows that urban expansion has a relatively small impact on the overall exposure of the population, and the impact is less for those living in suburban areas rather than city center with high-density locations (De Ridder et al., 2008). Thus, sprawl becomes not only a cause of external factors, but in some cases the cause of environmental justice as those who have the means to get out of the city have less exposure to health risks. Transportation-related air pollution is a major concern in major cities, where urban sprawl contributes to the problem by increasing average travel times and traffic congestion (Pucher et al., 2007).

After many debates, many researchers acknowledged that climate change is one of the most important challenges of this century that urban planning is facing with (Blanco et al., 2009). The main linkages between urban sprawl and climate change observed in fossil fuel consumption in the planning literature, which is the largest contributor to anthropogenic emissions of carbon dioxide and greenhouse gases, are caused by land-use change (Griggs & Noguer, 2002; IPOC, 2007; Smithson, 2002).

2.3.3. Impact of Urban Sprawl on Energy

The effect of land use and urbanization on the outcomes of the energy use is still a debatable matter in the literature of urban planning.

The results of the Newman and Kenworthy (1989) study confirmed that the most compact urban form is also the more energy efficient one (P. W. Newman & Kenworthy, 1989). These results have been supported by several studies (Mindali, Raveh, & Salomon, 2004; van de Coevering & Schwanen, 2006). Loss of energy through transport lines, large heated areas, and increased surface temperatures due to the thermal island effect especially in sprawl areas show the link between urban sprawl and climate change (Ewing & Rong, 2008). Compact development within the existing urban area is more compact in case of density and average structure, with lower rates of residential energy consumption (Ewing & Rong, 2008). Dodman (2009) stated that most densely-populated cities use less transportation energy (Dodman, 2009). However, Echenique et al. (2012) showed a scenario-type modeling study of some metro areas in England, and they found the impact of compacting urban form on energy use to be "very modest" (Echenique, Hargreaves, Mitchell, & Namdeo, 2012, p. 136), making the debate on this issue controversial.

Some studies link sprawl and energy consumption in the context of developing countries, especially China, with the largest amount of representation (Lehmann, 2013; Pucher et al., 2007; Wilson & Chakraborty, 2013; Zhao & Lu, 2011; Zhao, Lü, & de Roo, 2010). The study of Pucher et al. (2007) revealed a significant increase in private motorized vehicle travel in both countries with attendant increases in greenhouse gas emissions (Pucher et al., 2007). Moreover, the urban poor are disproportionately affected by the social and environmental impacts of transport system vulnerabilities. They were forced to live on urban periphery where public transport options are limited. The increased use of motor vehicles increases the consumption of transport energy, traffic hazards, noise and air pollution (Wilson & Chakraborty, 2013).

2.3.4. Impact of Urban Sprawl on Water

Sprawling development is characterized by an increase in impervious surfaces, and has wide and well-documented effects on hydrology including an increase in the volume, rate and contaminants of storm water (Arnold Jr & Gibbons, 1996). Some studies reviewed have examined watershed health (Berke et al., 2003) or balance of urban water (Haase & Nuissl, 2007; Poelmans, Van Rompaey, & Batelaan, 2010). However, other studies focus more on rainwater runoff (Davis, Pijanowski, Robinson, & Engel, 2010; Pauleit et al., 2005; Tang, Engel, Pijanowski, & Lim, 2005), supplying water (Kucukmehmetoglu & Geymen, 2009; Rayne & Bradbury, 2011), flooding (Brody et al., 2011), or housing consumption (House-Peters & Chang, 2011).

A study presented by Poelmans et al. (2010) found that the spatial scale of urban sprawl has a negative hydrologic effect that is much higher than the type of urban sprawl, and it has far greater effects on runoff compared with evaporation and groundwater water recharge (Poelmans et al., 2010). Another study investigated the impact of residential subdivision development on groundwater resources in Southeast Wisconsin where suburban developments often depend on local wells. It concluded that development size, a spread of subdivisions and soil type all play significant roles in groundwater recharge (Rayne & Bradbury, 2011).

After reviewing articles regarding the context of developing countries, some articles focusing on the loss of wetlands and the ecological services provide a prominent theme (Kamini, Jayanthi, & Raghavswamy, 2006; Zhou, Shi, Wang, Yu, & Gao, 2010),

whereas water supply (Kucukmehmetoglu & Geymen, 2009) and general watershed health (Wang, Wang, Wang, & Dong, 2011) are also represented.

The article of Kucukmehmetoglu and Geymen (2009) focuses on Istanbul, Turkey, which is classified as one of the most densely populated cities in the world whose geography and size make access to water particularly difficult. They pointed out that the population growth rate of 4.5 percent and the intense growth pressure to expand out of the crowded core was that water resources were severely constrained. Using GIS and satellite imagery, the authors found that the leapfrog and low-density development have increased in recent decades, largely due to capital elaboration projects designed to improve access to the city's core.

These four main elements of ecosystems have an impact on each other. For example, lack of green spaces and agricultural lands affects the increase in air pollution (Foley et al., 2005). In turn, air pollution contributes to the pollution of water bodies, and this affects the amount of water suitable for the population and agricultural lands (S. R. Carpenter et al., 1998; Shao, Tang, Zhang, & Li, 2006). The energy consumed by transportation also increases the amount of air pollution (Frank et al., 2006; Friedman, Powell, Hutwagner, Graham, & Teague, 2001).

From the previous reviews and as a response to urban sprawl, further research is needed to examine the interaction between the various factors contributing sprawl and how this relationship is shaped by the context.

2.4. Tools of Controlling Urban Sprawl and Its Environmental Effects

The studies reviewed presented several policies and proposals to control urban sprawl, focusing more on smart growth and more compact growth encouraging (Lehmann, 2013), employment and housing balancing (Zhao et al., 2010), and transportation investments policies (Sietchiping, Permezel, & Ngomsi, 2012; Zhao & Lu, 2011) were the most frequently proposed policies to control sprawl. Some studies support the growth management policies that inhibit urban sprawl by increasing density, encouraging mix land-use, and reducing dependence on cars (Wilson & Chakraborty, 2013; Zhao & Lu, 2011).

Reviewed studies from China and India, the fastest growing developing countries, stated that smart growth solutions are the proposed strategy to control urban expansion

(Fazal, 2001; Zhao & Lu, 2011). Although the adoption of smart growth principles is most often suggested as a way forward, other articles are questioning the overall effectiveness of this strategy (Wilson & Chakraborty, 2013).

Policies of growth management such as urban growth limitation and smart growth achieved the internal density raise, but were unsuccessful in preventing the growth of low residential density in farmland and rural areas (Robinson et al., 2005). Similarly, zoning policies solely were inadequate to save farmlands from urban growth in the Spanish region of Bilbao (Abelairas-Etxebarria & Astorkiza, 2012). In addition to the doubt in the validation of smart growth policies, some studies have not considered sprawl as a threat to control and mitigate it (Garcia & Riera, 2003; Holden & Norland, 2005).

Conceiving urban sprawl as a pattern of development exposing over time that is conflicting with commonly accepted features of environmental resilience can potentially mitigate many of the difficulties that have plagued sprawl research, bridging the idiosyncrasies of growth across national contexts and relieving the need to give a definition of sprawl that works everywhere. Another benefit of situating sprawl research within the context of environmental resilience is an increased chance to link with extensive conversations and policy debates.

Some of the policy interventions that can help control urban sprawls and degradation of the environment to enhance the quality of life of the inhabitants are:

Zoning and land use controls promoting multi-use: Zoning and land use controls should be set so as to minimize the barriers between different types of uses. Residential areas, commercial areas, parks and playgrounds should be easily accessible, and create opportunities for public interaction. New developments can be restricted to specific areas, and additional density incentives can be offered for abandoned or under-used sites.

Decentralization and multi-nodal cities: Since the 1950s, decentralization policies have been used with limited success. Governments tried to create decentralized centers to shift the commercial and office spaces to these locations. There were, however, no significant attempts and investment on other essential supporting facilities such as services, transport, housing, schools, etc.

2.5. Experience of World Cities on Urban Sprawl

Experiences of urban sprawl, its causes and how to deal with it in cities in other countries and continents is investigated under this section, including cities in North America, Europe, Canada, Russia and developing countries.

2.5.1. The United States and European cities

There is an increasing awareness and concern about urban form development in the United States and European cities (F. Dieleman & Wegener, 2004). The growth of low-density urban spatial patterns, large outward expansion, spatially separated land use, leapfrogging in urban development and wide development of the trade sector are generally considered unfavorable to a good quality of life in cities (Burchell, Listokin, & Galley, 2000). Many politicians, planners and academics have an idea that governments should try to organize and control the development of the urban form to avoid the outcomes of urban sprawl, which are often seen as undesirable (Basudeb Bhatta, 2010; Brueckner & Largey, 2008; Ewing, 1997; Hesam, Pourahmad, & Ashor, 2013; Johnson, 2001; Song & Zenou, 2009).

The experience of the United States and western countries is different from the developing countries. In the developed countries, suburbs of satellite cities can be seen as urban sprawl. Disorderly settlement/layout and suburbs is the general pattern of urban sprawl in developing countries. Such an extension of this type of development led to low-density land use patterns. Sprawling neighborhood residents also tend to incline further into farmlands, and cause more pollution per person and suffer more traffic deaths. In the United States, movements that promote state regulation of urban growth are known as "New Urbanism" and "Smart Growth". It is an attempt to create a better and more sustainable place to live by promoting environmentally friendly habits through the creation of walkable, playable and mixed function neighborhoods. Hence, the idea of New Urbanism has risen to satisfy these needs and to define the obligations of growth in cities (Wey & Hsu, 2014).

Smart growth focuses on growth in compact, walkable urban centers to parry sprawl. New urbanization and smart growth are seen as alternative approaches to urban expansion in urban planning (Wey & Hsu, 2014). Smart growth policies have been implemented in some states and counties in the United States; known cases are the states of Oregon, Maryland, and Montgomery County, Virginia, and even in Michigan,

in the city of Detroit, which is the metropolitan that has the biggest amount of urban sprawl in North America (Galster et al., 2001; Knaap, 2002; O'Neill, 1999).

For decades, national governments in some European countries have tried to regulate the development of urbanization in a series of national spatial plans, focusing on compact urban growth on the environment in the 1980s. Its objectives are well-aligned with the goals set by intelligent growth policies in some United States cities (F. M. Dieleman, Dijst, & Spit, 1999; P. Newman & Thornley, 1996; Salet, Thornley, & Kreukels, 2003).

Containment policy is also used in some countries to manage and control the problems of urban growth and its related sprawl. Containment policies can be defined as policies, tools and plans aimed at limiting urban growth through land use regulations that constrain or inhibit urbanization in certain urban or peri-urban areas, directing development to specific areas. Such measures are often found in the form of urban growth limits, different forms of zoning or green belt protection. The United States and several European countries have been using containment policies in preparing their urban and regional plans for decades. Many cities have adopted strong policies and strategies including containment (Jørgensen, Nielsen, & Grünfelder, 2011; Woo & Guldmann, 2014).

Examples of such policies are the green belts in London and Frankfurt, the Green Hart strategy from Rundstedt in the Netherlands and the finger-plan in Copenhagen (Jørgensen et al., 2011). Although these methods seem easy to implement, the results of these tests are not as planned as in the beginning. Development processes and previous planning plans may result in urban and semi-urban growth resulting from changes in rural and agricultural land use beyond the limits adopted by these policies (Woo & Guldmann, 2014). It is thus clear that the regulation of agricultural and rural land uses is essential for urban expansion.

The discourse of urban sprawl in the United States includes contradictory views on whether suburban businesses on the city's edge could grow independently of central cities (Garreau, 1988), or whether central metropolis and suburban are largely interconnected. The recent view confirms that the extension in the suburbs is linked to the decline of the central cities, which negatively affects the future of the city (see

Figure 2.6) (M. Danielson & Wolpert, 1994; M. N. Danielson & Wolpert, 1992; Savitch, Collins, Sanders, & Markham, 1993).

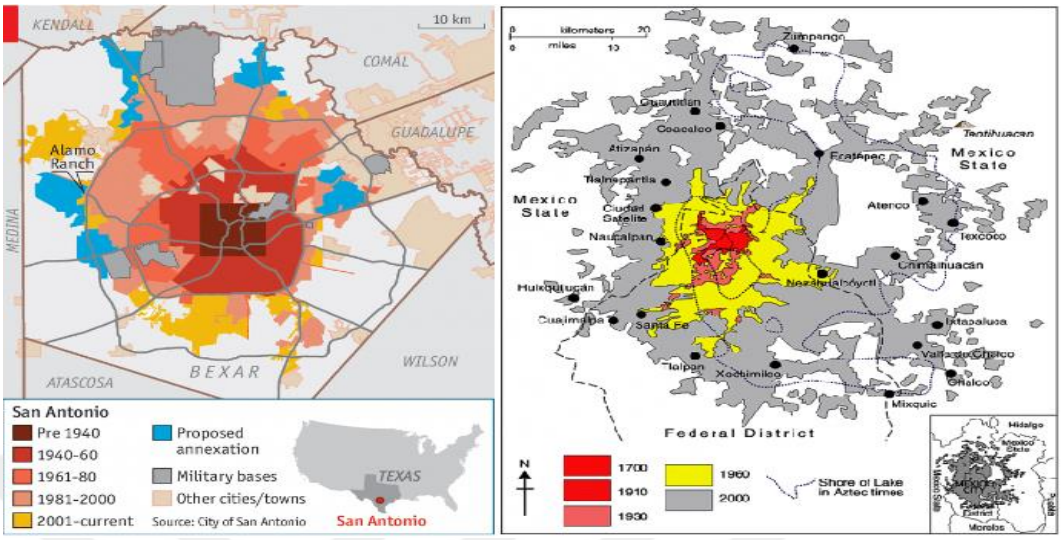


Figure 2.6. Spatial growth of San Antonio city and Mexico City metropolitan area, USA. (Source: Connolly & Wigle, 2017)

Planning policies in the United states have slowed down the progress of the urban sprawl only to a certain extent, and as the period of political decentralization continues, it is unlikely to succeed in stopping an unwanted urban expansion. According to Hart (1993), conserving green and open spaces is far more difficult politically than recounting the horrific stories of famine to preserve arable land. Countries such as the Netherlands tried to absorb the urban functions created within the boundaries of the urban city. These attempts did not achieve their goals and continued the movement of urban expansion towards the edge of the city and its outskirts (see Figure 2.7) (Van der Veer, 1998).

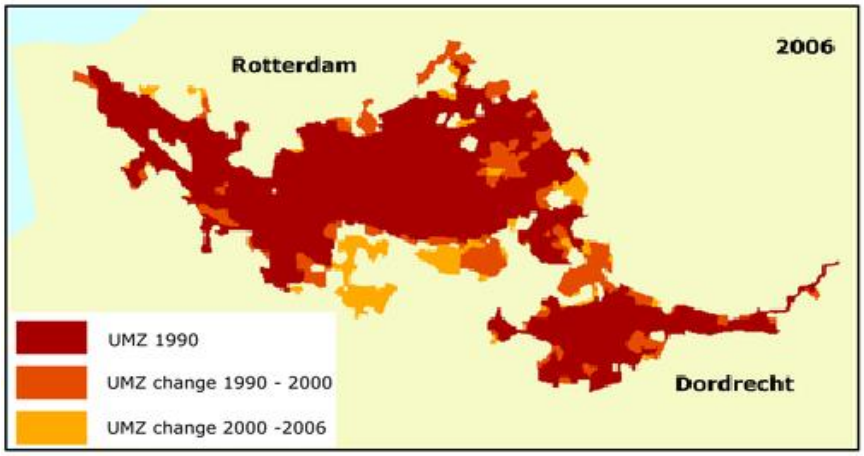


Figure 2.7. Spatial growth in Rotterdam and Dordrecht, Netherlands. (Source: EEA / ETC LUSI, 2007)

2.5.2. Canada

Accepting the inevitability of increasing urban decentralization is the most practical approach, as high-density development corridors can be channeled to suburban communities to preserve greenbelts and open spaces in between. Integration or establishment of high-level urban municipalities in terms of urban services and local government reform was considered a strong policy for rationalizing urban development and preventing uncontrolled sprawl (Breheny, 1995; Thomas, 1990). However, not all local municipalities are able to reduce the decentralization of jobs and people. For example, most of the population growth occurred in the suburban areas, usually outside the administrative boundaries of the cities of Canada's strong metropolitan municipalities (see Figure 2.8) (Rothblatt, 1994).

Thus, recent experience in many Western countries suggests that metropolitan municipalities do not certainly participate in the protection of farmlands and open spaces, and do not supply a solution to development disputes in urban fringes (Habibi & Asadi, 2011; Pumain, 2004). Thus, "compromise" policies aimed at rationalizing, rather than curbing urbanization patterns seem more feasible and effective than major rationalization efforts based on legal planning or local government reform (Razin, 1998; Rothblatt, 1994).

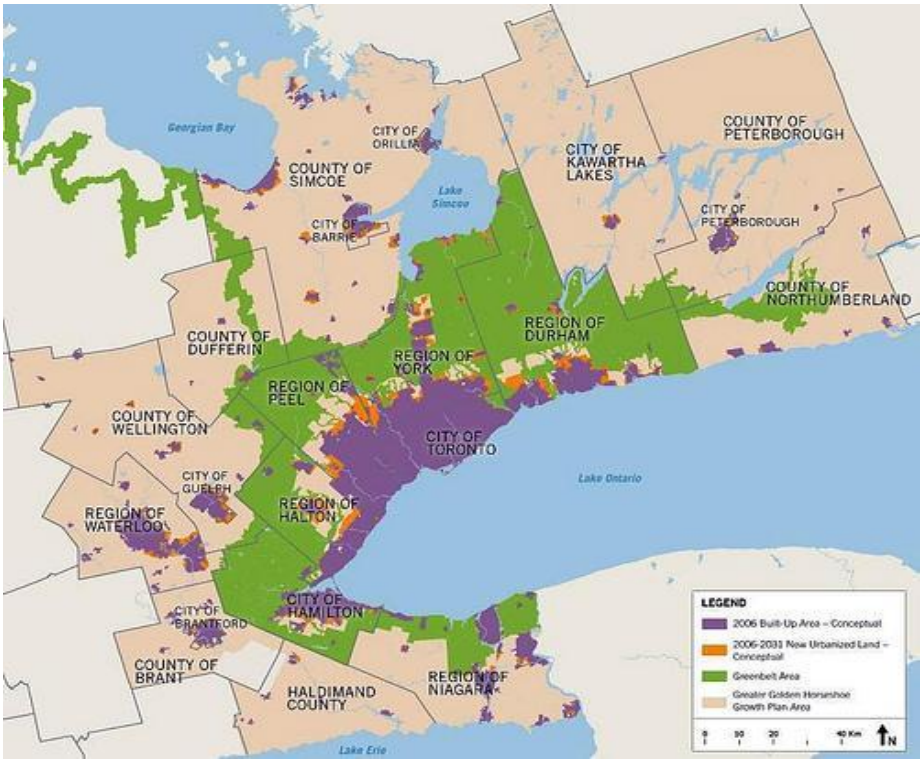


Figure 2.8. Administrative boundaries of the cities of Canada's strong metropolitan municipalities. Greater Golden Horseshoe Growth Plan - 2031 Urbanized Land (Source: urbantoronto.ca, 2012)

The conditions associated with each time period produce policies that are urgent in time, including highway construction, suburban land use planning and ample open spaces that have led to dispersion (Batty, Besussi, & Chin, 2003; Bourne, 1992; GOLBERG & MERCER, 1986). On the contrary, there are policies that promote growth within the core of the agglomeration, such as recycling untapped areas, promoting public transport and establishing a subway system (Filion, 2000; Habibi & Asadi, 2011). These policies were implemented in the Canadian city of Toronto starting from the early 1970s. However, the city did not succeed in its attempts to induce concentration beyond the prewar urban environment (Filion, 2000).

2.5.3. Russia

Urbanization in Russia is very rapid and began in the 1930s. Urban populations increased dramatically during and after the war, with the transformation of the population of cities in Russia at the end of the civil war from 14% to 74% at the end of the Soviet period (Becker, Mendelsohn, & Benderskaya, 2012). This caused a shortfall in the rural population resulted from their relocation to new industrial areas near urban centers. The central system of planning in the period of the Soviet Union has greatly influenced the formation of cities and their spatial distribution, where urbanization was tied to economic planning. The Central Command was redistributing economic activities and population (Dale, 2015), and the Soviet-era population was restricted. The road network of the 1980s and its maintenance in the 1990s were not sufficient in most cities (Hanson, 2014).

This resulted in traffic congestion in most cities, and caused an increase in housing prices in the urban center and near the business areas to avoid congestions. The demand for lands outside the center meant urban sprawl. However, the demand for suburban housing has increased from certain layers. It is clear that urban urbanization in Russian cities was a result of the suppression of the spatial policy (Becker et al., 2012).

St. Petersburg is one of the most developed economic centers in Russia, where special characteristics of the form of urban sprawl in the peripheries in the post-war period can be found (see Figure 2.9). Here, most of the inhabitants of the areas of urban expansion are rich, young and highly educated people using their own cars or means of public transport to move to the city center. Land prices vary by the area and distance

from the metro station and the availability of green spaces. Studies have found that most newcomers to St. Petersburg after the war prefer suburban housing, as well as car owners (Becker et al., 2012; Hanson, 2014).

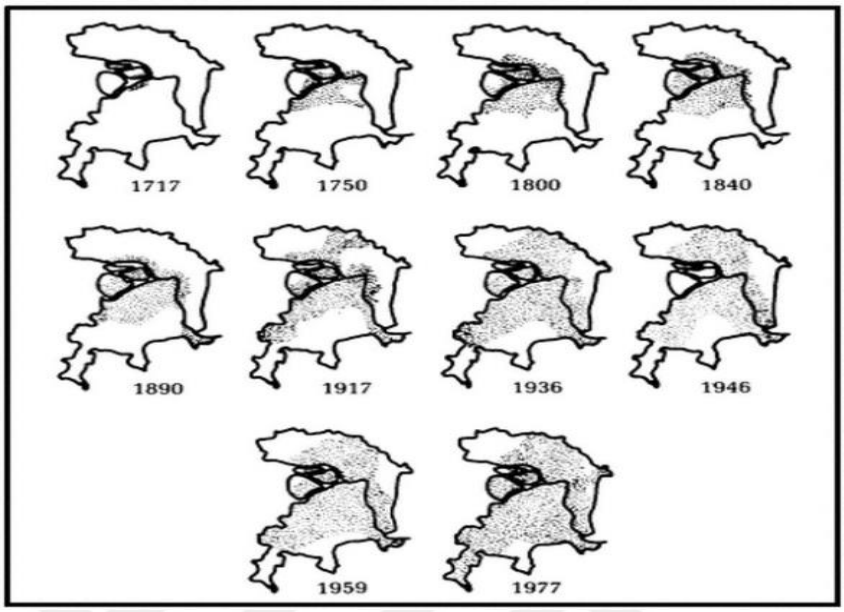


Figure 2.9. Urban development in St. Petersburg city, Russia from 1717 to 1977 (Source: http://petersburgplan7002.weebly.com)

2.5.4. Developing Countries

The negative impact of urban growth is mainly the rapid spread of urban areas in agricultural areas and forest areas, which is often uncontrolled and unplanned in developing countries. In fact, this study will raise the awareness that developing countries have faced a large expansion of informal settlements that cause many problems. The massive migration from rural to urban areas in developing countries has greatly increased the population density of their major cities. One of the reasons for this problem in developing countries is that governments support large cities and increase their hegemony at the expense of rural areas. Priority is given to investments in these cities, attracting more people to settle in these places. These policies create informal settlements and cost governments huge budgets to find solutions to these uncontrolled developments (Wyly, 2012). Morelli et al. (2010) notes that this phenomenon of urbanization over a region has become a debatable issue, and emphasizes that it applies to subjects in various disciplines, such as ecology, environmental science, economics, geography, urban planning and sociology (Morelli & Salvati, 2010).

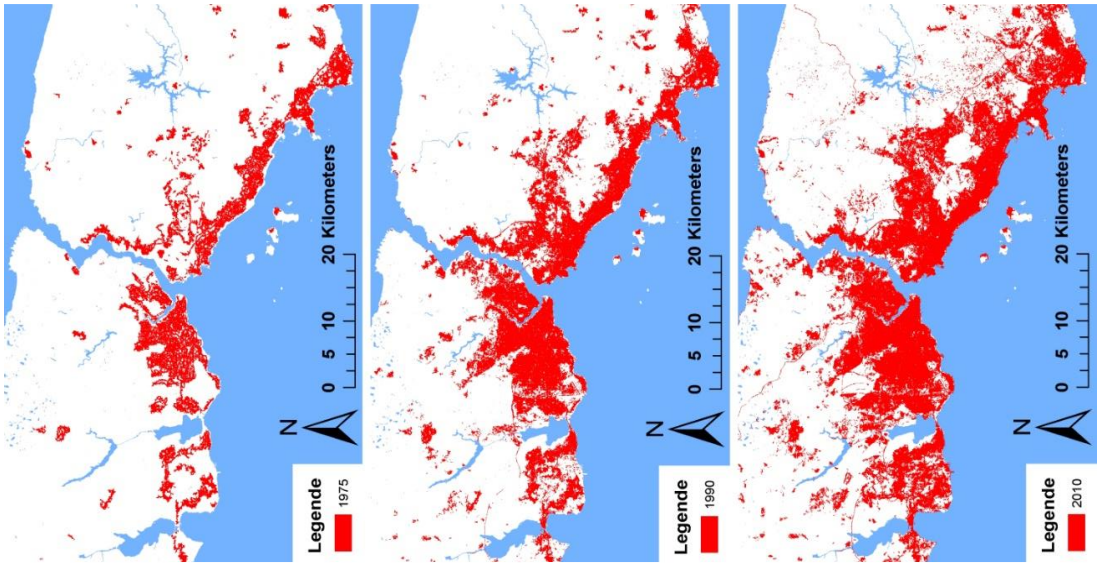


Figure 2.10. In the last 35 years, the urban area of Istanbul has tripled (Source: Demirtaş, 2009)

Several studies have been conducted in the developing countries in response to the large increase in urban sprawl, to learn how to eliminate or mitigate the effects of this phenomenon. Random settlements began to develop in the late 1940s in some developing countries (Melese, 2004). One of the first random settlements of this contemporary character was observed in Istanbul, Turkey (Demirtaş, 2009). The term "landed at night" was used to indicate that the people arrived there had built, finished and lodged overnight to avoid demolition and any charges from the government (see Figure 2.10). In fact, this situation reflects what is happening in many developing countries (Melese, 2004).

Melese (2004) stated that the emergence of informal settlements in Addis Ababa, Ethiopia, arose as a result of many factors, such as the delayed implementation of legal housing, high rental costs and delays in the provision of legal land supplies. It is also mentioned in this study that there are political and legal failures that appear in the absence of governmental procedures to control and arrange open spaces, the absence of a law enforcement service to regulate and monitor the appearance of illegal building of the house, the lack of comprehensive guarantees of legal responses to the continuous emergence of squatting phenomenon, land sale by land speculators and legalization (see Figure 2.11) (Melese, 2004).

Some developing countries, in recent years, tried to achieve a higher rate of social and economic evolution. Most of these countries rely mostly on mining or agriculture (Adaku, 2014). Some studies indicate that the absence of varying economic wealth

brings a failure to control economies, and therefore, the state has failed in providing a suitable life for its citizens. All this resulted in the government's lack of interest in how people treat their daily lives. Some of these governments propose to establish residential communities in these informal areas and to provide basic services available to the middle and high income classes (Cheema & Ward, 1993).

Figure 2.11. informal houses in Addis Ababa (Source: https://100resilientcities.org, 2018)

Cheema & Ward (1993) explained that these governments do not take into account the low-income classes, which leads the latter to get their residential needs by informal means. This has pushed the urban poor to get land without permission and in illegal procedures, as it happens in most developing countries. In the absence of government planning policies and implementation regulations, informal settlements and uncontrolled urban sprawl have spread in the cities of developing countries (Cheema & Ward, 1993).

Fernandes and Varley (1998) underlined that the fact of illegal observation is not confined to poor urban areas. Distinct community groups may be present in informal settlements. Hardoy et al. (2013) supported the fact that, in developing countries, these illegal settlements have spread on highly productive agricultural lands, and Egypt and North Africa are the best examples. Thus, the degradation of agricultural lands and natural environments with valuable ecological functions is a negative impact and a result of the growth of unrestricted cities (Hardoy, Mitlin, & Satterthwaite, 2013). For

example, the most productive agricultural lands in Egypt have shrunk by more than 10% due to uncontrolled urban expansion (Hardoy et al., 2013), with potentially more damaging consequences in relative terms.

North Africa is the most urbanized region compared to the rest of the continent (Potts, 2009). It is expected to be about 60% of the total population in the northern areas of urban areas by 2025. These percentages vary among countries (R. A. Obudho, 1999). According to Obudho and Mhlanga (1988), the proportion of people living in the areas of random expansion in African countries amounts to 30 % of the total population (R. Obudho & Mhlanga, 1988). Despite the efforts made by many countries, this percentage had remained the same until recent years, based on the UN-Habitat report in 2010 (Un-habitat, 2010).

It is estimated that the population of informal settlements in Africa in the 1980s increased by 15% annually. This growth of population contributed to the spread of the urban sprawl and slum settlements, which was in addition to urban growth rates that were unmatched in the world history. This was due to a staggering rural-urban migration coupled with a very high rate of natural increase of population at the same time. The number of people who experienced the lack of adequate housing has increased due to this migration (Un-habitat, 2010).

Developed countries have implemented strong policies and strategies to solve the problem of urban sprawl as mentioned above, and developing countries have used these guidelines and strategies. Many countries have received support from agencies such as the World Bank and UN-HABITAT (Un-habitat, 2010). However, the situation of urban sprawl in the African countries is different from the situation in the developed countries, and it also varies from one country to another as it is affected by changing causes and effects (Dericioglu, 2018).

The North African countries have made efforts to alleviate informal housing. Attention has been shifted from large cities to small cities in terms of development and sustainability trends. Countries such as Morocco, Algeria, Egypt and Tunisia have taken comprehensive national development decisions to provide for the greater development of secondary cities and reduce pressure on major cities and its urban areas. One of the objectives of these policies was the restructuring, improvement and redevelopment of slums and informal settlements (Habitat, 2013; Madbouly, 2009).

In the past, stakeholders such as local communities, politicians and economists have not been involved in the urban planning process. This process has led to the failure of urban planning plans in many North African countries, such as Libya. In turn, the North African countries have developed planning methodologies in response to volatile environmental and economic aspects.

They adopted urban planning approaches similar to those used by the European countries in past decades, where urban planning relies on bottom-up approaches. These approaches appeared as a response to the failure of master planning and the lack of a comprehensive, long-term spatial plan (Madbouly, 2009). Policies in Morocco and Egypt pursued to direct urban populations to new areas. The advantage of these policies was to protect the limited agricultural lands adjacent to the urban areas of creeping architecture.

It can be seen that through relentless efforts to improve the quality of life in general in the informal regions of the North Africa, informal urban areas declined approximately by 43% between 1990 and 2010. Similarly, except Libya, most North African countries have moved forward for improving conditions of life in the illegal urban areas. This development involves the provision of affordable homes regardless of the economic recession experienced by most North African countries (Un-habitat, 2010). The next step of this policies is the transformation of these areas for the benefit of high-income classes, and that is what has been experienced in Turkey (Dericioglu, 2018).

There are countries such as Tunisia and Morocco, which have succeeded in overcoming the negative effects and difficulties resulting from uncontrolled urban expansion through several policies. These policies involve the level of existing housing and the establishment of new housing at affordable prices in cooperation with the private sector. The Egyptian government has pursued sustainable development of desert areas and the creation of new cities. These plans have contributed to reducing the increasing number of visitors from rural areas and reducing overcrowding in major cities such as Cairo and Alexandria (Hegazy & Moustafa, 2013).

This strategy maintained arable lands, because it directed development to the desert (Madbouly, 2009; Un-habitat, 2010). The continuation of these strategies and the continuation of control in the areas of urban sprawl are linked to the return of political

stability in Egypt and Tunisia, where the unrest that began in the region in 2011 and the continued political stability in Morocco (Dericioglu, 2018).

Table 2.3. City examples of urban sprawl and its reasons and control tools (Source: Author)

City/ Country	Reason of Urban Sprawl	Types of Urban sprawl	Tools of controlling
United State, Michigan	Planning Policies	Leap Frog	Smart Growth, New urbanism
UK, London	Urbanization	Peripheral accretion	Compact urban growth Containment policy Green Belt
Netherlands, Rotterdam - Dordrecht	Urbanization	Peripheral	Containment policy Green hart
Canada Greater Golden Horseshoe	Urbanization	Peripheral Linear Leap Frog	Strong municipality boundaries Green belt Compromise policy
Russia Saint Petersburg	Urbanization - Suppression of Spatial policies	Peripheral	Recycling unlopped areas Promoting public transportation Establish subway system
Turkey Istanbul	Urbanization - Earthquake disaster (move to North and Northeast)	Peripheral Leap Frog	Compact development approach Restricted development policies Shifted to central areas from peripheral areas
Ethiopia Addis Ababa	Urbanization - No planning No low enforcements	Peripheral Leap Frog	Zoning Containment policy
Egypt Cairo Alexandria	Rapid Urbanization - Lake of housing Poor policies	Peripheral Linear Leap Frog	Establish new towns and cities Sustainable developments in desert areas
Morocco	Rapid Urbanization - Lake of housing Poor policies	Peripheral Linear Leap Frog	Establish new towns and cities Distribution of services in other cities

This chapter reviews various definitions of urban sprawl and the reasons that increase it, represented by urbanization and the accompanying economic growth, population growth, urban and political problems. Studies discussing the war as one of the reasons for the change in the spatial structure of cities are also reviewed. The chapter also reviews the theoretical basis for the evolution of the phenomenon of growth on the outskirts of cities and urban sprawl. Measurements of sprawl ratio and its shapes are reviewed. The chapter discusses the consequences of urban sprawl on the city's dimensions, and focuses on reviewing the consequences in the environmental

dimensions of land, air, water and resources. The chapter concludes with a review of examples of urban sprawl from different world cities and a review of the strategies in which these cities address this problem.

Table 2.3 shows examples of urban sprawl in some cities, and explains its causes and the strategies that these cities have taken to control the sprawl.

CHAPTER III

3. THEORETICAL FRAMEWORK OF ENVIRONMENTAL RESILIENCE

This chapter reviews and analyzes the literature on resilience and its definition, explains how to construct it in a specific planning system and how to measure the system's resilience to cope with or reduce risks and vulnerabilities. The chapter also explores the environmental resilience strategies and what benefits it may add to urban planning and cities to make them more resilient. The chapter includes the urban system vulnerabilities and their indicators which have been analyzed and used in the literature.

3.1. Understanding the Concepts of Resilience and Environmental Resilience

Resilience and environmental resilience concepts, including definitions and frameworks, are reviewed and discussed in this part.

3.1.1. The concept of Resilience

The origin of the word “resilience” is the Latin word “resilio”, meaning “to bounce back” (Klein, Nicholls, & Thomalla, 2003). The concept of resilience developed in the first place as an ecological concept (Holling, 1973), was applied to social studies (Adger, 1998), and combined with human environment researches (S. Carpenter, Walker, Anderies, & Abel, 2001; Folke, 2006). It was also applied as an approach for short-term disaster cases (Bruneau et al., 2003; Tierney, 1995) and long-term disasters such as climate change (Dovers & Handmer, 1992; Timmerman, 1981). Despite all these valuable researches, a common concept of resilience is still missing.

The interest in resilience has grown, following the growing awareness of risks and because it is associated with multiple crises like economic turmoils, conflicts and terrorism (Lloyd-Jones, 2013). In particular, resilience has appeared as an attractive concept in relation with cities, which are often addressed as highly complex and adaptive systems (Batty, 2008; Godschalk, 2003). Resilience has a conceptual

ambiguity that is useful in making it to act as a "boundary object," a mutual object or concept that calls to multiple "social worlds" and, therefore, be able to promote multidisciplinary scientific collaboration (Star & Griesemer, 1989). The flexible meaning of resilience allows actors and stakeholders to accept a collective term without asking them to certainly agree on a strict definition (Brand & Jax, 2007). The importance of resilience planning has recently been heightened in an age of increasing uncertainty, which has prompted some researchers to propose the idea of cities that accept the concepts of turbulence and change as essential for urban planning (Ahern, 2011).

3.1.2. Concept of Environmental Resilience in Cities

Resilience has its origins in environment (Folke, 2006; Holling, 1973; Meerow et al., 2016; Wilson & Chakraborty, 2013). This concentration is now expanded to contain responses to social and economic impacts besides the ecological ones that are crucial to urban system performance (Brand & Jax, 2007; Lloyd-Jones, 2013; Meerow et al., 2016). The use of the concept of resilience can also be seen more broadly in scenario planning or other approaches that clearly recognize the uncertainty in future planning (Chakraborty, Kaza, Knaap, & Deal, 2011). Resilience thinking is an approach referring to the interaction between social systems and ecosystems (Walker & Salt, 2012).

Environmental planners are aiming to cope with urban growth and urban sprawl in addition to the aim of environmental resilience. Environmental resilience is the process of creating decision-making policies without complicating land development implementation taking into account the natural environment, social, political, economic and governance factors, and it provides a comprehensive framework for achieving sustainable results (Hardoy et al., 2013). Environmental resilience aims to create sustainable communities aimed at conserving non-urban lands and protecting resources. Environmental resilience deals with decision-making processes where they are required to manage existing relationships within and between natural systems and human systems. It seeks to manage all these processes in an equitable manner for all components within these systems at present and in the future. Current environmental resilience practices are the result of continuous improvement and expansion of decision-making processes. Social and economic development, regional development, natural resource management and integrated land use and infrastructure systems

governance frameworks are the key elements of contemporary environmental resilience (Beatley, 1995).

Daniels (2009) defines environmental resilience as the theory and practice of making fine and interrelated decisions regarding the natural environment of natural resources, wildlife, natural hazards, landscapes of farms, forests, the land where minerals are extracted, the public health of air, water, pollution, toxins, waste disposal and built environment. Daniel (2009) explained in his article the five periods of time in the development of environmental planning in the United States, where he claims that each period produced an appropriate approach in its time to identify and solve problems at the time (Daniels, 2009).

It could be seen how environmental resilience exists as a part of legal and policy processes for land-use planning, as well as for a wide range of sectors and other organizations - such as water and energy companies, state forest committees and watershed partnerships. Each institution will have its own preferences, stakeholder groups, strategies, financiers and preferred geographic areas. The challenge for environmental planners is how to reconcile all these different probabilities, from the legal to the illegal, from formal to informal, and how to arbitrate between the often conflicting objectives while seeking to strike a balance between the protection of private interests and the promotion of public interest (Allmendinger & Haughton, 2010; Daniels, 2009).

While environmental resilience focuses on development policies and decision-making, urban sprawl, in turn, represents the other direction in terms of growth in the absence or weakness of policies and regulations that limit and fortify it. Effective urban planning policies and decision-making using resilient environmental planning methods will create a balance between the equitable use of land for urban purposes and conservation of resources, pristine land, pastoralism and environmental life, thus, contributing to the reduction of urban uncontrolled urbanization (Beatley, 1995; Hesam et al., 2013).

As a result of dynamic interactions between the socio-economic and biophysical operations occurring on multiple scales, urban ecosystems change over time and place. The environmental resilience of urban ecosystems is affected by these interactions (Alberti & Marzluff, 2004). The factors that limit urban resilience on a large scale are

loss of limited agriculture lands, fragmentation of natural habitats, changing energy flows, nutrient cycling and disrupting hydrological and air systems. Urban form and land use distribution as alternative urban patterns cause many effects on the dynamics of ecosystems and their environmental resilience.

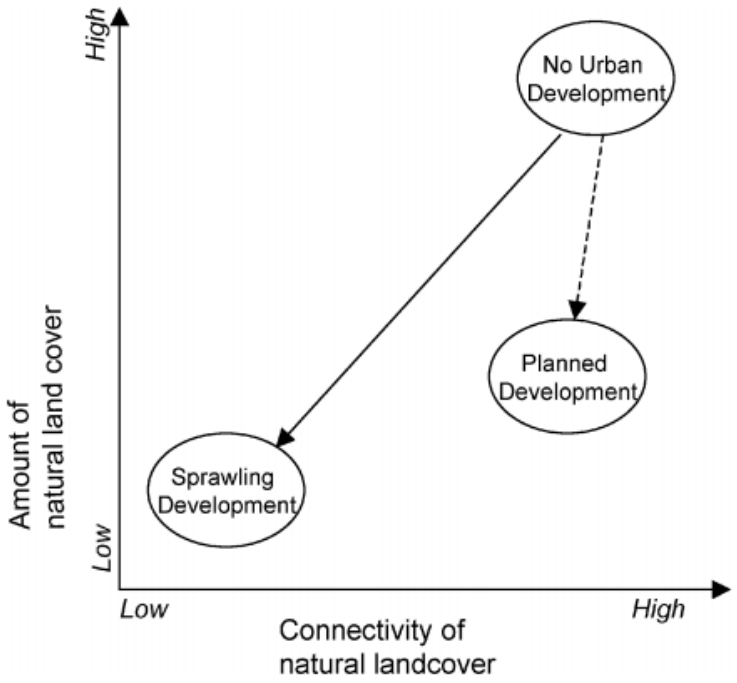


Figure 3.1. Stable cases and transitions in urbanizing environments. (Source: Alberti & Marzluff, 2004, p243)

Urban crawling causes loss of agricultural lands, pollution due to traffic congestion, loss of energy from transportation and impact on the hydrological environment (Alberti & Marzluff, 2004). Urban sprawl in cities and urban areas produced a transformation from the innate stable case of rich and well-connected land cover to another stable case of highly-fragmentized and greatly reduced natural land cover (Figure 3.1).

Planning and consideration of benefits of natural land cover to human services can force a different equilibrium that simultaneously supports humans and other species in urban ecosystems. However, this forced equilibrium has very low resilience, because the provision of ecosystem services pulls it towards the natural steady state and provision of human services pulls it towards the sprawl state (Alberti & Marzluff, 2004, p. 243).

Ecosystems are complex, active and unbalanced. This has intimations for the involvement of multiple states and the assessment of the effects of urban patterns in terms of the capacity of a given system to sustain human and ecological function in the long term. The feedback techniques can extend or regulate a particular effect. Nonlinearity is an essential aspect of any complex system, it means their activities can result in multiple potential outcomes (Levin, 1998). In urban areas, urban sprawl can lead to changes in the quality of naturalist land cover, from a stable natural state of abundant land cover closely linked to a second case of very low and highly fragmented land cover.

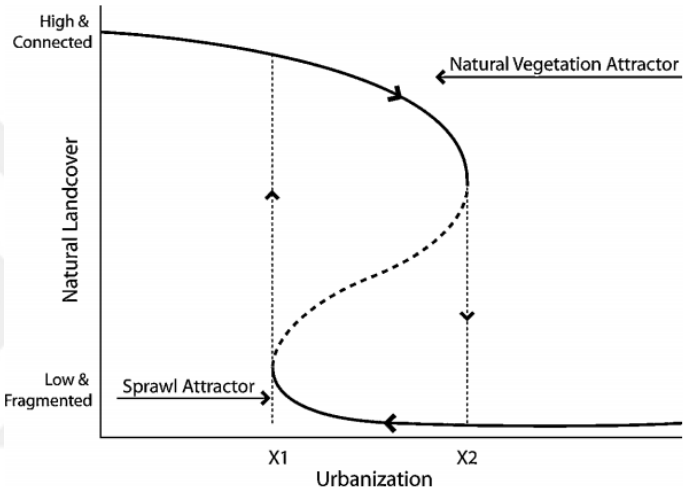


Figure 3.2. Impact of urbanization on resilience. (Source: Alberti & Marzluff, 2004, p244)

In response to the human-related, ecological and economic consequences of urban sprawl, urban planners have attempted to stabilize unstable systems by their nature, i.e. to balance the conversion of natural land cover and the development required to sustain human functions (see Figure 3.2) (Alberti & Marzluff, 2004).

From a system dynamics perspective, we can indicate that the state of an urban region is likely to be driven between natural and human function states by the extent of urbanization. As urbanization increases, natural vegetation decreases. The system moves along the upper solid line (Natural vegetation attractor) until a point (X2) is reached where natural vegetation is too degraded and fragmented to perform vital ecological functions, and the system becomes unstable (dashed portion of curve). As urbanization reduces the ecosystem function, the system flips into a sprawl state (the lower solid line, sprawl attractor) where human functions replace ecosystem functions.

Eventually, ecosystem function is degraded to a point that cannot support human function, urbanization declines and the system becomes unstable again (X1). The system eventually returns to the natural vegetation state (Alberti & Marzluff, 2004, p. 243).

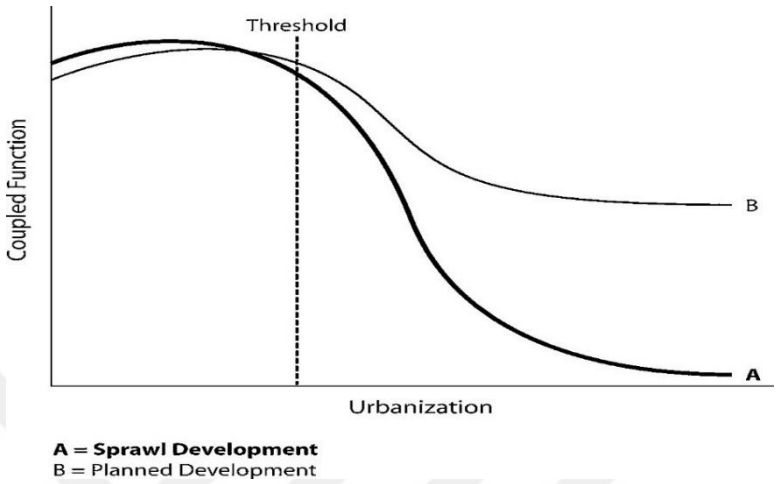


Figure 3.3. Relationships between urbanization patterns and ecosystem and human functions. (Source: Alberti & Marzluff, 2004, p250)

Alternative urbanization patterns have different levels of resilience measured by their capacity to simultaneously support ecological and human functions. Sprawling development (A) leads to a decline in coupled system function associated with the sprawl attractor state represented by the lower left corner of the diagram in Figure 3.3. Planned development (B) is an urban development pattern that simultaneously supports ecological and human functions, allowing a greater resilience of the coupled urban ecosystem (Alberti & Marzluff, 2004, p. 243).

Using best practices of environmental resilience in city development, they can support increasing the capacity of ecosystems in and around these cities to provide better services and to accommodate balanced urban growth (ICLEI, 2013; Schewenius et al., 2014). To build a resilience system for cities and to develop solutions to the problems of urban sprawl, long-term impacts should be taken into account not only for the city but for the rest of the region, the country and the planet (Elmqvist, 2014). How ecosystems respond to rapid urbanization, climate change and extreme events could be determined by the biogeographic context of the urban area (Solecki, Leichenko, & O'Brien, 2011). Other contexts also affect ecological adaptability, including economic, social and political context, and even with different cities in size and

location, system characteristics, development paths and the impact of ecosystems may be similar (Romero-Lankao & Dodman, 2011). However, they often vary, some expand, while others shrink; others have multiple trends running parallel to the same city. In addition, some cities are sprawling, even as their population declines (Schmidt, 2011).

Many reviews state that the definitions of environmental resilience have not developed well enough to address the important conceptual contradictions that appear in the literature on environmental resilience in urban studies, and while discussing these contradictions in researches, the authors' ideas are often inconsistent (Meerow et al., 2016). Lloyd-Jones (2013) defines also the environmental resilient city that can resist shocks and capable of rebuilding itself, without sacrificing the basic environmental characteristics of its control and functions. The author indicates the five factors to make a city environmentally resilient:

- Understanding and anticipating (planning for) risk and uncertainty,
- Preventing impacts of risk that can be anticipated (such as urban sprawl),
- Resisting those that cannot be anticipated (disasters such as war, earthquake),
- Recovering fast and well,
- Learning and adopting.

Lloyd-Jones (2013) indicates that, to build an environmentally resilient city, focusing on technical aspects are obviously important; for example, appropriate building codes and planning regulation must be properly enforced. The second main challenge is in governance (political will, stakeholders' involvement and appropriate institutions). Developing countries and communities are those under risk the most and vulnerable to disasters, and, at the same time, urbanization brings about increasing vulnerability (Lloyd-Jones, 2013; Smyth, 2014).

An environmentally resilient city is an integrated one adaptive to changes in the networks of city inhabitants and physical systems. Physical systems include all city components of buildings, infrastructure, roads, energy and water networks, geology and topography of the city. The degree of resilience of a city depends on the ability of those component systems to survive and function in the face of disasters. Those physical systems act as the human body of the city. Cities are complex interactions between social and technical elements, consisting of dynamic connections of social

and physical networks. Resilience planning for cities in the face of risks requires designing cities that combine characteristics that appear to be contradictory, including efficiency and redundancy, interdependence and diversity, flexibility and strength, autonomy and cooperation, adaptability and planning (Godschalk, 2003).

The city and its partners contribute to data collection and methodology to develop the city profile and urban system model. This city profile contributes to improved policy and investment decisions. The final product will be producing standards for urban resilience.

Environmental Resilience Strategy is an intermediary step between the Strategic Plan targets for the near future and longer-term Strategic plans. Resilience Strategy helps define new projects with longer-term results and clear benefits aimed at diminishing the city's vulnerabilities while increasing its resilience (Eraydin & Tasan-Kok, 2013). Unfortunately, planning practice has been unable to satisfy the needs, and existing planning theories have failed to come up with a framework to deal with the increasing vulnerabilities of urban areas and cities and the insecurities of the public. Planning for resilience to the effect of stressors within the city network disturbance needs an assessment of the vulnerability of network components. Planning should consider and understand how these combinations simplify particular interactions. It should have a capacity to plan several components with their interactions within the eventual target of reaching a resilient city (Desouza & Flanery, 2013; Meerow et al., 2016).

It is an approach that helps link social and economic processes with ecological processes, calling for a reconsideration of the "substance" of planning so as to enhance capacity to deal with slow and sudden changes of different forms (Brand & Jax, 2007; Eraydin & Tasan-Kok, 2013). Resilience approach described here is based on both social and physical interactions consisting of "(1) the amount of disturbance that a system can absorb while still remaining within the same state or domain of attraction; (2) the degree to which the system is capable of self-organization (versus lack of organization or organization forced by external factors); and (3) the degree to which the system can build and increase its capacity for learning and adaptation.'' (S. Carpenter et al., 2001).

The former view of resilience allows a return to the steady state that existed before the external shock threatened to bring radical and fundamental change, while, in contrast,

the latter interpretation sees resilience as a dynamic process involving the rejection of the status quo, as there can be no return to the circumstances that actually caused the problem in the first place (Raco and Street 2012). The latter definition, accepted here as the core of the resilience planning paradigm, can be defined with respect to three dynamic assets of the urban systems: **adaptive capacity**, **self-organization** and **transformability**, rather than characteristics connected to the steady-state condition.

The adaptive capacity, which is at the core of a new paradigm for planning practice, aims explicitly at equipping urban systems to deal effectively with slow and radical changes. The enhancement of adaptive capacity is a necessary condition for reducing vulnerability. **Self-organization**, which is a process of internal organization within a system without being guided or managed by an outside source (Heylighen 2002; Holling 1992), establishes the arena for evolutionary change. However, self-organization is not always possible, and systems have had to undergo thorough change. **Transformability** in such cases is inevitable, being the capacity to create a fundamentally new system when ecological, economic or social (including political) conditions make the existing system untenable (Walker et al. 2004); and planning may play a vital role within this process. According to (Eraydin & Tasan-Kok, 2013):

Evaluating urban systems with respect to these assets enables one to determine the critical issues for resilience planning:

- **Firstly**, it has to be dynamic, not seeking to return to stable equilibrium under external disturbances and changes due to local dynamics, but adapting and adjusting to changing internal or external processes (such as urban sprawl).
- **Secondly**, it has to consider economic, social and ecological heterogeneity by concentrating on not only the form but also function and process of urban systems.
- **Thirdly**, resilience planning needs to be based on systems analysis, which will enable to define the points and issues of vulnerability of urban systems and to be focused on key issues, which are related to the adaptive and transformative capacities of urban areas in terms of determining strengths and weaknesses in the context of opportunities and threats.

