Cairo University
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Land Suitability Analysis for Urban Green Areas Using New Methods and Techniques

A thesis submitted in partial fulfillment of the requirements of
The PHD. of Science Degree in Urban Design and Planning

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Last, but not least, thanks to my husband for his patience and understanding. His confidence and faith in me have been a constant source of my strength.

God gives success

Dedication:

I would like to dedicate this thesis to my husband, my elder son “youssof” and his brother “samir”

بسم الله الرحمن الرحيم

"وَقُل رَّبِّ زِدْنِي عِلْمًا"

سورة طه, اية ١١٤

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Literature Review

People have used maps for centuries to represent their environment. Maps are used to show locations, distances, directions and the size of areas. Maps also display geographic relationships, differences, clusters and patterns. Maps are used for navigation, exploration, illustration and communication in the public and private sectors. Nearly every area of scientific enquiry uses maps in some form or another. Maps, in short, are an indispensable tool for many aspects of professional and academic work[1].

Cartography is the art and science of making maps. The oldest known maps are preserved on Babylonian clay tablets from about 2300 B.C. Cartography were considerably advanced in ancient Greece. The concept of a spherical Earth was well known among Greek philosophers by the time of Aristotle (ca. 350 B.C.) and has been accepted by all geographers since. Greek and Roman cartography reached a culmination with Claudius Ptolemaeus (Ptolemy, about A.D. 85-165). His "world map" depicted the Old World from about 60°N to 30°S latitudes. He wrote a monumental work, Guide to Geography (Geographike hyphygesis), which remained an authorities reference on world geography until the Renaissance[2].

At around the time of 500 years B.C, the Greeks understood that the earth was round and this was an essential development for cartography since people earlier had been describing the earth as a flat surface[3].

At around 200 B.C, the Greeks started to create more accurate maps of North Africa and in Europe, around the Mediterranean. They even tried to estimate the length of the equator, which they managed to do quite well. This is amazing considering the tools they had at this time[4].

During the middle Ages, the field of cartography in Europe suffered from a setback caused by the conservative church, which did not allow the field and studies of cartography to develop. It was not until the renaissance began[5].

At A.D. 150, Ptolemy's map of the world, republished in 1482. Notice the use of latitude and longitude lines and the distinctive projection of this map[1].

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[1] Blakemore, Michael J. and J. B. Harley, (1980), Concepts in the history of cartography: A review and perspective. Cartographical 17(4), Monograph 26.

[2] Merriam, D.F, (1996), Kansas 19th century geologic maps. Kansas Academy of Science, Transactions .

[3] Anthony Grafton (Author), Daniel Rosenberg , (March 3, 2010), Cartographies of Time: A History of the Timeline, Princeton Architectural Press.

[4] IBID.

[5] Merriam, D.F, (1996), Kansas 19th century geologic maps. Kansas Academy of Science, Transactions 99.

Figure 0-1 A world map at A.D.150

(Source: Borden Dent, 2008, Thematic Map Design, McGraw-Hill Science)

During the Medieval period in the beginning of the 12th century, European maps were dominated by religious views. The T-O map was common. In this map format, Jerusalem was depicted at the center and east was oriented toward the map top. Viking explorations in the North Atlantic gradually were incorporated into the world view beginning in the 12th century. Meanwhile, cartography developed along more practical and realistic lines in Arabic lands, including the Mediterranean region. All maps were, of course, drawn and illuminated by hand, which made the distribution of maps extremely limited[2].

Figure 0-2 A classic "T-O" map with Jerusalem at center and east toward the top.

(Source: Borden Dent, 2008, Thematic Map Design, McGraw-Hill Science.)

1 Borden Dent, Jeff Torguson, and Thomas Hodler, (August, 21, 2008), Cartography: Thematic Map Design, McGraw-Hill Science/Engineering/Math; 6 edition.
[2] IBID

In the 12th century, al-Idrisi's map of the world, 1456. Al-Idrisi was a muslin scholar in the court of King Roger II of Sicily. He completed a map of the known world. Drawn with south at the top[1].

Figure 0-3 Al-Idrisi's map of the world

(Source: Katharine Harmon, 2010,Contemporary Artists Explore Cartography, Princeton Architectural Press.)

From the 12-14th centuries, S. Munster's Cosmographia (1588) mapped the northern regions map from north Atlantic region. One of the last wood-engraved maps, done in the style of copper-plate engraving[2].