Defining the main aspects of environmental resilience planning will be by comparing the two dominating planning paradigms, namely; rational comprehensive planning,

which had been the basis of planning practice from the 1950s up to 1980s, and communicative planning, which has dominated new planning practices since the 1980s. One of the critical issues to be addressed while defining a possible framework for integrating resilience thinking into planning practice is its rationality. Rationality in planning can be defined as the guiding principle of the human mind in the process of thinking and the application of reason to collective decision making (Alexander, 1997; Eraydin & Tasan-Kok, 2013; Faludi, 1998; Taylor, 1998). Planning literature argues that different planning paradigms are based on different rationalities, and that creates diversity in planning practice (Alexander, 2000).

Alexander (2006) proposes a system of classification of rationality associated with different planning paradigms. Briefly, he defines **instrumental rationality**, corresponding to the logic of choosing the best means to achieve a particular goal; **substantive rationality**, demanding consideration of the goals themselves, selecting between objectives and assigning priorities; **bounded rationality**, providing a context for decision making; **strategic rationality**, making the decision maker and other actors interdependent; and **communicative rationality**, shifting focus from decision making to social interaction (Alexander, 2006).

Environmental resilience planning needs a system approach, defining means but not ends, and resilience that enables urban systems not only to adapt to, but also to benefit from expected and unexpected disturbances. Therefore, the instrumental rationality, which is the basis of comprehensive planning or communicative rationality that leads to communicative planning based on socially constructed values and social interaction, do not offer a sound basis for resilience planning. Neither the bounded nor strategic rationality that are mainly focused on planning as frame setting is able to serve the needs for resilience planning. It aims not to provide the means for clear ends, but instead the means for undefined ends to make sure the loss from an unexpected event is minimal (Eraydin & Tasan-Kok, 2013; Meerow et al., 2016).

Therefore, planning based upon resilience thinking has to have an integrative framework that combines rational and communicative planning with rational planning based upon instrumental rationality and communicative planning resting upon communicative rationality. As Alexander summarizes (2000), an integrated rationality

is “a complex construct, a recursive process deploying different forms of rationality at successive stages by various actors in changing roles” (Alexander, 2000, p. 247).

Environmental resilience planning that uses integrative rationality obviously necessitates not only actors as individuals, but also individuals in interactive groups, in addition to interdisciplinary teams with technical experience to be involved in the different stages of planning practice. While the interdisciplinary teams engage in the planning practice to analyze urban subsystems and define the key vulnerabilities of the systems, the involvement of social groups as learning agents of change is necessary. However, it needs to be based upon a commitment to prepare urban areas for long-term changes and disturbances. Resilience planning includes the recognition of urban vulnerabilities and the development of adaptive capacities convenient for each of those vulnerabilities (Eraydin & Tasan-Kok, 2013; Müller, 2011). Effective implementation rises the level of resilience in cities.

There are common issues between strategic planning and environmental resilience planning, those issues are that both have almost the same rationality by making the decision maker and other actors interdependent and by focusing in defining means. Strategic planning is to handle the future of a city when the future itself appears to be more and more uncertain, and it is the same idea of resilience thinking. Strategic planning is used here to direct the activities of others (different authorities, different sectors, private actors), which is the same in resilience planning approach.

3.2. Disturbances and Vulnerabilities in Cities

Disturbances and vulnerabilities are usually caused by urbanization, natural disasters and man-made disasters.

3.2.1. Vulnerabilities Caused by Urbanization and Urban Sprawl

Urbanization is accompanied by several issues, including vulnerability. As urbanization increases in a region, vulnerability in this region may increase or decrease depending on the strength or fragility of many dimensions of this urban area (Adger, 2006). Urban vulnerability is a disaster perspective that attempts to understand the interrelationship between complex social, economic and political conditions that contribute to destructive events (Jean-Baptiste, Kuhlicke, Kunath, & Kabisch, 2011). Vulnerability is linked to many factors, including socio-economical ones that

accelerate rapid urbanization, population concentrations and population movements, which considerably increase vulnerability to disasters (Srinivas, 2007).

Urban population in developing countries with fragile, weak governments and unstable political situation has increased by a staggering 326% (De Boer, 2015). Urbanization and population growth are expected to add 2.5 billion to cities and urban areas by 2050, and nearly 90% of this increase will be concentrated mostly in developing countries (UN-Habitat, 2016). As these growth rates continue, future humanitarian crises will emerge more in urban areas than in rural areas, and these urban areas in these countries at the expense of rural areas in fragile and conflict-affected countries will be the most vulnerable areas. How will these countries handle this prompt urbanization? As their population gathers in cities at an accelerating pace, it is reasonable to assume that their governments' ability to deliver services will diminish, response to disasters will be reduced, provision of security will decrease, and all these will push the government to the brink of collapse (Brinkerhoff, 2007; Kaplan, 2014).

A study has been conducted with more than 100 densely populated cities worldwide, and the study found that 78% of these were exposed to one of the major natural disasters such as volcanoes, earthquakes, windstorms and tsunamis. 86% faced more than one threat only in developing countries cities (Quarantelli, 2003). Several studies have investigated urban vulnerability to disasters in multiple dimensions and levels. These studies were examined in various areas such as research on social-ecological resilience, sustainability and human environment systems. Vulnerability research in urban areas covered several topics, including urban vulnerability to climate change (Fang, Wang, & Fang, 2016; Grasso, Moneo, & Arena, 2014; Hay & Mimura, 2006), social vulnerability to environmental hazards (Boruff & Cutter, 2007; Cutter, 1996; Siagian, Purhadi, Suhartono, & Ritonga, 2014), urban vulnerability to terrorist attacks (Mitchell, 2003; Piegorsch, Cutter, & Hardisty, 2007), and urban internal vulnerability to heat (Rosenthal, Kinney, & Metzger, 2014; Wilhelmi & Hayden, 2010).

Vulnerability is actively formed by factors such as poor or bad governance, poor development practices, political instability and military actions (Frerks, Warner, & Weijs, 2011). Vulnerability indicators in this dimension such as lack of economic capacity and population fragility, lack of quality education, lack of employment opportunities, gender inequality, racialism and social discrimination, lack of health

services and low financial status of some citizens lead to population separation. In addition, demographic problems such as population profile in terms of aging and pension for the population, urban population growth, rural-to-town migration and population separation may lead to vulnerabilities in an urban system.

Vulnerability is also affected by urban regression processes such as the detection of indicators that determine the level of urbanization, housing situation or deterioration, lack of public services and green areas, inadequate infrastructure, poor sanitation and housing shortages. These has led to irregular urban sprawl in city peripheries. (Cornado, Garcia-Almirall, Vima, Busqued, & Uzqueda, 2017). Along with the benefits of urbanization and agglomeration come environmental vulnerability, including encroachment on green areas, plantations, climate change, persistence, floods, lack of access to drinking water, waste recycling, pollution and carbon emissions (Lankao & Qin, 2011).

A disaster often reveals the unseen vulnerabilities of a community, society or group. However, an adequate vulnerability analysis can assist to detecting the structural elements and situational factors that can set a specific group vulnerable, which can later be prioritized for therapeutic procedures and assistance. The concept of vulnerability may suggest to some that they must strive to avoid vulnerability, but it may involve a non-dynamic and non-historical understanding of reality. Risks change as communities change constantly; old vulnerabilities may diminish or disappear, and new vulnerabilities emerge, so risk exposure cannot be completely excluded. Vulnerability in the context of urbanization should not be conceived as a fixed indication of a specific region or society, but as a process that can be reduced through appropriate policies and strategies (Srinivas, 2007).

3.2.2. Vulnerability by Wars in Cities

Cities are also centers of violence, with the growing population and power. The conflicts in cities such as South Sudan, Kinshasa, Beirut, Aleppo and Benghazi reflect the complexity and human cost of violent conflict. Services can be disrupted due to the destruction or damage caused by the conflict (OECD, 2016). Conflicts also limit the ability of local authorities to provide services to the population. Conflicts and wars within cities directly damage the built-up and environmental areas, and change the features of the landscape. As a result of conflicts, changes in people's lives and their

use of natural resources, which in turn are affected by landscape features, occur. Changes in land characteristics and changes in population vulnerability can therefore be linked to changes resulting from conflicts. Economy of war is imposed when conflicts occur, and individual transactions such as black markets and monopolies dominate. Spread of violations in human rights and restrictions on the work of monitoring bodies and assistance and all these problems constitute the vulnerabilities to citizens in conflicts (Mubareka & Ehrlich, 2010).

To develop indicators to measure exposure in conflict situations, information from mortality rates and satellite images is often used. The increase in the number of deaths during and after the war from diseases and war-related illnesses is a measurable indicator for war vulnerability (Guha-Sapir & D'Aoust, 2011). Satellite images are useful only when this information can be used to extract environmental indicators which can be linked to indicators related to potential harm to the population and land. The indirect effects of conflicts on the population show changes in the environment, and the effects of disasters over an area are often visible on the landscape. Environmental indicators can therefore be used in sporadic spatial ranges to interpret risks (Frohn & Lopez, 2017; Klemas, 2001).

3.2.3. Indicators and Measurements of Vulnerability

Vulnerability measurements could be conducted through variables related to exposure which generally include proximity to threat source, an incident frequency of probability, dimension, period or spatial effect (Cutter, 1996). Responses and social impact are usually measured out of threats to lifelines or infrastructure to support essential needs (Gasser & Snitofsky, 1990; Platt, 1991), special needs of the population such as the elderly and children, and indicators of poverty/wealth.

Evaluation of any vulnerability predicts what may occur to a specific group exposed to a specific risk or disaster. The risk of disaster has become recognized as a product of risk and vulnerability, which, on the other hand, has been seen to be the result of factors such as bad governance, poor development practices, and political and military instability (Frerks et al., 2011). Most cities and urban areas face challenges and vulnerabilities such as environmental degradation, economic restructuring, high rates of migration, water shortages, widespread poverty, political instability and civil wars (Swanstrom, 2008). Urban areas consist of natural and social systems, and they cannot

be separated from each other. They interact in nonlinear, complex and random ways. Thus, the vulnerability of communities to individual or multiple risks is analyzed through the consideration of environmental, social and economic dimensions, or through the analysis of associated human-environmental or socio-economic systems (Mendes & Gonçalves, 2012).

Research methods used for urban vulnerability measurements include DEA (data envelopment analysis) (Clark et al., 1998), GIS (geographic information system) (Ouma & Tateishi, 2014), VFBM (vulnerability-function-based method) (Wen, Ellingwood, & Bracci, 2004), scenario analysis (Barbat et al., 2010), and image integration (Bitelli, Camassi, Gusella, & Mongnol, 2004). Urban vulnerability research has evolved from vulnerability assessment associated with natural environmental degradation to an investigation of human activities impact on vulnerability (Fang et al., 2016).

Table 3.1. Vulnerability indicators of natural disasters found in the literature (Source: Author)

Vulnerability terms and indicators	Authors or Organizations	Type of disaster
Land structure, Non-material assets / knowledge and skills, Social and human capital Income opportunities, Capital/assets Structural societal position (gender/membership), Access to power, Political and economic systems, Rapid population change, Condition of the physical environment, Social relations	Wisner et al., 2004.	Climate change disaster
Education level, Employment status, Dwelling ownership, Age/sex, Household size	Haki et al., 2004	Earthquake
Building type and form, building condition, Building materials	Barroca et al., 2006	Flood disaster
Agricultural water use, Average precipitation, Area salinized by irrigation, Irrigated area, Agricultural value GDP, Population below poverty line	Iglesias et al., 2009	Natural disaster
Household size, Quality of building materials, Unemployment rate, Age Rate of female, Green areas,	Ebert and Müller, 2010	Flood disaster
Income Source, Educational Attainment, Assets, Social Network, Infrastructure, Warning system, Sense of empowerment	Mustafa et al., 2010	Natural disaster
Affected population per residential building including children and elderly people, Areas with non-sealed surfaces with soil erosion potential, Existence of school, kindergarten, hospital and pensioners homes, Existence of street and rails lines, Industrial buildings and commercial sites, Land value per floor space,	Scheuer et al, 2011	Flood
Demographic structure, dynamics, health status, Education, Gender status, GDP per capita, income, rent per capita, social cohesion, number of homeless, occupations in low-income activities, unemployment	Krellenberg & Welz, 2017	Natural disaster

The multiplicity of typical temporal and spatial scales, nonlinearity and complexity of natural systems resulting from the interaction of spatial, environmental, social and economic dimensions within urban systems made it difficult to obtain comprehensive

information to assess vulnerability. This led to a lack of comparability among the research data, resulting in tremendous difficulties in summarizing the conclusions through the comparison of independent research data. What could be done is classifying the risk to know which probability is more likely to occur according to its results. Then, studies to rank mitigation options by cost and effectiveness should be conducted. Policymakers must integrate the views of the population in risk analysis and results, and how to plan according to potential outcomes. These strategies will enhance the partnership needed to plan, respond, mitigate and adapt to disasters in accordance with the planning policy with citizens rather than for citizens.

Most of the indicators regarding vulnerability in the reviewed literature were concerned with cases of natural disasters (see Table 3.1). Indications were made of the effects of these natural disasters on other dimensions of cities, such as climate change, migration, population growth, informal developments, insecure land tenure and economic stagnation (see Table 3.2).

Table 3.2. Types of Vulnerabilities (Source: Author)

Underlying cases	Urban pressures	High risk conditions	Environmental hazards
Demographic and economic change **Poverty and inequality**	Migration, population growth Informal developments Building codes not enforced Insecure land tenure	Slump built in conflicts areas or steep slopes Poorly constructed buildings and roads using cheap materials	Climate change Increasing frequency/intensity of extreme weather events

Traditional planning attempts to minimize disturbances, and reduce the risks and negative effects of possible disturbances, while urban resilience planning extends the remit of planning to include disturbances as an integral part of planning process, and suggests a shift in priority from those that aspire to “CONTROL” the change to those that increase the “capacity” of the urban system to cope with, adopt to, and shape change by accepting the fact that changes are going to take place (Dericioglu, 2018).

What hinders the application of many of the criteria in this section is the provision of the required information to calculate each criterion and sub-criteria; for example, the average rate of carbon emissions per GDP and the comprehensive utilization ratio of industrial solid waste and other necessary data. It is difficult to find all data, especially in developing counties. The use of the criterion of land use change, and follow-up of

urban development and the proportion of spread of urban sprawl in agricultural areas and green belts using satellite images and comparing them with older images to obtain the percentage of change in the spatial dimension is more appropriate in the absence of the above data (see Table 3.3).

Table 3.3. Dimensions and items of vulnerabilities in cities (Source: Author)

Dimension	Vulnerability items
Social	Unemployment # of people under base wage Infrastructure Lake of services Displacement Population increases in cities Migration Mortality Aging Change in lifestyles
Economic	Inflation Destroying business centers Capital transfer Increase in prices Local and foreign employees %
Political	Conflicts Instability Weak policies Weak enforcement corruption
Environmental	Rapid Urbanization and distribution Vegetation cover, Urban land cover Uncontrolled urban development Oil and Gas production % Water Lack of resources Waste spread Air and surface water pollution

3.3. Vulnerabilities and Environmental Resilience in Cities

Resilience and vulnerability are closely related. When vulnerability decreases, the resilience increases, and vice versa. For example, the greater the vulnerability is in the environmental system in cities, the lesser the resilience of these systems becomes. They are concepts of system for understanding responses to change and unexpected shocks. Both are used in risk evaluation, but also in assessments of transformability and adaptability in physical, economic and/or social systems. Cities have faced with multiple challenges in the last decades either in general issues such as economic crises, political conflicts and instability, climate change, natural and technological hazards; or in urban specific issues (polarization capacity loss, social segregation, emigration, arable land loss, urban sprawl, etc.) (Bănică & Muntele, 2015). Williams and Kaputska (2000) described the ecosystem vulnerability as an ecosystem potential to adjust its

response to pressure in time and space, as it is an estimate of the inability of the ecosystem to withstand pressures in time and space (Williams & Kapustka, 2000).

Regardless of the need to think in systems to deal with the very real equity, livability, uncontrolled developments and climate change, defining, measuring, and evaluating resilience in the urban context mean dividing apart our complex urban systems into their parts. Developing metrics and indicators to evaluate social resilience, ecological resilience, and technical/built infrastructure resilience for particular challenges in a particular location is possible, but robust methods for evaluating resilience of a complex multi-scale system like a city are missing. Measuring and upgrading resilience is contingent on responding to the inquiry of resilience "of what, to what and for whom". Resilience to urban sprawl in a part of a city, for example, may have no, little or large influence on another part of the city or on the resilience of the all city systems (McPhearson, Hamstead, & Kremer, 2014).

Urban sprawl can be defined as the negative resilience of the citizens of a city. Resilience can be measured by monitoring unique indicators of performance over time. Firstly, urban sprawl risk should be understood, and then, the question of how resilience can be measured will be explored qualitatively and quantitatively. Adaptation to urban sprawl tends to be classified in three ways: accommodate (modify structures), protect (agriculture lands, green belts), and retreat (or at least stop development in those areas). Adaptation can be prioritized by using outreach strategies, policy actions and design standards (Bolter, 2014).

Risks in cities are distributed unevenly, socially and spatially (Adger, 2006). Risks are usually probabilistic in nature, related to either occurrence probability of a disaster or series of events with an undesirable outcome, or the probability of a disaster or outcome, which combines hazard event with its consequences (Downing et al., 2001; Jones, Boer, Magezi, & Mearns, 2004; K. Smith, 2003; Stenchion, 1997). Therefore, hazard and vulnerability are viewed as functions of risk (UNDHA, 1992). Vulnerability defines the degree to which a system is sensitive to, or incapable to cope with the adverse effects of a disaster (McCarthy, Canziani, Leary, Dokken, & White, 2001). Vulnerability is a function of the character, magnitude and rate of change (social, economic or spatial) to which a system is exposed, its sensitivity and its adaptive capacity. Smit et al. (1999) describes the vulnerability as the degree to which

the system is vulnerable to damage, harm or destruction (Smit, Burton, Klein, & Street, 1999).

Adaptive capacity is defined as “the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences” (McCarthy et al., 2001). Building adaptive capacity and resilience is enhanced by building the capacity to achieve a desirable state when the city is under pressure (Hu & He, 2018). The concept of adaptability is essentially associated with the concepts of vulnerability and resilience, which is an integral part of the vulnerability and resilience frameworks as shown in Figure 3.4. The process of building adaptive capacity usually corresponds to the process of reducing vulnerability (Engle, 2011).

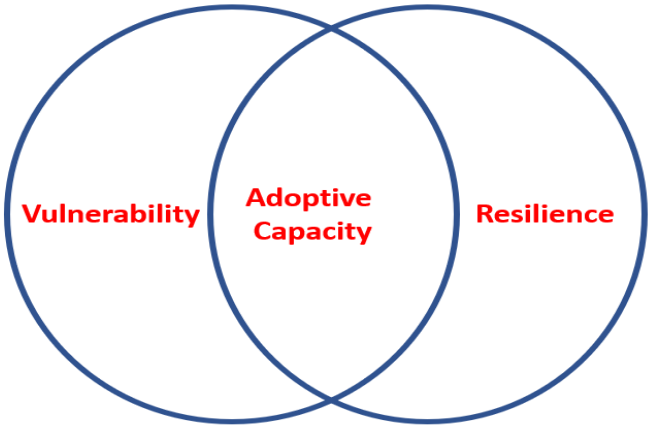


Figure 3.4. Vulnerability and resilience frameworks as linked through the concept of adaptive capacity (Source: Adopted from Engle, 2011)

Building adaptive capacity lies in reducing potential damage, coping with consequences, taking advantage of opportunities, and preparing the city for a new state of transition (Easterling, Hurd, & Smith, 2004; McCarthy et al., 2001). This promotes the concept that enhancing adaptive capacity reduces vulnerabilities and thus achieves resilience (Folke et al., 2002; Goklany, 1995). A more adaptive urban system has a greater chance of coping with stress. As a result, it is important to assess the urban adaptive capacity, which can foster realistic actions required according to a plan whose expected results will create a more stable and adaptive system.

Cities cannot be considered "sustainable" or "resilient" without their dependence on ecosystems and resources that come from either the surrounding or remote areas. Urban planning will, therefore, need to work increasingly in urban and peri-urban

areas, including regional standards (McPhearson, Andersson, Elmqvist, & Frantzeskaki, 2015). Multi-equilibria resilience in cities means that the state of the city should not be as it was prior to the disaster, and envisage alternative stability scenarios to correct some of the pressures and vulnerabilities in the current system. For example, the city of New Orleans has become a neighborhood of chaos, when transportation systems and institutions failed after the Katrina hurricane disaster. However, the pre-disaster situation has also been revealed as an unacceptable goal of recovery. People did not want to return to a situation of overcrowding and unequal service. There was a convincing pressure for a new improved system (Seeliger & Turok, 2013).

Cities have been forced to modify or adapt their urban fabric to changing circumstances and to invent their purpose and identity in the face of changes in the social, economic or political environment, or the loss of their former advantage and the search for a new advantage of the city. The first-generation cities have depended on industrial manufacturing mainly, and given the development and emergence of new industries based on knowledge, innovation and service, the reorientation of local educational institutions and the restructuring of real estate markets, the shape of these cities has changed accordingly. Cities founded on one natural resource or specialized industries often face significant difficulties in repositioning and diversification. (Simmie & Martin, 2010; Swanstrom, 2008; Turok, 2009).

One of the major vulnerabilities that cities may face with is political conflict and civil war (Baddeley, 2011; Sampaio, 2016). Measurement of conflict as a shock has not been adequately addressed in research. It is difficult to analyze the impact of conflict on resilience without standard measures to understand the effects of insecurity, conflict and violence. Common shocks with conflicts can be measured, such as precipitation levels, food price fluctuations and the level of vulnerability of the individual and the family, and these measurements may reflect resilience. Some events are also used for measurement in cities, such as the number of dead and wounded, the spread of infectious diseases, the number of suicide attacks or explosions barrels. However, these indicators do not include the full impact of violence and conflict on the civilian population. The numbers of displaced people, the amount of support and assistance required, and the levels of vital needs of migrants and displaced populations are measures for the outcome of the conflict, not for the conflict itself.

The impact of conflict extends in many ways, and is considered to be critical to the movement of people freely and their livelihood, disruption of markets, insecurity and lack of basic needs and services. It is very difficult to assess the ability of a population to adapt to an event resulting from conflict and war. In the spatial dimension, the assessment of wars and the impacts of conflicts can be measured, and the proportion of the city's resilience in the face of this conflict and its effects on buildings, agricultural land, the environment and the city's urban parts can be discovered. An example of such impacts is Nairobi, Kenya, which faced civil war and instability in political system for decades.

Disaster risk reduction, resilience building, environmental protection and natural resource management are often dealt with separately in policy. In practice, however, they involve very closely related processes and techniques (Béné, Wood, Newsham, & Davies, 2012). The UN has adopted a special program for environmental resilience in some fragile states such as the ones in Africa. This approach is the imposition of policies that adopt a holistic approach which seeks to engage in the integration of these elements to facilitate sustainable development using environmentally sound practices, including indigenous and local knowledge, addressing opportunities and challenges in environmental management and disaster risk reduction. Environmental management, disaster risk reduction and resilience are part of the United Nations program approach to support and strengthen the resilience of societies and to sustain difficult development gains (Blair, 2014).

3.5. Examples of Adaptive Capacity Building in the World

Europe

Doxiadis, who was one of the pioneers in urban planning after the World War II and the author of the theory of the 'ekistics', has planned a number of cities, especially in developing countries, including Libya. Urban conditions in the post-war period have been exacerbated by the fast change in the basic settlements dimension. The change rate was the main reason for the loss of urban spatial range, which contributed to the loss of understanding and meaning of the values and function of the city. The physical pattern of most cities has not been established to separate functions or to address the problem of increase in size and the dominance of cars. The growing overlap between the city and the village, and the loss of its natural suburbs were all remnants of the new

urban crisis (Middleton, 2009). Ekistics theory of Doxiadis emphasizes regional linkages and the city's ability to expand while ensuring the balance of power between humankind, his environment and technology.

Construction of new cities became the policy pursued in England after the World War II, in order to address the population increase in major cities. The policy of new cities at that time became the best solution to accommodate the population displaced from the slums that had been removed and the people fleeing the overcrowded cities. Eight new cities were built around London from 1950 to 1960, and the Greater London port was restricted by a green belt to prevent expansion (Bullock, 2002). Projects to remove slum areas within London have promoted the Green Belt policy. High buildings were built to accommodate urban growth, increasing the population density of these neighborhoods. However, the new cities policy did not integrate the social and economic development resulting from the new residential areas that do not offer any jobs, which has caused great criticism from new city companies to motivate the government to coordinate jobs, services and development between London and the new cities (Barnett, 1986; Girouard, 1985).

Urban growth occurs spontaneously or randomly after disasters in the absence or presence of urban planning. Post-disaster debate is usually about whether the city should be rebuilt quickly in a pre-disaster city pattern, or whether should be invested to design and build a better city. Planners in the post-disaster reconstruction process often face severe restrictions and opposition (Haas, Kates, & Bowden, 1977). Even in unrestricted circumstances, policies and methods of implementation are constrained by social context factors such as those of private interest groups and prevailing political and economic pressures (Horowitz, 1978).

Good examples of environmental resilience building could be found in cities like London, Athens and Rome. Future precautions plan and resilience building strategies for these cities identify the processes and actions to be followed in resilience capacity-building. The city of London is exposed to several types of extreme weather phenomena and multiple environmental problems represented by drought, high heat waves, severe cold, lack of resources, steady increase in population and changes in land cover, all of which has led to increased impacts of these risks (Gober, 2018; Nickson et al., 2011).

The specific steps to build resilience for London's ecosystems are as follows:

1. Understanding the future of the city (Summarizing natural and man-made disasters that are likely to occur)
2. Understanding and controlling the impact of disasters in their forms (Covering all expected impacts of potential environmental and climatic changes)
3. Evaluation of impact on city dimensions (environment - infrastructure - resources - social dimension economic dimension)
4. Implementing the strategy (Providing a roadmap to resilience with list of key actions-action plan.)

For Athens, the team identified the critical assets, shocks and pressures, and vulnerabilities facing and may face the city. Most of these challenges were concentrated on climate change and population growth, and their impacts on the environment in the city. Afterwards, experts and community leaders were interviewed to ask about their thought of what makes the city resilient and how they envisioned their city to be in 2030. A plan of actions has been produced to deal with any potential disasters and to address any potential impacts (Andrew, Paul, Scott, & Vittoria, 2018).

The goal of reaching a green city was flexible, and the strategy was as follows:

1. Climate Change Adaptation action plan
2. Authority for Managing green areas
3. Waste Management action plan
4. Sustainable Mobility Roadmap
5. Public Space Rejuvenation Initiative
6. Public Space Co-Development Framework
7. A sustainable Food policy plan
8. Climate Change Mitigation Action Plan
9. Energy Poverty Mitigation roadmap
10. Renewable Energy Cooperatives

North America

The debate began between 1941 and 1946 in the American cities about the policies to be followed in city planning after the World War II. The discussion focused in general on the centralization of urban planning. Supporters of this approach were a group of planners, including Lewis Mumford, Charles W. Eliot and members of the National Resource Planning Council, which was abolished in 1943 by the Congress. The strong

opposition to this centralized approach was advocated by the advocates of decentralization led by Robert Moses and his supporters, emphasizing the policies of public works rather than social planning policies, where he liked to be given the key role of private companies and not the government that provided support to these companies only.

Moses emphasized the viability of these special projects in urban development of cities, where he focused on transforming the industry of war into one of peace, employment, housing and transportation (Graham Jr, 1976; Nash, 1990; Schiesl, 1980; Scott, 1969). The World War II was a major factor affecting the urban west after 1945. Other influences helped identify and build the characteristics of many cities in the United States and Western countries. In the cities of the West, military and federal expenditures have greatly contributed to the geographic, social, physical and cultural development of most of the cities in the region, especially in the field of science and technology, which has been a constant source of cities such as Las Vegas, Denver, Phoenix and San Francisco (Clavel, 1986; Nash, 1985).

Japan

In Japan, during the post-World War II period, architect Kenzo Tange and his colleagues developed the policy of developing the Tokyo Bay in 1960, which was based on the organic reorganization of the city (Tange, 1961). Because the urban design of the Tokyo Bay has emphasized support for sustainable transformation, mobility, communication and movement activities, it has led to international enthusiasm for the importance of urban planning. The Tokyo Bay plan sets out a linear civil axis to redefine the direction of the city towards the Bay. Important governmental and urban tasks were moved along the urban center within the central spine. A linear system of secondary streets was separated from the linear spine in parallel lines that identified residential areas near the urban axis, where urban spaces developed in a clear and comprehensive way from the superstructure to the local residential community. It is aimed to produce new values for land by heading out into the sea (Middleton, 2009).

The studies concluded that the tools for peaceful transitions and conflict prevention such as stability, reconstruction aid and peacekeeping are affected by specific urban pressures associated with population growth, migration, ethnic tensions, institutional deterioration and weak urban services (Sampaio, 2016). Understanding local actors,

services and institutions that affect urban drivers at the onset of conflict can help formulate comprehensive policies to reduce the impact of urban conflicts and mitigate their environmental impacts. Some policies may be effective in preventing conflict.

Table 3.4. Building Resilience strategies examples

City	Disturbance	Adaptive capacity building tool
Athens	Climate change	• **Mitigation** (to climate change) intervention to reduce the sources or enhance greenhouse gases sinks • **Adaptation** (to climate change) adjustment in response to climate change impacts, which moderates harm or exploits • **Climate resilience**, through adaptation, the capacity to respond to a disturbance by resisting damage and quick recovery • **Action plan** Define and distribute responsibilities, budgets and projects to institutions to prepare, respond and recover
London	• Environmental problems (drought, high heat waves, severe cold, lack of resources) • Steady increase in population Land cover change.	• **Assess Risks and city future** (risk consequences and risk appetite - Cover all expected impacts of potential environmental and climatic changes) • **Evaluation and mitigate** of impact on city dimensions (environment - infrastructure - resources - social dimension economic dimension) **Adaptive capacity and resilience implementation** (Providing a roadmap to resilience with list of key actions-action plan)
North America	• Environmental Disasters. • Climate change • World war II effect	• **Mitigation** • **Containment** plan • **Decentralization** • Transfer from war industry to housing, transportation employment • Invest in Technology
Japan	• Environmental risks • increase in population Land cover change. No land to develop	• **Assess Risks and city future** • **Adaptive capacity and resilience implementation** (Providing a roadmap to develop in the bay) • **Organic reorganization** • **Action implementation** (Develop in the bay) And give new value heading to the sea

For example, the city of Medellin, Colombia, has helped raise the reputation of the city and even the "brand" as a case of success to recover from the conflict. The strategy was broad and inclusive: it included several types of interventions, from building public transport to libraries, schools and bold architectural projects in marginalized areas or slums. In addition, it was organized through a strategy with clear and specific objectives. It has focused on parties with high incidents of armed conflict and the presence of guerrilla units, with a view of integrating them into the wider urban society and thus encouraging education and employment (Cerdá et al., 2012).

What can be learned from the experiences of cities in the world and previous studies on how to build adaptive capacity for resilience to the environment specifically is that it should first investigate disasters and potential risks and vulnerabilities occurring in the city. Then, the effects are determined on the environmental dimension as well as on the other dimensions that affect the ecosystem. The identification process is carried out using indicators to measure vulnerabilities, as well as opinions from experts and community leaders and city actors, regarding potential impacts and potential future perceptions of the city. The final step consists of a set of resilience action plans for mitigation, adaptation and confrontation, following a general strategy for the city to make it more resilient as summarized in Table 3.4.

CHAPTER IV

4. THE CONTEXTUAL SETTING OF THE BENGHAZI CITY

This chapter presents the results of quantitative and qualitative data obtained from the available sources in Libya to collect data from reports, research papers and statistical information from Libyan census for different years and discuss these data and their effects. In this study, all dimensions of the city of Benghazi before the war were explored and studied.

Urbanization in Libya is no different from urbanization in the neighboring countries of North Africa. But it varies in terms of its effect on the basis of certain factors. Madbouly (2009) explained that North African countries differ in urbanization trends. Where the difference between these countries in the resources, political and economic freedoms and forms of government that regulates these freedoms. They differ in their political stability, social cohesion, recent power struggles, human development indicators and, in addition, they also have differences in their globalization receptivity (Madbouly, 2009).

Libya, with a small population, is considered more urbanized than the rest of North Africa countries, with more than 70% of its population living in cities. As stated by the UN Habitat Report (2010), 77.89% of the population of Libya was already in cities by 2010 (See Figure 4.1). They predicted that this number would rise to 80.29% by 2020 (Un-habitat, 2010). However, it was noted that the Libyan population in the cities exceeded those estimates for the UN Habitat projections to reach 89% in 2012, according to the 2012 Libyan census (GIAL, 2012). The annual growth rate for the urban population of Libya in 2005-2010 was estimated at approximately 2.31 percent, a relatively high rate compared to the region neighboring countries (GIAL, 2012; R. A. Obudho, 1999).

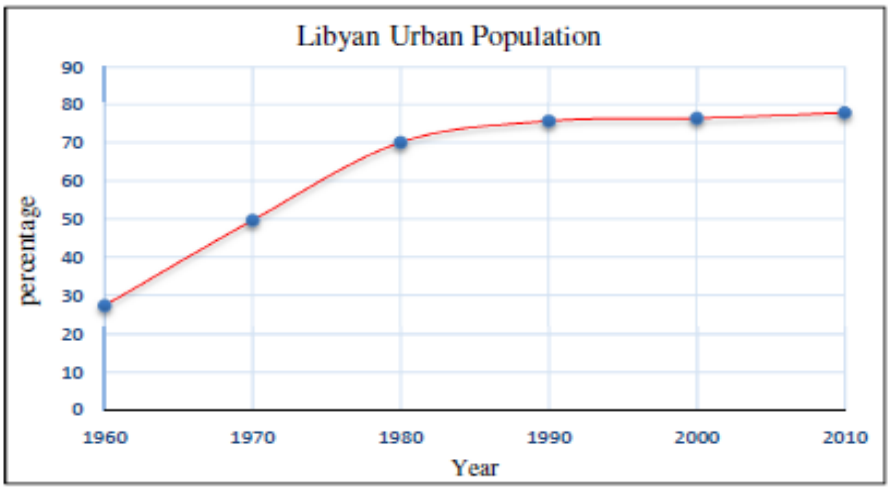


Figure 4.1. Libyan Urban Population distribution (Source: Author)

Benghazi is the second biggest city in Libya following the capital city Tripoli. It is one of the main sea-ports on the African coast of the Mediterranean. The coast of the city extends along 20 kilometers within the metropolis area (Amoura, 1988).

4.1. Socio-economic and Cultural Structure of the City

4.1.1. Demographic Structure

According to the population census of 2006, the Benghazi Metropolis‟ population is 601,287, which corresponds to 81% of the Benghazi Sub-region's population and 43% of the Benghazi Region (UN-Habitat, 2006).

Table 4.1. Population Growth in Libya and Benghazi. (Source: UN-Habitat, 2006)

Population	1973	1984	1995	2006
Libya Population	2,249,000	3,642,000	4,799,000	5,673,000
Benghazi Planning Region	587,888	912,089	1,199,971	1,384,677
Benghazi Sub-Region Population	332,333	509,012	665,001	746,395
Benghazi City Population (1)	270,403	411,024	529,925	567,082
The Benghazi Metropolis Population (2)	277,934	425,920	548,476	601,287

(1) Corresponds to Benghazi Shabiya population
(2) Includes Benghazi City and the settlements of Ganfouda Albahria, Bu Fakhra, Tika, Al Guarsha, Al Kwefiya and Budazera.

The planning area of the Benghazi Metropolis includes the Benghazi City and the settlements of Ganfouda Albahria, Bu Fakhra, Tika, Al Guarsha, Al Kwefiya and Budazera, which are located in the influence area of Benghazi City. Natural increase rate of population in the period of 1970-2005 has drastically declined from 34.7 per 1,000 to 14.9 per 1,000 in the sub-region. This drastic decline in natural increase is

related to the fact that decrease in fertility rates has become greater than the decrease in mortality rates faced in the same period (BSRR, 2009). Based on the estimation of fertility and mortality rate in next 20 years, the rate of natural increase of the population of Benghazi Sub-region is expected to decrease slightly below 14 per 1,000 in 2025 (UN-Habitat, 2006).

Demographic data specific to Benghazi City is not available. However, the demographic figures of sub-region may be assumed as valid for Benghazi City, owing to the fact that 81% of sub-region's population live in the Benghazi Metropolis and those figures of sub-region reflect almost the demographic structure of the metropolis (BSRR, 2009). The fertility rate in Benghazi Sub-region was around 45 births per 1,000 people until 1980. The economic developments and increase in number of educated and working women have led to changes in demographic structure in general. As result, fertility rate has continuously decreased in the period of 1980 – 2005 and reached 21.3 births per 1,000 in 2005. It is estimated that the birth rate in the Benghazi Sub-region will decline to approximately 15 per 1,000 within the next 20 years (BSRR, 2009).

The mortality rate for under the age of 5 have inevitably declined in last decades in Libya, due to improvements in living conditions and life quality, income level, education opportunities and health care facilities. Consequently, the mortality rate, which is about 10 per 1,000 births population in 1970 in the sub-region, has continuously declined in last three decades and reached 6.4 per 1,000 in 2005 births. The mortality rate, which was more stabled after 2000, is estimated to be between 6-5.5 per 1,000 people within the next 20 years (BSRR, 2009). Family and household sizes in Benghazi Sub-region range between 6 and 7 people in average as similar to whole Libya.

The long-term data shows that there is decrease in Libyan family and household sizes because of economic and social factors. In general, increase in rate of educated people; increase in number of women that are more educated and more involved into labor force in all sectors; and improvements in income level have caused increasing of the number of nucleus and independent families especially in cities.

4.1.1.1. Migration

Benghazi Sub-region had been subject to in-migration movement, especially in 1960‟s due to oil discovery and economic development. In-migration movement mostly directed from the rural settlements and small cities to bigger cities, among which the Benghazi had been the most attracting city in the region for the immigrants. The out-migration in the sub-region had reached the highest rate in the period of 1964 – 1973, during which Al Bayda and Tripoli were the main attracting cities due to the new job opportunities offered by the Libyan Government and the oil companies (AlEmara, 2009).

The annual net migration rate in Benghazi Sub-Region has continuously decreased between 1964 and 1995. Although continual decrease in the net migration rate is apparent, immigration rate has always been above out-migration. This means that Benghazi Sub-region is still an attraction region for inward immigrants due to mostly the presence of the Benghazi Metropolis. However, the attractiveness of Benghazi seems to be drastically declined in 1990‟s when compared to the past, since the annual net migration rate between 1973 and 1995 has declined from 1.30% to 0.23% (See Table 4.3) (AlEmara, 2009).

Table 4.2. In-migration and Out-migration Rates in Benghazi Sub-Region (Source: BSRR, 2009)

Years	Annual In-Migration Rate (%)	Annual Out- Migration Rate (%)	Annual Net Migration Rate (%)
1964 -1973	2.00	0.75	1.30
1973 -1984	0.80	0.35	0.045
1984 -1995	0.60	0.37	0.23

4.1.1.2. Population Forecasts for 2025

The population forecasts of the Benghazi Metropolis have been based on low, medium and high growth rates.

Table 4.3. Population Forecasts for Benghazi City and Benghazi Metropolis. (Source: BSRR, 2009)

Settlement	LOW (DECENTRALIZED)			MEDIUM (CENTRALIZED)			HIGH (BALANCED)		
	2006	2025	2025 with non-Libyans	2006	2025	2025 with non-Libyans	2006	2025	2025 with non-Libyans
Benghazi City	567,082	839,943	923,937	567,082	992,319	1,061,781	567,082	992,319	1,091,551
Benghazi Metropolis (1)	601,287	890,231	977,744	601,287	1,049,934	1,123,429	601,287	1,050,012	1,153,284

According to the figures of 2006, the average household size in the Benghazi Metropolis is 4.6. The average household size is estimated as 5 people for the Benghazi Metropolis in 2025 (BSRR, 2009).

Table 4.4. Estimated Household Numbers in Benghazi City and the Benghazi Metropolis. (Source: BSRR, 2009)

Settlement	2006		2025	
	No. of Household(1)	Aver. Household Size	No. of Household(1)	Aver. Household Size
Benghazi City	94,222	5.62	198,464	5.0
Benghazi Metropolis	100,062	5.59	211,509	5.0

(1) Non- Libyan households are excluded as they are in general not accompanied by their spouses.

Estimated distribution of population by age and sex age pyramid for the Benghazi Metropolis indicates mainly the following characteristics. The male are 53.6 % and Female 46.4% from total population (AlEmara, 2009).

4.1.2. Economic Structure

The Benghazi Sub-region is located at the western edge of the Benghazi Planning Region. Benghazi is the most populated and dominant city in all economic sectors in the region. The population of Benghazi City has doubled during the last thirty years and reached 567,082 in 2006. It means that 76% of the Sub-region's population is agglomerated in Benghazi City. It gathers population from all over the region due to its employment opportunities and metropolitan functions (BSRR, 2009).

The level of economic services (mainly commerce and business), the provision of higher order and quality administrative, public and social facilities (e.g. education, health, culture, etc.), and the existence of international airport and seaport make today Benghazi first rank center in the region. A role for Benghazi is also important on the international stage: oil production and the trade links have widened the range of business and economic relationships, more prominently with the eastern Mediterranean and the eastern European countries (UN-Habitat, 2006).

For Libyan people, the share of males and females in total employment is about 76% and 24% respectively. Non-Libyan workers constitute 12% of total employment in the Benghazi Metropolis. According to 1995 census, service sector with 75.8% share in total employment is the primary sector in the Benghazi Metropolis. It is followed by industry with 20.8% and agriculture with 2.8%.

The economy of Benghazi Planning Region (BPR), as in other regions in Libya, relies on hydrocarbon industry. Despite the heavy reliant on hydrocarbon sector, majority of people are employed in non-oil sectors. Public and community services are the primary sector, which provides more than half of total employment. This is followed in general by commerce, agriculture, industry and transportation and communication sectors (BSRR, 2009).

4.1.2.1. Agriculture

Fertile agricultural and farmlands in the Benghazi Metropolis are mainly concentrated in the settlements of Al Guarsha, Al Nejeela, Al Faakat and Bu Fakhra around the Wadi area. The Green Belt in the Benghazi City has also agricultural character.

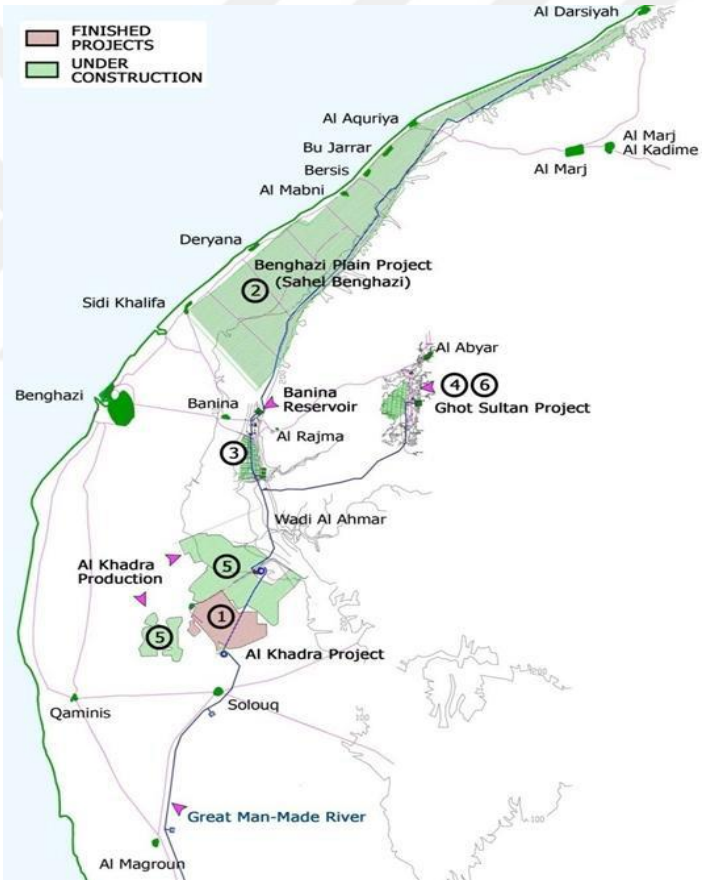


Figure 4.2. GMMR Agriculture Projects. (Source: AlEmara, 2008)

However, some areas in Green Belt especially in east and northeast of the city are partially occupied by low density-random developments. Banina and Bu Atni in east of Benghazi City are surrounded by fertile agricultural lands. All the land in a belt between Al Kwefiya and Sidi Khalifa parallel to the coastline is also cultivated, but to

a lesser extent. The depressions in Al Kwefiya, known as “Hava” are utilized for agricultural activities (BSRR, 2009). The share of agriculture sector in total labor force in sub-region level is estimated as 6.8 % in the Benghazi Sub-regional Plan Report.

Accordingly, as the metropolitan characteristics of Benghazi are taken into consideration, it can be assumed that the agriculture sector provides less than 5% of total employment in the Benghazi Metropolis. Since 1970‟s there have been substantial funds spent on agriculture plan, programs and projects in Benghazi Region in order to improve the agricultural production and the husbandry activities. The Great Man-made River Program, which was initiated in 1980, is the most important project for the agricultural irrigation and development in the Sub-region (AlEmara, 2009).

As seen in Figure 4.2, the majority of the projects included in the GMMR projects (namely Benghazi Plain, Wadi Al Qattara and Al Khadra Projects) surround the Benghazi Metropolitan area in north, east and southeast directions. Therefore, the GMMR projects and their probable effects on the migration movements and employment structure in future will be taken into account in the 3rd Generation Master Plan studies of the Benghazi Metropolis.

4.1.2.2. Industry

The industry sector in the Benghazi Metropolis is mostly based on small and medium scale- light industrial establishments, among which food and textile factories constitute the majority. Heavy industries are comprised of the cement, chemical, and metal (pipe, steel, etc.) factories. Industrial establishments are mainly developed in three zones along the main roads (AlEmara, 2009; BSRR, 2009).

Southwestern Zone: It is a wide area extending between the roads to Qaminis and Solouq, where Al Hawari, Al Guarsha and Ganfouda are the focal settlements for a numerous light and heavy industries, small-scale manufacturing facilities, wholesale stores and warehouses. Cement, steel and water pipe factories constitute the heavy industry establishments, whilst light industry establishments are rather specialized on production of building materials, chemical, paper and wood materials. Warehouses in Ganfouda district are used mostly for food storing. The main advantage of this zone is to be isolated from the housing areas and to be far from environmentally sensitive areas and natural resources like sabkhas and lakes, fertile agricultural lands and underground water resources. On the other hand, proximity to coastal and periphery highways, and

to main roads as well, constitute the other location advantage of this zone for industrial development (AlEmara, 2009; BSRR, 2009).

Eastern Zone (Banina Airport Road): It extends from 4th Ring Road to Bu Atni area and along the Banina Airport Road. Small and medium-scale factories constitute the majority of industrial establishments, which are specialized on food and beverages (e.g. macaroni, biscuit, chocolate, milk and fruit juice). Modern stores and company head offices have a rapid tendency to develop in this zone (AlEmara, 2009; BSRR, 2009).

Northeastern Zone: It extends from the 5th Ring Road to Al Kwefiya along the coastal highway. The small-scale light industry establishments are mostly specialized on chemical and electrical products, textile and furniture, building material, and steel and aluminum materials. The petroleum storage and distribution tanks, and wholesale stores and a few numbers of warehouses constitute the other industrial uses in this area. In recent times, some industrial buildings in the area have been started to be transformed to administrative buildings or company head offices (AlEmara, 2009; BSRR, 2009).

All the industrial uses and small manufacturing activities occupy 1,152 hectares of land, which corresponds to 11% of total developed area in the Benghazi Metropolis. 900 hectares land in Al Guarsha in 2008 have been designated and officially approved as the industrial zone to be developed mainly for light industries. However, the specific location has not been clarified yet (AlEmara, 2009; BSRR, 2009).

4.1.2.3. Commerce and City Public Services

2004 figures show that the public services with 77% have the highest contribution to non-oil GDP, as compared to other sectors included in trade and service sector. Public services are followed by trade, restaurants and accommodation sector (17.6%); and finance, insurance and real estate sector (3.5%); and transportation and warehousing sector (1.9%). The number of licenses granted in trade and service sector reached 7,725 in the Benghazi Sub-region during 1992-2003. The individual licenses amounted to 86.5% whilst the licensed partnership and joint venture companies accounted for 11.9% and 1.6% respectively (See Table 4.6) (AlEmara, 2009; BSRR, 2009).

2,137 is licensed for wholesale trade and 8,826 is licensed for retail trade activities. The wholesale trade licenses in goods and services reached 2,137 in total. Distribution

of licenses, regarding six main activities in good sector and five key activities in service sector (AlEmara, 2009; BSRR, 2009). In 2006, the number of retail trade licenses in goods and services amounted for 8,826; of which 4,925 (56%) are licensed for goods and 3,176 (36%) are licensed for service activities, in addition to 46 bank branches, 642 consumer association and 30 fuel stations (AlEmara, 2009; BSRR, 2009).

Table 4.5. Number of Licenses Granted in the Benghazi Sub-region during 1992-2003. (Source: Benghazi Sub-region Report, 2007)

Activity	Individual	Partnership	Joint Venture	Total
Agriculture	7	8	1	**16**
Quarry	0	2	0	**2**
Processing	971	478	34	**1,483**
Construction	42	122	20	**184**
Wholesale and Retail Trade	4483	163	45	**4,691**
Transportation	58	56	2	**116**
General services	978	70	7	**1,055**
Other services	144	23	11	**178**
Total	**6,683**	**922**	**120**	**7,725**
% in Total	**86.5**	**11.9**	**1.6**	**100.0**

Benghazi with its employment opportunities and metropolitan functions is a focal city that provides various commodities and services at all levels for not only Benghazi Sub-region but also entire Benghazi Planning Region. In current situation 81 of the Sub-region's population has been agglomerated in the Benghazi Metropolis. As its role as the trade and commercial, educational, medical, and administrative capital of the region; higher order in public, social and cultural facilities as well as port, international airport and land transportation-related services, and accommodation facilities are considered, it could have assumed that more than two third of the trade, commerce and service activities are localized in the Benghazi Metropolis (AlEmara, 2009; BSRR, 2009).

4.1.2.4. Construction

Construction is the fastest growing sector and second productive sector after oil sector in Libya. The increasing demand for housing, infrastructure and other services will reflect in intense development in the construction sector which will in turn result in

better employment opportunity both for domestic and foreign people. According to figures of 2005 given in Al Emara Status (Sector) Report, number of officially working people in construction sector in the sub-region is estimated about 25,000; of which 70 is provided by Libyan workers and 30 by Non-Libyans. As stated in the report, the partnerships with 63.8, as a legal entity, constitute the majority in the construction sector. Joint venture companies with 27.3 follow partnership companies, and then the society owned establishments with 0.56 in the Benghazi Sub-region (AlEmara, 2009; BSRR, 2009).

New construction projects in housing; technical infrastructure and transportation in the Benghazi Metropolis as well as tourism and recreation projects in the city centre and coastal zone are all expected to contribute more than any other sector to economic growth and urban development in Benghazi. However, lack of enough skilled labor force as well as lack raw material and manufacturing industries at building material sector, and the limited know-how in construction technology have hindered development of the sector in the Benghazi Metropolis as the case in whole Libya

4.1.2.5. Tourism

Benghazi City with its transportation opportunities, accommodation services, restaurants and travel agencies that constitute the tourism infrastructure has a capability to meet the basic requirements and services for tourism, although most of facilities are in urgent need of upgrading in order to achieve more favorable and attractive conditions especially for foreign tourists. There are 31 hotels in different class and quality with approximately 4,500-bed capacity in the Benghazi Metropolis.

The hotels in general are in the category of city-hotel that serves to domestic and foreign tourists coming to the city with the aim of job and business. Those hotels are mostly concentrated in central districts of Benghazi City. The accommodation facilities in the coastal areas are limited with the holiday villages, provided by government for use of domestic people (AlEmara, 2009; BSRR, 2009). The restaurants, cafeterias and coffee shops in Benghazi City are mostly located in CBD, in historic City and inside the 2nd Ring Road.

In general, the economic situation before the uprising against the Gaddafi regime in 2011, public services, trade activities, light industry and construction are the main economic sectors in the Benghazi metropolis. Benghazi City served as the commercial,

educational, medical, and administrative capital of the Benghazi Region. The port activities, the international airport, regional highway connections and the already accumulated wholesale trade, the university, higher order in public, social and cultural facilities was guaranteed its role in future as primary center of the region. The communication and information technology based type of industries were missing in the city to improve and employment opportunities in service and business sector, transportation sector, commerce, construction and tourism sectors would increase. (AlEmara, 2009; BSRR, 2009).

4.1.3. Cultural Heritage

The historical background of Benghazi dates back to ancient times. Benghazi, as a permanent settlement, has more than two thousand years old history. Greek settlers of Cyrenaica founded the city at the end of the 6th century B.C. under the name of Euesperides. It was designed to be a port of a rural hinterland made up of the western sectors of Al Jabal Al Akhdar. By the 3rd century B.C. it was already a provincial capital in the Ptolemaic Kingdom of Egypt and received the additional name of Berenice. In much later periods, its continuity was ensured under the Ottoman occupation when Benghazi was selected as administrative centre. This function was strengthened by the transformation of the city into a chief military centre under the Italian occupation (1922-1942). During the Second World War, the city was almost destroyed; an image was changed little during the period of British Administration. After the Independence (1951), the city seems to have regained its prewar dimensions (AlEmara, 2009; BSRR, 2009).

The cultural heritages are very limited in Benghazi, despite the historical background of Benghazi dates back to ancient times. The Site of Euesperides, the Site of Sidi Khrebish (Berenice), the Historic (Old) city, the old cemeteries and some historical and religious buildings comprise the current cultural heritages in the city (Figure 4.3) (AlEmara, 2009; BSRR, 2009).

The Euesperides site has already suffered considerable damage with the destructive effect of the Second World War. Besides, the public facility investments and some urban developments in time have also caused the ancient ruins completely to be damaged. Two cemeteries exist in the ancient city (See Figure 4.3).

The old cemetery in north in established on the Sidi Abeid mound, and the cemetery in south is already dedicated to “The Martyrs” (A. Wilson et al., 2004). The site of Sidi Khrebish (Berenice), the second Benghazi, is an ancient site that is settled in Greek, Hellenistic, Roman, Byzantine period. In current situation, in the context of the on-going project, the antique Lighthouse and some ruins in its environs have been restored (AlEmara, 2009; BSRR, 2009).

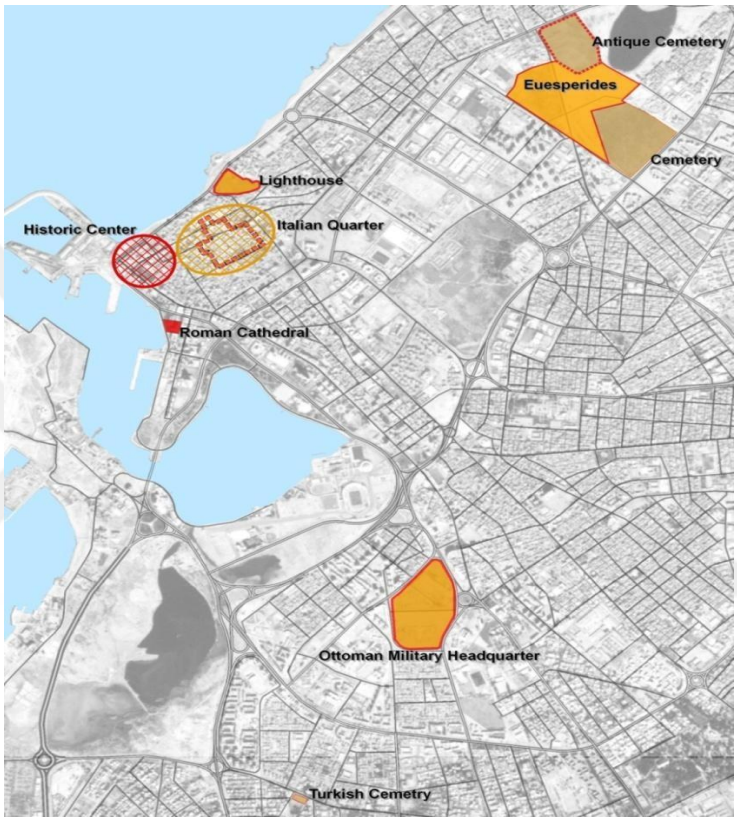


Figure 4.3. Archaeological Heritage in the Benghazi Metropolis (Source: adopted from BSRR, 2009)

Besides the historic center, the city also possesses several buildings of historical and architectural interest. These are regrettably confined solely to buildings of the Italian period and later. There are very few old Arab and Ottoman buildings in the city. However, most of them -except the religious buildings- are demolished in Italian period (AlEmara, 2009; BSRR, 2009). There are some cemeteries that are protected as cultural heritage within the urban area of Benghazi. Two cemeteries that are used regularly on the reclaimed land of Sabkha as Salmany in site of Euesperides have an area about 31 hectares. Turkish Cemetery on the so called “Pepsi Street” has an area about 4,400 m2 (AlEmara, 2009; BSRR, 2009).

4.2. Planning History and Urban Structure of Benghazi city

Spatial development of Benghazi City and urban structure is evaluated by relating with the planning studies experienced in three periods. These charts include Eaely Developments (before 1967), The First Planning Generation Period (1967-1988), and The Second-Generation Planning Project (1980-2000)

4.2.1. Panning History of Benghazi

The city form of Benghazi has been strongly shaped by a peculiar natural feature of the area, such as sabkhas or the coastal marshes, and the development was originally confined to a narrow strip of land between the sea and the sabkhas. It expanded at the end of the Ottoman period onto the open plain.

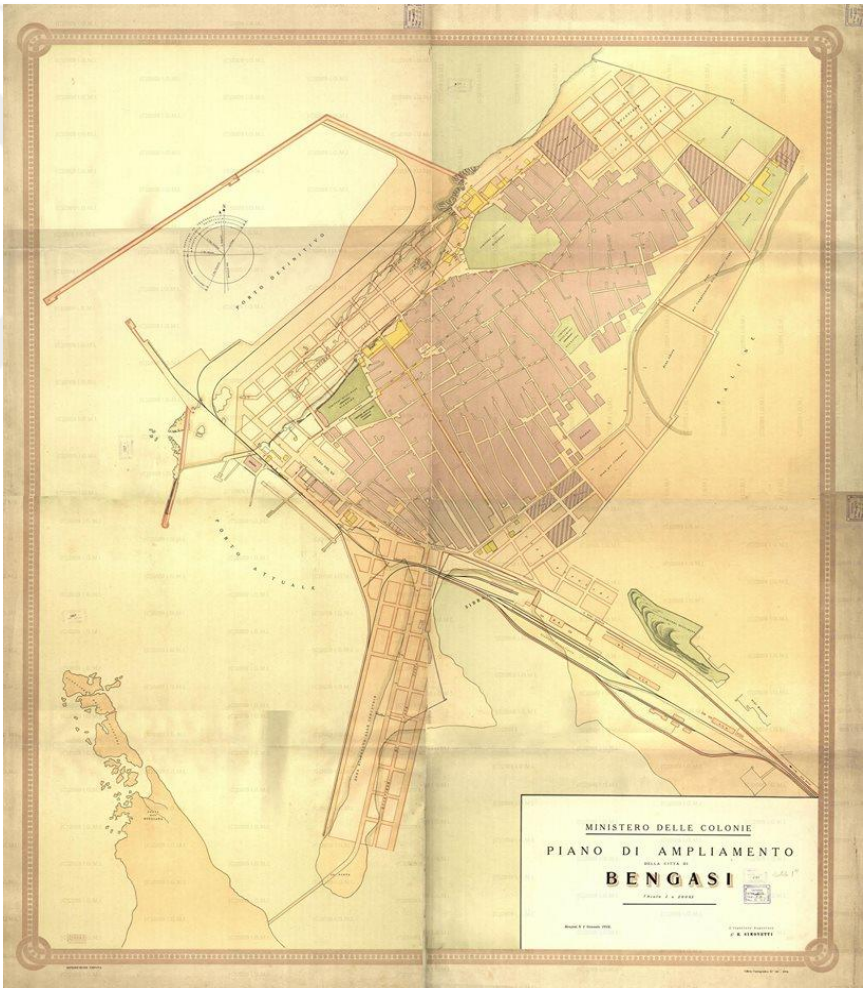


Figure 4.4. Benghazi city plan prepared by Piano di Ampliamento 1914. (Source: University of Texas Libraries)

A city plan, dating from the Italian period, encouraged development on the plain, mainly for residential, industrial and military purposes, while it provided for central

functions and services in the older parts of the city, because of their direct adjacency to the port. During World War II, the city was almost destroyed; an image was changed little during the period of British administration (See Figure 4.4 and Figure 4.5). After more than two decades of stagnation, the city of 1957 seems to have regained its prewar dimensions. Independence and the naming of Benghazi as an alternate capital gave new impetus to its growth.

During this early post-war period, the old core still dominated containing the bulk of urban development and able to respond to the needs of the inhabitants, but it also began to manifest an irrational distribution of landuses. Particularly with the oil discovery end the economic boom, relatively modern commercial and business establishments and crowded residential quarters with the concentration of instant commercial stalls (suqs), were giving rise to landuse and traffic problems especially in the city centre (AlEmara, 2009; BSRR, 2009).

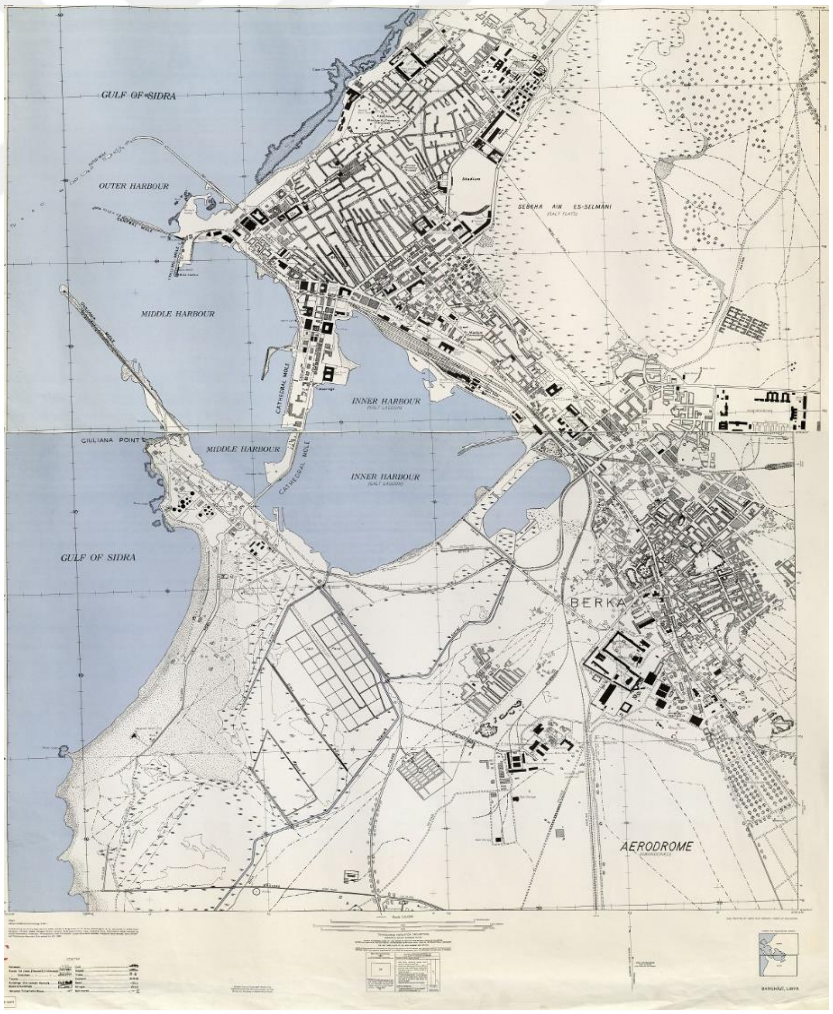


Figure 4.5. Benghazi 5K city plan prepared by US army 1962. (Source: University of Texas Libraries)

The 1st GPP that comprises the period from 1967 to 1988 was limited to the preparation of urban plans for certain cities and settlements based on limited expectations and low development rates. In this period, the 1966 Master Plan prepared by Doxiadis for Benghazi City sought to recognize the city functions by concentrating administrative, commercial and business activities in a "Central Business District" located between the reclaimed land of the Sabkha as Salmany and the landscaped shore of the Lake. The road network forms a radio-concentric pattern, with various ring roads and major radials, and included an inner loop encircling the CBD. The plan projected the population of Benghazi to 1 million in 2014 and included provisions for residential, industrial and ancillary uses accordingly (AlEmara, 2009; BSRR, 2009).

In general, the 1st GPP could not cope with the unexpected growth of the development needs not only in Benghazi, but also in other big cities and settlements. Large-scale projects were initiated in a wide range of sectors and the approved plans were unable to address the urban, industrial and demographic development in time. As result, development overtook planning and it became necessary in 1976 to prepare the required studies for a new planning period to cover the period 1980–2000 (defacto extended to 2006 for the finalization of the National Spatial Policy-NPS).

2nd Generation Plans prepared by Doxiadis Associates for the Benghazi City have been aimed to create conditions that would lead to the smooth functioning of all components of the socio-economic and technical infrastructure, together with the conservation of environmental assets (See Figure 4.6) (AlEmara, 2009).

Table 4.7 compare between those planning earlier planning projects and the uncompleted third regeneration planning project which was not completed due to the events in 2011. This comparison included explaining the plan, type of plan, and what are the planning theory on which the stakeholders are and the most important cash points against each project.

الجماهيريـــة العربيـــة الليبيـــة الشـــعبية الاشـــتراكية العظمـــى

Great Socialist People's Libyan Arab Jamahirya

اللجنـــة الشـــعبية العامـــة

General People's Committee

مصـــلحة التخطيـــط العمـــراني

Urban Planning Agency

مشـروع الجيـل الثالـث للمخططـات - إقليـم بنغـــازي التخطيطـــي

3rd Generation Planning Project

المخطـــط المعتمـــد للجيـــل الثـــاني

2GPP Master Plan of Benghazi City

أنجزت من قبل مكتب العمارة للإستشارات الهندسية بسنة (2009)

Produced by AL EMARA Engineering Consultance Office(2009)

Legend الإصـــطلاحات

Other Roads	طرق أخرى
Collector Road	طريق جامع
Secondary Artial Road	طـــريق شـــرياني ثـــانوي
Major Artial Road	طـــريق شـــرياني رئيســـي
boundry of al jabal al akhdar project	حدود مشروع الجبل الأخضر الزراعي
Boundary of Master Plan	حدود المخطط العام والشامل
Airport and Harbour	مطارات وموانيء
Lake	بحـــيرة
Transportation	النقـل والمواصـلات
Low Density Residential Area	منطقـــة ســـكنية كثافـــة منخفضـــة
Medium Density Residential Area	منطقـــة ســـكنية كثافـــة متوســـطة
High Density Residential Area	منطقـــة ســـكنية كثافـــة مرتفعـــة
Commercial and Buisness	التجارة والأعمـال
Public Building	مبـاني عامـة
Education	مبـــاني تعليميـــة
Health	مبـــاني صـــحية
Cemetry	مقـــبرة
Recreation Sport and Green Areas	مســاحات خضــراء منــاطق للرياضــة والترفيــة
Social Services	مـــرافق اجتماعيـــة
Heavy Industry	صـــناعات ثقيلـــة
Light Industry and Storage Area	صـــناعات خفيفـــة ومســـتودعات
Public Utilities	مرافق عامة
Agriculture Area	أراضي زراعية
Forest and Preservation Areas	غابات ومناطق حماية
Special Area	مناطق خاصة
Beach Area	منطقـة الشـاطئ
Preserved Area	مساحة محجوزة

Scale 1:125,000

1:125,000 مقياس رسم

Benghazi بنغـــازى

البحـــر المتوســـط

THE MEDITERRANEAN SEA

Figure 4.6. 2nd Generation Master Plan of Benghazi City. (Source: BSRR, 2009)

Table 4.6. Organizational Chart of Planning Phases and Development Projects in Libya (Source: Author)

PLANNING PHASES	PLANS	ACTORS	DESCRIPTION	CRITICISM
MASTER PLANS IN ITALIAN PERIOD	Urban Master Plans 1911 - 1947	• Italian Occupation government • Foreign planners	• The roots of town planning in Libya dates back to Italian era. • Four master plans prepared for Tripoli, Benghazi, Darnah and Misurata cities • Layout plans were prepared for towns and villages	• Colonial System • Plans to minimal return to local labor • Restricted resources
1st GENERATION PLANNING PROJECT	Urban Master Program and Plans 1966-1988	• Ministry of Planning and Development • Foreign planning offices (DOXIADIS)	• 1st GPP included only Master Plans and Layout Plans for major towns and settlements. • Al Marj Master Plan of 1963 was the first plan prepared by Libyan planners (Barca Reconstruction Organization) after independence, and the second plan was master program and layout plan for Al Bayda	• Mixed colonial, kingdom and Dictatorial regimes • Focus only on residential landuse and no other landuse classified • One-way planning policy • No protection for culture and nature
2nd GENERATION PLANNING PROJECT	National Spatial Policy (NSP) 1980-2000 The National Physical Perspective Plan* (NPPP)	• PLANNING GENERALSHABIA • LOCAL SHABIA • Libyan Planning Agency • Libyan Survey Department • Foreign planning offices (DOXIADIS)	Sets the guidelines for the planning and management of settlements, infrastructure, services and landuse, within vast territory of the Jamahiriya.	• Dictatorial regime • Decision making by central authority • Process missed by planner's central role • No evaluation processes • Stumbled economic reforms • Contradictory legislations • inefficient patterns of land use unsatisfactory urban environment.
	Benghazi Region Physical Development Plan (BRPDP) 1985-2000		• Refers to NPPP • The BRPDP covers Al Butnan sub-region, Darnah subregion, Al Jabal Al Akhdar sub-region, Al Marj sub-region and Benghazi sub- region	
	Sub-region Physical Development Plan (SRPDP) 1985-2000		• Refers to the BRPDP • Prepared for Al Butnan, Darnah, Al Jabal Al Akhdar, Al Marj and Benghazi	
	Urban Master and Layout Plan 1985-2000		• Refers to the SRPDP • Master and Layout Plans for major towns and settlements	
3rd GENERATION PLANNING PROJECT	National Economic Strategies (NES) 2006-2019	• General Committee of Libya • Ministry of planning • Urban Planning Authority (UPA) • UN-Habitat • Libyan Survey Authority (LSA) • Libyan consulting offices with Foreign planning offices • Local municipalities	□ A set of strategies to upgrade the global competitiveness of Libyan economy	• Not completed • Data and information plans based on, have been changed • Faces new reality of Libyan changes and civil war • Same contradictory legislations and policies are still in role
	National Spatial Policy (NSP) National Physical Plan (NPP) 2006-2030		• Benefited from NES and 2nd GPP and previous version of NSP • The guidelines for the planning and management of settlements, infrastructure, services and landuse within vast territory of Libya • Provided guidance to the regions and sub-region plans	
	Benghazi Regional Plan (BRP) 2000-2025		• Refers to the NSP, NES and 2nd GPP • Covers Al Butnan, Darnah, Al Jabal Al Akhdar, Al Marj and Benghazi sub-regions	
	Sub-regional Plan (SRP) 2000-2025		• Refers to the BRP • To be prepared for Al Butnan, Darnah, Al Jabal Al Akhdar, Al Marj and Benghazi sub-regions	
	Urban Master and Layout Plan 2000-2025		• Refers to the SRP • Master and Layout Plans for major towns and settlements	

4.2.2. Urban Structure of Benghazi City

The natural resources in Benghazi City, namely the Mediterranean Sea and coastline, and the Sabkhas that forms a ribbon parallel to sea and the topography with an almost level featureless plain have played a major role in identification of the city macroform. Benghazi City in terms of macroform was perfectly adapted to these natural conditions during its development process. The city limited by the coastline in west side, has spread out in east, south and north directions concentrically by starting from a nodal point named as Old Benghazi. Ring roads interconnect radial roads moving towards this nodal point (eventually associated with the CBD) and both categories then constitute the backbone of the overall urban development (AlEmara, 2009).

Certainly, the concentric and compact urban macroform has been greatly influenced by the two master plans prepared by Doxiadis in the last half-century. This planning approach was consistent with the modernist-rationalist and comprehensive planning understanding commonly adopted in the World in that period. It can be said that the compact macroform achieves the convenient urban texture in terms of the Doxiadis Plan's policies defined as "providing equal opportunities for all". Besides, the natural thresholds like sabkhas and lakes in south and north direction of coastal zone rationalized such a city macroform for Benghazi (AlEmara, 2009).

The metropolitan area of Benghazi covers an extensive half circle in the form of concentric zones extending from Sidi Khalifa in the northeast to Ganfouda in the southwest, with a sectoral growth in east at Bu Atni zone and along the Banina Airport Road. As the natural phenomena like sabkhas, lakes and swamps have limited the urban developments in coastal zone in south and north directions, the City is mostly developed inside the 5th Ring Road.

Some partial implementations and random developments especially outside the 5th Ring Road had increased in recent years before 2011 in order to meet the land requirement for new investments and housing need of the city people. In northeast part of the City, the areas outside the 5th Ring Road consisted of mostly residential uses developed randomly or with partial plans. Besides, some handicrafts and repair services are also developed as mixed use. The residential areas in this zone -except the new villa-type of houses- have been developed with low standards and quality. Some unplanned development has also emerged through Al Nawaqia-Solouq Road, where

the cement factory has been the main factor that encourages the unplanned developments in this direction.

4.3. Environmental Structure of The City

In this part, the study will present the city climate and geological formation of the city as the environmental structure.

4.3.1. Climate

There are five different climatic zones in Libya, but in general, the dominant climatic features in the country are influenced by Mediterranean and Saharan. In most of the coastal regions, the Mediterranean climate characteristics with warm summers and mild winters are dominant. Influence from the southern desert area and Mediterranean Sea cause sudden changes in weather in different geographical parts, namely Mediterranean coastal strip (Coastal area), the escarpments plateaus (Mountain area), and southern slope of the Green Mountain and far inlands (Desert area) of the Benghazi Planning Region (BPR).

The climate in coastal zone in Benghazi is relatively pleasant even in summertime. The maximum temperature in coastal area is slightly over 26^{o}C in summer while the minimum temperature in winter is around 10^{o}C. Dust storms are common generally throughout the region. `Qbli` (warm, dry sandstorm), which is the most characteristic feature of climate, occur mainly in the summer months and normally last for one or two days and can reach speeds of up to 150 km per hour.

Benghazi's climate is akin to the typical Mediterranean due to its location on the Mediterranean coast, far from high mountain ranges and at considerable distance from the Sahara Desert. Temperature and humidity, as two primary climatic features, create a generally favourable climate in Benghazi during most months of the year. The annual average of temperature is around 20oC, whilst the average humidity is 65%. The southerly "Qbli" carry large quantities of sand from the desert and cause rapid rises in temperature in summer (BSRR, 2009).

However, the sand loaded desert wind blowing from the south and the hot and dry local wind, namely the "Qbli", are the most characteristic feature of climate. The "Qbli" is effective especially during spring, early summer, and during autumn and causes a sudden rise in temperature and a striking decrease of the relative humidity.

Total number of days with sandstorm is around 180 in a year. The sandstorm is effective especially in autumn and spring seasons (BSRR, 2009).

4.3.2. Geological Formation of Benghazi

Benghazi Planning Region contains dense sequences of sedimentary rock formations of Upper Cretaceous (Chalk), Tertiary and Quaternary formations. Limestone, dolomite limestone, sandstone, marl and gypsum constitute the larger part of the thick, well- stratified carbonic sedimentary rock strata outcropping throughout the Benghazi Planning Region. The Benghazi Sub-region is characterized by intense existence of surface carbonate rocks of tertiary era that are concentrated in particular lime rocks at Al Rajma heights and Al Qattara depression and the neighboring areas of eastern coastal belt of Benghazi Sub-region.

These geological formations belong to Eocene and Oligocene and Miocene eras and are covered with multi sediments of fourth era, which is characterized by existence of calcarenite and conglomerate rocks besides sand dunes and marsh sediments. Benghazi City is located in the coastal part of Benghazi plain. The geological structure of the city and its broader environs is characterized by mainly Tertiary and Quaternary formations (See Figure 4.7) (IRC, 1974).

Eastern, north-eastern and south-eastern part of Benghazi City consist of tertiary formations belongs to “middle miocene” age. The geological formations of Al Rajma Formation and Benghazi Member (TmRB) emerge in wide areas. These formations consist of limestone, dolomite limestone, fossiliferaus limestone, algal limestone and calcareous clay. The limestone, which is a typical of the lower part of the Benghazi Member is mostly soft, whilish grey, highly fossiliferous algal limestone, thick-bedded or without marked bedding (AlEmara, 2009; BSRR, 2009).

Quaternary formations are basically composed of sandy marl, alluvium and pebbles. Calcarenite rocks, conglomerates, sand dunes, and different Sabkha deposits constitute the main characteristics of quaternary formations in Benghazi Sub-region. The coastal zone and south part of Benghazi City consist of different quaternary sediments. According to their origin they may be divided as alluvial and coastal sediments (AlEmara, 2009; BSRR, 2009).

Figure 4.7. Geological Map of Benghazi (Source: Adapted from Geological Map in Explanatory Booklet, Libyan Arab Republic, Industrial Research Center, 1974)

Alluvial sediments are represented by loam, silt, gravel, cemented gravel. They cover extensive areas in south part of the city, especially at Wadi al Qattara and its vicinity.

Beach sand forms a belt along the south and north coast of the Benghazi City. Sand is mostly fine-grained, relatively equigranular, largely composed of calcareous material (shell fragments, limestone grains) and sandy gravel (AlEmara, 2009; BSRR, 2009).

Sabkha sediments form a belt along the coast as parallel to coastline by expanding in patches. This formation consists of salty clay, clay sand materials, and also contains fine-grained beach sand redeposited by northwestern winds blowing from the coast and brownish red silt brought in by southern winds from inland. Lagoons are usually

separated from the sea by a belt of beach sand, which allows marine water to be connected with, and provide a permanent supply of salt to the lagoons (AlEmara, 2009; BSRR, 2009).

The threshold for the city will be analyzed in terms of topology, geomorphology, water and energy sources, natural thresholds and protection areas in the city, and showing areas where future urban developments might be.

Topography of Benghazi City is generally uniform as it is located on the coastal plain. The symmetrical contours with low slope characterize the main topographical feature of the land in the Benghazi City.

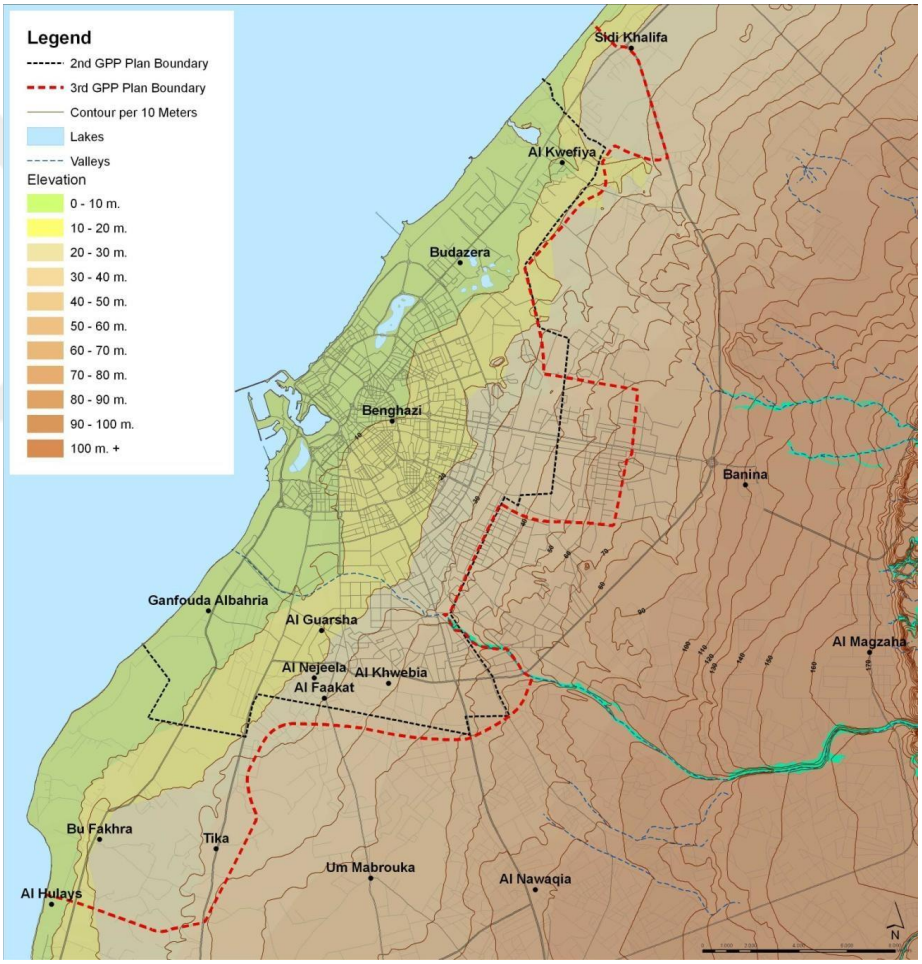


Figure 4.8. Topography and Elevation Zones in the Benghazi Metropolis. (Source: BSRR,2009)

This characteristic of the topography slightly changes towards to Banina, where the height increases to 90 - 110 meter above sea level. This structure clearly appears in north of Banina plateau, which gradually elevates until reaching the contour line of

150 meter at the bottom edge of Al Jabal Al Akhdar (See Figure 4.8) (AlEmara, 2009; BSRR, 2009).

Al Jabal Al Akhdar Plateau is considered the most active zone in terms of earthquake and tectonic activities compared with other regions in Libya. In fact, 70% of earthquakes recently occurred in Libya have took place in this area. The fault lines, lying mostly in east-west directions in many places and numerous fractures lying in different directions are most common in all plateau area. However, fault lines and fractures are infrequent in the Benghazi Sub-region (AlEmara, 2009; BSRR, 2009).

4.3.3. Geomorphology

Benghazi City and the other settlements in the Benghazi Metropolis are located in a semi-arid flat plain, known as Benghazi plain. Benghazi plain forms a large triangle between the Tukra village in the North and the Zaitonia village in the south and bordered by the eastern coast of Sirt Gulf in west and Al Jabal Al Akhdar edge in the east. Its land area is estimated for 6,500 km2 and characterized by narrowness in the north due to closeness of the edge to the coast and gets wider in the southern part due to the distance of edge from the coast gradually. The maximum width of the plain reaches 50 km.

Around Benghazi it has 25 km width from east to west. The plain starts getting higher above sea level gradually towards the direction of Al Jabel Al Akhdar first edge, where its maximum height reaches 300 meters in the northern part. Its least height is 2 meters in south of Al Magroun area in the southern part. The main geomorphological phenomena in Benghazi basin, formed as a consequence of tectonic movements and underground water movement, are mainly characterized by the valleys, among which the most important ones are Zaza valley and Al Qattara valley; and the cretaceous phenomena such as lakes and caves concentrated in eastern and northern part of the Benghazi Metropolis; and the marshes and dunes lying along the coastal strip (AlEmara, 2009; BSRR, 2009).

The main geomorphologic phenomena in the Benghazi Metropolis are classified within the three group as the cartaceous phenomena (lakes, holes and caves) resulting from underground water activities; valleys and alluvial fans resulting from surface water activities; and geomorphologic formation in coastal strip such as sand dunes,

coastal marhes (sabkhas, salinas, swamps) and coastal lakes (See Figure 4.9) (AlEmara, 2009; BSRR, 2009).

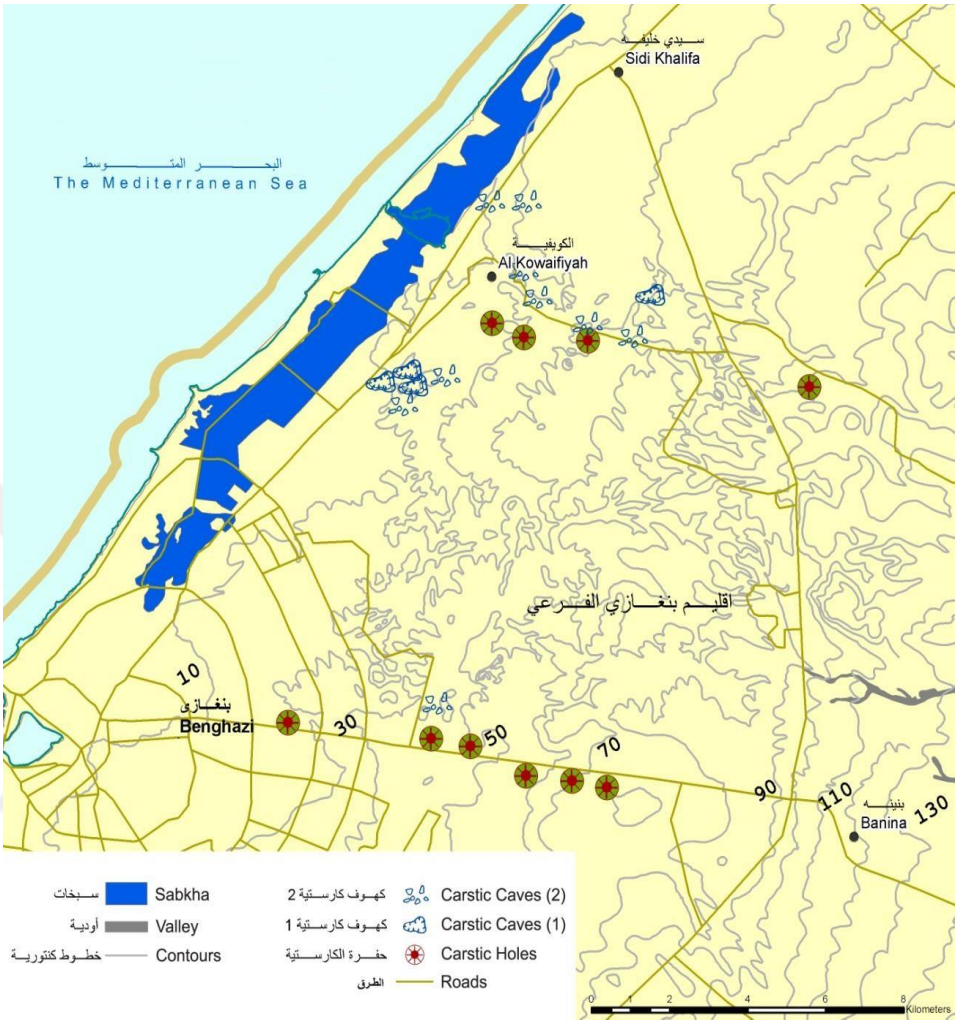


Figure 4.9. Some Karstic Phenomena in Benghazi Plain (Source: BSRR,2009)

In the southern part of Benghazi plain, there is Al Qattara valley, whose water reaches out to the sea. Al Qattara with 52 km length is the longest valley leading to the west. What characterizes Al Qattara valley is its dangerous floods, especially during the years of heavy rains. Two barrages have been constructed in the valley to store and use its water besides prevention of floods that threaten the City of Benghazi from time to time. Al Qattara basin is characterized by its easy corrugation with less topography of extreme slopes (See Figure 4.10). Above Banina and Al Rajma hills the surface is covered by thin layer of red clay residues or terra rosa (AlEmara, 2009; BSRR, 2009).

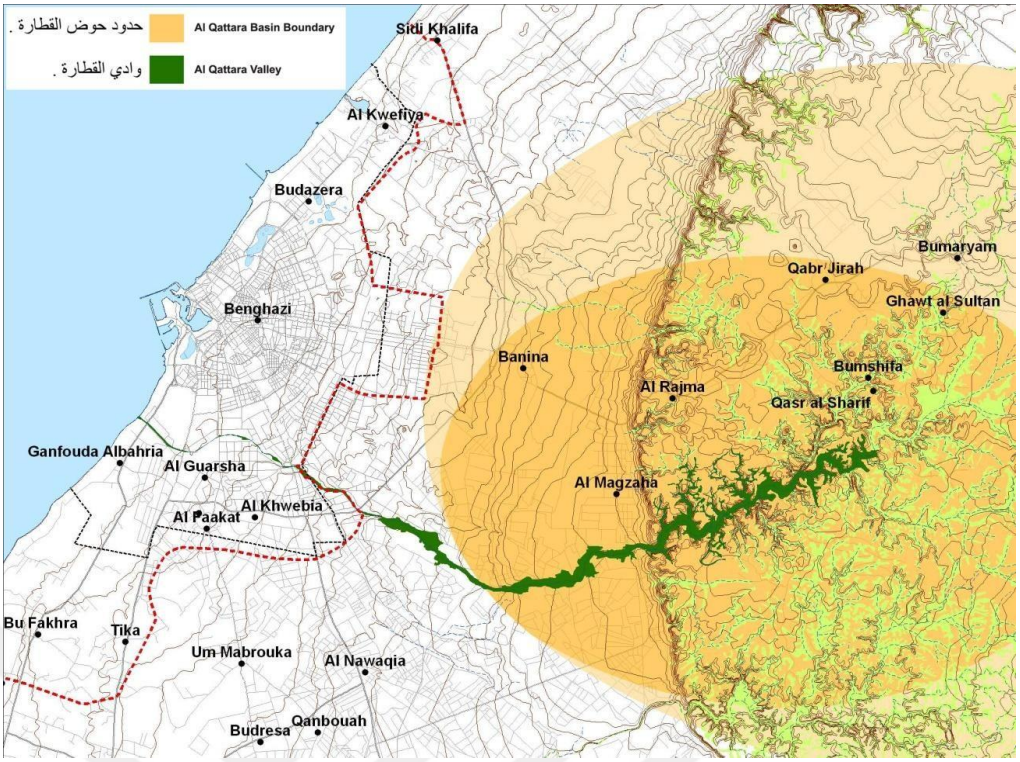


Figure 4.10. Al Qattara Valley (Source: BSRR,2009)

As examples of such fans are the ones locating at the mouth of Albab valley in southeast of Solouq area and the alluvial fan produced from Al Qattara valley. The valley ends with an alluvial fan covering the area situated between Nawaqia and Benghazi City. Extreme slope, pediments, and alluvial fans that in certain case form a plain with good soil used for agricultural and grazing purposes characterize the face of this edge (AlEmara, 2009; BSRR, 2009).

The coastal strip of the Benghazi Metropolis is characterized by the existence of lagoons, marshes, fossil sand dunes (calcarnite) and newly formed beach sand dunes.

Parallel to immediate coastal line there is a belt of newly formed sand dunes with white–yellow color. These sand dunes might be continuum or separated. Their height ranges between 5 - 10 meters and they are still under the process of formation. These dunes may be traced from the south of the plain to the north. The fossil sand dunes are formed by means of wind carriage of sand residues away from the beach, and then got fossil and amalgamated with limestone fine granules and shells fragments with adhesive material. These fossils are available in a form of connected edges or longitudinal hills (AlEmara, 2009; BSRR, 2009).

Numerous coastal marshes exist along the coastal area of Benghazi plain. There is a series of long marshes on top of which is Alkooz marsh of 11 km, Bu Jarrar and Bersis marsh in north of Benghazi City. In the southern part there is a plain of other marshes, in which the larger is the one extending from Abu Qateefa with a very narrow strip of 60 km length and Karkura marsh that extends to about 52 km, Garyounis marsh and others. In most cases these marshes are separated from beach line by a belt of white shining sand dunes. Such salt lakes, which are periodically submerged by the seawater, are exposed drought in summer. The formation of these marshes and lakes is due to occasional gradual sea retreat and sea tide in some other cases. Their formation may pertain to climatic changes. The residues of such marshes consist of red salt and sand clay besides a big portion of sodium chloride, gypsum crystals and cohesive clay and the marsh surface is covered with a cortex of salt and gypsum (AlEmara, 2009; BSRR, 2009).

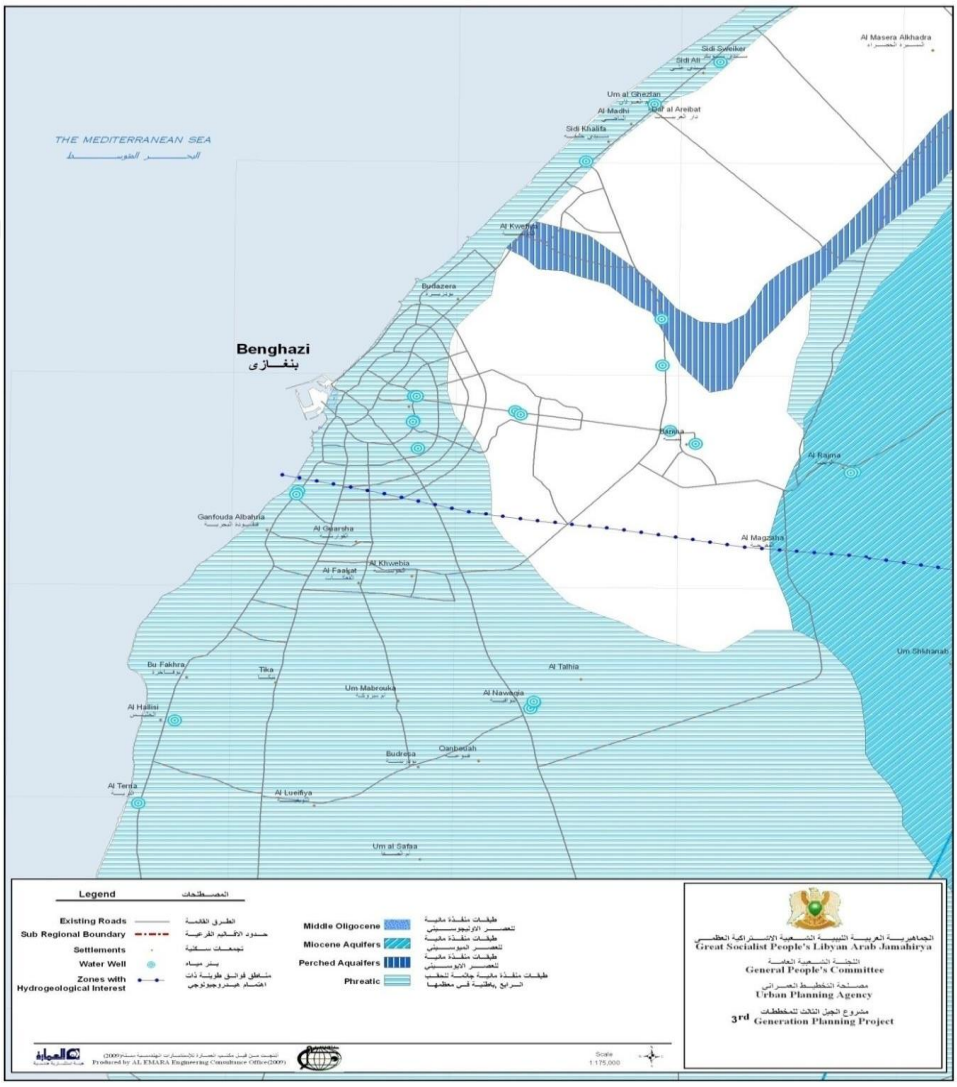


Figure 4.11. Hydro-geological Formations in Benghazi Sub-Region (Source: BSRR,2009)

Like other Libyan plains, Benghazi plain is full of coastal lakes such as Budazera and Ain Ziyanah. Ain Zaiyanah is the largest spring located in the northern part of Benghazi plain. Its waters flow to natural basin open on the sea, known as Blue Lake (AlEmara, 2009; BSRR, 2009). Water resources in the Benghazi Region, as similar to different parts of Libya, has a critical importance for the sustainability of human settlements and industrial and agricultural activities as well. Underground water represents about 95 % of all water resources currently available in Benghazi Region. Benghazi Sub-region has been hydro-geologically located among Al Jabal Al Akhdar water basin, whose total area is 215,000 km2 (Figure 4.11) (AlEmara, 2009; BSRR, 2009).

4.3.4. Water Resources

The main water sources in Benghazi Sub-region are as follows (Figure 4.12). Underground water represents about 95 % of the whole available water resources. The components of the tripartite era's dams in Benghazi plain represent the main underground water source for Benghazi City, where most of the water used for domestic, agricultural and industrial purposes.

Benghazi plain, included in the 1st Hydrologic Unit in Benghazi Sub-region, cover the whole area extending from the northern side of Solouq in south to Benghazi City up to the north of Al Marj City. The total area is about 2,807 km2, and the annual rain fall rate is 701,750,000 m3/year. Water fields in Banina and Sidi Mansur are the main sources that supply water to Benghazi City and other settlements in metropolis (AlEmara, 2009; BSRR, 2009). The water field of Banina lies 18 km east to Benghazi City, and its total area is 542 km2. Well depths vary from 100 meters to 180 meter, and the well productivity is between 27 and 324 m3/hour. The intensive existence of wells near to each other leads to an increase in salinity degree of water in the field. The production capacity of Banina water field is about 3,500,095 m3/day in 2002 (AlEmara, 2009; BSRR, 2009).

These wells are found in eastern and southeastern of Benghazi City. The pipeline company in Al Guarsha has created 7 wells in order to use the water in the factory and connected a branch line for drinking water for Al Guarsha. Well depth in Hawari is 140 meters, with a production capacity 605 m3/day (AlEmara, 2009; BSRR, 2009).

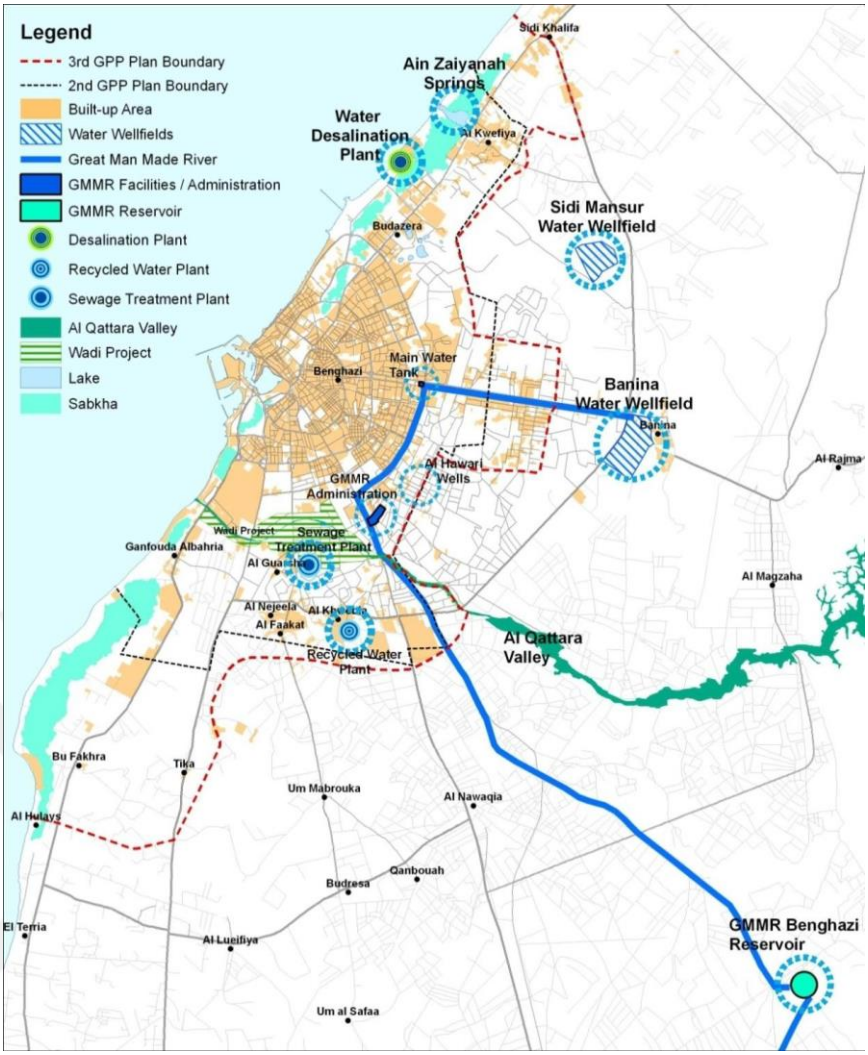


Figure 4.12. Water Sources of the Benghazi Metropolis (Source: BSRR,2009)

The surface water in the sub-region represents only a minor percentage of the total water sources. Total amount of surface water ranges from 230 mm in Benghazi, and 270 mm in Banina. The quantity of rainfall in Benghazi is 23 million m3/year, whilst it is about 11.11 million m3/year in Banina. 10% of this water is filtered to feed the underground dams. Few amounts of water are utilized in houses, especially in Benghazi, as water that fall on Benghazi City goes directly to the sea.

Ain Zaiyanah spring located in north of Benghazi City is the largest spring in the Benghazi Sub-region, with a yearly discharge of 90 million m3. Surface water flowing from Al Jabal Al Akhdar heights to the valleys are collected in the dams constructed in Al Qattara and Zaza valleys in the Benghazi Plain. The surface waters accumulated in Al Qattara Dam are only used in feeding the underground dam (AlEmara, 2009; BSRR, 2009).

The Man-Made River Project (MMR) was initiated in 1980 to transport water from desert to solve the water problem of the coastal settlements of the country (See Figure 4.15). Total amount of water conveyed by the MMR Project will be over 6 million m^3 per day or approximately 2,200 million m3 per year. It is projected that 70% of transported water will be used for agricultural purpose. This ratio is 28% for municipal and domestic use and 2% for industrial use. In the context of the MMR Project, Benghazi is supplied with water by the Sarir-Sirt, Tazerbo Benghazi System (SSBT), which is currently in use. Tazerbo water is being transported to Benghazi and reservoirs have been constructed. MMR Benghazi reservoir with a capacity of yearly 76 million m3 has already been completed at approximately 40 km distance in southeast direction of the city (AlEmara, 2009; BSRR, 2009).

4.3.5. Vegetation

The vegetation in Benghazi plain is poor in general. All types of desert scrubs and Mediterranean plants constitute the typical vegetation Benghazi Plain. Scrub lands and forest areas in the plain are composed of small tree groups and all types of desert scrubs. Those types of vegetation are spread in areas around Budazera, Al Kwefiya and Sidi Khalifa in north, around Bu Fakhra and Tika in south and around Banina in east.

There are also small forest areas around the Wadi area. Palm trees in the coastal part of Benghazi plain constitute an important landscape asset, whilst the cultivated farmland (mainly grape fields) or fenced-in orchards (mainly olive and eucalyptus groves) are prominent features in the south and southeast. The vegetation becomes sparser towards the east and south of the plain, due to the natural and climatic impact of arid Sahara Desert. Desert vegetations in Benghazi Plain comprise the poor scrubs and seasonal grasses such as bagarawn, rateema, kharshof, Alhareeg and others whose existence is related to rainfall (See Figure 4.13) (AlEmara, 2009; BSRR, 2009).

In general, the plant cover in the coastal strip is not intensive. The most important types of bushes include tamarisk and ratam that are common around Sidi Khalifa in north and Al Maqroun in south. Besides, mathnan in the southwest of Benghazi at Tika, and rimth in the northwest of Qaminis constitute the major types of coastal vegetations. Grasses in this region include mainly orchids and awjaz in the south and

sebel grass at Sidi Khalifa area, whilst squill and some other grass types exist in scattered places of the plain (AlEmara, 2009; BSRR, 2009).

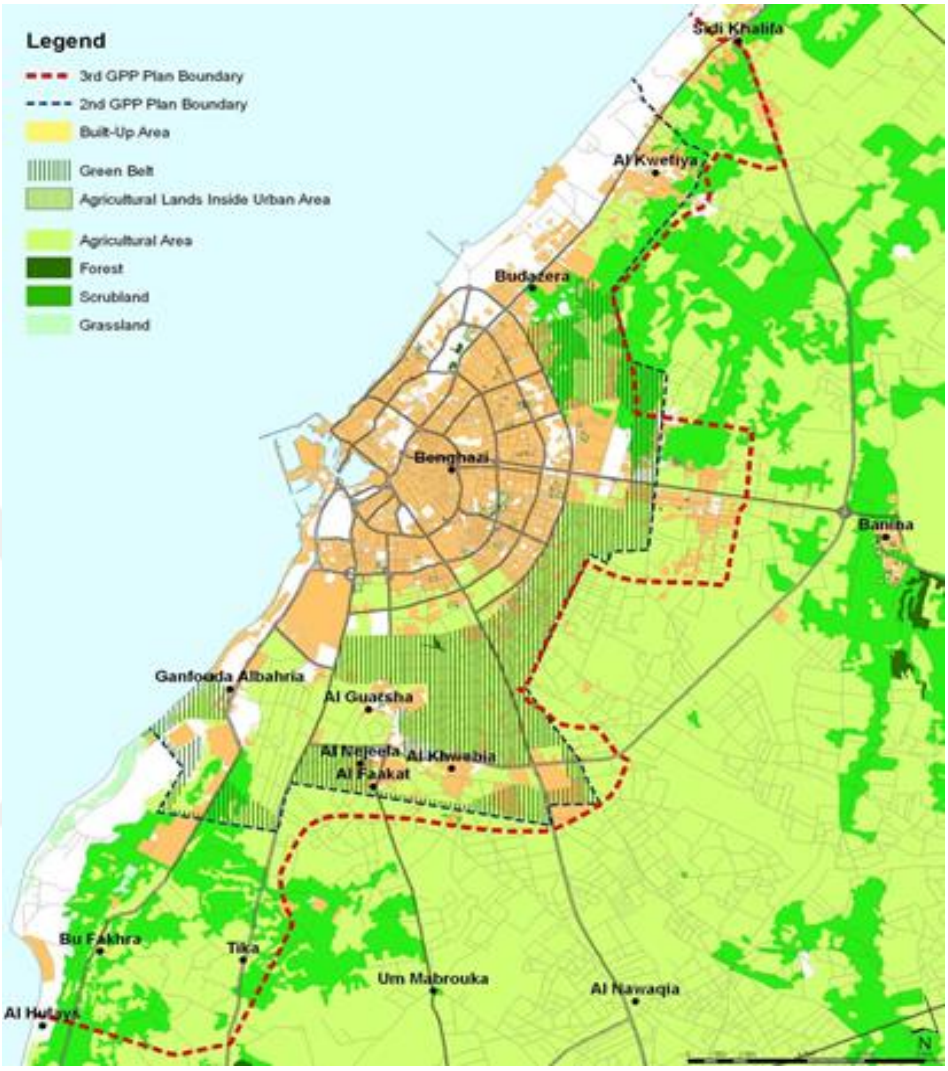


Figure 4.13. Vegetation Cover and Agricultural Lands in the Benghazi Metropolis (Source: BSRR,2009)

Soils of Benghazi Plain are characterized by clay soils of heavy mesh, most of which generally derived from lime rocks as they represent the main rock in the region. At the feet of mountain edge red and alluvial soils are spread. However, the valley soils are existing along their streams, while rock soils are available in north of the plain and east of Benghazi City.