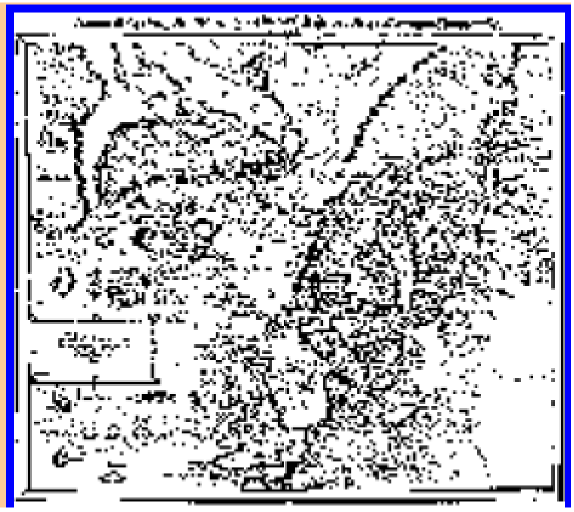

Figure 0-4 Northern regions map

(Source: Whitfield, 1994, The image of the world, Pomegranate Art books Press.)

[1]Katharine Harmon and Gayle Clemans, (Sep, 2010), The Map as Art: Contemporary Artists Explore Cartography, Princeton Architectural Press

[2] Whitfield, 1994. The image of the world: 20 centuries of world maps. Pomegranate Art books Press, San Francisco.

In the 16th century 1507, Waldseemüller's world map, the first map to incorporate new world discoveries. This map is based on the Ptolemaic projection, but does not show the entire globe[1].

Figure 0-5 Ptolemaic projection map

(Source: Gretchen N. Peterson, 2009, GIS Cartography, CRC Press.)

In the 16th century 1508, World map of Rosselli, the first map to show the entire globe. A mythical southern continent is shown, and ocean areas are much too mall. Nonetheless, it is a true world map[2].

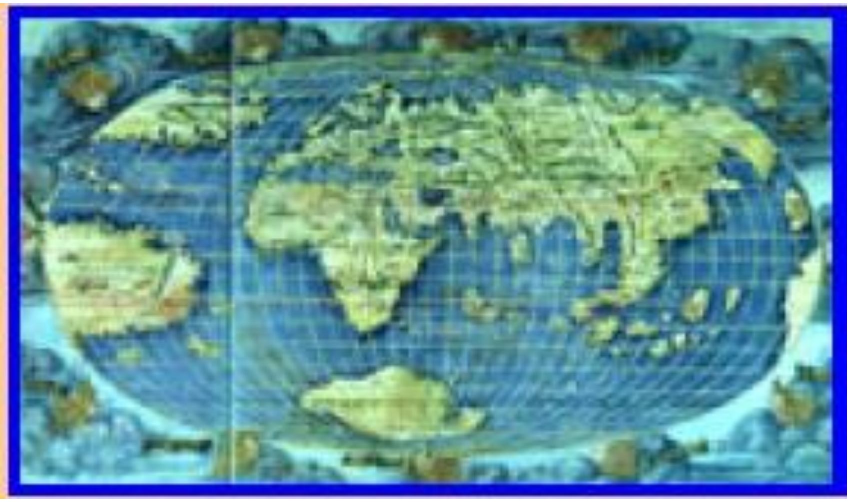

Figure 0-6 World map of Rosselli

(Source: Gretchen N. Peterson, 2009, GIS Cartography, CRC Press.)

[1] Gretchen N. Peterson, 2009, GIS Cartography: A Guide to Effective Map Design, CRC Press; 1 edition
[2] IBID

In the 16th century 1530, Heart-shaped world map of Apian. A fully expanded Ptolemaic projection of the world results in this heart-shaped map. Popular during the Renaissance, this kind of map is a novelty today[1].

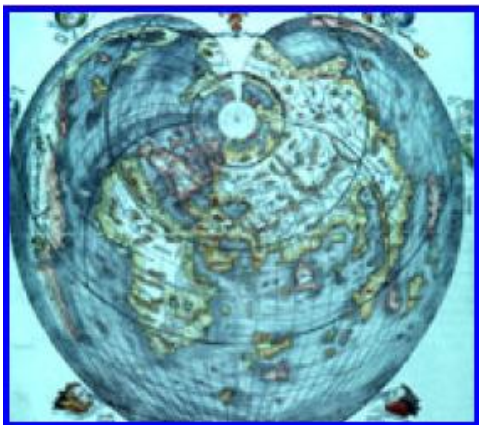

Figure 0-7 fully expanded Ptolemaic projection of the world

(Source: Gretchen N. Peterson, 2009, GIS Cartography, CRC Press.)