Among the other problems facing soil in Benghazi Plain is water and wind erosion. Along Benghazi Plain valleys different patterns of erosion, (e.g. surface erosion, tartar erosion, and soil drift) are observed. Wind erosion is the most severe and clarity in the

southern section of the plain due to rain scarcity on one hand and weak vegetation on the other hand (AlEmara, 2009; BSRR, 2009).

Fertile agricultural lands in the Benghazi Metropolis and its environ are mainly concentrated in south, southeast and east directions. In south, the settlements of Al Guarsha, Al Nejeela, Al Faakat and Bu Fakhra around the wadi area have agricultural character (See Figure 4.14) (AlEmara, 2009; BSRR, 2009).

Figure 4.14. Typical Vegetation and Agriculture in "Hawa" in Al Kwefiya (Source: Google image,2017)

The Green Belt in Benghazi City has also agricultural character. However, some areas in Green Belt especially in east and northeast partially occupied by randomly developed residential, commercial and warehouse type of uses. Banina and Bu Atni in east of Benghazi City are also surrounded by fertile agricultural lands. Coastal zone and Sabhkas are not suitable for agriculture. All the land in a belt between Al Kwefiya and Sidi Khalifa parallel to the coastline is also cultivated, but to a lesser extent. The natural precipitate lands, known as "Hava", in Al Kwefiya are also fertile agricultural lands (See Figure 5.28). Those areas, besides its agricultural significance, are the

valuable lands in terms of vegetation, biodiversity and landscape characteristics that enrich the natural environment in north of the metropolis (AlEmara, 2009; BSRR, 2009).

4.3.6. Natural Protection Areas

The sabkhas, lakes and some crest caves in coastal zone of the Benghazi Metropolis constitute the significant natural formations that should be considered as natural protection areas. The soft lands (sabkhas, salinas, swamps, lakes) that form a semi-linked chain in the coastal zone of Benghazi plain (See Figure 4.20), are defined as the natural areas that are permanently or temporally flooded by water, stagnant or flowing, fresh or with low or high salinity.

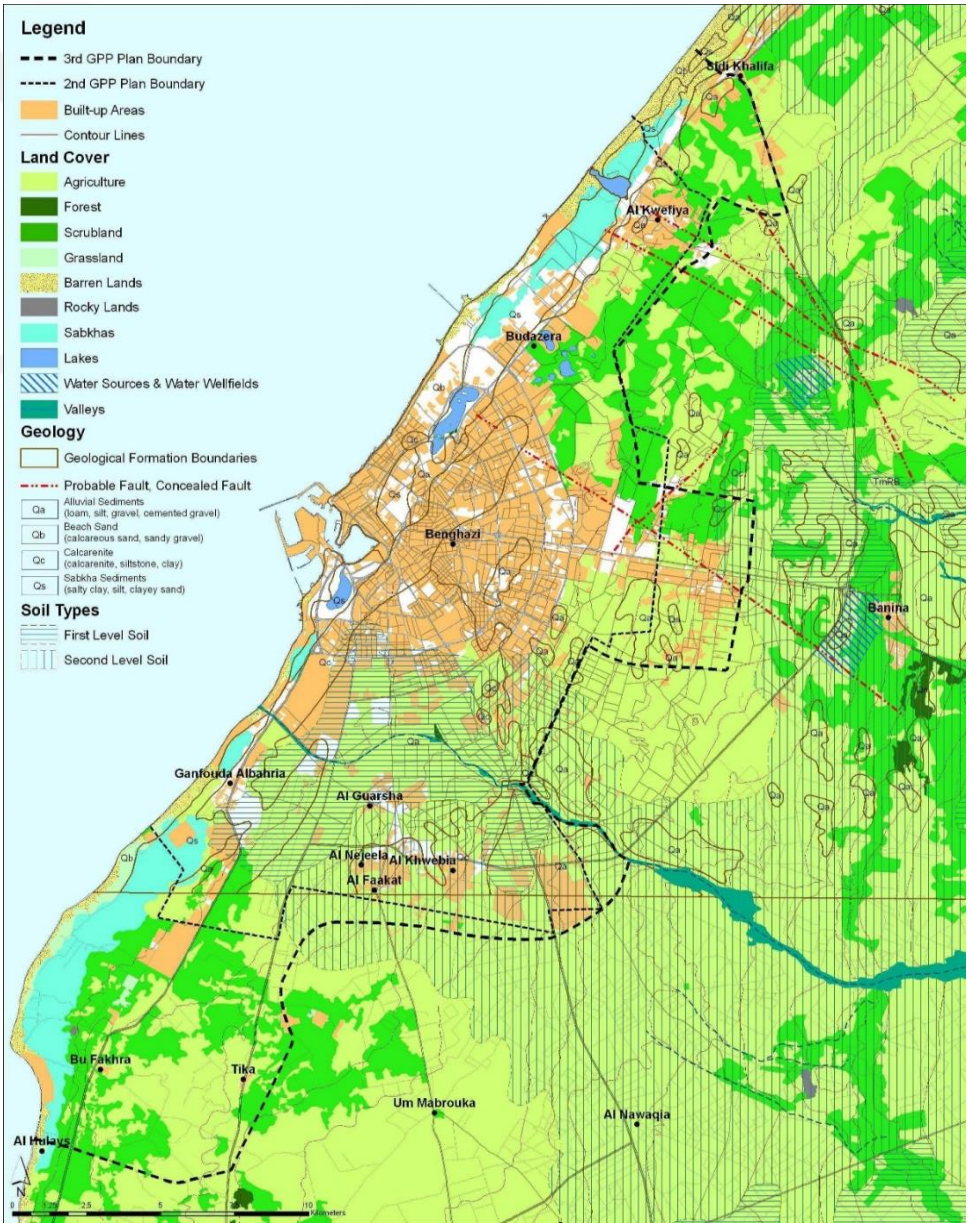


Figure 4.15. Natural Protection Areas (Source: BSRS,2009)

The soft lands with their natural and ecological features are considered as an organizer of maritime-life, wildlife, and biodiversity in the region (See Figure 4.15). Additionally, they have an economic value as they create a significant potential for scientific investigations, eco-tourism, and recreational activities (AlEmara, 2009; BSRR, 2009). Large sabkhas that are found along the shoreline of the Benghazi Metropolis include Most of these locations are now in a very bad environmental condition due to the continuously growing destructive human activities that led to disappearance of areas of them to be turned into dump sites used for disposal of solid waste and sewage water. The saline areas should be carefully studied within 3rd GPP and the urban expansion should be directed as to prevent the exploitation of some of these Salinas - through protection as natural reserve areas and using only for the facilities related to eco-tourism and recreational purposes. The shoreline of the Benghazi Metropolis, as like other parts of the region, is also characterized by sand dunes, sabkha formations and coastal lakes those of Garyounis and Al Kwefiya (See Figure 4.16).

The sabkhas typically are very shallow depressions that lie back from the shoreline, usually behind a barrier of sand dunes. When flooded with water, Sabkhas provide an important habitat for immigrating birds. The environmental risks especially generated by human activities should be eliminated and they should be protected as potential nature reserve sites for the sustainability of natural habitat, wildlife and biodiversity assets in the region (AlEmara, 2009; BSRR, 2009).

Figure 4.16. Sabkhas in Benghazi City (Source: independentarabia, 2017)

There are numerous crest lakes along the coastal zone of Benghazi plain. Some of them are totally closed by sand barriers, whilst some are connecting with the sea. Among the crest lakes found in the Benghazi Metropolis, Lakes of Budazera (Al Romal) and Ain Zaiyanah in north of the City are the largest and most important ones (See Figure 4.17). Ain Zaiyanah Lake is located 15 km northeast of Benghazi City. It is partially linked with the sea and serves as outlet of mixed water flowing from the south passing through Al Kwefiya to the sea. Its land area is 40 m2 and depth is 500 meters, whilst the ground basin is 4,200 m3, covering the northwestern slope of Al Jabal Al Akhdar. The water sources at Ain Zaiyanah consist of eight springs and represent the largest ground water drainage in the Benghazi plain (AlEmara, 2009; BSRR, 2009).

Figure 4.17. Ain Zaiyanah Lake (Source: independentarabia, 2017)

Ain Zaiyanah is a complicated cretaceous phenomenon, as from spring water flows from the shallow ground Miocene reservoir that passes through Banina and Sidi Mansour, and then saline water reach the sea in the opposite direction of Al Kwefiya area through deep horizontal canals. A horizontal canal (Almoraisi canal) with 7 meters diameter and 700 meters length has been discovered in the area. This canal is pouring into the Blue Lake and then to the sea. Its water is inclined to be saline and not good for consumption in the current situation. The Ain Zaiyanah is used for wastewater drainage of the surrounding settlements. Many geological and hydrogeological studies are made around the site of the spring to find a solution to improve water quality for any use (AlEmara, 2009; BSRR, 2009). In the Northern Lakes region, there are two lakes located 5 km north to the Benghazi City. They are linked with the sea through two channels.

4.3.7. Environmental Problems in the City of Benghazi

The Benghazi Metropolis, as a consequence of being the most populated, urbanized and industrialized settlement in Benghazi Region, has been inevitably faced with all types of environmental pollution (i.e. air pollution, solid waste pollution, water pollution, etc.).

In general, all the agricultural soil in the sub-region suffers from pollution generated by industrial activities and urban sprawl, besides the chemical pesticides used for combating pests, and chemical fertilizers used to increase the soil fertility and productivity (AlEmara, 2009; BSRR, 2009). The Benghazi Branch of General Corporation of Environment estimated the quantity of pesticides and chemical fertilizers imported by the local companies to the Benghazi Sub-region in 2005 is about 83,823 kg. Pesticides are considered a direct and an indirect source of underground water pollution. The direct pollution occurs due to spread of pesticides around the wells, or due to either their use in irrigation systems or bad storage procedures and conditions. The indirect pollution occurs when pesticides penetrate through the soil particles to the bottom and reach the underground water (AlEmara, 2009; BSRR, 2009).

Benghazi City is the biggest city in the local sub-region, and all cities in the sub-region are suffering from the solid waste collection and their transfer and removal. Increase in solid wastes as parallel to increases in population and consumption in the Benghazi City has become one of the serious problems in the recent years for public sanitation. In 2005, the city produced 350,365 tons of solid waste, not including refuse material of the buildings.

This production is equivalent to 1,000 Tons/day. In addition, the house solid waste in the city is 195,457 tons, which correspond to 56% the solid waste, not including the refuse material of the buildings. Table 4.12 shows the proportional distribution of solid waste of houses in Benghazi City, in which organic types of wastes constitute the majority with 54% in total (AlEmara, 2009; BSRR, 2009).

In Benghazi City, two methods are used in managing the solid wastes. The traditional technique consists of dumping of the wastes to open garbage sites, burning or burying of wastes, or filling the low-level lands with waste, whilst the modern technique represents the manufacturing the organic fertilizer.

In Benghazi City, noise concentrates in the crowded streets, in heavy residential and commercial areas, and inside the factories and industrial units lacking noise suppression devices. The air transportation is another source of noise pollution especially in residential areas close to airport in Banina.

4.3.8. The Threshold Analysis for the future urban developments

The process of analyzing the thresholds in the city of Benghazi included the topological analysis of the city and its outskirts and the areas to be protect from agricultural lands, green areas, natural protection areas and historical areas (See Figure 4.18).

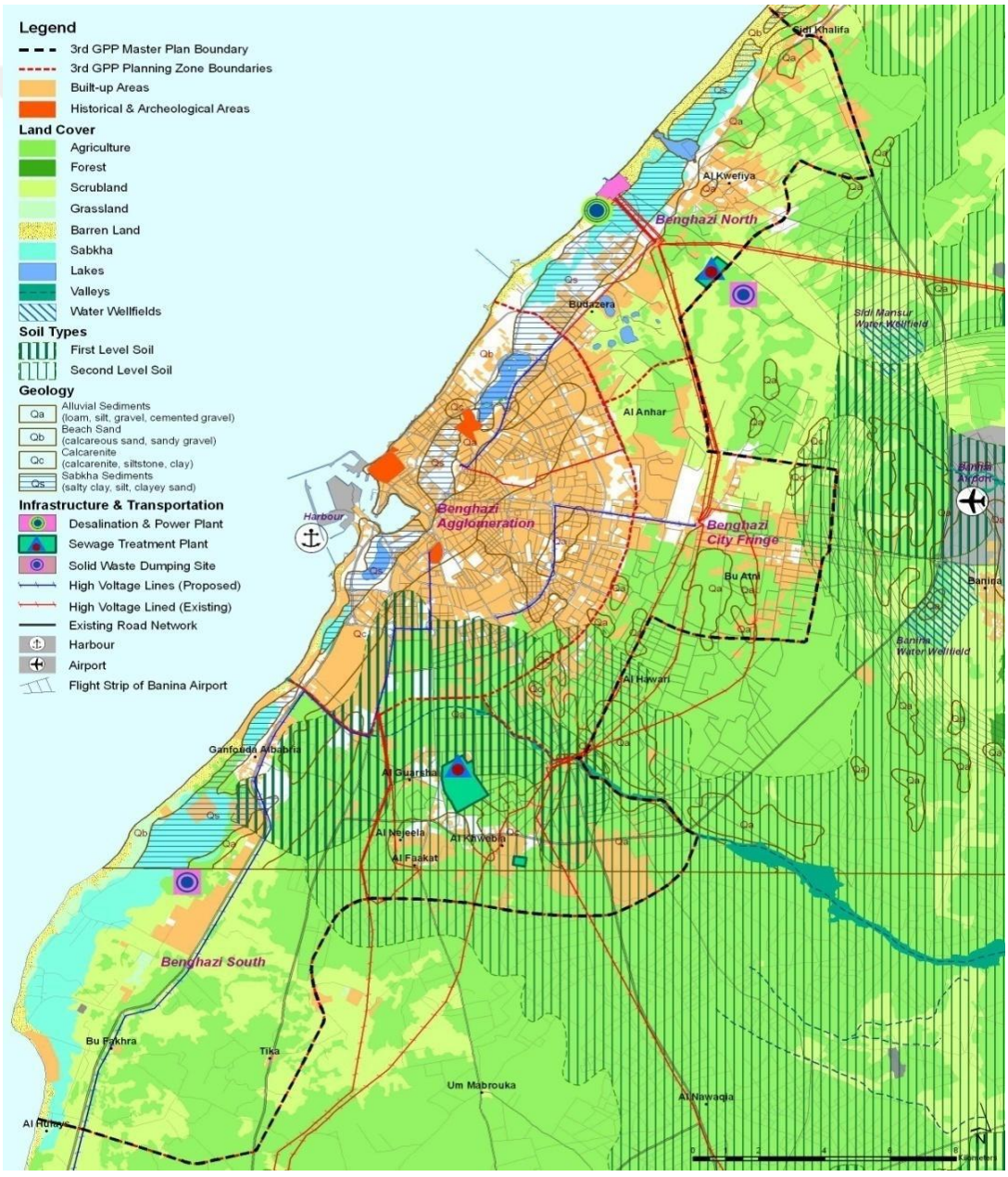


Figure 4.18. Synthesis analysis of environmental structure of Benghazi city (Source: Author)

The availability of water resources in Benghazi has a critical importance for the urban. The coastal zone of Benghazi is characterized by the belt of low sand dunes of a varying width. The coastal area at a distance of 100 meters from +/- 0 point of sea line is prohibited by the current laws for any construction, which may cause any change in the sea currents or cause any drift or precipitation in any adjacent area. The coastal zone offers opportunities for both recreational and relaxing activities (panoramic views to the sea, etc.) particularly in the downtown area. Where such locations are associated with wave less sea as in Juliana beach, they became an important source of recreation in summer (swimming and similar activities). In other locations, the coast is defined by the petrified sand dunes forming ridges reefs, as in front of the Old Core (Historic City). Outside the urban area, the long beach's offer good opportunities for daily recreation activities like picnic, camping and fishing by associated with other activities.

Water is obtained from underground supplies, from rainfall and from the sea through desalination and transported water by the MMR (Man-Made River). "Phreatic Aquifer" areas disperse as to cover Benghazi city, coastal zone and south of the city, whereas "Miocene Aquifer" areas disperse at eastern part of Banina. The water well fields at Banina and Sidi Mansur are the main underground water source supplying water to Benghazi City. As no permanent flows occur over the whole area, underground water sources in the Benghazi Metropolis have the vital importance. So, there is a need to define the protection zones for both the underground water sources and also water well field areas, in which the restrictions for spatial developments and construction rules are specifically defined in master plan process. Soils of the Benghazi Metropolis are characterized by rock soils existing in east of Benghazi City; and sand and marsh soils covering all the coastal areas. The fertile lands with very high soil ability are mostly available in southeastern part of the metropolis.

Benghazi Plain assumes an important portion of the region‟s fertile land valuable for agricultural purposes. Agricultural lands surround the City are especially concentrated in north-east and south directions. The settlements of Al Guarsha, Al Nejeela, Al Faakat and Bu Fakhra around the valley at south have agricultural character, where in addition to agriculture; mixed uses comprising residential, commerce and industrial activities have also been developed. The natural precipitate lands, namely "Hava" around Al Kwefiya, besides their agricultural significance, are the valuable lands in

terms of vegetation diversity and landscape characteristics enriching the natural environment.

The Green Belt designated in 2nd GPP and the surrounding area of the city have agricultural character. However, some areas in green belt especially in east and northeast of the city and some areas in Bu Atni and on Banina Road are partially occupied by low density-random developments comprising residential, commercial and warehouse type of uses. According to the current legislation and official policies, the fertile agricultural land -in principle- should not be converted to other uses. In this context, owing to the reason that Benghazi settlement is surrounded by agricultural area, it is appropriate to control the development areas and adapt a compact development instead of an expansive development in order to protect the agricultural land.

Protection areas defined by legislation to conserve the natural, historical and cultural values and nature protection areas, and special usage and infrastructure facilities, airports, flight strip, military zones, pipelines, energy transmission lines, railways, and highways also constitute the thresholds. Solid waste dumping sites, sewage water treatment plants, energy plants and similar establishments, which necessitate the buffer/protection belt, should also be considered according to their environmental impacts. Based on the assessment of thresholds, the development potentials of the Benghazi Metropolis are evaluated by three zones and explained in Chapter 8 under the Suitable Lands for Urban Development section.

CHAPTER V

5. METHODOLOGY AND DATA COLLECTION PROCESS OF THE STUDY

This chapter presents the research methodology used in this study. The research methodology is "the art of the proper organization of a series of multiple ideas and methods for the discovery of truth." The approach is the objective mechanism leading to truth, which, in its simplest definitions, is the path leading to the discovery of truth in science through a range of general facts that dominate the mind and determine its information processes (Antwi & Hamza, 2015; Suter, 2012). The right combination, good organization and discovery of ideas and information require considerable attention in choosing the appropriate approach. Those approaches vary according to different topics and phenomena. Each subject has its methodology based and depending on the course of the study. Therefore, this study relied on the analytical descriptive methodology including mixed quantitative and qualitative research approach, which is considered the most widely used method in social sciences (Amaratunga, Baldry, Sarshar, & Newton, 2002), and suitable for the subject of the study.

The main objective of this research is to explore the problem of environmental degradation resulting from urban sprawl, uncover the causes of this sprawl in Benghazi City and investigate the reasons for the increase in this sprawl during and after the war. The research also aims to find an appropriate solution to this problem using urban environmental resilience strategy for the city. There are no studies concerned with the planning and environmental problems in Benghazi during or after the war, and the problem is not covered in the literature. This study was designed to be an exploratory and comparative case study. The case study was conducted in the city of Benghazi, the second capital of the State of Libya.

In this chapter, the research approach and research questions are presented, discussing the tools and procedures for collecting primary and secondary data to answer these questions and reach the research objectives. The implementation of the case study in the city of Benghazi will be reviewed. Pilot and main group discussion works will be also reviewed.

5.1. Research Approach and The Case Study

This study aims to develop an environmentally resilient framework to cope with environmental degradation resulting from urban sprawl and the war in Benghazi. This research design is formulated to answer one main research question: (1) "**What is the environmentally resilient framework for the city of Benghazi to cope with the uncontrolled urban sprawl resulting from the war**?" and four sub-questions: (i) What is the concept of urban sprawl, and what are the reasons and consequence; (ii) how did the war affect the increase in urban sprawl, and how did this affect the increasing environmental vulnerability in the city; (iii) how does the environmental resilience strategy cope with the environmental vulnerability as part of the city's vision; and (iv) what are the action plan and projects sensitive to environmental resilience and capacity building to overcome future environmental vulnerability in Benghazi.

These questions were not answered or discussed in the literature and studies on Benghazi. Moreover, there is no study in the literature examining the relationship of war to the increased environmental vulnerability resulting from urban expansion. Consequently, this study intends to overcome the shortcomings of urban studies of Benghazi City regarding the problems of environmental vulnerability resulting from war and urban sprawl in general.

The study followed two main procedures to answer the research questions. First, an exploratory methodology for the case study of the city of Benghazi was implemented as a process to collect qualitative and quantitative data. A case study was conducted in Benghazi and its periphery. The city was chosen for the special circumstances, environmental and urban problems resulting from the civil war, and the lack of studies to address these problems. Moreover, the researcher's desire to present this study is to solve part of his city's problems.

Then, this study carried out both qualitative and quantitative mixed analysis processes. First, to explore the factors affecting urban expansion in the city, a content analysis was conducted on maps and reports. Then, to explore the extent of the spatial structure change, the increase in urban expansion, the decrease of green lands and the encroachment on the green belt, remote sensing analysis (spatial analysis) of the city's satellite imagery at multiple time periods was conducted.

A discriminant analysis on the results of remote sensing was conducted to show the prevalence, randomization and trends of urban sprawl in the city. Then, factors and contents were analyzed to measure the city's vulnerabilities that could be measured. To explore a future vision of the city and to find out what the action plan is according to the resilience strategy, a discussion group was formed and interviews were conducted. Results were analyzed using discussion, evaluation and comparison analysis techniques. Finally, to conduct the city's resilience action plan and define the procedures to be followed and prioritized, evaluation and SWOT analysis was used.

In this study, a mixed quantitative and qualitative research approach was used to achieve the research objectives. Qualitative research depends on the study, and reading of data and events in a non-quantitative manner. Data is not converted into numbers as in the case of quantitative research, but results are obtained from observation and analysis of events, situations, images, documents and verbal and nonverbal communication (J. K. Smith, 1983; Trend, 1978; Zikmund, 2000). In the approach, the research depends on the use of the inductive method, which is based on starting or thinking of the finished point of the studies, where the researcher starts from the data collected or observations that the researcher noted to reach certain results (Patton, 1987). This means that the hypotheses and theories emerge or derive from the data set during the data collection process and after the analysis. The researcher examines the data for descriptive purposes and the virtual relations between the phenomena, and then returns to the study community or place it to collect the data to test the proposed hypotheses (Morse & Field, 1995).

Qualitative research is used when there is limited or simple knowledge of a particular field or subject, and when the researcher doubts the knowledge available in this field or the theories available about it, or that these theories are seen by the researcher as biased. It is used also when the research question is directed or seeks to understand or

describe a particular phenomenon or event, when the researcher does not know much about it or has limited knowledge (Denyer & Tranfield, 2006; Hoepfl, 1997). In this perspective, a large part of exploratory research is a kind of qualitative research. Exploratory research is used when there is insufficient information about the phenomenon or the problem in question, especially in the absence of previous studies on the problem under investigation (Elliott & Timulak, 2005).

In contrast to qualitative research, quantitative research looks at the causes and facts and the relationships between variables from a perspective, so that broader and more comprehensive relationships between these variables can be explained and accurate predictions can be made about the phenomenon or phenomena under study (Osborne, 1977). Unlike qualitative research, quantitative research aims to test experimental variables, while controlling or adjusting the intercept variables that appear in the context of the study. Thus, relationships between variables can be generalized and predicted in similar fields or research communities (Morse & Field, 1995).

Quantitative research aims to test theories and researchers work here in a deductively way. This is done by identifying the theory that already exists in the previous literature and acquiring the necessary concepts and definitions. The relationships between the variables are assumed, and the data are collected and analyzed statistically. In the light of the results obtained by the researcher, hypotheses are accepted or rejected, and then the theory is accepted, rejected or modified. In the context of quantitative research, the study is designed (hypothesis development, description of variables, method of measurement, etc.) while preparing a draft study and before starting data collection, unlike in qualitative research (Ritchie, 2003; Yilmaz, 2013).

Quantitative research is used when there is available knowledge about the subject that the researcher wishes to study. The fact that there are specific theories and literature available to the researcher unlike in qualitative research, or that the degree of clarity of the phenomenon or problem under study enables the researcher to use the quantitative input in the research. This is in addition to the availability of fixed and statistically valid measures for the variables to be studied (Morse & Field, 1995).

The mixed qualitative and quantitative approach can be used to search for and to identify the problem at the same time. This method is known as triangulation. In this context, it is intended to study a single phenomenon in more ways. Here, the qualitative

approach is used to describe the sentimental aspect in the field under study. The quantitative approach is used to measure other variables. For example, the survey may include closed questions and open questions. Closed question data is analyzed quantitatively, while open question data is analyzed qualitatively. This will allow more freedom for correspondents to give their answers than the use of a closed-ended survey or specific choices (Tashakkori, Teddlie, & Teddlie, 1998). The use of this mixing of the two approaches shows the benefits of both quantitative and qualitative approaches together, and gives flexibility to the researcher in the compilation and analysis of data (Guetterman, Fetters, & Creswell, 2015).

It was impossible to collect data on urban sprawl and environmental vulnerabilities in Benghazi City after the war by just using quantitative data collection techniques due to the lack of registered data under the war circumstances. Therefore, the study aimed to benefit from qualitative data produced by the stakeholders of the city collaboratively in group discussion and interviews, and the quantitative data from satellite images and remote sensing analysis by applying a mixed research method. After the analysis process of those two groups of data, the analyzed data was synthesized in order to develop a framework for the environmentally resilient Benghazi to cope with urban sprawl.

5.2. Case Study Research Approach

This study is based on a case study of Benghazi City. The case study is expected to reflect the complexity of one case being investigated in its natural context with many ways, and the methodology that has enabled this has been developed in the field of social sciences. This methodology is applied not only in social sciences, such as psychology, sociology, anthropology and economics, but also in practical-oriented areas such as environmental studies, social work, education and business studies (Johansson, 2007). Researchers in the case study emphasize different features. Robert Stake (1998) points out that research in the case study does not represent the methods of investigation. Rather, the subject of the study is the case (R. Stake, 1998; R. E. Stake, 1995).

As a form of research, the case study is defined by the attention directed to individual cases, not by the means of investigation used. Other researchers, such as Robert Yin (1994), focus more on the method and techniques that make up a case study (Yin

Robert, 1994). One of the main features of the case study methodology is the combination of different methods and the purpose of illuminating a situation from different angles. The triangulation approach is used by combining quantitative and qualitative methodologies (Groat & Wang, 2013).

Groat and Wang (2013) explains the relationships between the methodologies, as shown in a diagram, by saying that those close to each other have more similarities than those that are far from each other. Qualitative and interpretive research is involved in a holistic approach to research, but with different time perspectives. Interrelated research, on the other hand, shares with qualitative research a focus on conditions that occur naturally, but they rely on quantitative data. The experiment also depends on the quantitative data, but only if the researcher can handle the isolated variables. Similarly, simulation requires control and manipulation. The logical argument - which includes, for example, space analysis in space - is shared in simulation in abstraction. Theoretical historical research depends on the logic of interpretation.

In this regard, it can be said that the case study is descriptive. The location of the case study in the middle of the diagram is not intended to be more important than other methodologies. However, case studies in practical research, such as engineering and planning, are of particular importance. The ability to act within the framework of professional practice is based on the knowledge of a range of situations. These cases are based on personal experience or model cases established within the profession. Case studies contribute to building a professional reference. The work of the designer relies on comparisons between the known cases of the reference and the actual design position (Schön, 1991).

The case can be deliberately chosen by virtue of being, for example, informative, critical, revolutionary, unique, or extreme (as opposed to the selected cases within a representative sample strategy used in conjunction research) (Patton, 1990; R. E. Stake, 1995). If a case is deliberately chosen, there is an interest in circulating the results. Generalizations of cases are not statistical, they are analytical. It is based on logic. There are three principles of thinking: deductive, inductive and vocal. Generalizations can be made of a case using one of these principles or a combination of them. When the generalization is based on the principle of induction, the procedure is similar to an experiment: a hypothesis is developed, and the testable results are

drawn by conclusion. By comparing the expected results, derived from theory and case, with empirical results, it is possible to verify or falsify the theory (Johansson, 2007).

The case study in Benghazi City was chosen to conduct in-depth and comprehensive investigations and take multiple perspectives on the research problem (see Figure 5.1). The case study in the present research is a comprehensive study in all dimensions of the urban city to solve the problem of environmental vulnerability resulting from urban sprawl during and after the civil war in the city between 2011 and 2017. The case study in Benghazi was to understand and evaluate the pre-war situation, and uncover variables, problems, vulnerabilities and causes after the war.

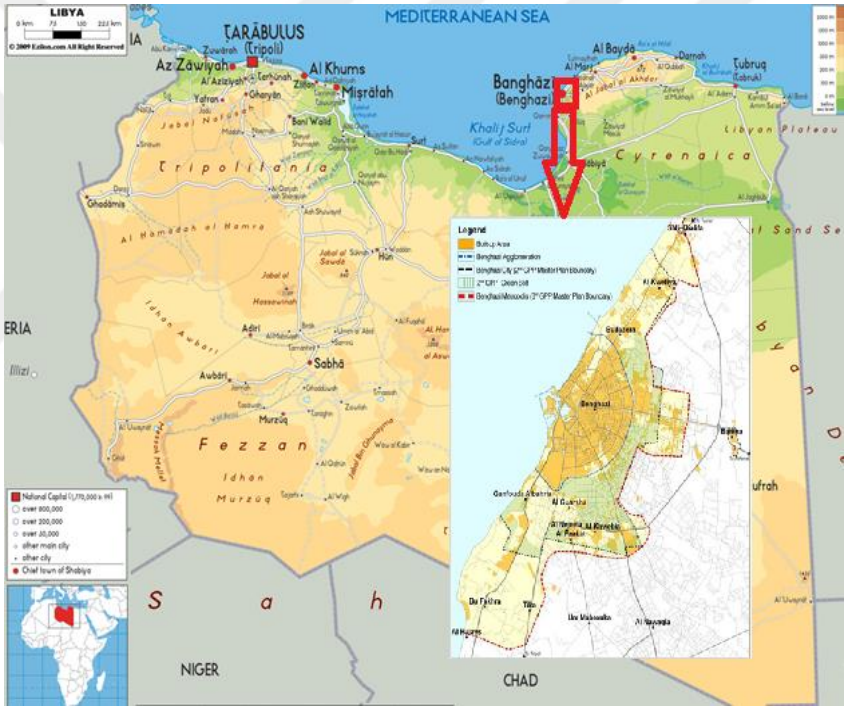


Figure 5.1. Study area of Benghazi City (Source: Author)

The type of case study in the present research is an exploratory and descriptive study that included data collection and field work, and included studies and comparisons to develop a visualization of the city's situation in the event of no war. In the literature on urban sprawl, there is a lack of empirical evidence for the relationship between environmental vulnerability resulting from urban sprawl and civil war. The current research attempts to overcome this lack of literature, and explore the causes and relationships regarding environmental vulnerability and urban sprawl in Benghazi during the war. The case study is designed to meet this goal. Since the case was studied,

explored and compared to the city before the war, after the war and at war, multiple case study was chosen.

5.3. Data Collection Procedures and Data Source

Primary and secondary data were collected and analyzed in the Benghazi case study. Secondary data were divided into qualitative and quantitative data. These data included newspapers, published censuses or other statistical data, data archives, research articles by other researchers, government reports, reports of sub-regional and urban plans for the city of Benghazi, as well as technical reports on the economy, health and education in the city. There are also a few scientific articles published about the city and the Libyan state to study some urban aspects.

All these secondary data were reviewed according to their classification, whether it was qualitative or quantitative data. Qualitative data were collected and analyzed with document review techniques and monitoring methods. The quantitative data contained in the secondary data were collected and analyzed using assessment, comparison, triangulation or convergence techniques.

These data were collected between the years 2015 and 2019. They were compiled using either reports, books or CDs, with most of them being brought from Libya, and review articles from scientific journals in the digital library of Çankaya University. The fact that there was limited data on the city was an obstacle especially for the period after the war, and made it difficult to obtain reliable data. In general, the data obtained were sufficient to reach a basic basis for understanding the causes and stages of the problem of urbanization.

The primary data in Benghazi case study included a combination of methods of collection and analysis. The first technique was the collection spatial data at variable times using satellite images and the analysis of them using spatial analysis methods. These methods included remote sensing and Chi square technique to determine the degree of freedom of urban areas in the city, and predict the expansion trends using the technique of urban growth index.

A discussion group of experts from Benghazi and other Libyan cities and participants from Turkey who participated in the urban planning project in Benghazi in 2009 was also used as another primary data source. The two discussion sessions took place in

Ankara, Turkey. The first session took place on February 21, 2019 and the second was on May 14, 2019 with the same number of participants. The resulting data were analyzed by evaluation, discussion and comparison analysis techniques. Primary data were collected on the causes of expansion and how to reduce it, the possibility of using resilience strategies in the city and how to apply and see the participants in the future of the city and how to reach it.

Any data that could be useful were recorded comprehensively, accurately and systematically, using field observations, drawings, audio tapes, photographs and other methods described in the methodology chapter.

5.3.1. Secondary Data Collection Process

Visual experiments included the presentation and analysis of satellite images and the application of remote sensing methods. These images were analyzed to obtain the information of urban growth and urban sprawl and to track the extent of incursion into the green lands and the environment around Benghazi City. The scope of map production was to generate reference content to the pre-event situation and a damage assessment after the violent conflict between the parties in Libya. The conflict started in 2011, turned into a war in May 2014, and is still ongoing.

The collected data were used to conduct the urban growth and urban sprawl analysis. All data were collected between March 2018 and December 2018. Objective image analysis (OBIA) was used to identify the built-up area based on Landsat 4-5 TM, Landsat 7 ETM+, Landsat 8 OLI/TIRS and Global Land Survey data with a spatial resolution of 30 m. High resolution imagery data (< 5m) from Google Earth (2005 and 2016) and Sentinel-2 imagery (10m) for 2018 were used to provide appropriate reference information to validate the built-up classification techniques over the area of interest. For the year 2004, a visual comparison with available Land sat data has been conducted.

All satellite images have been radiometrically enhanced and georeferenced. All satellite images have also been atmospherically and geometrically corrected. The estimated thematic accuracy of this production is 94% or better, as it is based on OBIA approach with fuzzy rule sets and ERDAS Imagine techniques (Blaschke, 2010; Hussain, Chen, Cheng, Wei, & Stanley, 2013). The focus and the analysis were only confined to the area enclosed by the area of interest.

The data used in this analysis contains different types of satellite images. Those image layers include:

1. LANDSAT 4-5 TM – U.S. Geological Survey (2004), (acquired on 14/12/2018, GSD 30m, approximately 0% cloud coverage)
2. LANDSAT 7 ETM+ – U.S. Geological Survey (2010), (acquired on 14/12/2018, GSD 30m, approximately 0% cloud coverage)
3. LANDSAT 8 OLI/TIRS – U.S. Geological Survey (2018), (acquired on 15/12/2018, GSD 30m, approximately 0% cloud coverage)

And contain Raster layer including urban sprawl object-based image analysis results for 2004, 2008, 2010 and 2018. All data sources are complete and with no gaps.

Many techniques were used to analyze the data generated from remote sensing of satellite imagery. The analysis techniques used in this study are listed as follows:

5.3.1.1. Eight regions technique

This technique is based on the analysis of the urban area by dividing it into eight regions according to the known geographical trends (Figure 5.2). The data from satellite imagery was used in the analysis, and classification and remote sensing process was used. The classification method under supervision was used to create a Maximum Likelihood Classification. This method is one of the most widely used methods for classifying satellite imagery for its accuracy and ease of use (Aburas, Abdullah, Ramli, & Ash'aari, 2015; Al-Sharif, Pradhan, Shafri, & Mansor, 2014).

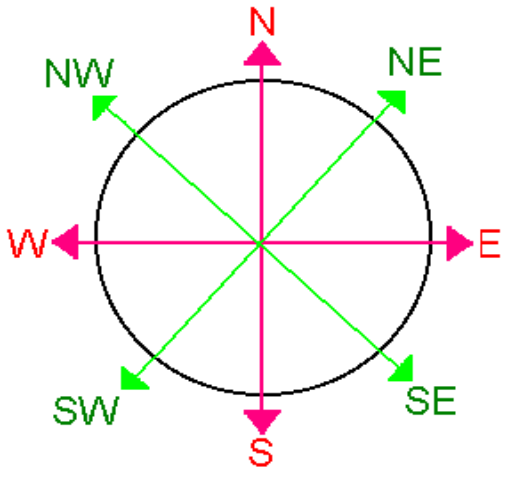


Figure 5.2. An eight regions according to the geographical trends (Source: Generated by Author)

The study area was classified into two categories of land use, urban and non-urban, in order to serve the objectives of the study in analyzing the patterns of urban growth. Urban areas include residential, commercial, service, industrial and road areas, while non-urban areas include lakes, water, agricultural areas, forests, rural areas and open areas. The analysis of the results enables researcher to reach at the urban growth trends and its extent of expansion in multiple periods of time, which are then compared to extract the final results.

5.3.1.2. Pearson's chi-square

It is a set of tests based on a series of assumptions, and is often used in the statistical analysis of experimental data. It is commonly used to test relationships between categorical variables (Bolboacă, Jäntschi, Sestraş, Sestraş, & Pamfil, 2011). It has been used in many studies related to planning works and comparisons of urban expansion and population growth, including measuring the degree of freedom of urban growth of the study area in different directions and time periods equation (Ren, Gan, Yuan, Zong, & Xie, 2013).

$$x_i^2 = \sum_{i=1}^{m} \frac{(m_j - m_j^E)^2}{m_j^E}$$

Where: x_i^2 shows the degree of freedom of i-th temporal span,
mj shows observed growth of built-up area in j-th column, and
m_j^E shows expected growth of built-up area in j-th column.

The degree of freedom coefficient is an indicator of the amount of random development in urban areas and their rapid spread. Where the degree of freedom increases, the region is considered to be undergoing a rapid urban development. A higher degree of freedom for an area is a warning of unbalanced growth within the region as time changes. This means that the region needs planning consistency, managing and monitoring of urban growth (Al-Sharif et al., 2014).

5.3.1.3. Urban Expansion Intensity Index

This index was used to quantify and analyze differences in urban spatial expansion. Furthermore, UEII can be used to identify the preference for urban growth in a given period. It reflects the potential future direction and potential of urban expansions, and

compares the speed or intensity of change in urban land use at different time periods. The UEII standard is divided as follows: 0 to 0.28 is slow development; 0.28 to 0.59 is low-speed development; 0.59-1.05 is medium-speed development; 1.05-1.92 is high-speed development; and >1.92 is very high-speed development. It is calculated with the following equation (Ren et al., 2013):

$$UEI_{it} = [\ (ULA_{i,b} - ULA_{i,a})/t]\ /TLA_i * 100.$$

Where, UEI_{it} shows the annual average expansion intensity index of i-th spatial direction during the specific time t; $ULA_{i,a}$ and $ULA_{i,b}$ show the starting and ending the built-up area of i-th spatial direction; TLA_i show the total land area of i-th spatial direction.

The findings of this secondary data analysis will be discussed in Chapter 7.

5.3.2. Primary Data Collection Process

In this part, the primary data process method of collection and analysis will be reviewed

5.3.2.1. Group discussion

The group discussion method of primary data collection was used to uncover the strengths, weaknesses, opportunities and threats, and to define a set of goals to reach a resilient vision of the city in order to face urban sprawl and its consequences of environmental vulnerability.

The limitation of this search appears in that collected data represents the view of a specific group, not the entire population. Therefore, some groups (urban planners, politicians, academics, administrators, decision-makers and city opinion leaders) are overrepresented. The selection itself is biased that there may be sampling errors. This means that the results cannot be generalized.

To ensure access to the required information, the researcher followed effective strategies of design of the workshop questions, in order to increase the rate of response. The questions of the workshop were designed to be short, obvious, and plain as much as possible, and were well-coordinated. The workshop questions were designed based on the theoretical framework and aim of the study. The workshop's questions were

divided into five main parts. The first part included positive and negative factors globally and locally, which affect Benghazi City and its development. The second part of the questions focused on knowledge of the strength and weaknesses in the city, the planning problems and problems causing urban sprawl as well as the solutions proposed and agreed by participants in the workshop for these problems. The third part discussed the participants' future visions of the city considering their strengths and weaknesses. This section ended with agreement and the adoption of a future vision for the city which was approved by all participants. The fourth part discussed how to implement this vision; what strategies and projects should be implemented; how to implement them according to resilience thinking to deal with the problem of urban sprawl; and how to prioritize these projects and explain their time period for implementation.

5.3.2.2. Participants' Profile

It is very important to identify a research group that reflects the real picture of the study. Since this research focuses on coping with and controlling of urban sprawl problem, the appropriate professions were determined to be planners, architects, decision makers and opinion leaders. Therefore, the correspondents of this study are comprised of these professionals who are dealing with the urban planning issues, including consultancy firms in both governmental and private sectors.

As the group discussion was aimed at the Libyan urban planning problems and their relations to all city dimensions, the first step was to contact practitioners and planners familiar with the planning problems in the city as well as decision-makers and opinion leaders, who are influencing the planning and future of the city. The current political situation of Libya, which led to the existence of two separate governments and the deterioration of the security situation, has limited the responses of only to the Libyans in Turkey and the participation of only some individuals from the city of Benghazi through the Skype group chat program. The participatory was composed of professionals who were volunteered to engage in the workshop.

Among the planners, decision-makers, opinion leaders and academics contacted, only a few had agreed to participate. In total, nine participants, who played important roles in the development plans and programs of the state and involved in the design works of major projects, agreed to attend the workshop and provided their assistance to enrich

the discussion in the group discussion. Those participants were (detailed information about participants are in Appendix A):

1. Saad Qizziri, city planner and decision maker
2. K.Taylan Dericioglu, planner
3. Adem Tunca, planner and GIS technician
4. Omar Al Ameen, urban planner.
5. Mohamed Akreem, municipality member
6. Nidal Fathi, urban planner.
7. Hosam Dwela, decision maker
8. Mansour Bartouh, environmental studies.
9. Mahmoud Soliman, natural and climatic planner.

These local stakeholders were considered to be appropriate for this primary data collection method as they had practical experience in the urban planning sector and influence decision-making in the city of Benghazi.

Prior to the final group discussion, a pilot focus group discussion was conducted to test the comprehensiveness and relevance of the questions as well as to ascertain whether the questions and their responses were clear and feasible or not, and to avoid any ambiguous words and sentences. A group consisting of five individuals of different specialities was adopted as a sample for conducting the pilot group discussion. Therefore, group discussion was conducted with the participating members of the fields related to planning and decision-making in the city of Benghazi on the date of 21.02.2019. Based on feedbacks from the pilot study, the questions of the final group discussion were finalized.

After making the necessary modifications to the group discussion questions, based on the observations received from the pilot group discussion, some questions emerged in the pilot group discussion were modified due to the participants' lack of understanding. The list of the twelve final questions was finally as below:

1. In your opinion, what are the barriers and opportunities (positive and negative factors) that affect working together for Benghazi?
2. In your opinion, what are the positive and negative developments in the WORLD, political or economic, that influence Benghazi City?

3. In your opinion, what are the positive and negative developments in LIBYA, political or economic, that influence Benghazi City?
4. What are the weaknesses of the city now and in future?
5. What are the strengths of the city now and in future?
6. In your opinion, what are the vulnerabilities and planning-related problems in the city of Benghazi now and in future?
7. In your opinion, what are the problems associated with urban sprawl?
8. In your opinion, what are the suggested solutions to these problems?
9. In your opinion, what is your vision for Benghazi City within its strengths and weaknesses?
10. In your opinion, what are the strategies and projects that should be developed to achieve this vision?
11. Which of those projects can be evaluated as a resilience strategy for the city to face the threat of urban sprawl? Who are the decision makers and stockholders for each project?
12. In your opinion, what is the TOP FIVE prior strategies and projects that should be started immediately, and when they should start for the environmentally resilient Benghazi?

The group discussion was initiated on Saturday, 04.05.2019 by introducing the participants to each other in order to create a spirit of rapprochement. This contributed to enriching the discussions on the questions posed. The discussion process was asked by the researcher on each participant and the answers were recorded to the wall panel. After all the answers were compiled, a discussion was held on how to crystallize the common and agreed answer by all participants to a given question. The answer was clearly written for approval by all.

This strategy was implemented on all twelve questions. After the completion of the analysis of the answers and discussions, the results were compiled by the researcher; placed in the tables; shared with the participants in the group discussion via e-mail; and their comments or any objection regarding the final results agreed upon were requested.

5.3.2.3. Expert Interviews

Personal in-depth interviews were subsequently conducted with Dr. Taylan Dericioglu, Dr. Saad Qizziri and Dr. Mansour Al Babour. Professor Qizziri and Professor Mansour were interviewed on Skype on July 23 and 24, 2019, and the interview with Professor Dericioglu was made on July 27, 2019. These interviews were to present the results of

the discussion groups, and asked about their opinion on the results of the twelve questions from the discussion group, and each question was commented on separately. They were asked about the SWOT analysis of the city, their opinions on the proposed city vision, and on the steps of the action plan and proposed projects. They were asked about their opinions regarding the environmental resiliency of this plan and its efficiency in facing urban sprawl. The interviews aimed at this stage to examine and validate the results of the discussion group. Their comments were collected and analyzed within the results of the primary data collection that will be discussed in detail in the next chapters.

5.3.2.4. SWOT Analysis Process

SWOT Analysis is an analysis method used to assess strengths, weaknesses, opportunities and threats involved in an organization, plan or project. It is divided into external and internal factors. Internal factors are the strength and weakness points in the city, and indicate the extent of the city's ability to reach a specific goal and the amount of weakness it has, which opposes reaching the goal. As for the external factors, they are opportunities and threats, which the city may benefit from in reaching its goals, and threats are factors that threaten reaching this end. (Gürel & Tat, 2017). Knowing all these points for a city or region is a good basis for formulating strategies and action plans. This technique is one of the popular methods in the management sectors of government and private institutions. SWOT analysis is widely used for short, medium and long-term planning, as well as in strategies for developing new projects and plans. This analysis is based on looking for opportunities and looking at the climate in which a given plan exists. For this reason, a table, often known as the Swot Matrix, is created and helps raise issues related to the institutional context, which must be considered while making substantive decisions in the future plan. Additionally, using this analysis also helps improve monitoring and follow-up (Pickton & Wright, 1998; Valentin, 2001). The advantage of this methodology is that it is used to address a variety of issues simultaneously, making it a desirable method to support fruitful discussions and decision-making. However, the method’s disadvantages, such as the subjective analysis of issues, make it less desirable for some decision makers and planners. (Valentin, 2001).

SWOT analysis was used in this research to assess the strengths, weaknesses, opportunities and threats of Benghazi in general, focusing on the assessment of the

environmental dimension and its risks. Understanding all these attributes of the Benghazi City and its environmental and spatial dimension is a valid basis for formulating strategies and action plans to achieve the vision of an environmentally resilient city.

Primary data from discussion groups and interviews were used in SWOT analyses. The aim of the SWOT analysis was to reach an environmentally resilient vision based on an assessment of Benghazi's strengths, weaknesses, opportunities and threats. The analyses linked the problem of urban sprawl to the environmental degradation resulting from it and from the war, with all the steps of assessing the city, until a comprehensive framework for urban sprawl and environmental resilience is formulated.

Table 5.1 displays the research questions, data type and study analytical procedures that have been discussed above.

Table 5.1. The research questions, data type and analytical procedures (Source: Author)

RESEARCH QUESTIONS	DATA GATHERING	DATA ANALYSIS
What is the concept of urban sprawl and what are the reasons and consequences?	• Reports • Maps	• Document analysis • Spatial analysis (Remote sensing)
How did the war affect the increase in urban sprawl, and how did this affect the increasing environmental vulnerability in the city?	• Reports • Maps • Satellite images	• Spatial analysis (Remote sensing) • Eight regions technique • Pearson's chi-square • Urban Expansion Intensity Index
How is the environmental resilience strategy cope with the environmental vulnerability as part of the city's vision?	• Reports • Maps • Satellite images • Group Discussions	• Swot analysis and • Synthesis of the outcomes of analysis
What are the action plan and projects sensitive to environmental resilience and capacity building to overcome future environmental vulnerability in Benghazi?	• Reports • Maps • Satellite images • Group Discussions • Expert Interviews	• Synthesis of the outcomes of analysis

CHAPTER VI

6. SECONDARY DATA ANALYSIS PROCESS AND FINDINGS OF VISUAL EXPERIMENTS: URBAN SPRAWL AND ENVIRONMENTAL VULNERABILITIES IN BENGHAZI BEFORE AND AFTER THE WAR

This chapter will present the analysis of the secondary data that collected through the remote sensing of the satellite images and the review of literature

6.1. Document Analysis Process and its Findings

Secondary data were collected from satellite images and remote sensing, and from reviewed literature in the second and the third chapters. These data contain a set of keywords including “urban sprawl” and “resilience”. The second chapter focuses on the urban sprawl problem in cities, and discusses the dimensions and definition of urban sprawl concept, with its roots and theories. The chapter also discusses spatial types and measurement of urban sprawl, its causes and consequences. The chapter reviews the impact of urban sprawl on citizens and cities; the environmental impacts of urban sprawl, rehabilitation and policy actions to control urban sprawl; and lastly, the worldwide examples of urban sprawl and the lessons learned. The third chapter deals with resilience, and reviews the previous studies and research related to resilience in terms of the concept of resilience and urban resilience, the dimensions and framework of urban resilience, measuring urban resilience, environmental resilience and its concept, urban system vulnerabilities and its indicators, vulnerability reduction, adaptive capacity building, and urban resilience building examples.

After the review and analysis of previous studies on urban sprawl, it turned out to be a phenomenon associated with urban growth in many cities. It is a negative phenomenon in developing cities, according to several researches. It increases urban city problems, reduces resources, destroys open spaces and increases traffic. Urban sprawl is often associated with poor land-use planning, poor economic performance

and instability in the political system. The forms and patterns of urban expansion in the cities of developing countries differ from those in the cities of developed countries. Most case studies focused on urban sprawl and land use change in the developed country cities. There are few studies that have examined the problem in the cities in developing countries. After reviewing theories of urban growth, it became clear that external economic and political forces are essential in shaping urban areas. Studies have shown that wars and conflicts have been instrumental in shaping urban areas in the 20th century.

The research concluded from the previous studies that the most common approach in the studies analyzed to determine the basis of urban sprawl was to focus on dynamic aspects, understand the process and monitor land-use change using scenarios and remote sensing techniques. Most studies have found that urban sprawl is a low-density extension in rural or agricultural areas adjacent to cities accompanied by a lack of basic urban services and facilities. They acknowledged that all these increase uncertainty in those areas and exacerbates their vulnerability. It is difficult to know the nature of land use and the future direction of development. This creates difficulties in following the planning process. This research adopts the definition of sprawl that increases uncertainty, and focuses on it as a negative phenomenon affecting the city, agricultural lands and open spaces surrounding the city. Uncontrolled sprawl and increased uncertainty create difficulties in following up the planning process, producing comprehensive growth plans for the city, and anticipating the trends in its development.

As some researchers have mentioned, urban development in Libya, as in many African countries, occurred without industrialization. Previous theories may help explain and simplify the understanding of the structure of the Libyan urban system as well as illustrating how Libyan urban development has evolved. In practice, the above theories do not apply to the future development of Libya, where dependency theory promoted geographical disparities between urban centers as well as disregard rural areas. On the other hand, the urban bias theory depends on changing the process of development to a political perspective from an economic one. From this concept, it seems that the country was not formed and was not guided by any of the earlier theories in the interpretation of urban development in Libya. This because the country was closely

linked to the production of natural resources, such as agriculture and oil, rather than relying on manufacturing and economic development.

The previous discussion shows a great variation in the way sprawl is perceived and analyzed in recent researches. Moreover, the level of analysis and methodologies used for the sprawl also differ significantly across the studies reviewed, which confuses efforts to summarize what has been learned from urban sprawl research. This study handles these divergences by limiting the study to the outcomes of environmental impacts occurring because of sprawl, according to the three main types of urban patterns that can be identified for any monocentric or polycentric urban region, namely; linear development, peripheral accretion, and leap-frog development. These forms of urban sprawl can be seen in the city of Benghazi, its periphery and main roads. However, the situation of urban sprawl in the African countries is different from the situation in the developed countries, and also varies from one country to another as it is affected by changing the causes and effects.

Some studies have suggested political interventions that can help control urban sprawl and environmental degradation. These interventions are zoning and land-use controls that promote multiple use and decentralization, and multiple nodal cities. Many politicians, planners and academics have an idea that governments should try to organize and control the development of the urban form to avoid the outcomes of urban sprawl. Some countries such as the ones in North America and many European countries have used containment policies, tools and plans aimed at curbing urban growth. This was through land-use regulations that restrict or prevent urban sprawl in some urban or peri-urban areas, and direct development to specific areas. These measures are often found in the form of limits to urban growth, various forms of zoning and protection of green belts.

Several studies have been conducted in developing countries in response to the dramatic increase in urban sprawl, to find out how to eliminate or mitigate the effects of this phenomenon. These policies address the problems that aggravate urban sprawl such as delayed implementation of legal housing, high rental costs, and delays in the provision of legal land supplies. It is also stated that there are political and legal failures that appear in the absence of government measures to control and arrange open spaces, such as; the absence of a law enforcement body to regulate and monitor the emergence

of the illegal construction of houses; and the lack of legal responses to the continued emergence of the squatting phenomenon; and land sales by land speculators and legislation.

Chapter 3 on the review of studies on resilience, urban and environmental resilience includes all studies and topics on the definitions and concepts of resilience, and on how to measure the resilience of the system to withstand any threat or problem. The chapter also explored strategies for environmental resilience and the benefits it may add to urban planning to make it more resilient. The reviews included the vulnerabilities of the urban system and its indicators that were analyzed and used in the literature. Finally, some examples of building resilience and how to implement their strategies were reviewed.

By reviewing the literature on the definitions of different elasticities, it is found that most research has defined it as the ability of an element or entity to deal with a certain stress, and absorb the shock resulting from this stress. This research adopted the definition of the resilient city that can resist shocks, rebuild itself and maintain its function and structure during and after the process of disturbances. The five factors to make a city resilient are; understanding and anticipating (planning for) risk and uncertainty; preventing the impacts of risk that can be anticipated (as disasters and conflicts); resisting those that cannot be anticipated (such as earthquake, war); recovering fast and well; and learning and adopting.

Traditional planning attempts to minimize disturbances, and reduce the risk and negative effects of possible disturbances, while urban resilience planning extends the remit of planning to include disturbances as an integral part of planning process, and suggests a shift in priority from those that aspire to “control” the change to those that increase the “capacity” of the urban system to cope with, adopt to, and shape change by accepting the fact that changes are going to take place. The essence of the resilience planning model with respect to three dynamic assets of urban systems are: adaptive capacity, self-organization and transformability, rather than characteristics connected to the steady-state condition. A review of resilience studies shows that adaptation is essential in resilience, and how to adapt to changing circumstances and take advantage of new opportunities and then change should be understood and accepted. Adaptive capacity aims to equip urban systems to deal effectively with slow and radical changes.

Building adaptive capacity and resilience is enhanced by building the capacity to achieve a desirable state when the city is under pressure. The enhancement of adaptive capacity is a necessary condition for reducing vulnerability. Self-organization, which is a process of internal organization within a system without guidance or management by an outside source, establishes the arena for evolutionary change that may, in some cases, evolve to increase vulnerability.

In reviewing the previous studies on the concept of resilience strategy, it was concluded that resilience strategy is an intermediary step between the strategic plan which targets the near future and longer-term strategic plans. Resilience strategy helps define new projects with longer-term results and clear benefits aimed at diminishing the city's vulnerabilities while increasing its resilience. It is an approach that helps link social and economic processes with ecological processes, calling for a reconsideration of the "substance" of planning so as to enhance capacity to deal with slow and sudden changes of different forms.

Resilience planning needs to be based on systems analysis, which enables to define the points and issues of vulnerability of urban systems and to be focused on key issues, which are the ones related to the adaptive and transformative capacities of urban areas in terms of determining strengths and weaknesses in the context of opportunities and threats (SWOT analysis). Strategic planning is to handle city future when the future itself appears to be more and more uncertain; it is the same idea of resilience thinking. Strategic planning is used here to direct the activities of others (different authorities, different sectors, private actors), which is the same in resilience planning approach. From the anticipated explanations based on the books and references, reviews and the study of examples of building resilience in some of the cities of the world mentioned in Chapter 3, there are agreed-upon steps that the cities should follow to be resilient (see Table 6.1):

Table 6.1. Steps to build resilience for cities (adopted from (Gober, 2018; Nickson et al., 2011)

1.	Understand the future of the city (Summarize natural and man-made disasters that are likely to occur)
2.	Understand and control the impact of disasters in their forms (Cover all expected impacts of potential environmental and climatic changes)
3.	Evaluation of impact on city dimensions (environment - infrastructure - resources - social dimension economic dimension)
4.	Implementing the strategy (Providing a roadmap to resilience with list of key actions-action plan.)

6.1.1. Understanding Urban sprawl Problem in Benghazi Before War

6.1.1.1. Urban Sprawl in Benghazi Before War

In Libyan context, random settlements appear in many cities, especially large cities such as Benghazi, Tripoli and Misrata. This phenomenon is manifested in frequent violations of public and private land, mostly arable lands, mainly in the absence of government institutions. After the independence of Libya and the discovery of oil in the 1950s, development activities started from industrial complexes and commercial areas in the big cities of the country, reinforcing the theory of urban bias. As a result of these activities, a large number of Libyans moved from rural areas to major cities such as Benghazi and Tripoli. These transitions formed the so-called shanty areas on the outskirts of these cities (Omar & Ruddock, 2001).

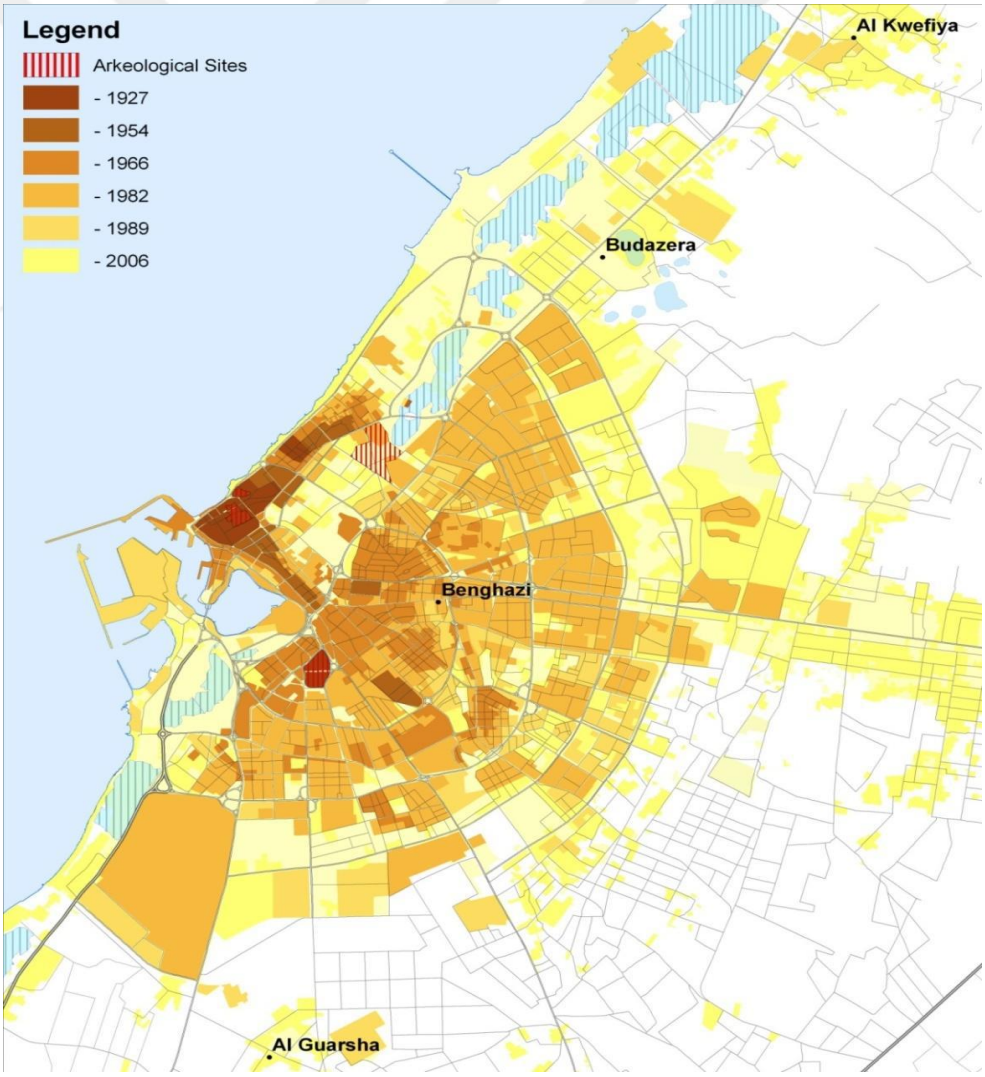


Figure 6.1. Spatial Development of Benghazi from 1927 to 2006 (Source: adopted from BSRR, 2009)

In response to this phenomenon, during the royal period (1951-1969), the Libyan authorities applied many plans and strategies to cope with the humanitarian aspects of the problem. The Government of the Kingdom has built housing projects in the cities to accommodate the residents of those areas and the new arrivals, and obtained the land purchased from landowners to provided plots of land free of charge in some areas that have been incorporated the city plans with established the necessary services and facilities. Those free plots were given as a priority to the inhabitants of shanty areas and to low-income people.

During the period of Qaddafi's rule (1969 to 2011), in the early days of his rule during the 1970s (see Figure 6.1), a considerable forward movement was made in the development of housing plans and strategies (Amoura, 1988).

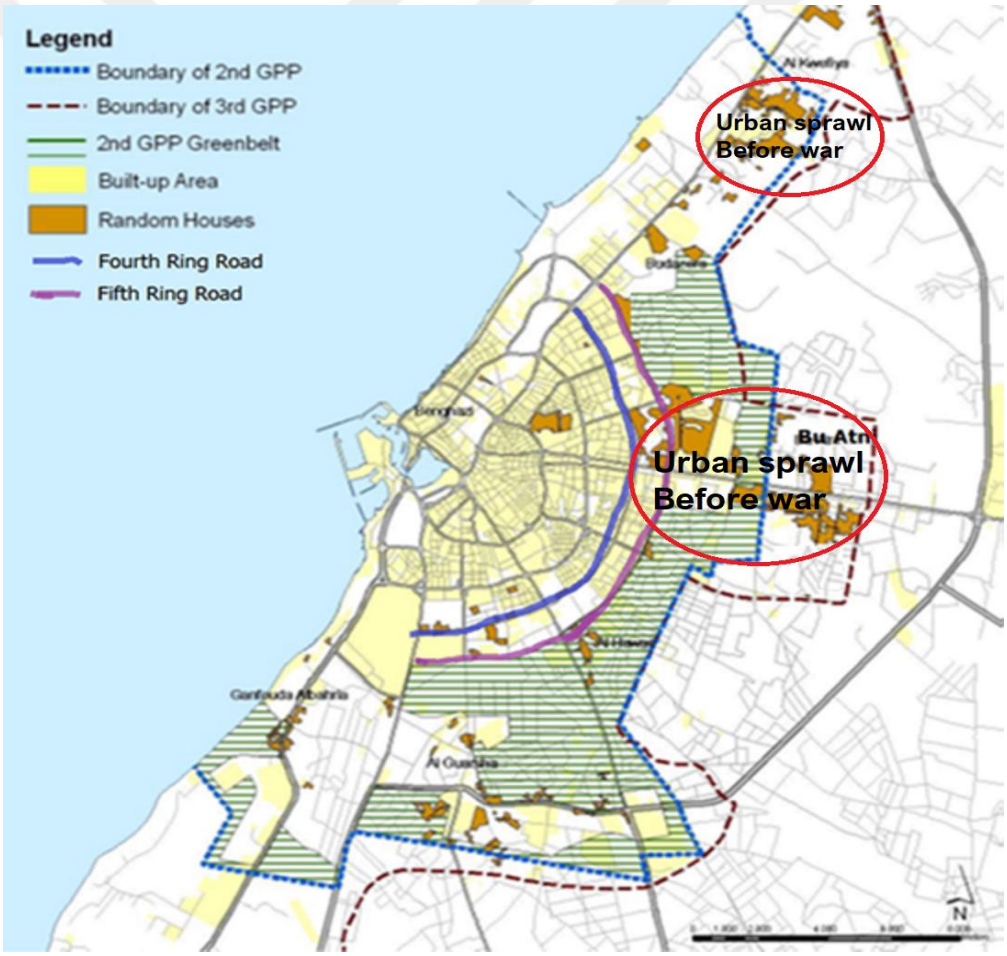


Figure 6.2. Urban sprawl in Benghazi city before war (Source: BSRR, 2009)

This development was the result of improved economic conditions of the country and citizens, also government provided short-term and long-term interest-free loans. These

efforts continued until the early 1980s, thereafter, as a result of changing policies and new ideologies of governance, other sprawl areas on the outskirts of cities have steadily grown (Omar & Ruddock, 2001). It is seen that the City is mostly developed inside the 5th Ring Road till today. In last decade(2000-2010), random developments began to appear between the 4th and 5th Ring Roads, in Bu Atni zone in east direction and in the outer zone of 5th Ring Road in the northeastern part of the city (See Figure 6.2) (BSRR, 2009).

The problem with this urban sprawl was not taken care of, as it was not significant, according to the comments of the Urban Planning Authority. This sprawl was only in the Bu Atni and in the areas between the fourth and fifth ring roads and were villas and private buildings for residents looking for larger areas. But the local authorities have put in place strict laws regarding construction in the Green Belt. It can be notice from the Figure 7.2 that the sprawl on the Green Belt in the pre-war period were very few. Therefore, there were no serious attempts to address this problem by the municipality until the problem was included among the planning problems that must be addressed in the agenda of the third generation of plans that were initiated in 2008 and stopped in 2011 due to the uprising.

6.1.1.2. Urban Sprawl in Benghazi If No War

The large scaled public funded housing projects would especially become a determinant factor for the city macroform, and limited flexible approaches and proposals, which would differentiate the alternatives from each other to a desired extent. Furthermore, the planning strategies related to concentration in the Benghazi Agglomeration or supporting the fringe developments, protection of green belt or proposing a new green belt in outer periphery would also differentiate the city planning alternatives. It can consider that the proposed third generation plan is the appropriate plan for the city and its conditions in the event of no political instability in 2011 and the occurrence of war within the city in 2014.

The third-generation planning project was the result of the completion of the second-generation planning project, which was completed by the year 2000 target. This phase also emerged as a result of radical changes in the political system that opened the country to the world. Thus, relieving and dispensing with socialist and ideological systems. The 3rd GPP was considered important and urgent for many reasons. The most

important is the increase in population growth, especially in Tripoli and Benghazi. And the emergence of new variables in the Libyan scene, such as foreign investments after the end of international sanctions on Libya, and the completion of new water sources represented in the project of artificial river, or the proposed rail system.

The initial ideas of the third-generation project were trying to adopt new trends to diversify sources of national income rather than relying on one source represented by oil and its products that may be depleted at any time. The project generally sought to regain control of urban growth and planning throughout the country, as well as provide concrete foundations for future generations of the country and develop it through the development of education and professional processes (Ali, Hashim, Rostam, & Jusoh, 2011; Dericioglu, 2018).

The city's urban plan strategy in no war situation would consider the natural thresholds with the priority of agricultural areas, coast and sabkhas as the main factors determining the development directions and macroform of the city. Some random housing developments and some non-residential developments on the green belt and along the Banina Road had the tendency to sprawl towards the fertile agricultural lands. These developments also emerged through Al Nawaqia-Solouq Road, where the cement factory has been the main factor that encourages the unplanned developments in this direction. The ribbon strip developments along the coast was having also a tendency to grow.

Ring roads interconnect radial roads moving towards this nodal point (eventually associated with the CBD) and both categories then constitute the backbone of the overall urban development. Certainly, the concentric-compact urban macroform and the urban structure in terms of landuse and road network has been greatly influenced and shaped by the two master plans that dominated in the last half-century.

Despite the city macroform envisages a compact development in the center, different approaches for further developments in the Metropolis are adapted in alternatives in the form of reshaping this macroform with the linear development in the north-south axis or fringe developments in north, south and eastern directions. The planning proposals in terms of the location of some main functions in the Metropolis are developed within the following framework:

The planning decisions related to the railway route and station, two bus terminals in north and south, new industrial zone, development of industrial zone in Al Guarsha, evacuation of existing cement factory and planning of this area for light industries, free trade zone and fair area in south, large scaled housing projects in Ganfouda, Al Kwefiya and Al Anhar, and housing projects inside the Benghazi agglomeration are common for all development planning alternatives. The second university campus and techno park are also proposed in three alternatives despite their locations differ (AlEmara, 2009). As a result of these strategies, small urban centers in rural/agricultural areas beyond the fifth ring road and the green belt may emerged.

As previously mentioned, the uncontrolled urban expansion of the Qadhafi era was the result of the lack of urban plans for more than 20 years and the failure of the government to provide the needs of the growing population of suitable areas for urban growth according to policies and plans for a comprehensive city and governmental vision. Despite these tendencies of urban sprawl in the northern, eastern and southern directions, the economic and urban renaissance in the last years of the Qadhafi era, which began almost in 2006, would reduce these tendencies and reduce urban expansion in the green belt and agricultural land.

It was estimated that these large urban projects would be completed in 2011 and 2012 and would provide housing units for the needs of the population for two decades. This would have had the effect of reducing uncontrolled urban growth in the green belt and agricultural areas and weakening the existing trends of sprawl in these areas. As well as the availability of policies and the state applied to it at that era was the reason for the non-spread of slums significantly as is happening now in the periphery of the city. Therefore, it can be said that the form of urban sprawl in the event of non-occurrence of events in 2011 and its evolution into civil war, will be close to that in 2009 and 2010 and there will not be a significant increase and significant difference in the uncontrolled urban expansion in the city (Dericioglu, 2018).

The plans that were developed for the city in the third generation were aimed at the strategy of decentralization. Where the idea of metropolitan developments and agropolitan developments consensually was adopted. The plan was designed to create small urban centers in the areas beyond the Fifth Ring Road and in the Green Belt and agricultural areas. The idea was to contain the current and future expansion of the city

and to solve its problems of overcoming the accumulation of services and government sectors in one urban center, causing great congestion and urban problems. The proposal of these strategies followed by the Third-generation planners of the city is supposed to maintain the planning organization and absorption of population increase and to reduce the indiscriminate growth in those lands and areas beyond the Fifth Ring Road. The strategy of the scheme included the existing tendencies of the trends of growth and expansion of the city and therefore proposed a system of integration between metropolitan development and the agropolitan development of and decentralization strategies.

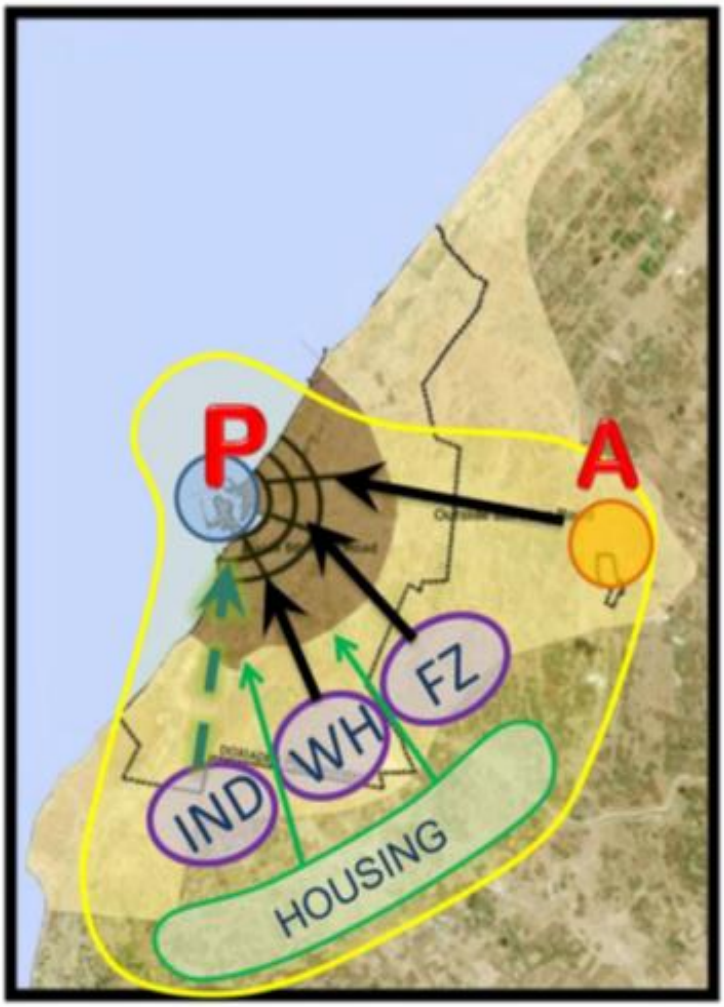


Figure 6.3. Macro-Spatial Model for Proposed development locations and Planned strategies for Benghazi from 2011 to 2025 (Source: Author)

The designated projects regarding public funded mass housing, transportation including highway, national railway and upgrading of the harbor and Banina international airport, technical infrastructure, and utilities, some of which was already

put into implementation would be also considered as de facto components and reflected to the development alternatives. These development projects may stimulate some urban sprawl, especially in the southwestern direction of the city (See Figure 6.3).

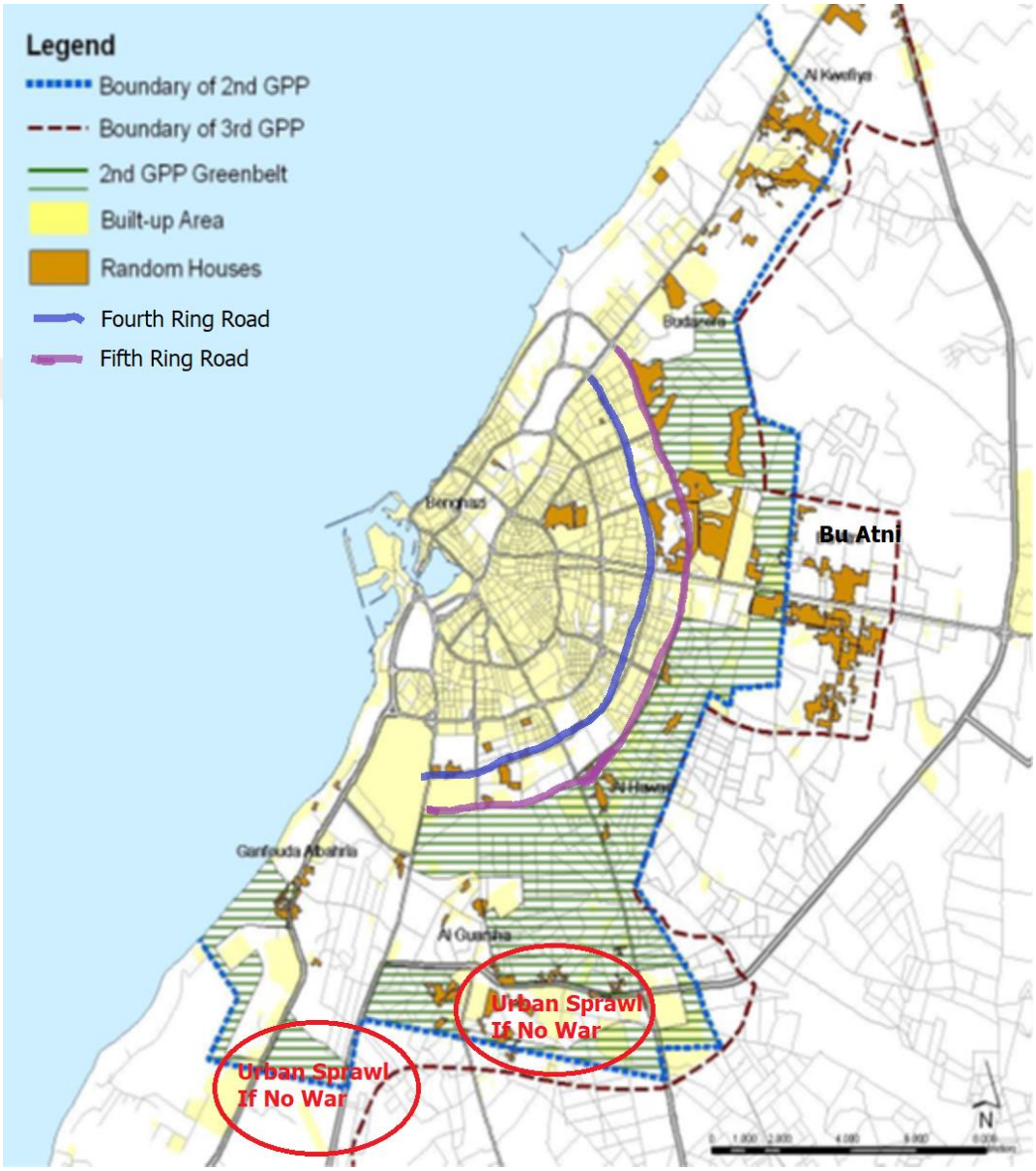


Figure 6.4. Urban sprawl Targeted areas in Benghazi city if No war (Source: Adopted from BSRR, 2009)

Until 2011, some small-scale industrial and handicraft and residential and mixed uses in addition to agricultural activities are developed. These kinds of uses had the tendency to develop on the green belt. These industrial developments have encouraged random residential developments in the Green Belt and agricultural areas (BSRR, 2009). These activities may continue to attract a number of residents, commercial and

handicraft activities, and light industries, so that urban sprawl may expand, and its direction will be in of Bu Atni, Al Nawaqia, and Al Kwefiya (See Figure 6.4).

6.1.2. Understanding the Urban sprawl Problem in Benghazi After War

6.1.2.1. War Disturbance Shock in Benghazi

After the uprising against Qaddafi's regime in 2011, political events and conflicts in Libyan cities accelerated in order to control power and wealth. Conflict has evolved into wars. The war in Benghazi began in 2014 to fight terrorism in the city and continued until the end of 2017. The situation remains unstable and there is no political stability. This war was the disturbance shock in the city. The war resulted in the destruction of the city center and destruction in many dimensions of the city. The Libyan crisis is a conflict between two rival governments seeking to control Libya. The roots of the crisis lie in the situation that prevailed in the country after the revolution in 2011 and highlighted the presence of many armed groups outside the control of the government.

The conflict erupted between the then internationally recognized government of the democratically elected House of Representatives in 2014, which is headquartered in the city of Tobruk and officially known as the Libyan Interim Government, based in the eastern city of Al Bayda. The Government of National Accord, based in Tripoli, has emerged from the consensus of some political forces, including the Libyan parliament, and has won the approval, recognition and support of the United Nations. The conflict of these governments resulted in civil war in many cities and regions including Benghazi city. In May 2014, ground and air forces loyal to General Hafter launched an ongoing military operation called Operation Dignity against Armed Groups in Benghazi and against the GNC in Tripoli. In July 2017, General Khalifa Hafter declared victory for the LNA at the Battle of Benghazi after three years of conflict with armed groups. The war increased pressure and vulnerabilities in the city and destroyed the dimensions of the city.

In the current situation of the city after nine years of political unrest and civil war, the planning has stopped completely and the lack of implementation of policies and approved plans has exacerbated the urban problems dramatically and made the city in a state of unclear macroform, where we cannot say that it is centralization or decentralization development. This has resulted in a significant increase in the urban

expansion and diversity of its forms, especially with no attempts to update and create urban plans until the time of writing this study.

6.1.2.2. Dimension of War Destruction in The City

Wars bring instability and insecurity to cities that not only influence the demographic, economic, social, environmental structure of the city but also threat the urban macroform (Grünewald, 2016; Hills, 2004). It has similarly experienced in the Benghazi city. The lack of studies for the city of Benghazi showing these changes prevented access to accurate information about the city situation after war.

The war in Benghazi city affected the mortality rate. For ages between 17 to 46, it was 6.4 per 1000 before war in 2005 and its increased to 9 per 1000 in 2016 (Daw, El-Bouzedi, & Dau, 2016; Hewitt, 2017; Koenig, 2017). Although it is not prevalent for war situation, the fertility rate also increased from 21.3 to 22 per 1000 in the city. Before war as stated by the UN Habitat Report (2010), 77.89% of the population of Libya lived in cities in 2010 (See Table 6.2). It predicted that this number would rise to 80.29% by 2020. However, Libyan urban population exceeded projections and reach to 89% in 2012 (GIAL, 2012). The annual growth rate for the urban population of Libya in 2005-2010 was approximately 2.31 percent, a relatively high rate compared to the region neighboring countries (GIAL, 2012; R. A. Obudho, 1999).

Table 6.2. Fertility, Mortality and Natural Growth Rates in Benghazi Sub-Region. (Source: BSRR,2009 Daw et al, 2016)

Year	Fertility rate per 1000	Mortality Rate per 1000	Natural Growth Rate per 1000
1970	44.9	10.2	34.7
1980	39.2	8.4	30.8
1990	28.6	6.7	21.0
2000	22.8	6.6	16.2
2005	21.3	6.4	14.9
2016	22	9	15

Wars lead to various forms of instability and insecurity including threats generated by identity issues, chronic violence and other political conflicts. Under those conditions, one of the critical decision during war case is to stay at the hometown or to move out to other places (Muggah, 2012). The groups who decide on moving out permanently or temporally either migrate to the outskirts of the city or to another city or even to another country (Marion & Maurice, 2010).

Almost all economic activities, especially oil production, which is the mainstay of the Libyan economy, have witnessed a sharp decline after the uprising in 2011. While there was some recovery in 2012 when the war ended, and oil production returned faster than expected. But production soon declined as a result of the civil war that began in 2014 (M. Khan & Mezran, 2013).

Average consumer prices rose in 2011 by 16 per cent, and by the end of the year inflation was about 30 per cent. This ratio jumped to the equivalent of 80% in 2016. The budget shifted from continuous surpluses to a deficit of 19% of GDP. The external current account surplus fell to 9.1 per cent of GDP after averaging about 25 per cent per annum compared to the previous decade (Pedde, 2017). The situation remains volatile and there is still considerable uncertainty about when the country will achieve political stability and some degree of security to improve the economic.

The city of Benghazi suffered particularly from the aftermath of the war. Where the area of commercial centers in the city center was destroyed and followed by the destruction of many factories and private and public stores. This led to a recession in the city during the war. Banks' liquidity has also been severely curtailed, and it is difficult to withdraw money. All this led to a decline in purchasing power and a significant increase in prices.

Civil wars usually stem from political, sectarian, religious, tribal conflicts. They additionally lead to more disintegration in the society, increase in enmity and division, and reduction in the sense of community (Rotberg, 2005). Unemployment and poverty rates increased in the city of Benghazi after the destruction and closure of many of the city's commercial and industrial businesses.

The city's infrastructure was severely damaged after many of the roads, electricity, water and communications networks were destroyed. The downtown area contains many historic buildings as well as the main service centers of the city. Many buildings in the most densely populated neighborhoods such as city center, Sabri, Lithi and Hawari and many important and iconic buildings in the city have been destroyed (See Figure 6.5).

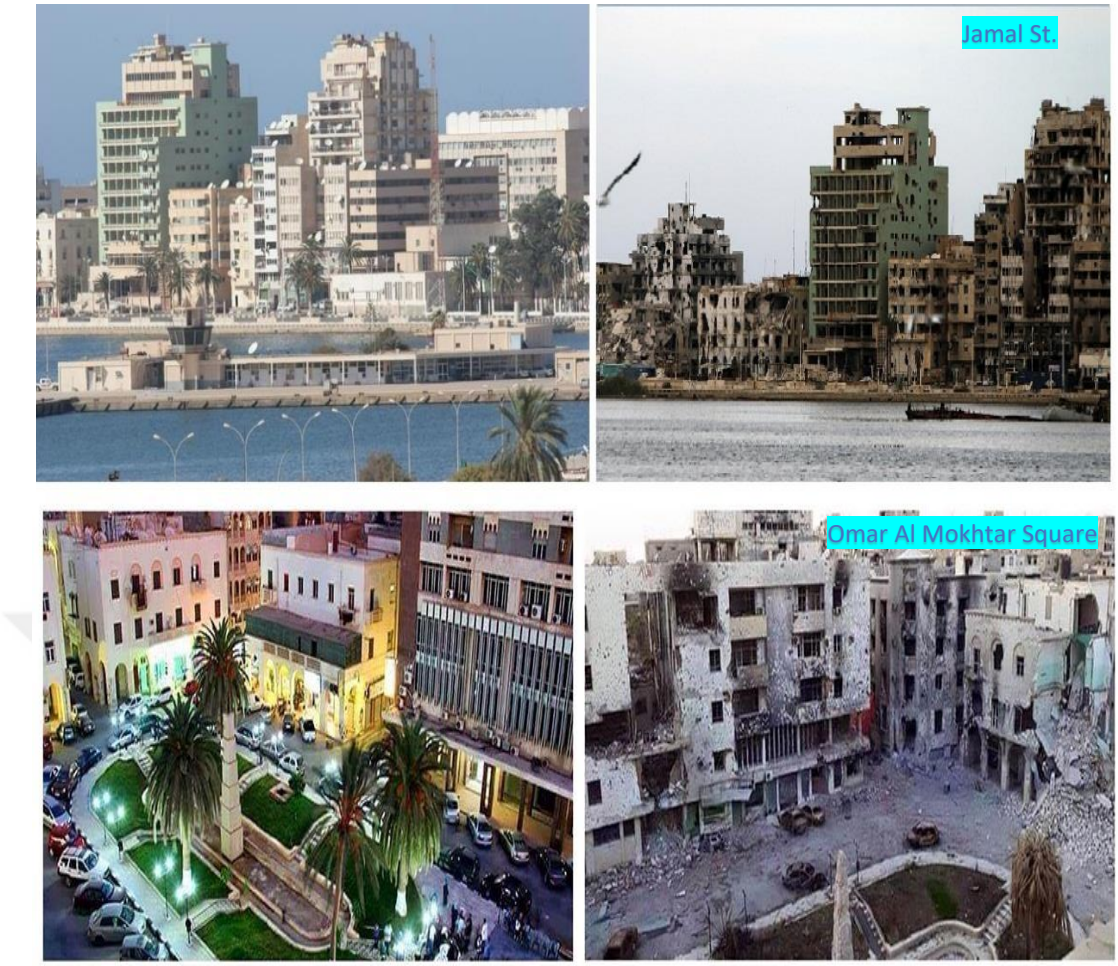


Figure 6.5. "Omar Al Mokhtar Square and Jamal St." in Benghazi city center before and after war in 2014 (Adopted from http://www.searchmap.eu)

The political instability since 2011 and the civil war inside the city since 2014 has created pressure and vulnerabilities and changed the city's urban structure and caused many problems. These environmental problems can be observed in the amount of weapons contamination, damage to energy sources, wells, surface and groundwater, and the burning of agricultural crops. The war also caused sewage overflow in the city centers areas that were experiencing armed clashes. The spread of garbage and the failure to collect it also was the result of the war and the lack of urban services in the city, which caused air and water pollution, as well as visual pollution. The war also has some effects and destruction on spatial and environmental structure of the city that resulted from random developments and urban sprawl.

6.1.2.3. Reason of urban sprawl in Benghazi city

Based on site visits conducted by the researcher and the opinions of planning experts who met with the researcher (Dericioglu, 2018), this phenomenon accelerated in the

Libyan cities after the so-called Arab Spring in 2011 in the absence of administrative and legal authority of the state. This phenomenon increased in particular in the city of Benghazi, after the war. Urban sprawl problem in Benghazi has not occurred due to unmanageable urban development under fair and peace conditions as mentioned before. It is a natural and unavoidable outcome of a chaotic situation determined by the civil war happened in 2011. It is absolutely not a consequence of an enforcement failure in urban management under ordinary circumstances.

In The Benghazi city, the migration rate before war in years from 1973 to 1984 was 0.045% and in years from 1984 to 1995 was 0.23% (BSRR, 2009). Because of the uprising against the Gaddafi regime in 2011 and the subsequent conflicts and wars until 2017, about 40% of the residents living in the center of conflicts in Benghazi moved to other parts of the city such as Bu Atni, Sidi Khalifa, Al Kwefiya, and Al Hawari, and a few of them moved to neighboring cities such as Al Marj, Al Bayda, Tobrouk Ejdabia. There has been also a reverse migration from neighboring villages headed to the city. The number of displaced migrants outside the city is almost equivalent to the number of arrivals to live in the city (UNCHR, 2017). The destruction of residential neighborhoods inside the city forced a large number of inhabitants to move to the suburban areas, towards the city green belt. (Dericioglu, 2018) (See Figures 6.6). Low prices of land and housing in the green belt, and agricultural areas have scientifically helped the displacement people to settled there and increase the housing density and urban sprawl towards these areas. The unplanned housing development and, also, non-residential developments on the green belt, along the Banina Road, has triggered urban sprawl towards the fertile agricultural land.

6.1.2.4. Urban sprawl and Environmental Vulnerabilities of Benghazi

The war has not only resulted in physical destruction in the city center and residential neighborhoods, but also triggered uncontrolled urban sprawl towards the green belt and arable areas as a negative resilience act. Finally, the pressure on the natural environment has threatened environmental resources providing nourishment, fresh air and recreation to the city, and the city resilience. War also caused spread of rubble, sewage and garbage which led to an increase in pollution in the city environment (See Figure 6.7).

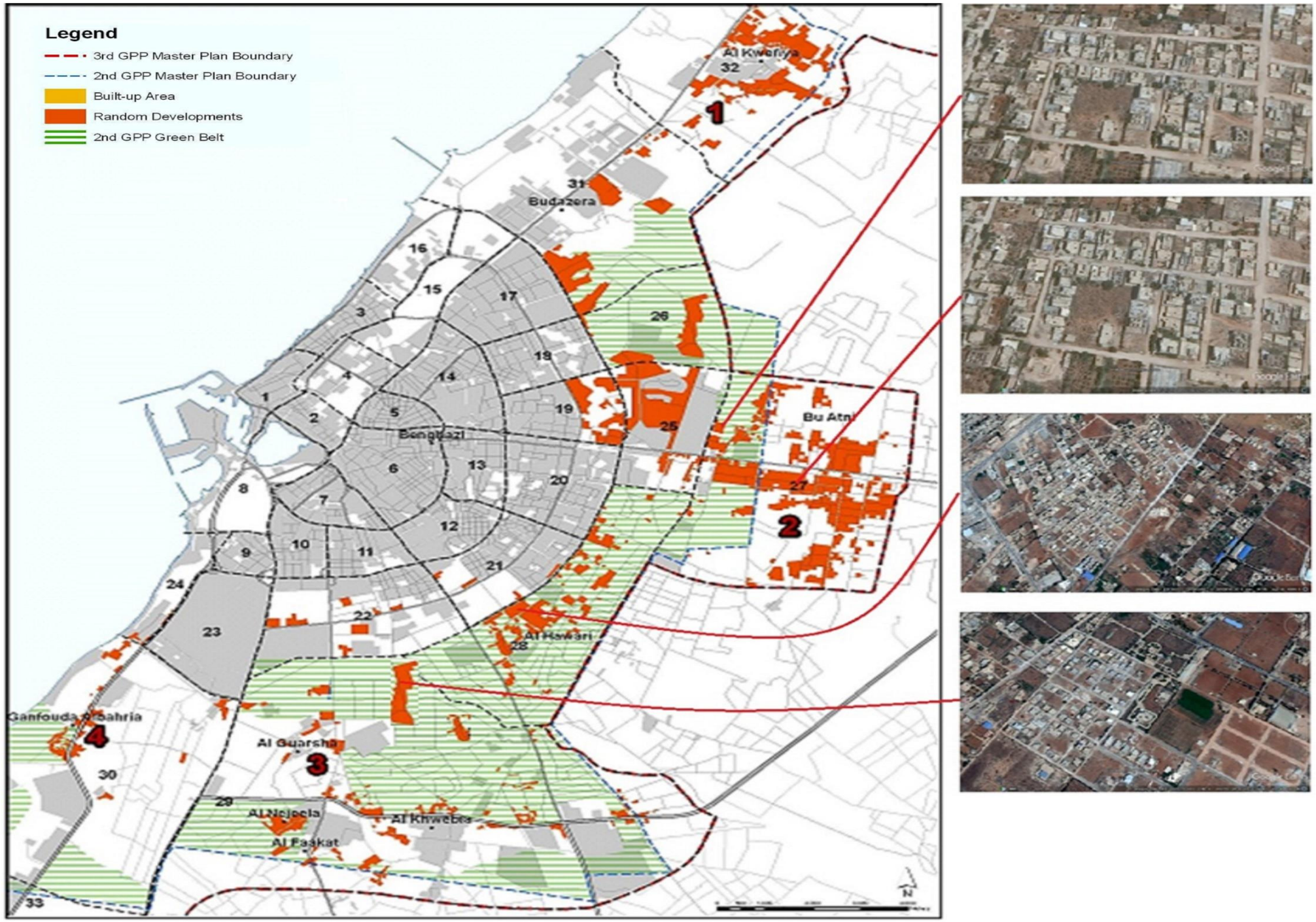


Figure 6.6. Random Developments in the Benghazi Metropolis after 2011 (Source: Author)

Figure 6.7. The spread of rubble, sewage and garbage in Benghazi city center (Source: arabstoday.net, 2017)

This uncontrolled urban sprawl greatly affects the environment, agricultural land and natural resources of the city. The impact of urban sprawl was not only on the environmental dimension, but also on other dimensions, such as increased traffic congestion and numbers private cars which increase the air pollution. As well as the increase of groundwater consumption as a result of the frequent drilling of wells by the new inhabitants because there is no government water source in these areas. All of these problems aggravate environmental degradation and increase its vulnerabilities (See Table 6.3).

Table 6.3. Environmental vulnerability reasons in Benghazi City (Source: Author)

Vulnerability items
Rapid Urbanization and distribution
Vegetation cover, Urban land cover
Uncontrolled urban development
Lack of resources
Waste spread
Air and surface water pollution

6.2. Analysis Process of Visual Experiments and Urban Sprawl Degree

In many studies, several quantitative methods have been mentioned to measure the phenomenon of urban sprawl and determine its spatial patterns. As well as differences with respect to the area under study. Where Case studies of the United States focus on

single-family housing units, road network indicators and intersectoral densities. While European case studies focus more on land use. Mixing and penetration of the ground cover. And in particular studies, a combination of indicators is merged in a measured index, in order to obtain a more combined technique. This study will be based on a refined indicator system for measuring and assessing the spatial characteristics of urban sprawl in the city of Benghazi. To do so, a system of indicators is proposed that adapts to the specificities of Libyan cities that tend to be unique in terms of urban sprawl practices. A sufficient set of satellite image-based indicators that can be applied to the city of Benghazi will be proposed.

6.2.1. Visual Experimentation Findings

The visual experiment was based on the collection and analysis of satellite images of the city of Benghazi in 2004, 2010 and 2018 and processed by remote sensing programs.

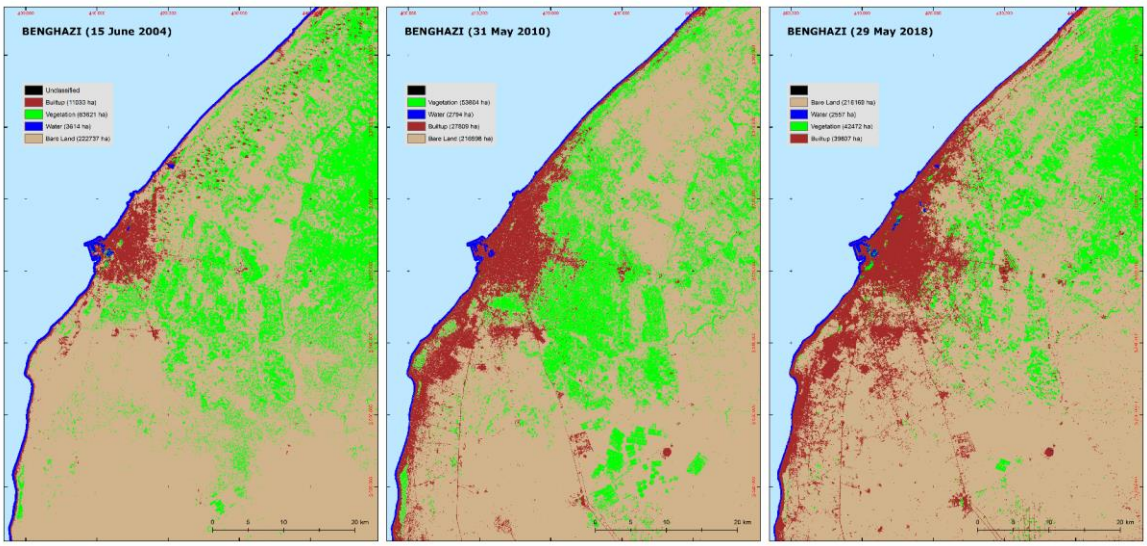
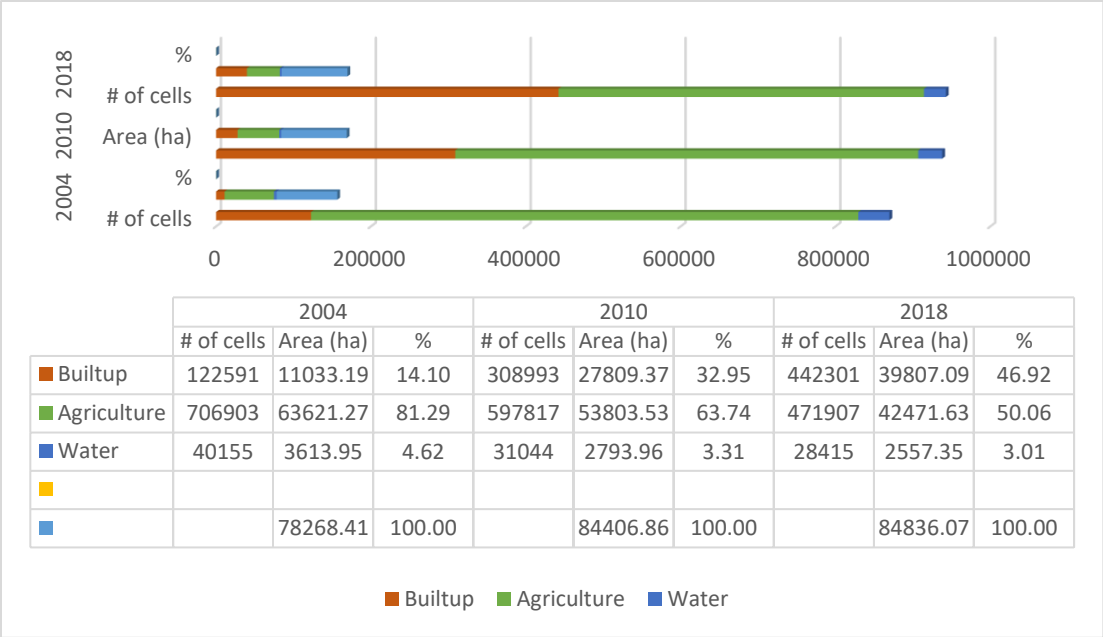


Figure 6.8. Benghazi urban growth change detection using remote sensing – June 2004, May 2010 and May 2018 respectively

The data extracted from the remote sensing of satellite images of Benghazi city (See Figure 6.8). The breakdown calculation in this table shows in detail the changes in built-up areas and agricultural area. The figures resulting from the calculation of the analysis and the classification mechanism after the remote sensing process confirm the

impact of the war. Which showed a significant increase in the proportion of built-up areas to 13. 22% in 2018 compared to 9.2% in 2010.

This increase may be considered normal in cities that grow naturally but, in a city, suffering from continuous war is a significant increase in built-up areas. The experiment also shows the percentage of agricultural land shortage around the field, which decreased from 18% in 2010 to 14% in 2018.



	2004			2010			2018		
	# of cells	Area (ha)	%	# of cells	Area (ha)	%	# of cells	Area (ha)	%
Builtup	122591	11033.19	14.10	308993	27809.37	32.95	442301	39807.09	46.92
Agriculture	706903	63621.27	81.29	597817	53803.53	63.74	471907	42471.63	50.06
Water	40155	3613.95	4.62	31044	2793.96	3.31	28415	2557.35	3.01
		78268.41	100.00		84406.86	100.00		84836.07	100.00

Figure 6.9. Change in built-up areas in Benghazi 2004, 2010, 2018

The analysis of satellite imagery and the results of remote sensing processing shows that the increase in urban growth, particularly in agricultural land east and south of the city, which was increased significantly between 2010 and 2018, a period that accompanied instability and civil war in the city. This confirms the increase in the city's environmental vulnerabilities and the impact of the war on increasing its urban sprawl (See Figure 6.9).

The analysis of satellite imagery and the results of remote sensing processing showed an increase in urban growth, particularly in agricultural land east and south the Benghazi city, which was increased significantly between 2010 and 2018, a period that accompanied instability and civil war in the city. This confirms the increase in the city's

environmental vulnerabilities and the impact of the war on increasing its urban sprawl. The results of the experiment will be discussed with the framework for building resilience of the city and its vulnerabilities in the discussion chapter.

6.2.2. Degree of Urban Sprawl and Environmental Degradation

The process of measuring the degree of environmental degradation is through the process of measuring urban sprawl penetrated in agricultural land and the green belt of the city. This process was done by visual experiment, which contains the collection of satellite images from different times and analyze them using remote sensing software.

6.2.2.1. Eight Regions Technique

The techniques described in the methodology chapter were used to evaluate urban growth patterns in Benghazi city. These techniques allow to detect the changes in land-use and urban sprawl and show the environmental degradation. The same satellite imagery previously used in the analysis, classification and remote sensing process was used. The study area was classified into two categories of land use, urban and non-urban, in order to serve the objectives of the study in analyzing patterns of urban growth. Urban areas include residential, commercial, service, industrial and road areas. While non-urban areas include lakes, water, agricultural areas, forests, rural areas and open areas.

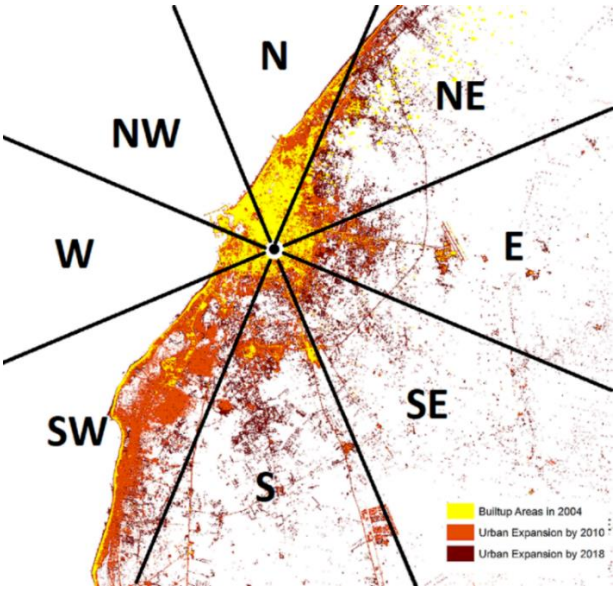


Figure 6.10. Divide the urban area based on the spatial directions approach (Source: Author)

This Technique is based on analysis of Benghazi urban area by dividing it into eight regions "N-S-E-W-SE-SW-NE-NW" (See Figure 6.10), where the selected urban area is fully integrated into a large circle centered on the Dubai street business district. Urban areas were cut within the ARCMAP program and urban area was calculated in each direction by applying quantitative calculations. The aim of these measures is to understand the urban growth and its patterns within the city of Benghazi according to each geographic direction. This approach provides a deep and effective understanding of the quantitative and qualitative assessment of urban growth patterns.