In the 16th century 1569, the modern cartography really started to develop. One very important person in the development of cartography was **Gerardus Mercator**, who lived in the 16th century was the leading cartographer of the mid-16th century. He developed a cylindrical projection that is still widely used for navigation charts and global maps. He published a map of the world in 1569 based on this projection. Many other map projections were soon developed. World map in Mercator projection by van Keulen, about 1720. On this projection, all straight lines are true bearings. This results in great size distortion toward the poles[2].

Figure 0-8 World map in Mercator projection

(Source: Gretchen N. Peterson, 2009, GIS Cartography, CRC Press.)

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[1] Gretchen N. Peterson, 2009, GIS Cartography: A Guide to Effective Map Design, CRC Press; 1 edition
[2] IBID

Then cartography progressed fast from the 16th to 19th century, but the really modern cartography didn't develop until about a hundred years ago. Now days the world are quite skilled in this area, and can do very complicated, as well as simple, maps. Users are often using GIS and satellite images in map making, and to get better and better instruments making it able to describe the earth with higher and higher accuracy[1].

Geographic information systems (GIS) emerged in the 1970-80s period. GIS represents a major shift in the cartography paradigm. In traditional (paper) cartography, the map was both the database and the display of geographic information. For GIS, the database, analysis, and display are physically and conceptually separate aspects of handling geographic data. Geographic information systems comprise computer hardware, software, digital data, people, organizations, and institutions for collecting, storing, analyzing, and displaying georeferenced information about the Earth[2].

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[1] Gretchen N. Peterson, 2009, GIS Cartography: A Guide to Effective Map Design, CRC Press; 1 edition

[2] Katharine Harmon and Gayle Clemans, (Sep, 2010), The Map as Art: Contemporary Artists Explore Cartography, Princeton Architectural Press

Introduction:

A worldwide revolution in information and communication technology is taking place. This transformation in communication and technology is fundamentally changing and affecting our life style. Traditionally, data providers have supplied data in open ASCII formats with systems simultaneously loading and translating it into the proprietary binary format. Data can be exchanged between systems where an import option exists for the particular formats. There are also bespoke translation tools available to cover every possible option. Exchange between formats has advanced further in recent years and the term interoperability has become important. Within a single organization there can be several different software products being used and it is imperative that information can be shared between them[1].

Sustainable urban development is essential to enhance the quality of life of citizens and to decrease the impact of cities upon resources outside the urban context. Redeveloping and planning green spaces and urban structure become the fundamentals of the sustainable urban planning of the city. An effective urban planning using recent technology is required to contribute to the social and physical development of the cities through promoting the land value[2]. The thesis aims to develop a method to select the most suitable spaces for green areas, to maintain ecological balance and organization of the urban green areas, using Geographic Information System that assist in effective planning in green areas. Land suitability analysis, ecological threshold method, and landscape ecology principle is going to be applied on one of the Egyptian new cities in desert environment (10th of Ramadan), as the practical part is going to suggest a method of green network planning that would help in enhancing the connectivity and reduce the fragmentation through integrated greenway system. Results are going to reveal that the green ways could be developed to play a more significant role to bring nature into the city. Finally an ecological base for building and eco-city of 10th of Ramadan is proposed.

The thesis is structured of seven chapters; the first chapter reviews the city as an open system that should strike the balance between modern development and retention of the historic heritage, the second chapter discusses urban planning process through the interaction between human activity and land uses including those factors producing pollution and stress. The third reviews the city structure as an object of general urban planning testing the structure of particular city zones, plot fragment, besides their groups as an object of detailed or spatial urban planning. The forth chapter discusses the land

[1] www.gao.gov/fraudnet/fraudnet.htm
[2] wsdot.wa.gov/eesc/environmental/ programs/watershed/snobas/other_links/final_report.cfm.

suitability analysis for urban green areas, the ecological factor threshold method, and the landscape-ecology principles in planning comprehensive green structure through the different international experiences. The fifth chapter deducted the methodology that has been concluded from the previous theoretical chapters to be applied on the case study. Chapter six brings up the case study using the GIS as a tool to determine the most suitable areas for urban green network to reach the carbon oxygen balance in the city. The last chapter has reached several general conclusions through the use of the theoretical study and the practical one while depicting their various parts and it also illustrated several recommendations for the urban planner while planning his new city.