The areas in Table 6.4 shows that urban growth has increased from 110.33 km2 in 1986 to 279 km2 in 2010 and to 398 km2 in 2018. This rapid increase in the built-up area, which includes residential, commercial, industrial and infrastructural areas, is a result of the city's population increase, commercial growth and instability and war.

The urban growth of the southern, eastern, south-eastern and south-western areas of the city is due to the fact that these areas have enough space for residential, commercial and industrial development. The land in these areas is considered cheap compared to the areas close to the city center.

Table 6.4. Urban Growth by Years (2004-2010-2018) (Source: Author)

	Built up areas (km^2)								
	North	**Northeast**	**East**	**Southeast**	**South**	**Southwest**	**West**	**Northwest**	**Total**
2004	27.73	34.22	6.28	3.37	5.11	17.52	6.71	9.40	**110.33**
2010	39.67	42.31	17.12	13.82	45.16	98.85	10.01	11.15	**278.09**
2018	40.57	76.71	36.45	36.21	80.81	107.46	9.14	10.72	**398.07**

The significant expansion of the built-up area in the various directions was calculated between 2004 and 2010 and between 2010 and 2018 as shown in Table 6.5. It is clear from the results that the expansion of built-up area has increased recently after the war, especially in the north-east, West, south and south-east, While growth and expansion in the west, north-west and north have almost been halted due to the city's natural anti-growth boundaries of the coast. In general, observed growth shows urban growth and its acceleration, trends, and the amount of variance in all directions.

Table 6.5. The observed growth of spaces built in different directions and time periods (Km^2) (Source: Author)

	North	Northeast	East	Southeast	South	Southwest	West	Northwest
2004-2010	11.93	8.09	10.83	10.45	40.04	81.32	3.29	1.75
2010-2018	0.89	34.39	19.32	22.38	35.65	8.61	-0.86	-0.43
Total	12.83	42.49	30.16	32.84	75.70	89.94	2.43	1.32

As mentioned in the review of method chapter, these techniques used to reach the urban growth trends and its extent of expansion in multiple periods of time, which are then compared to extract the results.

For a better understanding of the issue of regional expansion differences, this study conducted a comparative analysis of observable values and theoretically predicted values for urban expansion in the study area (See Table 6.6). The expected growth of the built-up area is calculated using the following equation (Bb Bhatta, Saraswati, & Bandyopadhyay, 2010):

$$M_{ij}^{E} = \frac{M_i^S \times M_j^S}{M_g}$$

Where, M_i^S = row total, M_j^S = column total, M_g = grand total.

Table 6.6. The expected theoretical growth of urban expansion in the study area in different directions and time periods (km2) (Source: Author)

	N	NE	E	SE	S	SW	W	NW
2004 2010	7.48	24.77	17.59	19.15	44.14	52.44	1.42	0.77
2010 2018	5.35	17.72	12.58	13.69	31.56	37.50	1.01	0.55

By subtracting the observed growth from expected growth, we can determine the extent of urbanization in the study area. Positive values resulting from the observed growth rate of expected growth or theoretical growth point to high urban growth while negative values indicate low growth. Table 6.7 shows that there is rapid urban growth in the southwestern part of the city, while the areas of the southeast, east and northeast have slowed urban growth and expansion compared to other spatial trends in the city.

Table 6.7. Difference between observed and expected growth in the study area in different directions and time periods (km2) (Source: Author)

	N	NE	E	SE	S	SW	W	NW
2004-2010	4.45	-16.68	-6.75	-8.69	-4.09	28.89	1.88	0.98
2010-2018	-4.45	16.68	6.75	8.69	4.09	-28.89	-1.88	-0.98

6.2.2.2. Pearson's chi-square

As mentioned previously, person's chi-square used in comparisons of urban expansion and population growth, including measuring the degree of freedom of urban growth for the study area in different directions and times. It is an indicator of the amount of random development in urban areas and their rapid spread.

The degree of freedom can be calculated for the entire study area and for each direction by the following

$$x_i^2 = \sum_{i=1}^{m} \frac{\left(m_j - m_j^E\right)^2}{m_j^E}$$

Where: x_i^2 shows the degree-of-freedom of i-th temporal span, m_j shows observed growth of built-up area in j-th column, and m_j^E shows expected growth of built-up area in j-th column.

Table 6.8 shows that urban growth in the study area is generally unbalanced or unsustainable between 2004 and 2018. The high degree of freedom does not mean the spread of the built-up area or its integration into a particular area but means that urban growth is uneven regionally from time to time or from place to place in the same region (Ren et al., 2013).

Table 6.8. The degree of freedom of urban growth for each time period (Source: Author)

Time span	Freedom (x_i^2)
2004-2010	**4.05**
2010-2018	**5.66**

In Table 6.9, we can note that urban expansion in the southwest and northeastern of Benghazi is incoherent and unbalanced and requires rapid urbanization policies to

rearrange the pattern of growth in this direction, while the north, northwest have the lowest values of freedom. In general, we can benefit from the knowledge of these values of the degree of freedom of urbanization in the future planning of a sustainable, resilience and balanced urban development that takes into account the resilience of land uses.

Table 6.9. Degree of freedom of urbanization in each direction (Source: Author)

	N	NE	E	SE	S	SW	W	NW
Freedom (x_i^2)	**0.64**	**2.69**	**0.62**	**0.95**	**0.09**	**3.82**	**0.60**	**0.30**

6.2.2.3.Urban Expansion Intensity Index

This indicator used to quantify and analyze differences in urban spatial expansion and reflects the potential future direction and potential of urban expansions and compares the speed or intensity of change in urban land use at different time periods.

The UEII standard is divided as follow: 0 to 0.28 is slow development; 0.28 to 0.59 is low-speed development; 0.59-1.05 is medium-speed development; 1.05-1.92 is high-speed development; and >1.92 is very high-speed development

The urban expansion intensity index for the Benghazi study area was calculated by the following formula:

$$UEI_{it} = [\,(ULA_{i,b} - ULA_{i,a})/t\,]\,/TLA_i * 100.$$

Where, $UEIit$ shows the annual average expansion intensity index of i-th spatial direction during the specific time t; $ULAi,a$ and $ULAi,b$ show the starting and ending the built-up area of i-th spatial direction; $TLAi$ show the total land area of i-th spatial direction.

The total intensity of urban expansion index (Table 6.10) shows that the index value of the period from 2004 to 2010 is 2.8. This indicates a very rapid urban growth in the study area, which confirms the results of the degree of freedom of urban growth that urban growth in the city is unbalanced and unsustainable.

The period between 2010 and 2018 witnessed a very rapid growth of 2.3 especially in its southern outskirts due to population growth in the city and the need for residents to new homes with large areas and due to the displacement of the population from the conflict areas after the war in 2014.

Table 6.10. Urban intensity density index for each time period (Source: Author)

Time span	UTI
2004-2010	2.8
2010-2018	2.3

The results presented in Table 6.11 show that all trends in the study area have high values indicating the speed of urban growth in the city except for the western and northern part of the city and the sea view.

Table 6.11. Urban intensity index for each direction (Source: Author)

N	NE	E	SE	S	SW	W	NW
1.2	2.3	2.8	2.5	3.1	3.2	0.15	0.61

A set of data was extracted from techniques (Eight regions Divide technique, Pearson's chi-square, Urban Expansion Intensity Index technique) used to analyze the results of satellite images of remote sensing processing as showing in Table 6.12.

As demonstrated by the ability of remote sensing techniques and geographic information systems technologies to be used and integrated with other quantitative techniques to obtain a deep, accurate, and realistic evaluation of the phenomenon of study. Through the results we can confirm that the city of Benghazi over the past three decades has witnessed significant changes in the form and patterns and areas of the urban area in all spatial directions. However, the analysis of the maps of the results of remote sensing of satellite pictures showed that the urban sprawl after war has increased significantly in the green belt and on the southwestern outskirts of the city and in the agricultural lands in the east and south of the city.

It has been also noted that the results of the Pearson's chi-square technique confirmed that the urban growth in the study area is unbalanced, unbalanced and incoherent. The results of the Urban Expansion Intensity Index technique confirmed that the city of Benghazi witnessed very rapid growth in all periods and in all directions.

Table 6.12. Findings extracted from techniques used to analyze the results of satellite images of remote sensing processing

DATA FINDING	Data Source and Analysis
1- Urban Growth by Years (2004-2010-2018)	Census 2006, Document analysis
2- The observed growth of spaces built in different directions and time periods (Find growth trends)	Remote Sen. Sat. Images – Map analysis -Eight Regions technique
3- The expected theoretical growth of urban expansion in the study area in different directions and time periods (Find the extent of random urban growth)	Remote Sen. Sat. Images – Map analysis -Eight Regions technique
4- Difference between observed and expected growth in the study area in different directions and time periods (Find the extent of random urban growth)	Remote Sen. Sat. Images- Eight Regions technique
5- The degree of freedom of urban growth for each time period (Find extent of random urban growth in time)	Remote Sen. Sat. Images- Pearson's chi-square technique
6- Degree of freedom of urbanization in each direction (Find the extent of random urban growth in each direction)	Remote Sen. Sat. Images- Pearson's chi-square technique
7- Urban intensity density index for each time period (Find the amount of dispersion in urban growth by time)	Remote Sen. Sat. Images- Urban Expansion Intensity Index technique
8- Urban intensity index for each direction (Find the amount of dispersion in urban growth by direction)	Remote Sen. Sat. Images- Urban Expansion Intensity Index technique

These results underscore the urgent need to create balance, effective and resilience urban policies to reduce the rapid spread of this phenomenon, which greatly increase the vulnerability of urban system in the city and have a major impact on the ecosystem in the near and long term.

CHAPTER VII

7. SWOT ANALYSIS AND ITS FINDINGS: DEVELOPING A FRAMEWORK FOR ENVIRONMENTALLY RESILIENT BENGHAZI CITY

This chapter firstly presents the primary data analysis and procedures, and the findings of SWOT analysis. The results are obtained either from the analysis of the group discussion and interviews. This procedure helped reach collaboratively produced outcomes for the city by trying to make the group members adopt the process and motivate them to take an action for the city, and followed the research objectives which were identified previously as follows:

- To identify the positive and negative factors affecting the city globally and locally.
- To identify the major vulnerabilities for the city of Benghazi.
- To formulate an environmentally resilient vision and objectives for the city.
- To identify the resilience strategies for the city planning problems with a focus on urban sprawl problem and environmental risks.
- To formulate an action plan sensitive to environmental resilience.

7.1. Primary data Analysis Process and Findings of SWOT Analysis

The research here analyzed the results of the primary data collection, which includes data extracted from the group discussion and interviews.

The aim of the group discussion was to gather data for detailed analysis in order to answer the third and fourth research questions, and to prove the theoretical framework of the research which was developed by the literature review, visual experiment and

case study. These analyses were used to constitute a comprehensive framework for urban sprawl and environmental resilience of the city. This framework was evaluated based on the strengths, weaknesses, opportunities and threats to the city. Urban sprawl and environmental resilience have connection with all SWOT factors and developments of the city in the proposed action plan. The following findings were obtained from the valuable responses obtained from the group discussion held on Saturday, 04.05.2019.

7.1.1. Opportunities and Threats Influencing Benghazi City

The group discussion participants were asked "what are the positive and negative developments in the world politically or economically that influence Benghazi City?". Opportunities and threats influencing Benghazi City are composed of positive and negative developments occurring in different scales: (i) Developments in the world; and (ii) developments in Libyan country as stated in Table 7.1.

Participants' responses were expected, where participants agreed that conflicts and political instability, weak government, and economy of neighboring countries are the most important reasons affecting the city. In addition, the influx of illegal immigrants across the southern and eastern borders of Libya (Egypt, Chad, Sudan, Ethiopia and Somalia) negatively affects the city of Benghazi, the largest city in which immigrants gather and move to Europe. As for the positive factors, the participants mentioned two points: increasing oil prices and the world union against terrorism and consider Libya as a part of those factors.

In the same context, participants were asked about the positive and negative developments in the country scale that influence the Benghazi City, and, in the end, they reached at a consensus on the following factors.

Local factors that negatively affect the city of Benghazi have converged with the global factors, as the participants agreed that the factor of war in cities like Tripoli, Sabha in south, and Misrata suffering from ongoing war and Derna and Sirte suffering from the war and political instability of Libya in general have a great impact on the city as well as the economic decline and migration negatively affected the city of Benghazi .These wars in the cities in the west and south led to migration to Benghazi after 2018, as it

was somewhat safer than the war-torn cities. There are still local factors that positively affect the city, such as the Libyans being one nation who all believe in one religion, speak one language and interrelate among tribes. Another factor is some stabilization in some neighboring cities and some economic recovery.

Table 7.1. World and local developments affecting Benghazi city

	Positive Developments	Negative Developments
World Scale Developments	Increase oil prices	Conflicts
	Union to fight terrorism	Political instability
		Informal migration from Africa
		Weak of neighbor's economy
County Scale Developments	Still one nation and one religion	War, conflicts
	Stability in some cities	Political instability
	Some economic recovery	Deterioration of the economy
		Migration
City Scale Developments	Intention to change	Lack of a team leader
		No adequate training and development
		Energies not employed well
		Team members selecting
		Significant individual differences are evident among team members
		Sedition and foreign conspiracies
		culture of individual work
		No attention to human feelings and relationships

The strengths and weaknesses of the city composed of positive and negative developments in the city in general and of vulnerabilities and planning problems of the city. From the answers of and after discussion among participants, the following points were agreed on as stated in Table 7.1.

Most of the participants' answers focused on the negative factors affecting the cooperation in Benghazi, where the participants focused on the lack of strong

leadership that has the experience and skill to build and lead an active and cooperative team. Participants also explained that the lack of training and administrative development, and consumption of efforts in the wrong place impeded the process of participation. Participants agreed that promoting a culture of individual work and competition rather than collective action and lack of attention to the feelings had an impact on cooperative work. As for the positive points agreed on by the participants that they increase participation and help work together in Benghazi. These are the only two points that there is an intent to change and improve as well as there are common motivations to see the city in a better condition.

Participants were asked about their opinion of strengths and weaknesses of the city now and in future, and the final agreed answer was as shown in the following table:

Table 7.2. Strengths and weaknesses of Benghazi city

Strengths	Weaknesses
Port - Airport – Location	Centralization
Benghazi university and the technical colleges	Management failure
Human resources and capabilities	Lack of updating laws
Human capabilities	Deprivation of private sector
Cement Factory- Building materials factories in the city	Political instability
	Lack of awareness of the management and population

The participants agreed on the strengths of Benghazi City in terms of its strategic location; the presence of an international airport, tourist port, commercial port; interdisciplinary universities and specialized colleges, as well as the human resources and capacity, medium-scale industries, cement and building materials factories. One of the weakness points agreed upon by the participants was the centralization restricting municipalities and limiting their authority, which affected the city negatively. Other weaknesses discussed by the participants were the failure of the administration, the failure to update the laws, the non-activation of the role of the private sector in

development, political instability, and lack of awareness among administrators and citizens alike.

The question was asked to the participants about their opinion on planning problems and vulnerabilities of the city and its association with the problem of urban sprawl. After collecting the answer points of each participant, the discussion was opened to reach the agreed vulnerabilities and planning problems of the city, and they were:

Table 7.3. Benghazi City vulnerabilities and planning problems

Vulnerabilities and planning related problems	Absence of political and economic stability
	Conflicts
	Administrative instability
	Lack of laws such as Law No. 4
	Lack of knowledge of decision makers and leaders
	Lack of communication between departments
	The lack of full implementation of urban plans
	Non-enforcement of laws and policies in the city
	Do not update urban plans

After many discussions among the participants, everyone agreed that the most important planning problems and weaknesses were political and administrative instability and the continued imposition of arbitrary laws such as Law No. 4 “The Property Law” which was proclaimed in 1977, stating that the ownership of land and all land belongs to the state and that any house inhabited by a person is his property even if it is a rented property. The law has thus far caused many property problems and reduced the participation of the private sector in the housing industry, as investors fear losing their assets to be owned by someone else.

Participants also sorted other weaknesses and other problems, including the lack of experience of decision makers, the difficulty of communication between municipality departments and implementation of utilities and projects, as well as the failure to fully implement old projects and plans, failure to implement updates to existing plans and weak planning laws and policies.

7.1.2. Problems Causing Urban Sprawl and Suggested Solutions

The question was asked to the participants about their opinion of the problems causing urban sprawl in order to collect and subtract various answers and define the main causes of the problem of urban sprawl. After agreeing on identifying the reasons, participants discussed possible solutions to cope with urban sprawl. The following agreed solutions, displayed in Table 7.4, were the outcome of this discussion:

Table 7.4. Reasons of and Suggested solutions for urban sprawl in Benghazi City

Problems causing Urban sprawl	Suggested solutions
War and destruction of densely populated neighborhoods	Review and develop laws and policies
Weak government	Review and update plans and clarify responsibilities for implementation
Lack of housing for citizens	Providing housing and residential lands
The lack of full implementation of urban plans	Establishment of public transport networks
Non-enforcement of laws and policies in the city	Protect agricultural land and green areas by activating and modernizing laws
Lack of public transport and dependence on private cars	Distribution of services and ministries between cities and move some of them outside Benghazi
Low land prices beyond planned limits	Raising awareness in the media and communication sites of the dangers of random developments
	Facilitate communication between municipalities and planning and implementation bodies and facilitate implementation procedures

The participants agreed that the main reasons for the indiscriminate urban sprawl is the continuation of the war and the destruction of a large part of the neighborhoods and houses of the city. This was caused by a severe shortage of housing within the city's borders, and this led to the displacement of the residents whose homes were destroyed to settle in the outskirts of the city and agricultural areas. As for the reasons before the war, which are still going on so far, their answers were the weakness of the government in the provision of permanent or temporary housing for the displaced and others; failure to implement the schemes completely; and the lack of policies and laws. The other reason for the expansion according to the opinion of the participants was the lack

of public connectors in the city and the total dependence on private cars, as well as low prices of land outside the boundaries of the master plan and agricultural lands.

The proposed solutions agreed after several discussions by the participants were diverse, including reviewing and developing laws and policies, reviewing and updating plans, clarifying implementation responsibilities and providing housing. The participants stressed the need to accelerate the establishment of public transport networks that could help reduce the problems of sprawl. They also agreed that the development of laws to protect agricultural land and green spaces through the activation and reviewing of laws is also necessary. Distribution of services and ministries between cities and the transfer of some outside Benghazi to other cities; dissemination of thoughts and raising awareness in the media and communication sites of the dangers of random developments; facilitating communication between municipalities and planning and implementation bodies; and facilitating implementation procedures will help reduce the problem according to their opinion.

7.1.3. Environmentally Sensitive City Vision

In a different context, the participants were asked, respectively, about their future vision of the city of Benghazi, considering strengths, weaknesses and threats. After collecting the answers, they were presented for discussion to draw a unified vision agreed upon by all participants for the future of the city, and they finally agreed on the following vision:

A global gateway commercial city specialized in the building materials manufacturing and technology industries, based on the Smart Village and Free Zone concepts, in addition to be a tourist-attracting city with its moderate climate and its Mediterranean maritime views. A city that is famous for its modern public transportation network linking all the neighboring cities and countries.

To reach a compact city vision, the participants agreed on the following vision:

"A gateway city of commerce and tourism, with an environmentally resilient urban planning understanding"

The city has the potential to achieve this vision, and this has been mentioned in the city's components in terms of its great location on the Mediterranean coast and its moderate climate throughout the year. The presence of an international airport, commercial and tourist ports; the presence of building materials factories as well as some medium-scale industries such as food and clothing factories to the factories of boats and yachts; the existence of universities, technical colleges and human resources; and partial implementation of the smart village and free zone concepts in the field are among the most important elements that could help achieve this vision. It should not be forgotten that the country's financial resources are still in good standing in the face of high oil prices and these resources along with rich resources will help achieve this vision.

After agreeing on the future vision of the city, participants were asked about the strategies and projects that should be created to achieve this vision. After discussions among participants, agreement points were reached to identify projects and strategies, and these were as follows:

Table 7.5. Projects to reach the Environmentally sensitive City Vision

Project Name
Light rail public transport and activate Public Buses project and complete the Int. airport
The Free Zone and Smart Village
Development of industries such as (building materials - recycling - medium industries)
Completing the Housing projects
Improving the infrastructure of the city
Developing tourist areas around the city and its beaches
Specialized agricultural projects development

7.1.4. Environmental resilience strategies

A question as follows was posed to the participants: "Which of those projects can be evaluated as resilience strategy for the city to face the threat of urban sprawl? "At the end of the discussion, the participants were asked about the order of these projects according to their priority and importance, and to set a time scale for each project. The

strategies, their related projects and their priorities to achieve the environmentally resilient Benghazi were formulated accordingly, and the participants agreed on the following list:

Table 7.6. Strategies and project priorities for environmental resilience in Benghazi

	Strategies	***Projects***	***Time Schedules***
Strategy 1	**Review the existing developments and evaluate and reshape them using mixed-land use planning and implementation (Containment of urban sprawl)**	The Free Zone Project and The Smart Village	Short run
		Completion of public housing projects	Short run
Strategy 2	**Activate and speed up the construction of the light railway(Containment of urban sprawl)**	Public Transport Project	Short run
Strategy 3	**Distribution of services and the establishment of new urban centers other than the only center in the city (Containment of urban sprawl)**	Building materials industries development	Short run
		Investment in agricultural techniques development	
		The Free Zone Project and The Smart Village	
Strategy 4	**Increase taxes on fuel and private cars (Decrease the depend on private cars)**	Establish polices ad regulation to increase fuel tax	Middle run
Strategy 5	**Community awareness of the threat of uncontrolled urban sprawl and the loss of natural resources.**	Tv, social media, conferences and University activity	Short run

After several discussions, the participants agreed on the seven main projects in terms of priority and implementation time. The question was asked about mentioning the main actors and stakeholders for each project. The answer was that at the moment they cannot be precisely identified, because governments are divided, and the war has divided politicians, ministries and stakeholders.

The discussion on the suitability of these projects has been opened for the city's resilience strategy to reduce urban sprawl. The results of the discussion were that the implementation of these projects will increase the resilience of the city, and reduce the vulnerabilities and urban sprawl. For example, the prevalence of public transport will

reduce the dependence on private cars and attract people to areas with general transportation, which in turn direct urban development to target areas. Another project that will solve the problem of housing within the city is the completion of large housing projects in the city, which will attract citizens and reduce their orientation to settle in the city periphery. The Smart Village project and the Free Zone area will attract new residents to the area, leaving their spread in agricultural areas and the green belts. The agricultural technology development project will also make citizens more interested in agricultural areas that will generate good incomes. The development and establishment of medium industries and building materials industries that the municipality can direct in the target areas of current and future developments will reduce the tendency and attraction to move towards environmentally endangered areas.

CHAPTER VIII

8. A SYNTHESIS FOR ENVIRONMENTAL RESILIENCE OF BENGHAZI FROM THE FINDINGS OF DATA ANALYSIS PROCESS

After the group discussion analysis results, interviews with Prof. Dr. Taylan Dericioglu, an urban and regional planner graduated from the Middle East Technical University, the former Turkish Undersecretary of the Ministry of Transport and Communications and director of the urban planning project in Benghazi; with Prof. Dr. Saad Qizziri, Director of the Urban Planning Authority of Benghazi and a decision maker; and with Prof. Dr. Mansour Al Babour, Former Dean of the of Benghazi University and a participant city decision-maker in the approval urban plans were conducted.

The results of the personal interviews that were conducted with the three professors after presenting the analyzing results of the discussion groups were consistent and confirmed the steps that must be taken to overcome the problem of urban sprawl and environmental degradation in particular and the city's planning problems in general. Also, the interviewees emphasized that these results should be analyzed, synthesized with the secondary data, and an action plan should be drawn up accordingly. Considering these results from these interviews, the study tried to reach a synthesis from the findings of primary and secondary data analysis in order to get the whole picture of the city with reference to environmental problems caused by urban sprawl, and the potential to attain environmental resilience if Benghazi to cope with urban sprawl. While trying to reach this synthesis, the study concentrates on the many factors of analysis as follows:

8.1. Developments and Constrains in in Regional and Metropolitan Context that affect Benghazi

Although the war affects and the developments in other settlements would slightly reduce the share of the Benghazi Metropolis, it is expected to accommodate almost half of the sub-regional population by the year 2030. Benghazi City with its metropolitan functions is the first rank center of the region and serves as the administrative, educational, health and commercial center in sub-regional and regional wise. Benghazi is the most active and dominant city in all economic sectors in the Sub-region. International, national and regional transportation connections provided through Benghazi port, international airport and regional highways; the existence of highly advanced universities, the provision of higher order administrative, public and social facilities (e.g. education, health, culture, etc.), the already accumulated commercial, business and industrial activities possess essential development potentials for the Benghazi Metropolis.

These potentials also guarantee its role in future as the primary business, trade, finance and service center not only for the Benghazi Region, but also for eastern Libya. A role for Benghazi on the international stage is also important: Oil production and the trade links have widened the range of business and economic relationships, more prominently with the eastern Mediterranean and the eastern European countries. One of the main potentials of the Benghazi Metropolis in regional scale is its location and function as the gateway to eastern Libya. Benghazi port is one of the main seaports on the African coast of the eastern Mediterranean. Therefore, Benghazi will be able to re-establish its role as an international gateway city and promote the particular character of the region.

Transportation facilities still expected to be more improved within the context of developing projects in city after war. In this context, Projects contracted before the war, which should be activated now such as Banina International Airport that will be modernized with a capacity of two million passengers per year and upgrading of Benghazi Harbor by installation of an international passengers terminal as well as construction of a new national highway that passes across the Region will render a

substantial increase in accessibility of Benghazi City. This will create favorable conditions for new investments in various economic sectors.

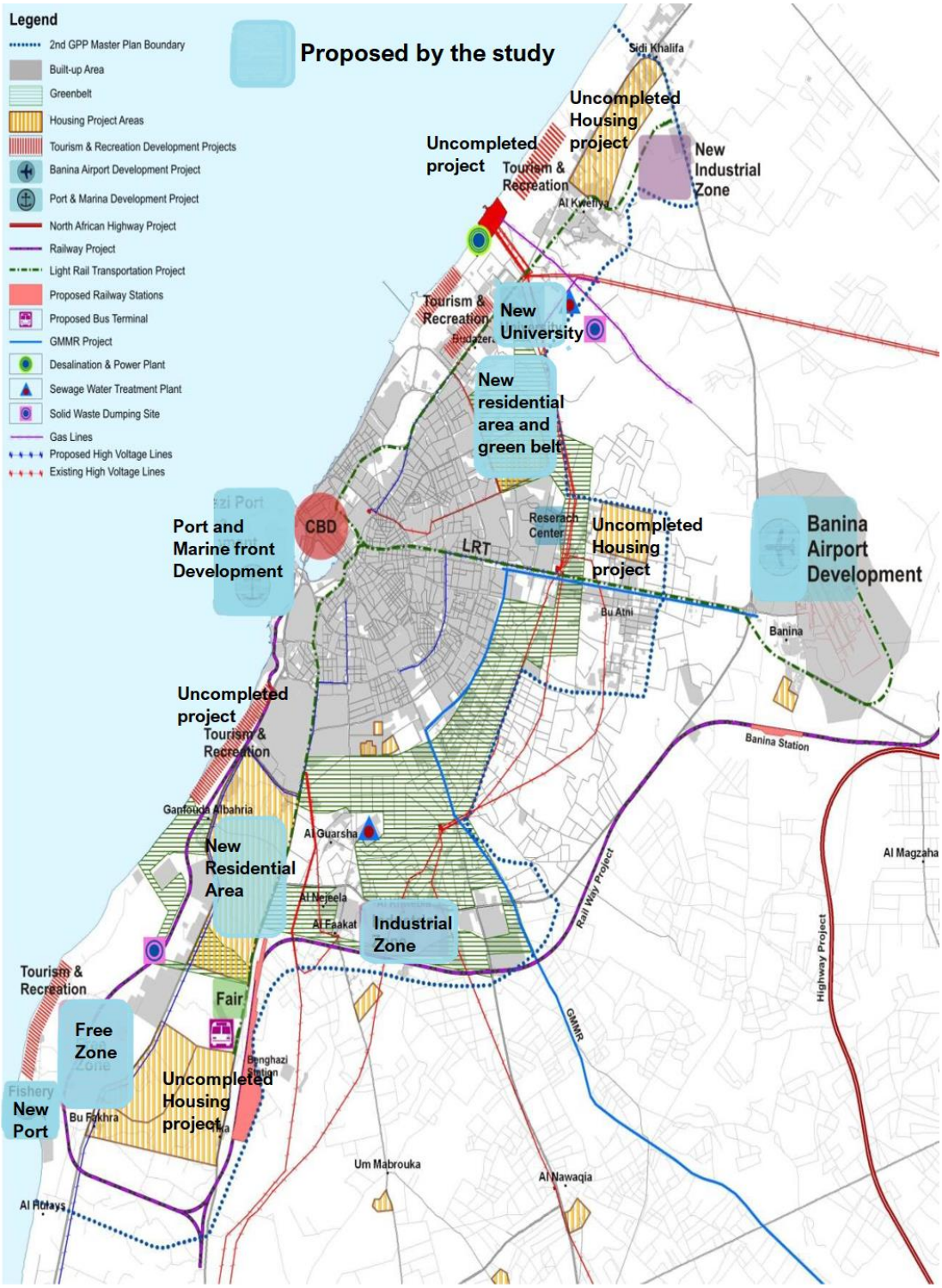


Figure 8.1. New Projects and Investments in the Benghazi Metropolis (Source: Adopted from BSRR, 2009)

In pre-war situation, numerous large scaled projects in housing, transportation, energy and infrastructure sectors have been initiated and some of them was already under construction or nearly completed and some other projects by proposed the study to achieve the environmental resilient vision of the city (Figure 8.1). These projects are;

- MMR Authority investments in Agricultural Project and water irrigation systems
- North African Highway and National Railway Projects
- Improvement of Banina International Airport
- Improvement of Benghazi Port and Fishery Port
- Metro/Light Rail Transportation (LRT)
- Solid Waste Treatment Plant, Wastewater Treatment Plant
- Power Plant
- Industrial Zone in Al Guarsha
- Housing Projects in Ganfouda, Al Guarsha, Bu Atni and Al Kwefiya
- University, Research Center, Techno Park,
- Tourism Development Sites in Al Sabri and Garyounis - Bu Fakhra
- Recreation and Tourism Projects in Coastal Zone and Lake Projects, etc.

The coastal zone with long and sandy beaches along with other natural resources such as sabkhas and lakes offer a potential for developing waterfront activities. This could be of significance for, mass tourism based on sun-sea-sand and eco-tourism attractive not only for domestic people but also for international tourism market unless the transportation, accommodation, technical infrastructure and other necessary services are provided at a desired level of quality and quantity.

As result, the Benghazi Metropolis with international, national and regional transportation connections, and service, trade, business, industry and tourism-based opportunities offers considerable development potentials in the region wise. However, in accordance with the “balanced resilient development” objective of the National Spatial Policy and the environmental resilience thinking strategies, this role must be shared by other medium-size settlements especially in the 1st Order Metropolitan Region of the Benghazi Metropolis, where the reciprocal and mutually economic relations are very intense.

The current development tendency of the Benghazi Metropolis could be explained as concentration in and around the city center coupled with unplanned development in peripheries. It is observed that the second-generation planning project has been implemented largely within the 5th Ring Road. Yet the provisions of the plan concerning peripheries remained undone. Although majority of the roads proposed in the second-generation planning project, the last approved urban plan for the city, have been constructed, there are roads remained unimplemented or partially implemented in the current situation. Functions and developments proposed in the plan inside the 5th Ring Road have largely been implemented. On the contrary provisions of the plan especially the ones concerning the areas outside the 5th Ring Road seem to be unimplemented. Moreover, provisions of the plan regarding CBD and coastal area (waterfront) have been implemented to a limited extent. The major reason behind the unimplemented provisions of the plan is considered as political and financial deficiencies.

Developments contrary to the approved urban plan are observed mainly outside the 5th Ring Road. A considerable counter development is also observed within the 5th Ring Road. On the other hand, unplanned developments exist both inside and outside the green belt. Before the intifada and political change in 2011, two reasons could be shown for counter or random developments. First, the plan has been inadequate to meet the need for housing and workplace. Second, there occurs an increasing tendency to own properties for living and working purposes. Another reason increased after the war, which is the exodus of large numbers of residents to the periphery areas to escape from the war which destroyed many buildings and large areas. Although most of the social and public facilities together with road and infrastructure facilities are lacking in unplanned developments and counter developments, the quality and value of the buildings in these areas are high.

It is appropriate to conclude that population goals set in 2nd GPP for the Benghazi Metropolis has not been achieved. Realization rate of population projections has been very low especially outside the 5th Ring Road. In this regard assessment of 2nd GPP enables to redistribute the population.

Here, the development constraints of the Benghazi Metropolis are defined within spatial, social, economic and administrative context:

- The concentric-compact city macroform with one dominant CBD structure and lack of sub-centers increase the development pressure and spatial problems in CBD and central districts; and restricts the development of further central and business activities in metropolitan level.
- Building density and traffic congestion in CBD; lack of well-defined road network and insufficiencies in parking areas; incongruity between building heights and road widths; lack of pedestrian roads and zones; insufficient technical infrastructure and lack of some essential social and cultural and leisure facilities constitute the main constraints for the spatial and functional development of CBD.
- Private car-based transportation and lack of different mode of public transportation systems have increased the traffic problems and have restricted the mobility of people and the spatial developments as well.
- The problems of lacking of well-designed and equipped green-open areas; the deficiencies in social and cultural facilities at residential or city level and the poor maintenance at building and living environment scale in the built-up area should be overcome to contribute the development of social life and improve the quality and standards of living environment. Although there is a green belt in the city, it is unexploited and unimplemented, and the planned areas of it were violated.
- The lack of technical infrastructure in metropolis level and the poor management in collection and disposal of solid waste could potentially hinder future developments as they lead to environmental pollution and weaken the attractiveness of Benghazi for new investments within the planned area of the city.
- Deterioration of cultural heritage buildings in Historic City, lack of protection mechanisms and the excavation works in archeological sites have weakened the City identity, the cultural richness and the tourism potential of Benghazi Metropolis.
- The coastal highway with heavy and speed traffic creates a barrier between residential districts and coastal areas and weaken the accessibility and development of coastal zone.

- Insufficient accommodation and recreation facilities in coastal zone, and lack of planning, urban design and landscape projects for the sabkhas and lakes that should be utilized by protecting their unique, ecologic and natural characteristics could be defined as other constraints for the development of the daily recreation and tourism activities in the Metropolis.
- The military areas in central districts; the industrial, warehousing and handicraft type of functions within the residential areas; slum process in built-up area especially between 3rd and 5th Ring Road; and uncontrolled random developments concentrated in Bu Atni Zone and outside the 5th Ring Road have led to irrational use of urban lands, which should be utilized more efficiently for residential developments and public services.
- Partial projects implemented without having an integrated master plan of land use, transportation and infrastructure lead to speculative and unplanned urban developments, and also increases the urbanization costs.
- The limited share of private establishments in economy, on which the public initiative is already dominant, is a significant constraint to create an efficient and competitive economic structure. So, the necessary legal regulations and financial incentives should be supplied for private investment especially in small and medium-sized industrial establishments in order to develop the economy of Benghazi and to decrease the dependency of economic development and employment to public sector.

Centralized (top-down) planning, weak responsibility of local administration in hierarchical structure and lack of participation of people to decision-making process constitute the administrative and organizational constraints to define the local expectations, priorities and initiatives for further developments as well as to manage or direct the plan implementations and new projects.

The activation of the potential projects will inevitably accelerate economic and social developments in the Benghazi Metropolis and will affect the demographic, spatial and employment structure in the capital. However, it should be included within the

proposed action plan and integrated into the city's capacity building process. Implementing an environmental resilience strategy.

In the context of land suitability analysis, the natural and infrastructural thresholds including natural limits, protected areas, agricultural areas, and green belt that should limit the spatial developments outside the urbanized area and the boundary of the approved plans to some extents have been defined in Section 4.8.6. and demonstrated in Figure 8.1.

8.2. Current and Future Urban Development of Benghazi That Affect its environmental resilience

Here, the study reached a synthesis about current development patterns and future urban development tendencies and possibilities of Benghazi that affect urban sprawl and environmental resilience of the city. I will discuss in 9.2.1 the current urban development of the city. In 9.2.2, the future urban development tendencies and possibilities will be discussed.

8.2.1. Current Urban Development of Benghazi City

The Benghazi Metropolis covers an extensive half circle in the form of concentric zones extending from Al Kwefiya in the northeast to Ganfouda in the southwest, with a sectoral growth in east encompassing the areas of Bu-Atni and beyond along the airport road.

The natural resources, namely the Mediterranean Sea and coastline, the Sabkhas that forms a ribbon parallel to sea have played a major role in the identification of city macroform by limiting the urban developments in coastal zone. Benghazi City in terms of macroform was perfectly adapted to these natural conditions during its development process. The city has spread out in east, south and north directions concentrically by starting from a nodal point named as Old Benghazi. Radial roads extending towards this nodal point (eventually associated with the CBD) are interconnected by ring roads and both categories then constitute the backbone of the overall urban development.

Certainly, the concentric-compact urban macroform and the urban structure in terms of land use and road network has been greatly influenced and shaped by the previous two

master plans dominated in the last half-century. New residential areas during the 2nd Generation Plan Period have spread along the arterial roads. It is seen that the City is mostly developed inside the 5th Ring Road. High density in central areas, and traffic congestion and parking problems in city center is one of the main urban problems faced in the city.

As mentioned previously, the second generation of plans is the last approved planning project in the city. The existing urban area of the Benghazi Metropolis covers 10,172 hectares land in total. 45.4% of the existing urban area was developed prior to 2nd GPP. However, 22.3% of it has been developed in conformity with 2nd GPP master plan. Percentage of developments which are contrary to master plan is 15.2%, whilst the development outside 2nd GPP is 20.1% (See Table 8.1).

Table 8.1. Physical Realization of 2nd GPP (Source: Adopted from: AlEmara, 2009)

Planning Zone	Zone Area (ha)	Urbanized Area 2006	Urbanized Area Before 2nd GPP	Development Consistent with 2nd GPP	Development Contrary to 2nd GPP	Development Outside of 2nd GPP
Benghazi Agglomeration	8,761	5,806	4,058	1,385	567	-
Benghazi Fringe	3,416	1,623	153	32	203	959
Benghazi North (1)	4,161	1,239	19	433	483	304
Benghazi South (2)	7,500	1,504	390	421	196	479
Benghazi Metropolis	**23,838**	**10,172**	**4,620**	**2,271**	**1,449**	**1,742**

(1) Budazera and Al Kwefiya
(2) Ganfouda, Bu Fakhra, Al Guarsha

The implementation rate of 2nd GPP within the 5th Ring Road is determined as 23.9%, which could be accepted as a high rate and 9.8% of the total area within the 5th Ring Road has been developed in contrary to the master plan. Unplanned developments and developments that do not comply. This is mainly due to lack of mechanisms that are in charge of plan implementations, acquisitions of large scaled private land for urban development, deviations in the plan prospective as well as rapid growth in urban and population development. With the former master plan proposed land use are becoming widespread in peripheral areas of the Benghazi Metropolis.

Partial project implementations and random developments had started to increase especially outside of the 5th Ring Road to meet the land requirement for new investments in different sectors and housing need of the city people, especially after the war destruction of the city center high-density areas. The random housing developments on the green belt and along the Banina Road have a tendency to develop by sprawling on the fertile agricultural lands in periphery of the city. Also, a considerable unplanned development has emerged through Al Nawaqia - Solouq Road (See Figure 8.2), where the establishment of the cement factory has been the attraction zone for the unplanned developments in this direction. The ribbon strip developments along the coast have also a tendency to grow. The Central Business District (CBD) of the Benghazi Metropolis has been developed with a compact and dominant single center characteristic. The CBD comprises the trade and business functions, the various public and administrative function; health and education facilities; and cultural, social and recreation functions.

Figure 8.2. Conceptual Diagram of Current Developments in the Benghazi Metropolis (Source: Adopted from BSRR, 2009)

This structure is expected to encourage the development pressures in the center as to lead to further increase in densities; increase in the vehicular traffic on the radial roads running out into CBD; and increase in infrastructure and parking problems. This also may lead to a destructive development process for historical and cultural values in Historic City where the historical buildings that have importance for the identity of the city, parts of which were destroyed by the war. It is observed that the internal trips that have both origin and destination within the city constitute the great majority of all trips, indicating short travel distances. CBD is the area, where the largest proportion of trips has their origin or their destination. This is quite understandable as most of the administrative, business and commercial activities, as well as the port, as a major traffic generator, are located in the CBD and adjacent areas (See Figure 8.2).

In current situation residential areas between the 3rd and 5th Ring Road have low standards in terms of building and environment quality, in addition to lack or low standards of public, social and cultural facilities. So, slum process in those areas is clearly observed. The war has also devastated much of the city's high-density areas such as the Al Sabri and Sidi Hussein areas, which are between the coastal road and the First Ring Road. And because the residents did not find a difference between the lack of services in these areas, which are considered within the approved plan, and living in the outskirts of the city with the lowest price for land and housing. This made them prefer moving to the sides to escape first from war and also from congestion and to demand more space of land. All this led to the spread of urban sprawl and environmental degradation in the green belt of agricultural lands in the city periphery.

The most common mode of transportation for inner-city trips has been based on taxi and private car transportation. Car ownership is continuously increasing as a consequence of rise in the average household incomes. This situation is worse after the war and expected to generate a serious increase in trip making and consequently the traffic problems and increase of urban sprawl in the city.

8.2.2. Future Urban Development Tendencies of Benghazi City

Although the target year of the existing master plans has expired, substantial amount of areas and zones, in which the provisions of the plan are not implemented, exist.

These areas and zones should be evaluated and undertaken in such a way to direct the new planning studies, especially the studies regarding the development potentials (See Figure 8.3). The comparison of the current situation and existing master plans indicates that most of the areas, which were designated as residential and industrial areas in Ganfouda, Al Guarsha, Al Askan Al Sinai, Budazera and Al Kwefiya outside the 5th Ring Road are not developed yet.

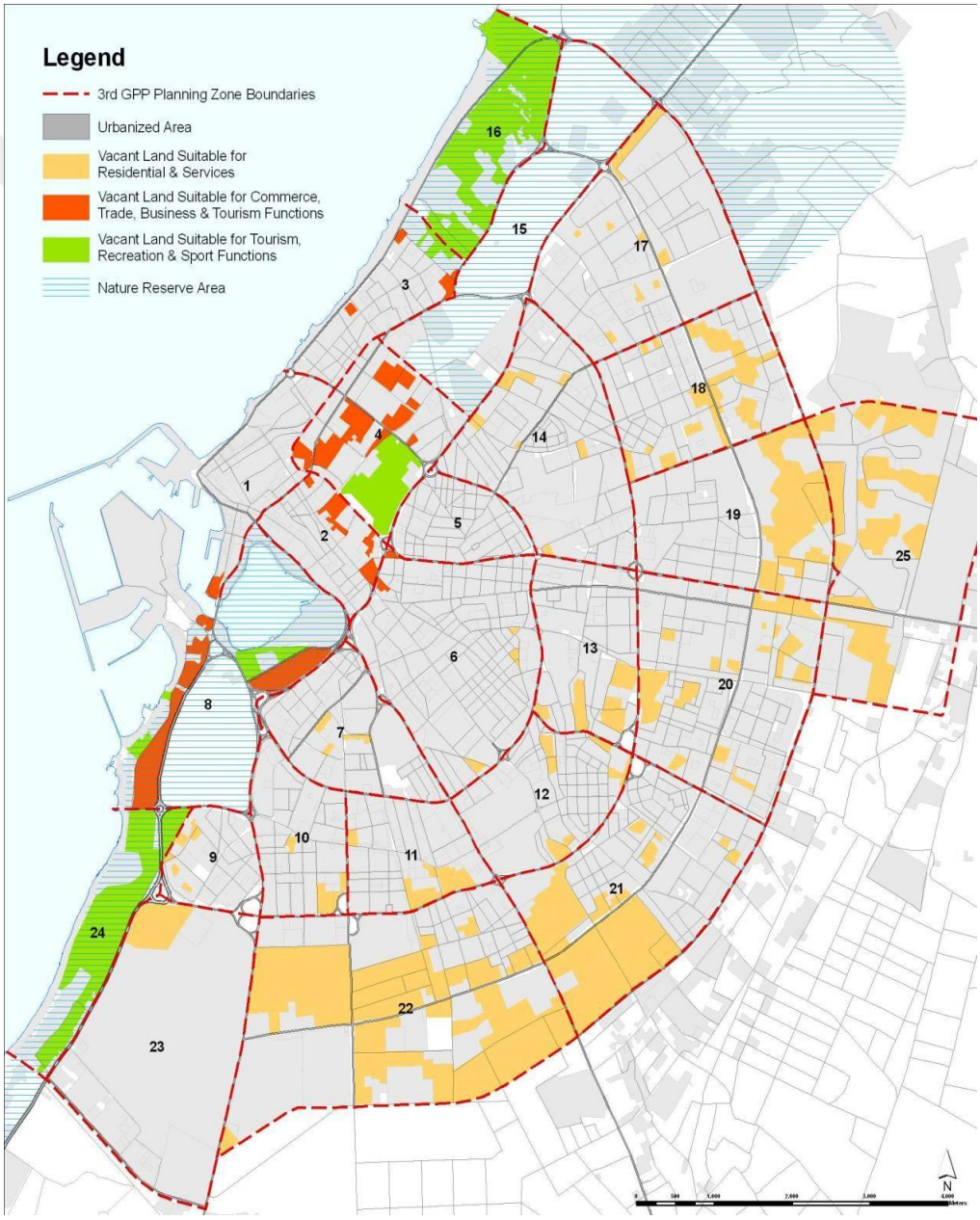


Figure 8.3. Vacant Lands and Possible Potential Landuse (Source: Adopted from AlEmara, 2008)

Table 8.2. Unimplemented Decisions of 2nd GPP Master Plan (Source: Adopted from: AlEmara, 2009)

Planning Zone	Residential				Industry	
	Unimplemented Residential Areas (ha)	Reserve and Additional Residential Areas	Total Unimplemented Area (ha)	Total Unimplemented Population Potential	Unimplemented Industry and Warehousing Areas (ha)	Industry Zone Outside 2nd GPP
Benghazi Agglomeration	470	-	470	38,100	-	-
Benghazi Fringe	446	-	446	30,000	152	-
Benghazi North (1)	137	776	913	64,000	707	387
Benghazi South (2)	1,232	1,141	2,373	173,000	803	-
Benghazi Metropolis	**2,285**	**1,917**	**4,202**	**305,100**	**1,662**	**387**

(1) Budazera and Al Kwefiya
(2) Ganfouda, Bu Fakhra, Al Guarsha

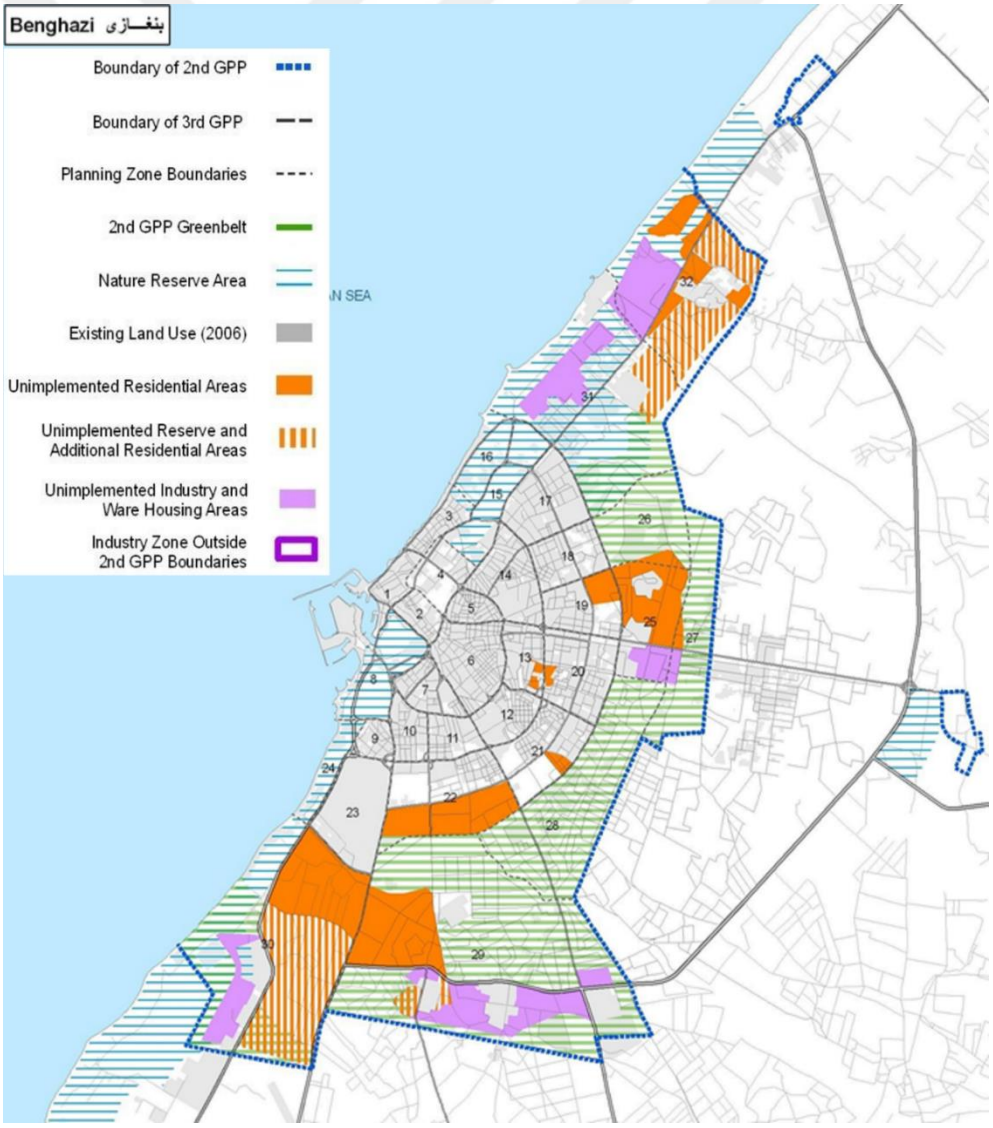


Figure 8.4. Unimplemented Areas of the last approved plan (Source: Adopted from BSRR, 2009)

Consequently, there exists development potential of settling 305,100 people within 2nd GPP boundaries in the Benghazi Metropolis. This potential is derived by considering the unimplemented residential developments; the reserve areas designated in 2nd GPP; the developed new housing projects; and the agricultural lands that could be subjected to residential development. The areas destroyed by the war have also been added as available space, which can be included among the areas used for resilience development. Besides, new planning studies should also consider the housing projects, which have a total population capacity of 58,000 people, developed for the areas outside 2nd GPP (See Figure 8.4).

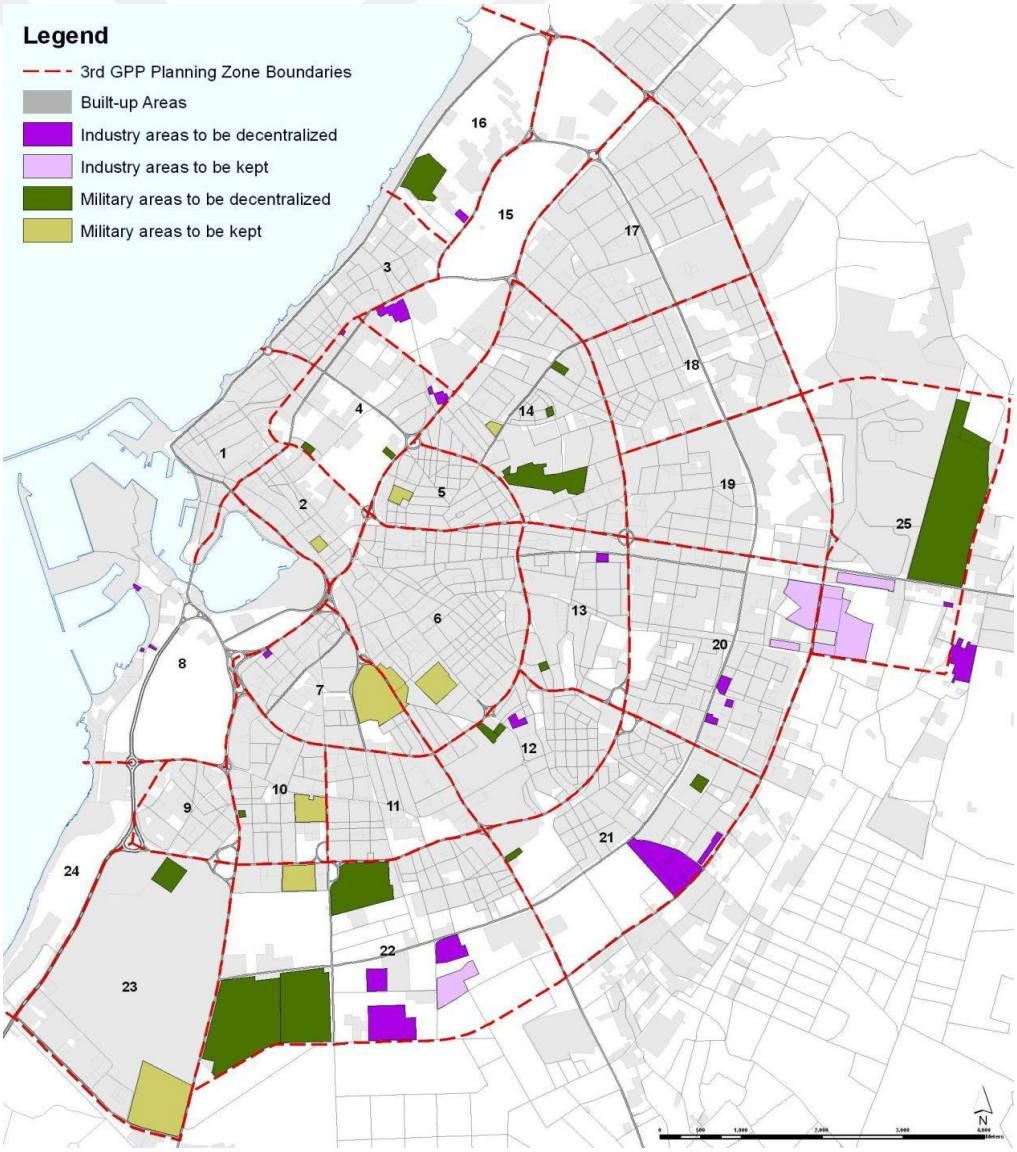


Figure 8.5. Potential Decentralization Areas in the Benghazi Metropolis (Source: Adopted from AlEmara, 2008)

Some military areas within the 5th Ring Road as well as the industrial, warehousing and handicraft establishments especially in central districts presents a considerable land potential, which can be utilized for residential developments, commerce and business, social and cultural facilities, and recreation and waterfront type of activities.

In current situation, the military areas cover 520.7 hectares area, whilst the industrial uses cover 198 hectares area in built-up area. 383 hectares of military areas and 110 hectares of industrial establishments are expected to be evacuated. Accordingly, 493 hectares land in central areas, most of which was destroyed by the war, could be supplied for the urban functions, as the decentralization process is completed (See Figure 8.4 and 8.5).

Table 8.3. Decentralization Possibilities in Benghazi Built-up Area

Landuse	Total Area (ha)	Potential Decentralization Area (ha)
Military Zones	520.7	382.7
Industry	198.0	110.2
Total	**718.7**	**492.9**

The field studies and analysis executed as a part of 3rd GPP studies indicate that some housing areas inside the 5th Ring Road and at Al Askan Al Sinai zone and areas totally or partly destroyed by war have been worn-out in terms of quality of buildings and standards of public services such as road and technical infrastructure, and social facilities environmental problems.

As the planned areas are concerned, the slum process at building and environment scale is easily observed in residential areas developed before 1980. Areas having the above-mentioned physical, functional and environmental problems within the 5th Ring Road exist largely in areas located between 3rd and 5th Ring Roads, particularly in neighborhoods named as Al Zaitun, Al Fatih, Al Mukhtar, Ali Ben Abi Talib and Boudhima. Besides, Al Askan Al Sinai region outside 5th Ring Road have to be assessed within this context. The total area subject to slum process is 1188 hectares, of which 212 hectares are in need of urgent renewal including the areas that destructed from war in the CBD as they have very adverse conditions, whilst the rest 690 hectares could be subject to rehabilitation or renewal (See Figure 8.6) (BSRR., 2009).

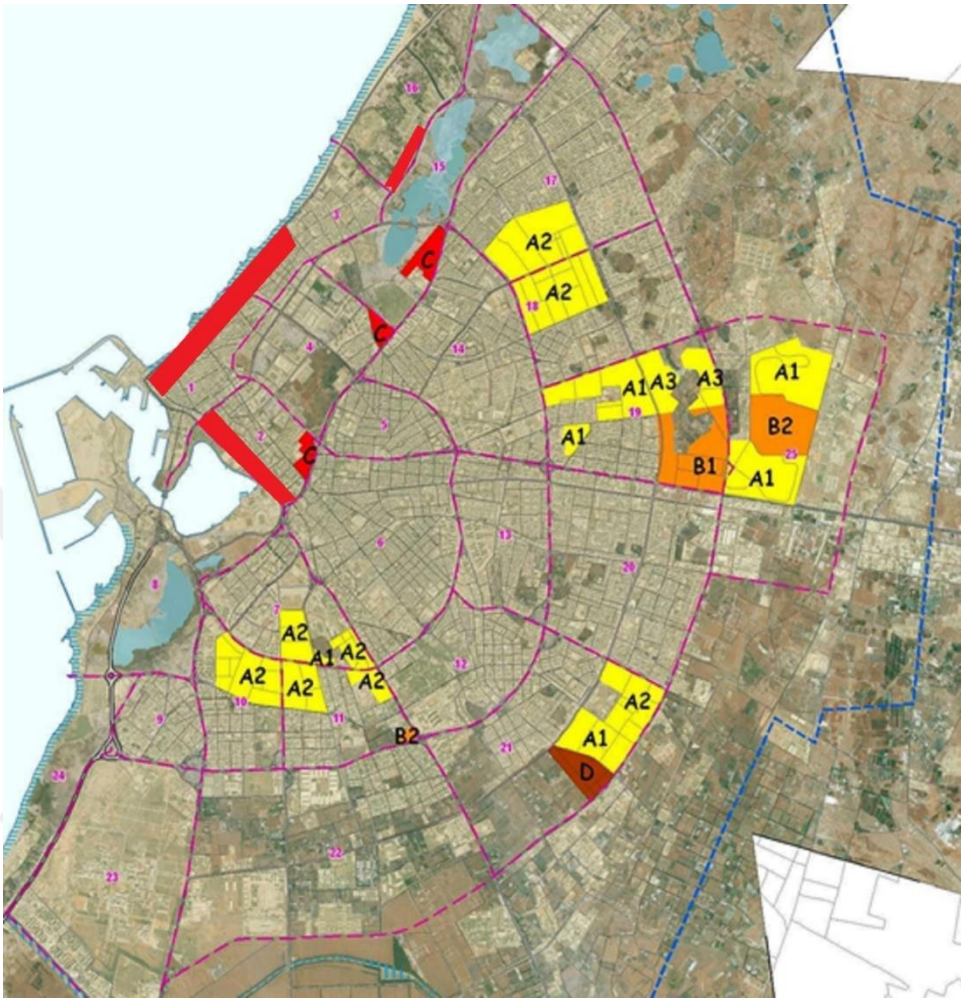


Figure 8.6. Slum Areas in the Benghazi city (Source: Adopted from AlEmara, 2009)

The periphery areas of Benghazi City have been developed as contrary to master plan. Those urban sprawl development cover 3,705 hectares area, where the residential buildings constitute the majority. The main reasons behind the random developments are the deficiencies in housing produced by the government and the preferences of people to have their own land and housing. The other reason is the war destruction of some density districts in the city center after 2011. Urban sprawl and random housing developments are mostly concentrated between the 4th and 5th Ring Roads; in Bu Atni zone; and on the green belt especially in south, east and northeastern part of the city.

This study indicates that 90% of urban sprawl mostly exist on rocky lands, agricultural lands and barren lands, whilst 10% are developed on sandy lands and sabkhas. Average

plot size is 550 – 600 m2, on which buildings are mostly constructed as one or two story. However, 3 or 4 story buildings are rarely found in urban sprawl areas. Urban sprawl buildings that were built during and after the war are often one or two stories high, and they are made of cement, but they are low quality and standards than their predecessors before the war.

The urban sprawl areas are assessed in the master plan according to quality and function of the buildings, and spatial and environmental conditions as well. The qualified buildings could be kept by improving the existing standards. However, sprawl buildings constructed in natural reserve, green belt and agricultural projects areas or those ones comprising inconsistent functions with the environment could be more subject to evacuation. This process needs a field study within the of developing the environmental resilience of the city.

The synthesis of future urban development tendencies included the process of evaluating the implementation of the second generation of the approved plan, clarifying the empty spaces inside the plan and the areas destroyed by the war and locating the possibilities of decentralization areas in the city, especially in military installations inside the city, some of which are destroyed by the war, to establish new sub-centers within the city approved plan. These proposals may help attract urban sprawl within the city boundary and reduce stress on the green belt and agricultural areas.

The synthesis clarified the worn-out housing areas between the third and fifth ring roads, areas totally or partially destroyed by the war in the city center. The slums areas were assessed in terms of physical, functional and environmental problems and their total areas and areas that could be subject to rehabilitation or renewal were clarified. The areas of urban sprawl and its directions and the difference between the urban sprawl buildings before and after the war were included in the synthesis. The synthesis included evaluation of the urban sprawl areas in the master plan according to the quality and function of the buildings, as well as the spatial and environmental conditions and risks.

8.3. Suitable Lands for Further Urban Development with Respect to Environmental resilient Benghazi

A threshold analysis is made to determine the suitability of the areas outside the urbanized/built-up areas for urban developments). National Spatial Policy Report as a basic document for directing spatial developments in whole country is emphasized in the Report of NSP, the concept and approach of "balanced resilience development sensitive to Environment" should be considered in urban planning process by establishing a balance between the spatial and economic developments and the protection of natural, ecological and cultural environment.

In fact, the environment, natural resources and cultural heritage areas constitute the main constraints or thresholds for the spatial developments. Thresholds consist of natural, physical and structural factors guiding the development of the settlements and restricting the developments. Threshold can either be overcome by meeting certain costs or can definitely restrict the development. They are classified in three groups;

- Geomorphologic and geological thresholds
- Thresholds based on resource potential
- Thresholds originating from infrastructural constraints

In the Benghazi Metropolis, the lakes and sabkhas (soft lands) between the highway and the coastal belt, the coast itself and the fertile agricultural lands in east and southeast zone of the Benghazi City are assessed as the significant natural constraints, which should be precisely and carefully evaluated to achieve a sustainable development in the Benghazi Metropolis. The threshold analysis indicates that the areas suitable for urban development's outside the settled areas are very limited in the Benghazi Metropolis.

The coastal zone with their unique and original characteristics should be protected. In fact, the coastal area at a distance of 100 meters from +/- 0 point of sea line is prohibited by the current laws for any construction. Besides, the back zone of the coast, ranging in between 500 – 2,500 meters, geologically is not suitable for development. This zone at the same time consists of sabkhas and lagoons defined as natural reserved areas due

to their ecological significance. So, the plan strategies as to achieve the protection the ecologic system and natural structure of this zone should be highlighted. Moreover, the environs of cartaceous lakes in Budazera and the cartaceous holes named as “Hawa” exist in Al Kwefiya and some other areas in metropolis should be functioned as to protect their natural and agricultural characteristics (See Figure 8.7).

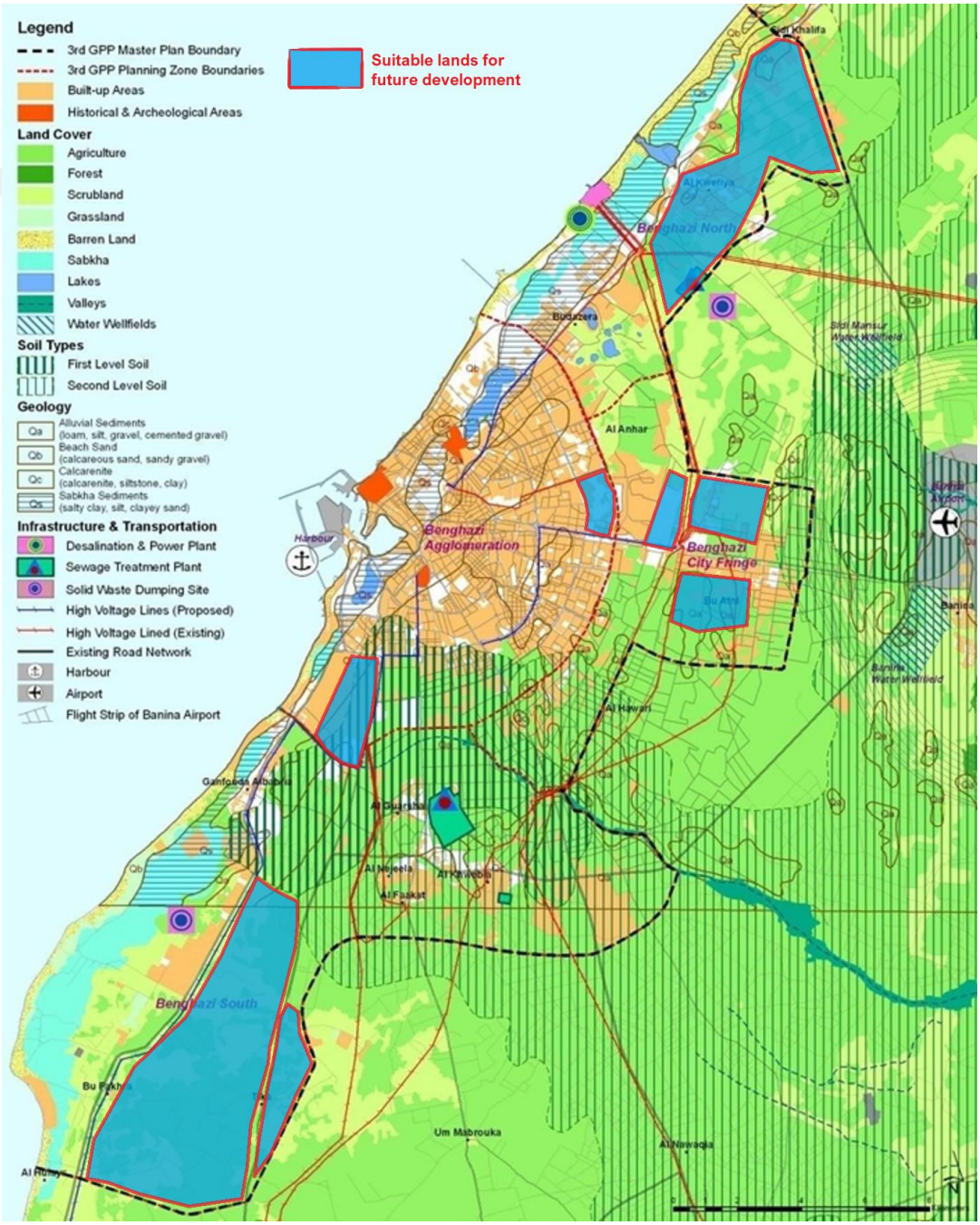


Figure 8.7. Threshold Analysis and suitable land for future developments in Benghazi city (Source: Adopted from BSRR, 2009)

The agricultural potential of the fertile lands in the vicinity of Benghazi City, especially Al Guarsha in south; Bu Atni in east and the lands on Banina Road is considerably high. The protection of these agricultural lands gains importance not only to enhance the existing natural economic resources, but also to keep their functions as green belt in the peripheral zone and contributions to microclimate. Based on the assessment of thresholds, the development potentials of the Benghazi Metropolis are evaluated by three plan zones (See Figure 8.7):

- **Benghazi Agglomeration**

Benghazi agglomeration comprises the areas within the 5th Ring Road, which are mostly urbanized (See Figure 9.9).

- The coastal zone, except harbor area, has the opportunities for the waterfront recreation.
- The back zone of the coast, where the sabkhas as natural reserve areas form an ecologic belt present favorable conditions for tourism and recreation activities.
- The south region of Benghazi agglomeration has rich agricultural soil with high fertility, and high recreation potential at the same time. However, these areas are under the risk of flood as the region stands within Al Qattara Valley.

- **Benghazi Fringe**

Benghazi Fringe that surrounds the east of 5th Ring Road is partially settled (See Figure 8.4). The agricultural resource potential is highly rich in this zone. Currently those areas in Al Hawari, in Bu Atni and on Banina Road are mostly utilized for agricultural purposes. The agricultural land is partially common in Al Anhar Zone as well. This area, which was planned as green belt in 2nd GPP Master Plan was supposed to be kept with its green belt characteristic. However, unfertile agricultural lands in this zone could be utilized for urban developments (See Figure 8.8).

- **Benghazi North**

This zone includes the settlements of Budazera and Al Kwefiya. The zone behind the coast, which has a 2 km width in between the sea and the Road of Benghazi – Tukra is characterized by sabkhas and lagoon lakes reserved as natural protection area. The

coastal zone and close environ of Ain Zaiyanah Lake could be functioned for recreation purposes (See Figure 9.9).

It is essential to evacuate the industrial zone in Budazera to achieve the continuity of ecological system lying till the city center. The cartaceous lakes with their environs in Budazera have also the status of natural reserve area. If this zone is protected and utilized for recreation purposes, it could be possible to have a green belt surrounding the Benghazi agglomeration. The agricultural potential in the vicinity of Al Kwefiya is almost low. The agricultural activities are partially carried on in south and north of the settlements.

- **Benghazi South**

The ecologic system formed by sabkhas continues in south part of the city. The agricultural characteristic of this zone is highly dominant. As Ganfouda and Al Guarsha stands at the valley of Al Qattara, the agricultural land has high fertility and mostly used for agricultural purposes.

Therefore, the protection of agricultural resources has a primary priority in this zone. Prioritizing of thresholds in planning process are determined according to the changes in legislations, planning principles and policies, size and distribution of development areas, targets of the planning, need for land and macroform policies (See Figure 9.9).

In this section of the synthesis, various analyses have been made in order to determine land supply potentials within the approved plan boundaries to meet the residential and other urban needs of the Benghazi Metropolis. Land demand should be investigated after this process, this will be suggested in the future study.

As the land is a scarce source that would not be increased, rational utilization of land is primary principle to achieve a resilient urban development sensitive to the city environment. The population increase, and the expected structural and functional changes, transformation process and war affect faced in the Benghazi Metropolis are the main factors generating urban land need.

The vacant lands in built-up areas, which are suitable for settling; some military areas to be evacuated in the context of decentralization policy referring to industrial,

warehousing and handicraft type of establishments in central districts to be transferred to outside the city. The physical renewal and functional transformation possibilities in slum areas, and finally the randomly developed areas constitute a substantial opportunity for land supply within the urbanized area of the Benghazi Metropolis in order to meet partially the existing and future landuse needs.

In the phase of specifying the urban development areas, physical thresholds, green belt, agricultural areas, natural resources, and the big-scale technical infrastructure and energy establishments as well should be taken into account as the factors constraining the development largely in order to protect the environmental assets and to decrease the urbanization costs. In the context of land supply policies, the coastal area, sabkhas and other natural reserve areas should also be precisely assessed.

The analysis regarding the potential development areas within the approved plan boundaries comprised the following issues:

- Vacant lands in built-up areas
- Decentralization possibilities
- Unimplemented Area of the approved plan
- Renewal possibilities in slum areas
- Urban sprawl areas
- Thresholds analysis and possible development areas

Potential development areas mentioned above have utilized in accordance to the following goals:

- to prevent and control the urban sprawl tendency in peripheries and to improve the spatial and environmental resilience and quality of these areas by further renewal and rehabilitation projects.
- to determine new urban development areas; to renew the worn-out texture in built-up areas; and to develop urban projects in decentralization areas

- to prevent overpopulation and to reduce transportation and parking problems in central zone
- to supply land for further trade, business and tourism activities within the city plan boundaries
- to improve the urban standards and the quality of living environment by developing the public, social, cultural and recreational facilities and coastal or waterfront activities serving at either neighborhood and district scale or the metropolis scale
- to use urban land more efficiently and to improve the quality of living environment by developing renewal and rehabilitation projects for slum areas

8.4. A Synthesis of Analysis for Environmental Resilience of Benghazi

As previously mentioned, below synthesis analysis for the environmental resilient Benghazi has been carried out to reveal "where the City stands today" to set the basis for where the city should go (See Table 8.4). This would further be incorporated in the updating of `vision`, `policies` and `strategies` leading to development of `actions` and `plans`.

Now, with the deep realization of the current situation of the city, analyzes of potential trends and opportunities for urban growth, and according to comprehensive analyzes of thresholds for protected areas, the green belt and agricultural lands, the study can move forward developing the environmentally resilient framework for the city by specifying goals and strategies for reaching this framework.

Synthesizing analyzes of strengths and weaknesses opportunities and threats to the city that directly or indirectly affect the problem of urban sprawl and environmental degradation will help formulate specific goals and plan of actions to increase the city's capacity to cope with environmental vulnerability and control and prevent future urban sprawl.

Table 8.4. Synthesis Analysis for environmental resilient Benghazi (Source: Author)

STRENGTHS	OPPORTUNITIES
• **A long seaside for diverse utilization possibilities** • **A relatively appropriate infrastructure** • **MMR Authority`s contentious investments in agricultural production, water supply and irrigation systems** • **Various types of ongoing housing projects**	• Construction of public transportation new highway and railroad • Integration of railroad and harbor • Redevelopment of seashore for tourism and commercial purposes • Encouragement of the private sector-led development • Structuring institutional organizations for innovation, expertise and technology spillover and their extensive services within the city plan boundaries • Proper climate for university-industry cooperation Large fertile agricultural land for development of agropolitan centers around Benghazi Metropolis • Renewal of housing stock
WEAKNESSES	**THREATS**
• **Political instability+ War affects** • **Migration** • **Several limitations for urban development** • **Lack of public transportation system** • **Weak institutional basis to spillover expertise and advanced technology** • **Inadequate recreational and socio- cultural facilities** • **Pollution from cement factory in the southeast and desalination plant in the north.** • **Contaminated natural environment** • **Limited expertise in management of irrigation systems and practices**	Growing industrial pressure Invasion of environmentally sensitive areas through rapid urban sprawl Desertification Over usage of underground water in vicinity of the Metropolis Extensive development of seashore area for tourism sector investments Traffic congestions Excessive growth trends in coastal lines Loss of fertile agriculture land around Benghazi

CHAPTER IX

9. ACTION PLAN AND STRATEGIES FOR ENVIRONMENTALLY RESILIENT BENGHAZI

After synthesizing the results of analyzing both primary and secondary data, a deeper understanding was reached of the city's post-war situation and the opportunities and strengths of the city to cope with urban sprawl and environmental vulnerability, as well as weaknesses and threats resulting from the war and from urban sprawl that affect increasing environmental vulnerability. The syntheses also gave a comprehensive understanding of future development trends after evaluating the implementation of the existing plan displaying the non-implemented and vacant areas and clarifying the suitable areas for future developments and decentralization opportunities.

From this synthesis, it is now possible to define strategies and goals that must be taken to build the capacity of the city and to reach a resilient environmental vision for the city. A proposal for an environmental resilience action plan will be presented according to the objectives of the city vision.

9.1. Planning Conceptual Synopsis

In order to explain the planning intentions focused on a certain metropolis or a city amply along with particular planning objectives as conceptualized within a consistent planning framework, it is an adequate approach to undertake a synthesis, which already implemented in the previous chapter, of (Strengths, Weaknesses, Opportunities, Threats) analysis which is a useful decision making and planning instrument.

While the synthesis ; on the one hand, reveals the current situation and structural features when applied to Benghazi city, it also; on the other hand, avails an appropriate basis for formulation of prospective steps to be undertaken for capacity building and environmental resilience maximization and competition-oriented actions. These attitudes require effective mobilization of local strengths and elimination of weaknesses for structural betterment purposes, whilst utilization of opportunities and diminishing threats for future environmental resilient oriented actions.

Based on the overall outlooks of the synthesis and development political views and aspirations, an environmental resilient plan for the future of the city could be verbalized, in which paramount and utmost development aim is articulated. This is the VISION demarcated for the city revealing a widely accepted and broadly shared desire of stakeholders and citizens as well as governmental and nongovernmental initiatives as the environmental resilient future image of the city.

The formulated concise vision for the development of the city has to be supported by decisive policies and strategies. Policies and strategies open the lanes for MISSION in compliance with the vision and accordingly give indications and orientations to tasks and obligations of decision makers, planners and practitioners. While the synthesis defines “where the city stands now”, the vision defines “where the city should stand in the future”. Policies and strategies determine the mission for achieving the environmental resilient vision; and in this respect, the strategies are the means and instruments which would build the city capacity to cope with the effect of war and urban sprawl on environment and carry it from current status to desired prospective status.

Synthesis together with the formulated vision that sensitive to environmental resilience and supportive policies as well as missionary organizations identifications are all components within the decision-oriented context of planning. based on the decision-making components, physical plans and action plans stand as implementation instruments in action-oriented context of planning. In such an approach, a rational methodology has been set up by interrelating successively synthesis with vision; vision with mission (policy and strategy); mission with plan and action. All these

consecutively undertaken planning steps constitute together the action and decision contexts of developing the resilience framework for the Benghazi city.

Keeping in mind the planning as a process which functions with monitoring, evaluation and control mechanisms for steady system betterment intentions and in anticipation of any disturbances, it is indispensable to incorporate the feedback actions to the planning frame, as well. Consequently; synthesis, vision, mission (policy and strategy), plan and action along with feedback steps compose the environmental resilience framework development prospects in all. The development prospects include decision, action and feedback contexts and constitute the planning conceptual synopsis (See Figure 9.1).

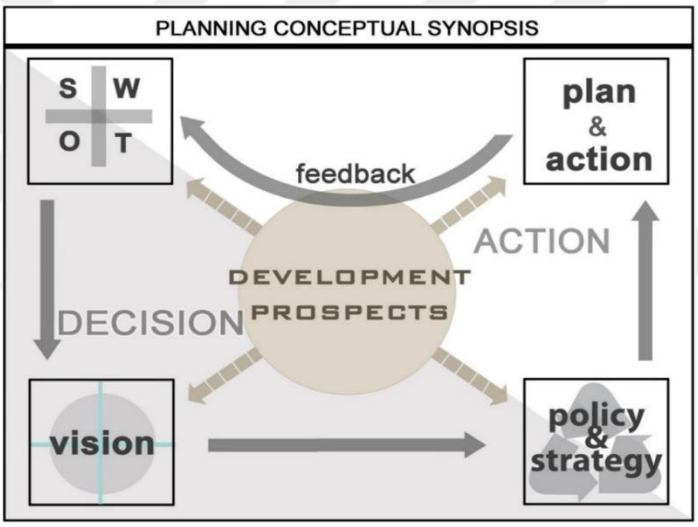


Figure 9.1. Planning Conceptual Synopsis (Source: Author)

Planning conceptual synopsis is a general framework, which contains essential components of planning and decision making in creating and designing environmental resilient urban development and action plans. It is furthermore the framework in which local spatial planning and local functionality planning approaches are integrated and reflected in physical planning structures and mixed landuse distributions.

The planning conceptual synopsis is a dynamic framework where planning for environmental resilience is handled as a process and based on iterative betterments by help of feedback loops in decision and implementation stages. Such an approach also adds dynamism to urban planning which is substantial in resilience planning in general.

It integrates the sensitive vision of the city's environmental resilience with the results of the synthesis within the strategies to formulate the action plan that achieves this vision.

9.2. Future Development Strategy and Goals for Environmental Resilient Benghazi

Based on the vision that was previously identified for the city and that will be environmentally sensitive and resistant to urban sprawl. Benghazi as a prospective global gateway, economical and tourism city that planning and environmental resilient city on North Africa has to maintain the metropolitan characteristics of the Benghazi in global context in accordance with the agropolitan development in the Benghazi Sub-region and developing the Metropolis as an economy, industry, and knowledge center of the entire region via information and communication-based technologies and innovative industries.

The development vision of Benghazi Metropolis is to be a global gateway, economical and tourism city that planning and environmental resilient as gaining a knowledge center role supported by advanced information and communications-based technologies and innovative industries. This has to be relied on respecting environmental, ecological, and cultural values while increasing the productivity and establishing a balance between the inherited and created wealth.

This strategy should follow an environmental resilient balanced development policy, which is ensured as depending on mobilization of metropolitan and utilization of agropolitan resources. Large availability of fertile agricultural land around the Metropolis has been relatively utilized by MMR Authority`s investments in agricultural production and water irrigation systems. The strategy supports and aims to facilitate implementation of these projects in order to achieve agropolitan centers where most appropriate. Therefore, agricultural lands within Benghazi Metropolis have to be protected from the urban sprawl and surrounding rural settlements should be developed as agricultural production based urban centers.

Being envisaged as a metropolis would also require high accessibility by extensive use of public transportation means, particularly of Light Rail Transport System; multi-

modal transportation nodes; efficient transfer availabilities between the CBD, airport, and the seaport. This will attract residents to the city to benefit from this public transportation and other urban services within the city planning boundary.

Long and unspoiled seaside of Benghazi is proposed to be developed as touristic sites. Beside permanent and static 3S (sea, sun, sand) alternative; archaeological, cultural, historic, environmental and ecologic values are to be restored from the war destruction and blended with diversified tourism activities for enriching alternatives and creating attractions for local, national and international target groups. It is specifically important that land uses of recreational areas along with historical sites and unspoiled natural areas are well integrated through the city planning works.

On the other hand, the quality of life should be upgraded with diverse housing projects in Benghazi Metropolis whilst urban renewal of downtown, reconstruction and redevelopment of coastal line, modernization actions in shopping districts along with development public parks and restoration activities of outstanding monumental buildings and landmarks , have to be harmonized and integrated with rest of urban areas in order to provide resilient development of the Metropolis.

Urban sprawl and desertification constitute one of the most harmful factors for the Metropolitan area as well as for those lands around the Benghazi where agricultural production is carried out. Combating urban sprawl and desertification requires maintaining and sustaining attainment of the Green Belt around the Metropolis supported with dense plantations, agro green belt, recreational and sports activities. This would help to ensure conservation of natural and environmental assets as well as contribute in resilient general wellbeing of the residential areas also providing houses and residential lands to meet the population demand.

Based on the proposed sensitive vision to the environmental resilience of the city, a set of objectives and strategies have been proposed to serve the interest of this vision (See Table 9.1).

Table 9.1. Goals, Objectives and Strategies for environmental resilient Benghazi (Source: Author)

GOALS and OBJECTIVES	
GOAL 1	**ENSURE THE PROTECTION AND CONSERVATION OF THE METROPOLIS' ENVIRONMENTAL AND VALUABLE NATURAL RESOURCES**
Objective 1	Preserving agricultural and green lands and prevent further urban sprawl
Objective 2	Maintain and enhance social, economic and environmental values of resources
Objective 3	Ensure balanced and resilient use of underground water resources while maintaining and enhancing environmental values
Objective 4	Maximize benefits from reuse of wastewaters
GOAL 2	**MAINTAIN AND IMPROVE A SAFE, EFFICIENT TRANSPORT INFRASTRUCTURE NETWORK IN THE BENGHAZI METROPOLIS THAT SUPPORTS COMMERCIAL, RESIDENTIAL AND INDUSTRIAL DEVELOPMENT**
Objective 1	Improve coordination and integration of different transportation options for people and commodities within and out of the Metropolis
Objective 2	Develop efficient public transport systems in large cities
GOAL 3	**A COMMERCIAL CITY**
Objective 1	Strengthen Benghazi City's role as commercial economic center focusing on investment in technology developments in agricultural and innovative building Materials industries.
Objective 2	Develop and establish commercial and industrial areas in specific location to prevent further urban sprawl and attract new growth to these locations.
GOAL 4	**PROVIDE HIGH QUALITY URBAN SERVICES WITHIN CITY BOUNDARY**
Objective 1	Increase accessibility of urban services
Objective 2	Reorganize the residential areas to meet the requirements of urban services within the city boundary
GOAL 5	**COMMUNITY AWARENESS OF THE PROBLEMS OF URBAN EXPANSION AND ENVIRONMENTAL VULNERABILITY AND DEVELOP THE SOCIAL, CULTURAL AND INTELLECTUAL CAPITAL OF THE METROPOLIS**
Objective 1	Provide awareness to the city's residents of the dangers of the problem of urban sprawl, environmental vulnerability and the loss of natural resources
Objective 2	Balanced distribution of natural resources and their consumption

These goals, objectives and strategies were proposed based on the environmental resilient vision proposed for the city. They were produced by synthesizing and detailing the objectives and proposals agreed upon by the group of experts in the group

discussion and interviewees, along with the use of secondary data, and according to the main objective of reducing urban sprawl and environmental vulnerability of the city. These objectives and strategies produced are the basis of the action plan that should be applied in the city to reach the proposed vision, and reduce the vulnerabilities in the city, build adaptive capacity, and enhance the resilience of all city dimensions.

In order to have a successful transformation, consideration must be given to numerous factors that will exercise impacts on Benghazi to be environmental resilient and guide the balance development of the city. In planning of the Benghazi Metropolis, therefore due considerations have to be devoted to global trends and their potential impacts on the Metropolis and on the Region as well. In terms of funding for the proposed projects, the Country has sufficient economic and natural resources, in particular vast revenues from hydrocarbon resources, to hold a challenging vision for the near future. The problem lies in however underutilization of available potentialities and opportunities.

Achieving environmental resilient Benghazi would require primarily activating and supporting agricultural projects, implementing recreational and sports projects and activities, and dense farms in the Green Belt, upgrading and developing an advanced infrastructure. This includes renewing and reconstruction of downtown as well as completion of the new Banina International Airport, new harbor with properly designed logistics infrastructure connected to main transportation lines, sewage infrastructure network, and waste and water treatment facilities as well as upgraded telecommunications and transportation network.

All this is done while maintaining the integrity of the urban environment and considering the environmental resilience thinking in completing the stages of the strategic plan to be implemented. Building of effectively functioning infrastructure will help to accelerate development of Benghazi Metropolis towards being an international and inter-continental business and commercial Centre. All these activities and services will be available only within the city limits will attract the grow to and within the boundaries of the city plan.

It is on the other hand important that extensive developments should not be limited to the nucleus of the Metropolis. While the Benghazi Metropolis is becoming centre for

new investments and development, its spatial influence should be counter-balanced, and its functional role must be shared by other medium sized settlements within the Benghazi Metropolitan Region. Tukra (Al Aquriya), Banina, Al Abyar, Solouq and Qaminis are potential development areas that need to be investigated thoroughly and planned appropriately in this respect.

This strategic environmental resilience plan envisages an integrated and harmonized metropolitan- agropolitan development model for Benghazi Sub-region as the strategic basis. This strategy follows a balanced development policy, which is ensured as depending on mobilization of metropolitan and utilization of agropolitan resources. Large availability of fertile agricultural land around the Metropolis has been relatively utilized by MMR Authority`s investments in agricultural production and water irrigation systems. If well organized and operated, this opportunity could easily turn into achievement of agropolitan centers where most appropriate. The agropolitan centers would exhibit integrated urban functions for rural population group. In character, these would be urban centers specialized in developing and integrating advanced techniques in agricultural production and marketing in order to supply high quality products to the Metropolis and other consumption centers. This will achieve development of rural areas as integrated with urban functions, which would counter-balance rapid growth of the highly urbanized and densely populated parts in the Metropolitan Region.

Agropolitan type of functional role could be well aligned with potentials of Solouq, Qaminis, and Banina settlements (See Figure 9.5). In addition, Al Abyar with potential for foodstuff based industrial development, Tukra (Al Aquriya) with tourism potential as one of ancient cities of the Greek Pentapolis and Banina with development of aircraft maintenance industry would fuel success of the Benghazi Metropolis as a global gateway city in North Africa.

Coexistence of metropolitan and agropolitan development in the Metropolitan Region is crucial for achieving balanced and environmental resilience development. This means that development of further advanced metropolitan services would not only be beneficial for the nucleus (Benghazi City) but also for the vicinity (small and medium

sized settlements around Benghazi). In return, possible attainment of agropolitan centers in the vicinity would also generate nuclei at a certain quality and quantity for promoting the primary sector activities. It will convert rural character of the vicinity into diversified and specialized urban character in a harmonized and integrated manner.

On the other hand, Benghazi City itself will continue to grow as the major metropolitan centre of Benghazi Sub-region focusing on the administration and control activities. These pertain to metropolitan management including integrated planning, land management and municipal finance systems, as well as participative approach to management styles. Benghazi metropolitan management should play a leading role to set a successful example for the contemporary regional, sub-regional, and metropolitan environmental resilient development in Libya.

Benghazi is expected to be the second major manufacturing center in the Country with diversified manufacturing activities. However, this role should not be given only to Benghazi Metropolis and must be shared by other medium sized settlements within the Benghazi Metropolitan Region as well. This approach is in line with the resilience strategies required to overcome and control unattended urban sprawl problems and minimize the environmental risks.

Tukra (Al Aquriya), Banina, Al Abyar, Solouq and Qaminis are potential development areas that need to be investigated thoroughly and planned approximately in this respect. Since extensive development of trade and services in the future is expected, it is accordingly obvious that such development will require the provision of landuse for commercial and institutional service activities in the urban plans. It is particularly important for the city of Benghazi that this potential growth be directed in directions away from agricultural lands, the green belt and protected areas.

9.3. Macroform Development Model for Environmental Resilient Benghazi

The data and analysis provided by the visual experiments conducted during this study are the basis for reaching this macroform proposal. Also follow the environmental resilience thinking derived from previous studies and examples. Benghazi Environmental Resilience Strategic Plan envisages Balanced Spilled Concentric and

N/S Polar. Balanced Concentric Development models as strategic basis for future development of Benghazi Metropolis. Since the former lacks the North and South Developments whereas the latter lacks the surrounding settlements, a synthesis of these two models could be configurated and named as N/S Polar Concentric Development model which is represented in Figure 9.2. This synthetic model reflects best the sub-regional development intentions, role, and functions of the metropolis in hierarchical settlements system, and intra-metropolitan activities and services.

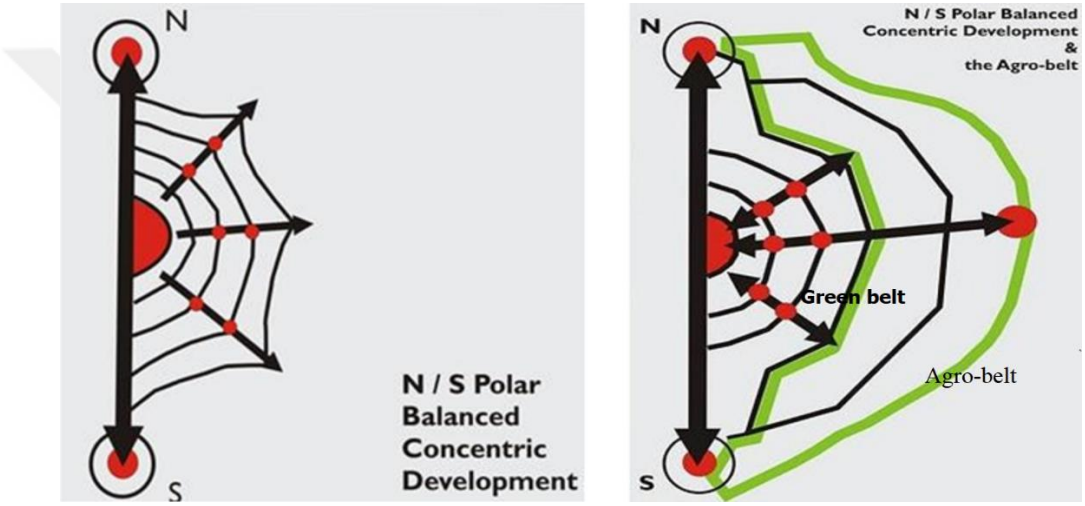


Figure 9.2. Macro-form Development Model for environmental resilient Benghazi (Source: Author)

A balanced development policy is ensured as depending on mobilization of metropolitan and utilization of agropolitan resources which in turn leads to less urban sprawl. CBD and sub-centers within Benghazi avail a rational metropolitan management scheme for accessible services and reflect the environmental resilience thinking as redundancy strategy. The external functional linkages abridge the Benghazi Metropolis and other relevant settlement centers in the proximity. The land use and urban fabric of the Benghazi city as well as its surrounding landscape and geographical texture create no serious and costly obstacle for further urban sprawl if it is managed wisely and in participatory management. Such a merged model with green-belt in and agro-belt around the Benghazi City represents a typical macro-form for planning works that should be carry out.

The proposed macro-form alternative for Benghazi metropolis is the N/S polar balanced concentric model, in which the metropolis is expected to expand towards north and south poles but with the inner sub-centers this time. The core advantages of the model would come out as better service supply to outer parts and higher life quality, internal socio-spatial integration along with dynamic, responsive, and resilient growth opportunities for selective investments (See Table 9.2). Although metropolitan and urban management of this model is a not an effortless and uncomplicated concern due to the potential irresistance to economic actors and power forces, its appropriateness for Benghazi metropolis case is considerably visible and renders the model rewarding. Irresistance can be overcome by activating participation in preparing the city vision, taking decisions and choosing projects to reach this environmentally resilient vision.

Table 9.2. Macroform Development Model for environmental resilient Benghazi (Source: Author)

N/S POLAR-BALANCED CONCENTRIC DEVELOPMENT	
• The metropolis extends to NORTH and SOUTH poles • Empty and available areas within the metropolis are utilized • Internal decentralization takes place	
ADVANTAGES	DISADVANTAGES
• Decentralization for CBD (Resilience) • Better service supply to outer parts • Internal socio-spatial integration and better quality of life • Dynamic, responsive and flexible growth opportunities for selective investments (Resilience)	• Troublesome metropolitan and urban management • Irresistance to economic actors and power forces

The expansion of the Benghazi Metropolis is considered to take place towards north where Al Kwefiya and towards south where Al Guarsha are located, respectively. Another expansion direction is identified along the axis, which connects the port and CBD of the metropolitan area with the international airport. In this regard, Ab-Atni and Banina gain considerable relevance and overtake new functions as integrated components of the Benghazi Metropolis. Especially the mass housing projects in south of the metropolis require adequate linkages with Al Guarsha, Ganfouda, Sidi Khalifa, Al Kwefiya and Al Nawaqia. The plan possesses indications pertaining to the application of the rationality and resilience principles for determining these linkages within the framework of metropolitan planning. This is conceivable in the magnitude

of the required development area revealing an optimal size based on the environmental resilience balanced development attitude when compared with other alternatives.

Applied planning principles in Benghazi Physical and Environmental Resilience Framework Development Plan are as follows;

- Developing a special area plan for protection of the sensitive wetlands along the northern and southern coasts,
- Protecting the agricultural lands in eastern and north-eastern skirts of the Benghazi Metropolis
- Supporting the housing project with required community services for southwards extension of residential land use in Benghazi,
- Supporting and developing the industries according to specific sites to avoid urban sprawl,
- Developing logistics services and warehouses in integration with the southern segment of railroad in Benghazi,
- Extending a railroad linkage to the Benghazi seaport,
- Creating a free zone in south of the metropolis to attract growth.

This strategy is expected to give a focus on the resiliency and the dynamics of development and issues to the environment, which may improve the implementation of physical plan rather than directly targeting specific physical forms. It is believed that unless a resilience/responsive policy/institutional infrastructure is available; the Metropolis cannot respond properly to the possible physical and non-physical development needs, and facing the dangers of sprawl on the environment in the future so that the plan should be used as an instrument for managing and adopting the change. In addition, it has also well integrated metropolitan functions including free trade zone, new commercial port and industrial development areas on the west supported and connected to up-coming national railway, highway, and airport.

By analyzing the results of visual experiments, it has been shown that Benghazi metropolis has the tendency to develop towards northern and southern poles together with inner sub-centers (See Figure 9.3). A major sub-center is initially proposed as a

single one located within the third or fourth ring road; nevertheless, an indispensable development axis towards the airport is expected. For that reason, smaller sub-centers; in other terms sub-sub centers, along the development axis are also proposed in order to balance urban functions along that extension. Figure (9.3) indicates development directions of Benghazi Metropolis by its constraints and potentials.

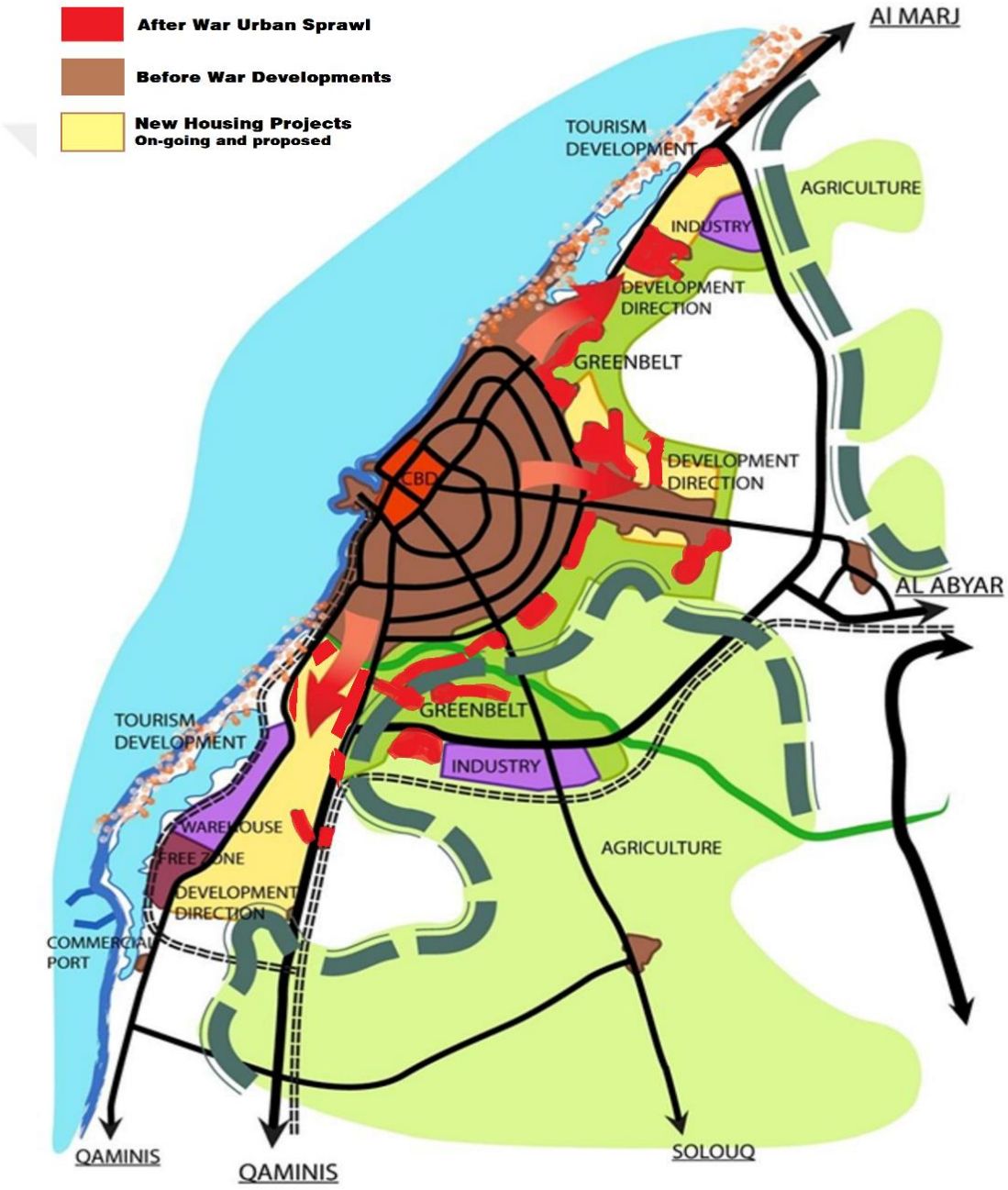


Figure 9.3. Future development possibility directions of environmental resilient Benghazi (Source: Author)

In the southern skirts of the Metropolis, there are three main clusters according to their socioeconomic and spatial development potentials. First and nearest one is the prospective economic development core of the metropolis, in which industrial facilities, manufacturing plants, logistic services, and warehouses will be located. This area should be well-served by the proposed railroad and an eventual seaport, and consequently be highly accessible. The boundaries of the city plan should be considered to prevent urban sprawl beyond these projects area.

The macro-dynamics of the Benghazi Metropolis give pertinent indications to diversity in metropolitan functions, sensitivity to environmental resilience, quality in urban services, efficiency in agricultural production, availabilities in tourism and recreation, facilities for processing and marketing, accessibility in transportation and communications, dissemination of technologic innovations. Some additional prime activities may take place after the year 2030 based on new and upgraded transportation networks and facilities as well as tourism and recreation-oriented investments based on natural, cultural, and historic assets.

The influence of Benghazi as the top rank center of the spatial cluster could be in form of dissemination of impacts of actions to surrounding subordinate settlements and areas, which take place within the main settlement center itself. The Benghazi Spatial Cluster reveals an overlap with Al Marj Spatial Cluster due to metropolitan dominance of the Benghazi City. Under the supreme functional coverage of the Benghazi Metropolis as the first rank spatial cluster, Al Marj City possesses second rank of territorial coverage encompassing Al Abyar whereas Qaminis, Solouq, Al Kwefiya, Banina, and Tukra are the core settlements of other third rank spatial clusters. Balanced distribution of industrial and commercial services to Those settlements will help to reduce future migration from them to Benghazi and decrease the congestion.

9.4. Action Plan for Environmental Resilient Benghazi

Matching of the outcomes of the synthesis analysis and the environmental resilient vision with the required actions, which reflects fundamental indications for adding a dynamic dimension to the planning approach. In this approach, identified strengths and opportunities of the Benghazi Metropolis are associated with required ACTIONS in

agriculture, environment, transportation and tourism sectors as well as in preservation, research and training activities. this is a process starting from strategies and decision aspects of planning based on analysis and proceeding towards action aspects of planning for implementations. Therefore, this process has to be conceptualized as a piecemeal of dynamism in planning.

The environmental resiliency aspect on the other hand has been extensively scrutinized under threshold analysis as presented in diverse chapters and sections of the research in connection with spatial development strategies identified for Benghazi Metropolis. It should be emphasized here that environmental resilience can only be achieved by achieving integrated resilience for all Benghazi city dimensions.

Before the war, recent endeavors of the government in the city were also concentrated on such an aim as pertaining to the development of commercial port operation facilities along with a series of construction activities comprising efforts to activate the construction process of developing Banina International Airport as well as a highway and a railroad across the country entering the Benghazi city. Besides efforts for introducing modern contemporary management practices in public transportation like light rail system, sophisticated service and international business investments are also currently undertaken in CBD of Benghazi. These efforts can be continued according to the proposed action plan.

The quality of life is upgrading with diverse housing projects would activated and implemented in the settlements located around the Benghazi Metropolis as well as in some selected quarters of Benghazi, whilst urban renewal and modernization actions in shopping districts along with removing remnants of war and restoration activities of outstanding monumental buildings and landmarks.

In urban design and townscape, more care is devoted to open areas, green and public spaces. In countryside and seashore landscape; on the other hand, more attention is attached to tourism resorts and recreational areas. Nature reserve project should be implemented to include the southern and northern lakes of Benghazi and the sabkhas that contain a natural life. In addition to these tourism projects along the coastline, these projects should protect and preserve the sabkha land from urban sprawl and

environmental degradation. With more environmentally conscious approaches of authorities and increased environmentally aware behaviors of the public, environmental management topics will gain relevance and operations related to combating environmental degradation and pollution will be more effective. Tourism potentialities in and around the Benghazi Metropolis are of cultural, historic and archaeological in kind blended with natural assets composed of beaches and sabkhas. Mobilization of these assets requires environmentally sound actions. These efforts should be accompanied by the environmental resilience development plan in order to improve the quality of life.

Diversifying agricultural production, rationalizing irrigation systems and enriching food processing practices are focal activities in encouraging and preservation of agricultural activity. Main activities to be carried out in the secondary sector are substantially metropolitan in character, which have more intensive relations with the external world rather than the local urban way of life. These are manufacturing plants, industrial enterprises, free trade zone and heavy industry district, which need to be located at appropriate places possessing international, national and interregional accessibility and to attract future urban development to these areas. It may also attract residents from green areas because of availability of commercial attraction and employment opportunities.