Research Problem:

Recent surveys have shown that the good quality of Egyptian life has been lost in our cities, as general planning doesn't contribute to the citizen needs and no carbon oxygen balance has been reached within the new cities, so urban planners should adopt to elect proper locations for the urban green spaces and to evaluate this selections in order to optimize the benefits of urban green spaces. It has been widely believed that urban green spaces an important component of urban ecosystems, and provides many environmental and social services that contribute to the quality of life in cities.

Research Goal:

Egyptian citizen dreams of a balanced environment for now to enjoy their lives and for the new generations to live in a healthy city. These dreams will take us to the research goal which is going to formalize methodologies to select suitable areas to be included in urban green spaces through:

- Land suitability analysis based on GIS.
- Quantifying green areas based on the ecological factor threshold method to maintain ecological balance.
- Applying landscape-ecology principles in organizing green spaces in urban areas.

The previous selection for urban green areas was mainly based on expert’s knowledge and strongly influenced by the existing City Master Plans. Referring to the fact that there was no formal method for this type of site selection process, so the research would introduce a new technique for this type of site selection.

Research Methodology

To reach the previous mentioned objective; the following methodologies will be adopted:

- The theoretical approach, the comparative, analytical approach, and the deductive approach.

The Theoretical Approach:

The theoretical approach will appear throughout the first three chapters of the thesis. This approach is depending on reviewing literature, books, and magazines.

This approach will be applied through, discussing the different concepts of the city as an open system, reviewing urban planning process through the interaction between human activity and land uses including those factors producing pollution and stress and amount of CO_2 emitted from each activity, and illustrating city structure as an object of general planning, and its zones as an object of detailed or spatial planning.

The Comparative, Analytical Approach : (Inductive approach)

The analytical approach will appear throughout chapter four and five of the thesis. This approach is depending on illustrating and analyzing the power of using GIS as a unique system in the land suitability analysis to reach ecological city, and also this approach depends on analyzing and processing international experiences of the ecological city.

This approach will be applied through, analyzing the city data, and urban green areas using GIS as an essential tool used for the land suitability analysis, ecological factor threshold method, and landscape-ecology principles in planning comprehensive green structure.

The Deductive Approach:

The deductive approach will appear throughout the chapter six, and seven. This approach is depending on deducting a methodology from the theoretical part and applying it on the case study to convert the desert city to ecological city through a network of urban green areas within the new city.

Research Hypotheses:

With the help of the new techniques and programs right decisions should be taken from urban planners in order to create a green network ecologically more effective than the sum of the individual green spaces, which will lead to form a base for an ecological city in the future that will maintain carbon oxygen balance. As current urban green areas do not maintain ecological balance and organization of the green spaces, and the future plan seems to lack a theoretical basis, or a holistic framework, at different scales.

Research Contribution

Identifying suitable sites for conserving and developing green spaces is the first important step to reach balanced environment to live in a healthy city, so the thesis is going to introduce a new method and technique for developing green spaces in urban areas through Land suitability analysis based on GIS, quantifying green areas based on the ecological factor threshold method to maintain ecological balance, and applying landscape-ecology principles in organizing green spaces in urban areas.

Figure 0-9 Shows research contribution method

(Source: Researcher.)

Research Case Study:

There are several types of the new cities, Desert new cities, Agriculture new cities, Coastal new cities; the research is going to deal with the desert new cities.

Research Scope and Limitation:

- The research will focus on the land suitability analysis for urban green areas.
- This research will introduce the different planning theories that contribute to the CO2 emitted from different land uses along the city.
- The research is going to deal with the theories that illustrate the landscape ecology principle for urban green areas along the city.
- The research case study will focus on converting the desert new city to ecological cities by maintaining its current land uses and developing a network of urban green areas.

Problems Facing the Researcher:

The main problem that faced the researcher was lack of official resources for the case study, thereby the researcher's main dependence was personal relationship to gather all the necessary information.