The strength of the Benghazi Metropolis based on MMR (Man-Made River) project have to be utilized by agricultural projects, in which efficient agricultural landuse is ensured under collaboration with the Benghazi University and sector entrepreneurs for education, research and training purposes in developing the field of agriculture and related industries. This action would open new lanes for more appropriate production and irrigation technologies to be applied in the Benghazi. By this way, a relevant opportunity will be utilized and large fertile agricultural lands in the Benghazi plain will be extensively, efficiently and cost effectively used.

The city of Benghazi should depend on successful actions to be undertaken specifically in transportation sector for quality improvement of roads; extensive use of public transportation means, particularly of Light Rail Transport System; multi-modal

transportation nodes; efficient transfer availabilities between the CBD, airport and the seaport. The lack of these public transportation and relying only on private transportation has greatly helped in urban sprawl spread.

Restoration and preservation and protection are prime actions to be undertaken for cultural and historical heritage assets along with CBD. Multiple strengths and opportunities of the Benghazi metropolis also comprise long and unspoiled seaside in certain sections, which are waiting for redevelopment actions. All these potentialities can be mobilized and utilized by protection of historic assets, activating the urban fabric, developing and implementing tourism projects, increasing the accommodation capacity, conserving natural beauties and aesthetics. Installation of marina in the port would change the overall outlook of the tourism sector. Tourism sector related strengths and opportunities require particular actions pertaining to diversifying the thematic features and availing alternative recreation activities. Beside permanent and static 3S (sea, sun, sand) alternative; archaeological, cultural, historic, environmental and ecologic blends and combinations have to be introduced into portfolio of tourism activities for enriching alternatives and creating attraction factors for multi-national target groups and will help preserve these assets.

The Benghazi Metropolis necessitates betterment actions in urban infrastructure. Besides shortages in material- technical infrastructure comprising water supply, sewerage disposal and wastewater discharge, electricity and communications network, solid waste collection and sanitary landfill, it is also obvious that traffic congestions are often taking place due to shortages in public transportation systems. The quality of some internal roads require improvement in order to provide additional and alternative routes to be taken by drivers between origin and destination points which would hinder traffic congestion in comparatively better and therefore widely preferred routes and bring efficiency to traffic flow. actions oriented towards strengthening public transport system will also contribute considerably in eliminating overcrowdings and congestions witnessed in certain segments during certain time periods along with and decrease the depend on private cars and reduce the urban sprawl.

The Benghazi Metropolis has limited urban development possibilities. The landuse model has to reveal an internally balanced and environmentally resilient development for utilization of empty spaces within and between built-up areas. The density distributions have to be also arranged accordingly within the internal spatial system without exposing structural disparities. Quality of life and environment should also be ensured in urban and metropolitan way of life. This could be achieved if necessary, actions are realized for terminating the dramatic environmental degradation caused by the urban sprawl and war in the city periphery as well as hindering the contamination of natural environment and agricultural production areas around.

The potential factors of threat for the Benghazi Metropolis are mainly centering round rapid urbanization, growth trends in coastal lines and farmlands, and industrial development pressures which constitute metropolitan management issues in essence and character. In connection with the metropolitan functions, the Benghazi port displays serious logistics and transportation problems. If actions confined on facility improvement in the existing port continue for providing better operation in passenger and commodity flow along with the railroad connection between the port and the train station, it would certainly create in future additional burdens for the city traffic.

Therefore, appropriate actions must be taken including establishment of an additional port for commercial purposes in south of the Benghazi Metropolis. Commercial port facilities have to be rationally linked with industrial sites, warehouses and free trade zone in the southern peripheries of the metropolis without any functional connection with the present port and to avoid further urban sprawl.

Urban sprawl is of the most harmful factors for the Metropolitan area as well as for those lands around the Metropolis where agricultural production is carried out. Combating desertification requires green-belt action in the metropolitan area and vegetation actions in agricultural lands.

However, both actions urge rational use of water resources because overconsumption of underground water and inappropriate irrigation technologies applied today threaten availability of water in the years ahead. sustainable use of water and all other relevant resources urges for rational actions and appropriate measures. Maintaining the green

belt, conservation of natural assets and use of renewable energy resources are substantial ACTIONS to be undertaken for performing a contribution in environmental resiliency.

For ensuring a convenient development in the future strengths and OPPORTUNITIES must be promoted and utilized for **maximization** of environmental **benefits** of Benghazi, whereas weaknesses and threats have to be hindered and eliminated for **minimization** environmental **costs** of desired balanced life quality. This **rationality** principle based on maximization of benefits and minimization of costs has to be applied in all planning tasks for conserving resources and welfare of the current and forthcoming human generations. These actions will help to build the capacity of the city overcome the war effect and cope with the urban sprawl and environmental vulnerabilities and achieve the environmental resilient vision of the city.

This actions package has been proposed to achieve the city vision that sensitive to environmental resilience. This package of actions which derived from the goals of the vision by implementing them within the balanced development plans in Benghazi will help in overcoming and coping with the urban sprawl problem in the city and increasing the city capacity to confront existing and future environmental vulnerability resulting from the war and urban sprawl. The Actions package is shown in the following Table 9.3.

Table 9.3. The Action Package for the environmentally resilient Benghazi vision (Source: Author)

Environmental Resilience Strategy	ACTION	Methods to cope with Urban sprawl and Environmental vulnerabilities
• Policies, rational planning and monitoring of land use, controlling urban • Facilitate the implementation of fertile agricultural land around the city • Maintaining and sustaining attainment of the Green Belt around the Metropolis supported with dense plantations, agro green belt,	• Activating and developing the agricultural projects • Protecting the green belt	• Preserving agricultural and green belt and prevent further urban sprawl. • Building Capacity to cope with Environmental Vulnerabilities

Table 9.3. Continued

Environmental Resilience Strategy	ACTION	Methods to cope with Urban sprawl and Environmental vulnerabilities
• Ensuring conservation of sabkha's and karstic lake's natural environment	• Development of a nature reserve project in the Sabkhas and Northern karstic Lakes.	• Maintain and enhance environmental values of resources • Preserving Sabkhas and karstic Lakes and the natural life in them
• Establishing a public transportation system • Establishing a metro/LRT line between Banina Airport and Benghazi Port • Encouraging public transportation Planning the bicycle routes in cities	• Activation and implementation of the public transport project and the light rail line • Maintain the transportation infrastructure of the city	• avoid urban sprawl • Avoid traffic congestion • To attract resident to settle inside the city • Increase accessibility of urban services • Decrease the impact of CO2 emissions • Building Capacity
• Balancing usage and preservation of coastal resources • Creating redevelopment of seashore • Encouraging implementation of integrated costal management	• The project of developing the waterfront and creating tourist projects for the sea front and beach.	• Maintain and enhance environmental values of resources • Building Capacity
• Integration of spatial functional area of small and medium-sized industries	• Development of the free zone and the new port in the south of the city	• Develop and establish commercial and industrial areas in specific location • Attract resident inside city
• Balanced distribution of industrial and commercial services to other settlements • Specify the locations of industrial and commercial • Developing stronger collaborative relationships between natural res.	• Distribution of industrial and commercial services and projects to settlements near Benghazi.	• Redundancy Strategy of environmental resilience • Reducing population pressure on the city of Benghazi • Reducing migration • Reducing congestion
• Designing housing projects in accordance with factual needs	• Activating housing projects	• Reorganize the residential areas to meet the requirements
• Providing efficient use of desalination and wastewater treatment plants • Ensuring reuse of wastewater in agricultural and industrial activities • Encouraging renewable energy resources • Setting environmental regulations in industrial areas	• Agricultural studies and research and balanced irrigation methods • Enable and encourage renewable energy projects	• Ensure balanced and resilient use of underground water resources • Building Capacity • Maximize benefits from reuse of wastewaters • Encourage development that minimize air pollution
• Spreading awareness of these problems in the TV and Radio	• Community awareness	• Provide awareness to the city's residents • Building Capacity

Regarding the stages of the resilient spatial development, it is highly anticipated that at the first stage the core portions in north (Al Kwefiya), east fringe and south areas (Bu Fakhra, Tika, Al Guarsha) will flourish together with the agglomeration area. These areas of priority development as indicated by "1" in Figure 9.4 will be followed by "2" areas in Al Kwefiya and Budazera in north, Ganfouda, Al Bahriyah, Al Guarsha in south as well as in eastern fringe. "3" areas are those which will be the outskirts of densely developed areas at "1" and "2" implementation stages.

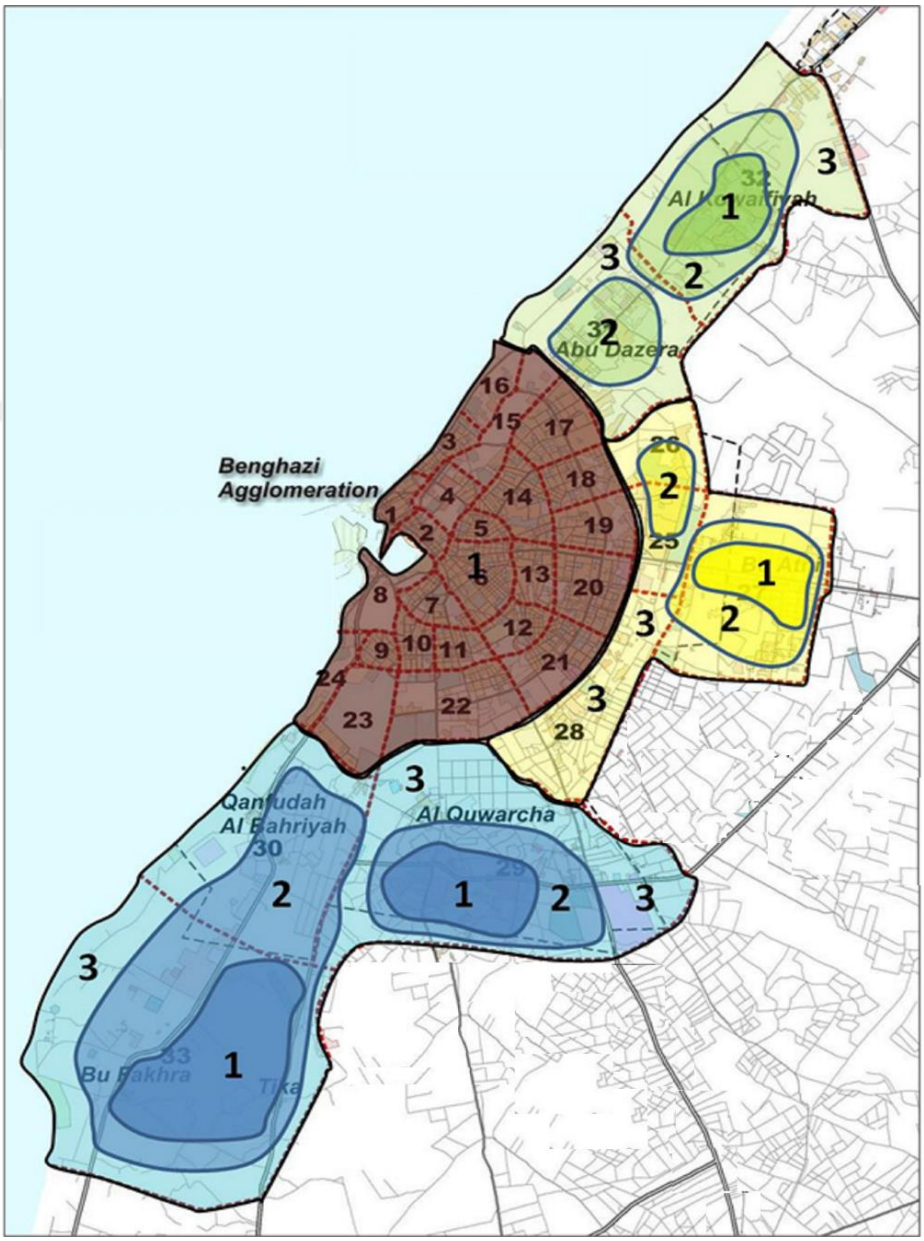


Figure 9.4. Development Spaces and Stages in the Benghazi

While a gradual development in northern, eastern and southern fringes of the Benghazi Metropolis is obvious, its Agglomeration Area exposes a continuous development and implementation process without any nominal or ordinal distinction and ranking amongst spaces and stages. It means that all spatial parts of the Benghazi Agglomeration will be equally treated throughout the implementation process encompassing “1”, “2”, and “3” stages.

The spatial development stages of the Benghazi Metropolis are closely associated with implementation phases of the projects and major investments, which in return determine the road map of environmentally resilient spatial development. In other words, prepared action plan and implementation program in this regard are determinants, which configure and give shape to gradual spatial development of the metropolis in course of time. Spatial development stages and directions for Benghazi (Figure 9.4) can essentially be identified as being;

i. The internal core of the Metropolis as roughly delineated by the 5th Ring Road which could be referred as the Benghazi Agglomeration Area,
ii. The northern development axis along the coastal corridor which could be referred as the Benghazi North Area,
iii. The eastern head of development pole lying between the CBD and the Banina Airport which could be referred as the Benghazi City Fringe (East) Area,
iv. The southern development axis along the coastal corridor which could be referred as the Benghazi South Area.

The apparent spatial development scenario exposes extremely marginal growth in the Agglomeration Area and inclination in North and South Areas as well as City Fringe in the east.

It is worthy to mention that the proposed model envisages a resilient balanced development between economy and ecology, which devotes importance to environmentally sensible areas in physical planning. Balanced and resilient planning principle pursued by this model also urges harmonized and depolarized socio-spatial development. Consequently; protection of ecological assets, avoiding density disparities, and spatially proportional distribution of economic activities require;

particularly at initial planning stages, deliberate approaches from population size standpoint. Protection of ecologically precious areas and warranting their liveliness as well as availing immense green areas and open spaces; (i) for recreation and leisure of citizens of the metropolis, (ii) for combating desertification, (iii) hampering urban sprawl and random development.

Table 9.4. Phases and time schedule of the action plan projects

Phases	**Project Name**
Phase I	• Activating and developing the agricultural MMR projects in the Benghazi Plain • Protecting the green belt by developing recreational and sports projects and dense farms • Activating housing projects in space areas within the city and encouraging mixed use of lands • Activation and implementation of the public transport project and the light rail line • Development of a nature reserve project in the region of Sabkhas and Northern karstic Lakes • Community awareness of the loss of resources and green areas as a result of urban expansion (television, radio, social media, workshops and panel discussions)
Phase II	• Maintenance and updating of the infrastructure, including services, methods, and communications within the city limits only. • Maintain the transportation infrastructure of the city • Development of the free zone and the new port in the south of the city • Agricultural studies and research and balanced irrigation methods and related industries at the University of Benghazi in cooperation with the public and private sector and developing agricultural projects in the Benghazi Plain • Distribution of industrial and commercial services and projects to settlements near Benghazi
Phase III	• The project of developing the waterfront and creating tourist projects for the sea front and beach. • Enable and encourage renewable energy projects.

The general planning philosophy revealed in the proposed framework is the reliance on factual potentialities, available capacities, and current capabilities. It is a kind of pre-cautious and a conservative approach, which typically looks after being on the sure and safe side by defending “the least achievable goal” thesis in planning. In this context,

the socio-economic and spatial development strategy and implementation stages designed for the Benghazi Metropolis possess a manifest and a latent character. The manifest character of the spatial development strategy is to ensure a resilient balanced development, whilst the latent character is to ensure a resilient development subsequent to the balanced development. It is therefore very relevant that throughout the development process, the metropolis ensures an internal balance in the "agglomeration area", an external balance in the "fringe areas", and an "overall balance" between the agglomeration and fringe areas of the Metropolis.

As for the time scale for the implementation of these proposed strategies and projects, the municipality, the Urban Planning Department, the Ministry of Planning and Housing and other city actors should through the participatory process formulate a comprehensive city vision, including an environmentally resilient city vision. Considering the urban sprawl and the environmental degradation problems as one of the most important problems facing the city at the present time, this thesis emphasize on urgently updating green belt policies and establishment of recreational and sports projects and dense forests in the green belt, as well as activating and supporting agricultural Man Made river projects urgently and necessary in the first stage of implementation in the city stakeholders discussions and decisions.

In table 9.4, the proposed projects for the environmentally resilient action plan were divided into three phases. The first phase is the stage that should be implemented immediately, followed by the second phase projects, which should take place in parallel with the first stage. Then comes the third phase projects, which should also implement during the next ten years.

CHAPTER X

10. CONCLUSION AND RECOMMENDATIONS

This chapter reviews the conclusion of the study and the discussion with the literature and previous studies. It also provides recommendations and suggests further studies.

10.1. Summary of the Study and Discussion on Findings in accordance with Related Literature

The main concern of this study was to enable the efficient use of urban land and to prevent urban sprawl in many directions in order to ensure the protection of agricultural lands around the city. This study intended to analyze this problem and attempted to develop a framework for environmental resilience to cope with urban sprawl problem and decrease the environmental vulnerabilities in Benghazi City. It is almost impossible to avoid each kind of vulnerability in cities, where the interaction of social and economic dimensions with the spatial dimension cannot be avoided. Also, wider contexts, including political, economic and social environments, people's expectations, motivations and attitudes are changing over time.

This dissertation was an exploratory study, which examined the relationship between the increase of urban sprawl and its effects on the environment, and the war impact on this phenomenon. This investigation not only uncovers the scale of urban sprawl and the extent of destruction caused by it on the environment, but also displayed the influence of war on these problems. After these investigations, it aims to build a framework for environmentally resilient Benghazi in order to minimize the effects and further development of urban sprawl problem in the city.

The research examined one main and four sub questions:

- **What is the environmentally resilient framework for the city of Benghazi to cope with the uncontrolled urban sprawl resulting from the war?**

  I. What are the reasons and consequences of urban sprawl in Benghazi?
  II. How did war influence urban sprawl in Benghazi, and what is the relationship between urban sprawl and environmental vulnerabilities in the city?
  III. What is the methodology to develop a framework for environmentally resilience Benghazi in order to cope with urban sprawl?
  IV. What are the environmental resilience strategies to cope with the environmental vulnerabilities of urban sprawl as part of the city vision?
  V. What are the action plan and projects for environmental resilience and for capacity building to overcome future environmental vulnerabilities in Benghazi?

To reach the answers to these questions and achieve the research objectives, the study was designed as a case study in Benghazi City, which is the second capital city of Libya. This study used a mixed research approach which conducted quantitative and qualitative techniques in a complementary way. The main reason for using these mixed techniques is the lack of available data due to the war and the lack of reliability of the available data.

First, quantitative data were collected from secondary data sources on the city and its environment, including raw satellite images before and after the war. This data was analyzed by using remote sensing satellite imagery and Eight regions, Pearson's chi-square, and Urban Expansion Intensity Index techniques. The research used the quantitative data to understand the war effects on the dimensions of the city, to define the problem of urban sprawl, and to understand its causes and effects. It has also been used to uncover the destruction of the environmental dimension within the framework of environmental vulnerability resulting from the uncontrolled urban sprawl.

The methodologies of quantitative research allowed for the application of multiple techniques from the results of remote sensing of different satellite images to reflect the amount of the change in land use, the speed of spatial development, the change of its characteristics, the amount of its dispersion and the temporal relationships. The

relationships between the effects of war and the increase in urban sprawl in the outskirts of the city of Benghazi and its impact on the environmental dimension were extracted. Remote sensing analysis revealed the differences in the extent of urban sprawl after the war and its extent over pre-war sprawl. Second, qualitative data was collected from the primary data sources including discussion groups of city stakeholders and interviews with selected stakeholders from the city. The raw data was analyzed by using the SWOT analysis technique.

Qualitative research methodologies facilitated the formulation of the vision of the city and proposal of the action plan collaboratively, which are sensitive to the environmental resilience of the city based on the objectives of this vision. It was also used to present the resilience strategies to increase the city's adaptive capacity to cope with environmental vulnerability caused by urban sprawl and future developments, and to propose projects with priorities to reach this aim.

The findings of the study revealed detailed answers to its research questions. These findings are categorized as follows:

Reasons and Consequences of Urban Sprawl in Benghazi City

The first question of this study is related to the identification urban sprawl and its reasons and consequences in Benghazi. Before examining this question for Benghazi, the literature on urban sprawl was reviewed in the second chapter. The review includes the concept of urban sprawl and its reasons and consequences on cities. It also includes the types of urban sprawl and demonstrates examples from cities to cope with the problem of urban sprawl. The findings of this research showed that the growth of urban sprawl in Benghazi City was affected by two factors. The first factor that affected urban sprawl is urbanization, and this finding is consistent with the location theory of Johann Heinrich von Thünen (1826), the center periphery theory of Wallerstein (1974), the dependency theory of Prebisch (1988) and the urban bias theory of Lipton (1977). This urbanization factor continues before and after the war. The urban sprawl in Benghazi before war was mostly due to the demand for large separate houses with gardens in connection with the nature in the periphery of the city, and introverted lifestyle, and

this is consistent with the pattern of urban sprawl in North America as mentioned in the study of Brueckner (2000).

The second factor that affected the increase in urban sprawl is war, where the study findings showed that the war is an influencing factor in increasing the phenomenon in the city periphery. The reviewed literature concerned the direct impact of the war on the destruction of private and public buildings and on city infrastructure which resulted in structural changes in cities, as was investigated in the studies of Abbott (1976) and Lotchin (1979). Other works, such as Coale (1989) and Webb (1963) demonstrated the impact of the war on the demographics of the cities and the emigration of the population. The consequence of war on economics was discussed in researches such as Collier (1999). Socio-cultural devastation as a result of war was investigated in the study of Khan (2013). The literature and previous studies reviewed did not address the factor of warfare as an influencing factor for urban sprawl development.

The study also showed the effects of the war on the destruction of the spatial and environmental structure of the city, which are consistent with the results of Sampaio (2016) and Glaeser and Shapiro (2002). The findings showed that there are two reasons of environmental destruction in the city. The destruction resulted from random developments, urban sprawl and the destruction from war in the case of Benghazi City, and the literature reviewed did not examine this relationship. The relationship between the effect of war and increasing environmental vulnerabilities resulting from urban sprawl has not been clarified in any previous literature.

Effect of War on Urban Sprawl and Benghazi City Environment

The second question of this study was related to the investigation of the effect of war on the environment of the city and vulnerability increase as a result of uncontrolled urban sprawl. From the study findings, environmental problems caused by the war were observed in the amount of weapon contamination and damage to energy sources, wells, surface and ground water, and of agricultural crops lost to fires. The results showed that the war also caused sewage to flow into the downtown areas that were suffering from armed clashes. The spread of garbage and the failure to collect it were results of the war and the lack of urban services in the city, which caused air and water pollution

as well as visual pollution. These findings are consistent with the studies (Boori, 2011; Li, Zhan, Liu, Zhang, & Zhang, 2018; Metzger, Rounsevell, Acosta-Michlik, Leemans, & Schröter, 2006; Richardson, 2002) examining the effects of war on city environment.

The findings of the study showed that war has displaced many people from their destroyed homes at the city center, and that residents of the city have fled to different parts of the city or safe neighboring cities. The major part of residents who were displaced because of the war moved towards the periphery of the city. Low prices of land in the green belts and the entity of agricultural areas enabled the displaced residents to settle down in those areas. This created pressure on natural resources and led to the deterioration of environmental structure, and increased the vulnerability of environmental and urban structures. As Partow (2008) and Richardson (2002) supported, all these negative developments in Benghazi confirms that urban sprawl as a consequence of war damages ecosystems and increases environmental vulnerabilities of the city.

Consistent with the findings of Xi, F. et al., (2012), Batty, Xie, and Sun (1999), Patacchini and Zenou (2009), and Mills (2003), this study revealed that the scale of environmental vulnerabilities due to war and urban sprawl in Benghazi has varied from the devastation of agriculture lands to that of scrublands, grasslands and the green belt. The main vulnerabilities that the study was able to measure are increased mortality, increased number of refugees, the deterioration of the economy, and the destruction of infrastructure and historical buildings. The rate of increase in urban sprawl, the rate of agricultural land and green belt shortages, and the lack of water bodies gave the answer to the third question of the study that was regarding the investigation of vulnerability. Thus, the study showed the relationship between urban sprawl and environmental vulnerability in the city of Benghazi, which is a positive relationship. The greater the spread of urban sprawl in the city's outskirts is, which are agricultural lands and the green belts, the more environmental vulnerability there is in the city.

The third question was about the methodology of developing a framework for environmentally resilient Benghazi in order to cope with urban sprawl. It was

impossible to collect data on urban sprawl and environmental vulnerabilities in Benghazi City after the war just by using quantitative data collection techniques due to the lack of registered data under the war circumstances. Therefore, the study aimed to benefit from qualitative data produced by the stakeholders of the city collaboratively. After the analysis process of those two groups of data, the analyzed data was synthesized in order to develop a framework for environmentally resilient Benghazi to cope with urban sprawl.

Environmental Resilience Strategies of Benghazi City

The fourth question of this study is related to the strategies of developing a framework of environmental resilience of Benghazi to cope with the destruction of the environment resulting from urban sprawl and war. The study defined resilience in terms of minimizing disorders (or change) through preparatory procedures to respond to acute and chronic disorders. It represents an ongoing process over time to reshape, organize and develop new adaptation strategies. This problem was tried to be handled as a comprehensive planning approach for the city in order to examine environmental resilience incrementally. Therefore, the first step was to conduct SWOT analysis to develop the city vision within its strengths, weaknesses, opportunities and threats.

A strategic action plan is proposed, which makes the city more adaptable and responsive to adverse event, and provides the basic functions for its residents in an integrated manner while preserving its environment. The study followed in the work of building resilience, the previous examples implemented in a few cities such as London, Athens, whose experiences in building resilience are mentioned in detail in the third chapter of this research. The study in the building process considered the differences and the specific conditions of the Benghazi City.

The study created an integrated framework for developing environmental resilience in Benghazi. The processes included conducting a collaborative environment through participation of stakeholders of the city including decision makers, academics, planners and opinion leaders. This was followed by identifying opportunities, threats, and the strengths and weaknesses of the city with these participants. Then, a vision of the city was formulated after SWOT analysis with stakeholders. The last step of this sequence

was identifying with stakeholders a set of actions that are sensitive to the city environmental resilience that should be taken to reach the city objectives in accordance with the vision with priority setting. The sequence included demonstrating the ability to build capacity from these actions to increase the adaptivity of the city.

The study formulated a sensitive environmental vision for the city with a set of goals that must be reached to achieve this vision. The proposed vision was according to the strengths, weaknesses, opportunities and threats of the city to be a national gateway city with a mixed economic, touristic and technological specialization, while preserving its environmental assets by making it a leader in the field of agricultural development. The study clearly and extensively identified goals and strategies to reach this environmentally resilient vision and to build the capacity of city for the future environmental vulnerabilities.

Actions and Projects to Achieve the Environmentally Resilient City Vision

The last question of this study was about the action plan and projects for environmental resilience and for capacity building to overcome future environmental vulnerabilities in Benghazi. The results of research analysis were translated into a set of actions. The findings of the present study showed that the stages of implementing the action plan based on a resilience strategy to reduce planning and environmental vulnerabilities in the city and specifically address the problem of urban sprawl,should be done through a deep understanding of the causes of the problem. The study conducted a strength-weakness-opportunity-threat (SWOT) analysis in order to derive and establish specific strategies that can accelerate the building of the adaptive capacity though a resilient action plan. Planning conceptual synopsis was used to combine the synthesis analysis, the vision and the strategies to propose an environmentally resilient action plan for the city.

As a result of these analyses, the study extracted strategies to be followed for a balanced development policy for the city depending on utilization of agropolitan resources and mobilization of Benghazi to achieve development of rural areas integrated with urban functions. That would counter-balance rapid growth of the highly urbanized and densely populated parts in the metropolitan region. This strategy includes a set of

actions for future urban developments in the city and selected projects in specific locations in the city and its vicinity. Development trends were proposed based on an analysis of thresholds, the current situation, and the proposed macroform development model which suggested a balanced development with the neighboring other medium-sized settlements and villages, such as Banina, Al-Abyar, Tukra, Solouq and Qaminis. This was to ensure an environmentally resilient urban development of the city and to build its capacity to cope with and adapt to future environmental problems and urban sprawl.

Building the Environmentally Resilient Benghazi Framework

From the answers of the research questions, the study reached to four general conclusions: Firstly, the study concluded that the urban sprawl in Benghazi City resulted from two factors. The first factor is urbanization, which is accompanied by urban sprawl as an inevitable outcome. The second factor is the war, for which the study demonstrated a significant increase in urban sprawl during and after the war. The study showed the effects of the destruction of the city's spatial and environmental structure due to the war. The study concluded that there were two reasons of environmental destruction in the city: the destruction resulted from random developments and urban sprawl, and the destruction resulted from war. The reviewed literature did not examine this relationship. The study found out a relationship that was not explained in the literature, namely; the effect of war on increasing the environmental vulnerability resulting from urban sprawl. Secondly, the study concluded that some environmental vulnerabilities can be measured even in the event of war. The study was able to measure the rate of increase in urban sprawl, the rate of agricultural land shortages, the green belt shortage, and the lack of water bodies. This helped in deriving the positive relationship between urban sprawl and environmental vulnerability in the city of Benghazi, where the environmental vulnerability increases with increasing urban sprawl.

Thirdly, the study showed that the lack of reliable quantitative data in the city of Benghazi due to the war directed the researcher use a mixed methodology from the available quantitative data and the quantitative data produced from the techniques of

satellite imagery with qualitative data collected by the participation from the city stakeholders. The study showed that this methodology helped in appropriately understanding the urban sprawl and environmental vulnerability problem, and developing an environmentally resilient Benghazi framework to cope with urban sprawl. Fourthly, the findings of the study indicated that the process of developing a framework of environmental resilience in Benghazi to cope with the destruction of the environment resulting from urban sprawl and war should follow a set of procedures:

- The first step is to assess the urban sprawl and environmental risks ,and their causes and consequences in the city.
- The second step is the evaluation of the impact on the dimensions of the city.
- The third step is the participation of stakeholders in solving the problem and devising an environmentally resilient vision for the city by using SWOT analysis.
- The fourth step is building adaptive capacity and resilience implementation (providing a roadmap for the city's environmental resilience with a list of the main action plan to reach an environmentally resilient city vision)

Implementation is the main challenge after the plans have been prepared, completed and made ready for actions in form of programs. Identification of the action phases and implementation tools has vital importance in order to produce an effective and environmentally resilient plan, which preserves its validity until the end of target time. Considering such a framework principle, an approximate physical macro-form of the Benghazi Metropolis is anyhow expected to be shaped by expansions in tips of northern, southern and eastern radial axii. While Figure 10.1 illustrates the existing situation, Figure 10.2 shows the proposed resilient macro-spatial development of the Benghazi Metropolis after the realization of investments and implementations for the environmentally resilient development. However, substantial development implementations will be intruded to the southern peripheries of the Metropolis on the roads to Qaminis on the one hand and to Solouq on the other hand. Green belt preservation and agro belt implementation, immense housing projects accompanied with major investments erecting warehouses and industrial sites will constitute the basic implementations and investment components in the south.

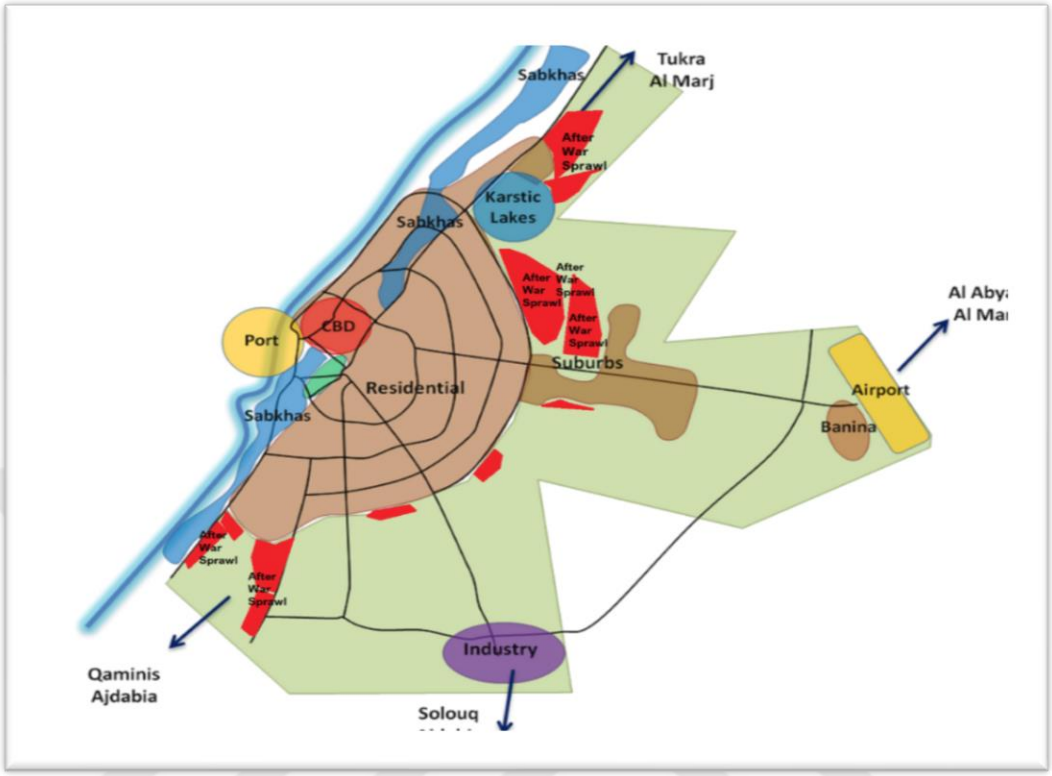


Figure 10.1. Current situation in Benghazi City (Source: Author)

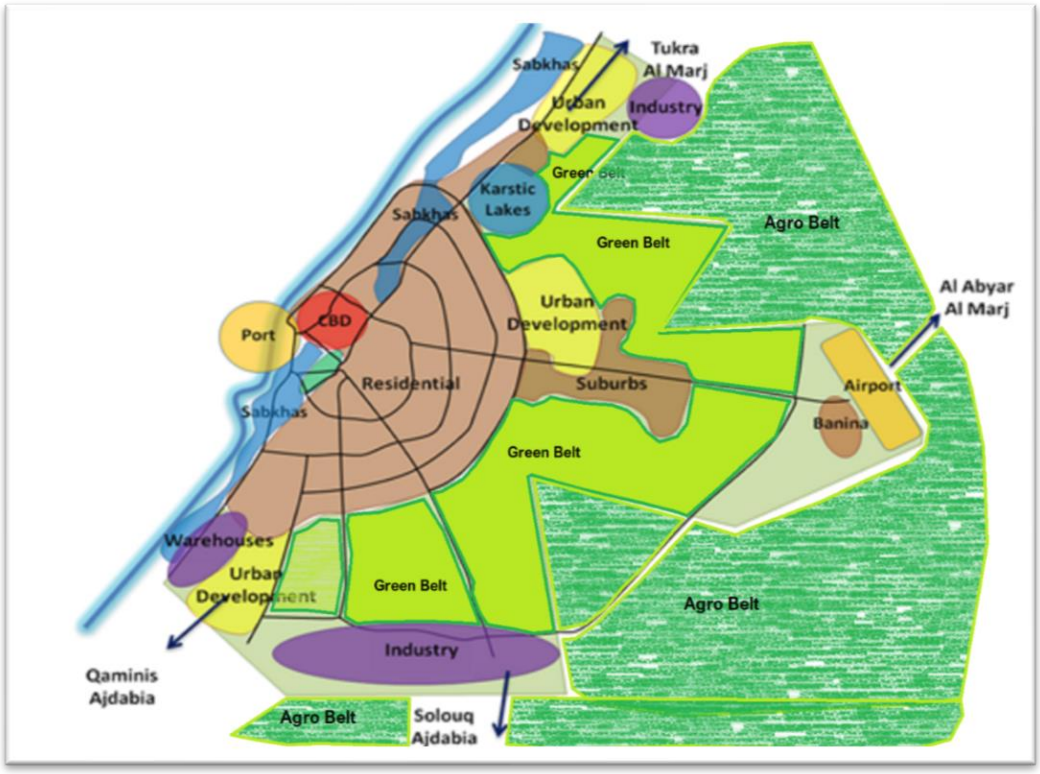


Figure 10.2. Proposed Environmental resilience framework development of Benghazi City

Sudden changes in politics, global markets, economic crises, declines and recessions as well as growths or innovations can affect the targeted time period for some goals of the plan. In order to be ready for such kinds of unexpected events, a prioritization of projects and identification of phases should be set forth as the essentials and pillars for overall future development. Following these steps, action plans have to be explained and inter-institutional coordination mechanisms have to be described for ensuring a well-organized planning system.

The present study extracted general concepts of building resilience to reduce the problem of urban sprawl and environmental vulnerability. Environmental vulnerability includes encroachment on green areas, plantations, climate change, persistence, floods, lack of access to drinking water, waste recycling and pollution. The adaptive capacity of the self-organization reacted with resilience reactions to some of these environmental vulnerabilities. Therefore, the city has speared to the outskirts of the planned areas, along the main roads in green belts and agricultural lands. The problem of uncontrolled urban sprawl as a result of this resilience reaction has accelerated, and put the city into a chaotic, catastrophic situation. Moreover, it increased the vulnerabilities on the city environment. It has threatened natural resources and the limited agricultural lands around the city.

In order to reduce the vulnerability of environmental change and reduce its risks, it is important to work on two levels along with the planning efforts; firstly, reducing the impact of society on the environment by changing the planning and environmental management thought and awareness; and secondly, reducing the vulnerability of society to such changes by addressing political vulnerability, problems of political instability and military actions, as well as social aspects.

The city is currently under pressure to renovate urban areas, to renew urban infrastructure, to cope with environmental degradation and to devalue its larger assets, which are the limited agricultural areas around the city. With the city's rapid growth and the local government’s obligation to try to develop an approach that ensures the resiliency of the city and the preservation of its limited resources, there are many continuing challenges that need a different approach. The adaptive capacity building

process for coping with and reducing environmental risks consists of a set of proposed actions with the participation of stakeholders from Benghazi Municipality, the Urban Planning Agency, the Ministry of Housing and Planning, and others in monitoring and updating.

The concept of environmental resilience in Benghazi will provide a new framework for communication between different urban aspirations and ideas about living, sustainability, cohesion, development and strength that also consider the chronic pressures and shocks facing the city. The city should adopt an environmental resilience view to allow for an integrated pattern of planning to pool the social, environmental and infrastructure aspirations that will shape the future of the city.

All these actions will build the adaptive capacity and increase the environmental resiliency of the city. Moreover, these actions may improve the capacity and the resilience of Benghazi in general, while coping with the urban sprawl problem and its negative effects on the environment.

The research provided an in-depth and comprehensive study on the current situation of the city. The study paid attention to the problem of urban sprawl, as it showed its causes, consequences and impact on the environment of the city. The study showed how the SWOT analyses produced collaboratively by the city stakeholders helped to understand the city's components and to reach the Benghazi vision and goals. The study concluded that the green belts, proposed agro belts and nature reserve areas are the main thresholds for the city to achieve environmental resilience.

The study concluded that the strengths of the city of Benghazi for environmental resilience are MMR Authority`s investments in agricultural production, water supply and irrigation systems, the long seaside for diverse utilization possibilities, and the various types of ongoing housing projects. The weaknesses of the city are war effects, political instability, migration, lack of public transportation system, lack of adequate recreation areas, contaminated natural environment, i.e. beaches, sabkhas, lakes, and weak institutional basis to spillover expertise and advanced technology. Opportunities for the city are the income from oil commerce, economic improvement, private sector participation opportunities, a gateway to Africa and proximity to Europe, and citizens'

motivation for change. The city's threats are the invasion of environmentally sensitive areas through rapid urban sprawl, desertification, loss of fertile agriculture land around Benghazi, growing industrial pressure, and extensive development of seashore area for tourism sector investments.

The study concluded that, by synthesizing the analysis results of the primary and secondary data to understand where the city stands today, the study reached to a comprehensive evaluation of the second-generation plans in terms of evaluating the unimplemented stages, vacant areas within the plan boundary, decentralization possibilities in the plan, renewal possibilities in slum areas, and possible development areas according to the threshold analysis.

After matching the outcomes of the synthesis analysis with the environmentally resilient vision, the study laid out the required actions for adding a dynamic dimension to the planning approach and building the capacity of the city to cope with the uncontrolled urban sprawl and environmental degradation. The study showed the process of associating the required actions in the sectors of agriculture, environment, transportation and tourism, as well as in conservation, research and training activities with the identified strengths and opportunities in Benghazi City. The study concluded that this process should start with strategies and decision aspects of planning based on analysis and by proceeding towards the action aspects of planning for implementations.

According to this arrangement, the study concluded with proposing an actions package that include a group of projects according to strategies and goals to reach the vision of the city of Benghazi, which is environmentally resilient and capable of coping with the existing and future urban sprawl and environmental vulnerabilities.

To conclude, the process of building the environmental resilient framework of Benghazi City should derive from an in-depth understanding of the essence of environmental vulnerability and urban sprawl, including causes and effects. It also includes analyzing and understanding the city’s current situation and formulating the city vision, with the participation of city stakeholders, based on strengths, weaknesses, opportunities and threats to the city. This should be followed by setting goals and strategies. The action plan according to these strategies is devised with a set of projects

aiming to increase the city's capacity and confirm its environmental resilience in the face of existing and future urban sprawl and environmental vulnerabilities.

The efforts of this study have potential to provide a resilience action methodology and offer useful information and analysis for the city of Benghazi and its stakeholders in many dimensions. The following part discusses the contribution of the study to the literature.

10.2. Contribution of The Study

The contribution to the literature presented by the study is its defining of the relationship of war with urban sprawl and environmental degradation in the city of Benghazi.

This study contributed to the literature theoretically, methodologically and practically. Firstly, the study was theoretically the first study in the literature that analyzed the impact of war with the framework of urban sprawl and environmental vulnerability resulted from urban sprawl. Second, the study conducted a mixed research approach of quantitative and qualitative data collection and analysis techniques together in a complementary way to overcome the lack of availability of data and lack of reliable data due to the war.

Additionally, it developed a framework for environmental resilience in a participatory process that helped the adaptation of produced knowledge to cope with urban sprawl and environmental vulnerabilities of Benghazi by its stakeholders. Last, the study contributed to the implementation of environmental resilience strategies. The study showed the action plan implementation process according to the city's environmentally resilient vision. The action plan included the strategies to be followed and proposed projects to achieve these strategies, while indicating their priority.

The results of this study are expected to contribute by providing valuable information to policymaking and implementing an urban action plan based on resilience strategies to solve urban and environmental problems that exist in other Libyan cities currently, and to avoid future problems. The results contribute to a deeper understanding of the main issues affecting the increasing environmental degradation and the spread of the

problem of urban sprawl. Although the results are relevant to the case of the city of Benghazi and the resilience plan was built according to the conditions of the city, it may be beneficial to planners and to policymakers in cities which experience inner-city migration due to conflicts in the city center.

The literature and the previous studies reviewed did not address the factor of warfare as influencing the urban sprawl development and increasing the environmental vulnerabilities. Future investigations may examine the reliability of these relationships revealed in this study.

This study will be useful for planners in the Urban Planning Agency in the city of Benghazi and for the decision makers and policymakers in the Benghazi municipality and the Ministry of Planning and Housing as well as Libyan researchers. The present research gave a thorough studying and a deep understanding of the current situation of the city, compared to the situation before the war and the situation in times of no war. This information may be useful to planners, experts and researchers in conducting other studies about the city. Researchers can use what the study presents about the causes of urban sprawl and environmental degradation, and use the analysis of vulnerabilities resulting from these problems and the implanting the resilience plan model to reduce these vulnerabilities and increase the adaptive capacity of the city.

10.3. Recommendation and Further studies

The present study makes recommendations for the planners and decision makers and policy makers in the Benghazi municipality and the Ministry of Planning and Housing as well as experts and city opinion leaders, taking into consideration its results and trying to implement it to reduce the city's environmental problems and cope with the urban sprawl consequences.

The study recommends that the municipality and their departments to run community awareness campaigns to inform the population about the problems caused by uncontrolled urban sprawl. Overcoming intermittent communication between agencies of the local government, intermittent inter-agency cooperation that creates mistrust and confrontation, and loss of creativity because of creative solutions are not linked to plans

and programs when formulated, but depend on all expected and unexpected possibilities.

The recommendation for the city's policymakers is to start developing and amending the laws to maintain the green belts and agricultural lands. It is also recommended for the practitioners to urgently start the application of participation in the consideration of the future of the city and the implementation of the resilience plan for the city, which will make the city resilient environmentally, socially, economically and politically.

The following is a set of studies recommended to be studied as a supplement to the course of this thesis:

- The study will be enriched with statistical investigation when these data are available in order to uncover the effect of war on urban sprawl.
- The primary data on vision, action plan and projects, and environmental resilience strategies will be collected through questionnaires which will be prepared through the findings of group works.
- Further studies may conduct these questionnaires on large samples to reach generalizable results.
- More investigation is suggested in order to determine the land demand to meet the residential and other urban needs of Benghazi.
- Simulations will be used to display the effects of environmental resilience strategy on the natural resources of the city.
- Similar methods will be used to examine the effect of war on different cities.
- The relationship of environmental resilience to other dimensions of the city and its impact on their resilience will be studied.

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APPENDICES

APPENDIX: A

Group Discussions Participants

1. Saad Qizziri, he is 64 years old, Director of the Urban Planning Department in Benghazi and a decision maker and city opinion leader, he has PhD degree in urban planning. He has number of planning books, including The History of Libya, Urban studies in Benghazi Region and Study in the Geography of Libya. the participant joined the workshop via skype.
2. K.Taylan Dericioglu, he is 65 years old, Formerly the Turkish Undersecretary of the Ministry of Transport and Communications and director of the urban planning project in Benghazi. He has PhD degree in Urban planning.
3. Adem Tunca, he is 44 years old, was working as 3rd Generation Planning of Benghazi project coordinator, MSc. Degree in satellite images, remote sensing and geographic information technology.
4. Omar Al Ameen, he is 58 years old, working as an academician in the University – He has his own urban planning and engineering consulting office. He has master's degree in urban planning.
5. Mohamed Akreem, He is 52 years old, working as an academician in the university –he also one of the municipality members responsible for urban planning work reviews in the municipality. He has PhD degree on architecture.
6. Nidal Fathi, he is 50 years, working as an academician in the university PhD degree in urban planning. Works with the Planning Ministry in evaluating technical and planning works and supervising private consulting offices.

7. Hosam Dwela, he is 43 years old, working as urban planner and decision maker in the ministry of planning in Libya, He has master's degree in urban planning. Responsible for approving plans in the ministry.
8. Mansour Bartouh, he is 53 years old, Politician and municipality consultant, Decision maker - PhD degree in environmental studies. He works in the assessment of the technical and planning works and monitoring the preservation of the environment in the municipality and works as one of the prominent politicians in the government of the East.
9. Mahmoud Soliman, he is 47 years old, working in Benghazi urban planning agency, he has PhD degree in Geography. Responsible for natural and climatic planning studies in Benghazi planning region in UPA - the participant joined the workshop via skype.

APPENDIX: B

CURRICULUM VITAE

Name: Abdelhamed A.M. Adam BARANI
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ACADEMIC ACHIEVEMENTS

- Bachelor of Science in (Electrical Engineering) University of Benghazi, Libya (1999-2000).
- Master's degree in Geomatics (Civil Engineering) Istanbul Culture University, Turkey (2007-2008).
- Ph.D. Candidate in (city and regional planning) Çankaya University, Turkey (2015- continue)

CAREER HISTORY

June 2013 – ……	**OYA Engineering Consulting & Technics Company,** One of the proprietors, Executive Manager
October 2011 – August 2012	**Libyan wounded follow up committee TURKEY,** Member of Committee.
July 2011 – October 2011	**Libyan wounded follow up committee JORDON**, Member of Committee.
July 2008 – ……	**Al Moaser Consulting Company, Libya** One of the proprietors, Executive Manager
August 2007 – ……...	**Omer Al Mokhtar University *Libya*** Member of the Board of Education, Lecturer
July 2007 – ……	**GEOTECH GROUPS 3rd generation planning** 3GPP of BENGHAZI, Director

August 2004 – July 2007	**Alnogom Al Lameaa, construction company** General Manager, **Benghazi- Libya**
August 2004 – July 2007	**Study Master's degree in Civil Engineering,** IKU, **Istanbul-Turkey**,
June 2000 – August 2004	**PWA (Public Works Authority), Vameed Co** Projects Technical consultant**, Benghazi- Libya**

CONFERENCE PRESENTATIONS and PUBLICATIONS

- BARANI, A., Kahraman Z. E. (2019). *Uncovering Vulnerabilities and Resilience of Benghazi After the War*. Resilience Journal, 3 (2), 165-171. DOI: 10.32569/resilience.586657
- BARANI, A., Kahraman Z. E., *Vulnerabilities and Resilience Strategies of the city under war: A Case Study of Benghazi*, International Disaster and Resilience Congress (IDRC 2019), Eskisehir, Turkey, June 2019
- BARANI, A., Kahraman Z. E., *Dimensions of War Destruction in the City of Benghazi*, BEYOND ALL LIMITS "International Congress on Sustainability in Architecture, Planning, and Design", Ankara, Turkey, October 2018

PROJECTS AND WORKS

- Investigating reviewing and monitoring all electrical and electronic works, warning and fire systems as well as supervising the project of repairing and renovating the 7th of April Hospital, under taken by the Austrian Company (Vameed) The value of the project is: 47 million L.D (2001- 2003) .
- Taking part in implementing the project of setting up GPS Real Time Kinematic Network for the entire state of Turkey, in association with Istanbul Culture University and the Technical Department of the Turkish Army (2005-2006).
- Taking part in implementing the project of supervising bridges and dams in east Turkey via satellite and employing the technology of (GPS), in association with the universities of, Yaldiz and in Germany (2005).
- The Engineering Management for the development and maintenance works in sirte International Airport (2008).
- Taking part in implementing the Maintenance works at Tubruq international Airport (2008).
- Preparation and implementation of the Third Generation plans for Benghazi Planning Region, from AL-Magrun in the west, to Emsaad in the east (2007_2010).

- Preparation and implementation of the Geographic Information Systems works, and the database for the Third Generation Planning project in drawing scales: 1:250.000, 1:25.000 and 1:10.000 (2007_2010).
- Implementation and completion of inventory works for, Benghazi, Tubruq, Darnah, AL-Bayda, AL- Marj, AL-Abyar, Shahhat and AL Qubbah; This include , Classifying all types of buildings , spatial and questionniaring data collection, and then inserting such data in the databases and incorporating them into the Geographic Information systems of the THIRD Generation Planning Project(2008).
- Field inventory of descriptive and spatial data of all education institutions with in Benghazi Planning Region, from AL-Magrun in the west, to Emsaad in the east, by employing the technology of (GIS), and then inserting such data into the database and incorporating them into the Geographic Information systems (GIS) (2007).

STUDIES AND TRAINING COURSES

- Preliminary course in management skills organized by Benghazi University-Libya (6 weeks) 1998.
- Training course in electric system & devices protection organized by Benghazi University-Libya (2 weeks) 1998.
- Computer's general usage course (Windows, Office Programs, Internet & Very active skill in using search engines) 1999.

KEY QUALIFICATIONS

- Distribution Design of Electrical and electronic networks.
- Projects technical managing
- Projects Supervising.
- GIS and RS background.
- Surveying using GPS and Total station.
- Possibility to reach the required resources such as qualified person, data, software, method, etc.
- Adaptation to different kinds of projects managing
- Experienced in preparing and answering the technical specifications of adjudications.

SOFTWARE INFORMATION

SOFTWARE	LEVEL
GIS & RS	

ArcGIS	I have used ArcGIS during my graduate education and in several of my professional projects.
ERDAS IMAGINE	I have used Erdas Imagine during my graduate education and in several of my professional projects.
DATABASE	
SQLServer	I have attended to APTECH-ACAD certificate programme for 8 months and started to study on SQL Server at that time. Later I have executed some projects using SQL Server while I am working for Geotech
MS Access	Besides my studies on MS Access at the university, the default RDMS of ArcGis is MS Access too. Therefore, I have use it for some works.
IMAGE PROCESSING	
Photoshop	These are not related with my professional career but with my individual interest.
Paint shop	These are not related with my professional career but with my individual interest.

LANGUAGES

A good command of the languages: **Arabic, English**
A Medium command of **Turkish** and **Italian** Languages

HOBBIES

- Reading, Travel, Swimming

REFERENCES

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PROF.DR. Faraj AL SHIKHI — Benghazi University, LIBYA
Head of Electronic Engineering Department
+218 61 2230317

OTHERS — Upon to request