Definitions:

Table 0-1 Terms that has been used along the thesis

(Source: Researcher)

Term	Definition
City	An inhabited place of greater size, population, or more important than a town or village.
City plan	An organized arrangement (as of streets, parks, and business and residential areas) of a city with a view of convenience, appearance, healthful environment, and future growth – city planning.
City planner	One that makes city plans - a professional who participates in such activity; urbanism.
Town	A cluster of aggregation of houses recognized as a distinct place with a place name; a large densely populated urban area.
Settlement	A small village.
Village	A settlement usually larger than a hamlet and smaller than a town.
Urban	Constituting a city.
Urban ology	A study dealing with specialized problems of cities (as planning, education, sociology, politics).
Urbanization	The quality or state of being or becoming urbanized.
Urban Sprawl	The spreading of the urban development's (as houses and shopping centers) on undeveloped land near a city.
Urban Planning	The act or process of making or carrying out city plan.
Metropolis	A large important city.
Attribute	Representation of an essential trait, quality or property of an object or entity.
Cartographic database	A set of cartographic data arranged systematically and methodologically.
Cartography	A method in geographic cognition as well as a field of scientific and

	industrial activity involving plane representation by graphic models of spatial natural and anthropogenic objects and phenomena, the production and publishing of cartographic products, and creation of geographic information databases.
Coordinate reference system	Coordinate system which is related to the real world by a datum
Data	A collection of related facts usually arranged in a particular format and gathered for a particular purpose.
Database	A collection of data, arranged systematically and methodologically, which may be accessed individually by electronic or other means.
Dataset	Identifiable collection of data.
Feature	Abstraction of real world phenomena.
Feature attribute	Characteristic of a feature.
Interoperability	Capability to communicate, executes programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units..
Land use	The determination of the use to which a property may be put, e.g. Residential, industrial, commercial, open space, etc.
Map	Portrayal of geographic information as a digital image file suitable for display on a computer screen. A graphical representation of geographic information. It includes geographic data and other elements such as a title, north arrow, legend, and scale bar.
Map projection	Mathematical mapping of a geodetic ellipsoid, or part of a geodetic ellipsoid, to a plane.
Map scale	The relation between the dimensions of features on a map and the geographic objects they represent on the earth, commonly expressed as a fraction or a ratio. A map scale of 1/100,000 or 1:100,000 mean that one unit of measure on the map equals 100,000 of the same unit on the Earth.

Research Contents:

The research comprises seven chapters presenting the following:

Chapter One: City as a system

Living in a healthy city is considered as an essential demand, which enables all its citizens to meet their own needs and to enhance their well-being, without damaging the natural world or endangering the living condition of other people, now or in the future[1]. Serving this idea, this chapter is going to review the city as an open system, discusses the type of the cities, common characteristics of inhabitant and their impact on the different parts in the urban areas within a city. It handles also economic basis of the city and its impact on the skilled workforce, the mobility along the cities of the government, and the impact of the mobility on the government enterprises. Finally, the chapter discusses the sources of pollution along the city and the traffic safety.

The urban planning process is considered the tool that is used to plan the previous city elements in an organized strategy to build the eco-city. This will be discussed in the next chapter.

Chapter Two: Urban Planning Process

Urban and regional planning underlies the fabric of society as users deal with it today. Without planning, cities, towns, rural areas, and residential communities will not run efficiently. While communities today face many challenges, such as pollution and traffic, it can be addressed by careful and creative planning. It is the planner’s job to address such problems and provide viable solutions for today and the future[2]. Serving this idea, this chapter discusses traditional and digital urban planning process, through interaction between human activities and land uses. It reviews also the territory planning as a preventive measures rather than investment. It also handles urban planning goals from the point of view that urban planning is not a onetime action but a continuous process, and finally discusses urban planning participant, and handles the stages and actions that are followed by urban planner in order to evaluate the general and detailed planning.

City structure is an object of general planning, and its zones are an object of detailed or spatial planning. This topic will be dealt with in the next chapter.

---

[1] Herbert Girardet,1999, Creating Sustainable Cities (Schumacher Briefing, No. 2.), Chelsea Green Publishing.

[2] Spector, L., and Hendler, J. 1994. The use of superve- nience in dynamic-world planning. In Hammond, K., ed., Proceedings of The Second International Confer- ence on Arti_cial Intelligence Planning Systems.

<u>Chapter Three:</u> City Structure and Pollution Emission

Cities with differentiated or integrated functions, open or closed structures, monocentric or polycentric, compact or discreet, can acquire a variety of forms according to either the natural conditions surrounding the city, or the planning form of it. Serving this idea, the first part of this chapter reviews city structure, city development concepts from the point of view of functional zones concept and functional integration concept, city development structure in terms of city development concept.

As urban planners play the roles of developing functional and aesthetically pleasing cities with the highest and best use of land, and at the same time ensure that they are ecological friendly. It is important to develop low carbon cities to ensure low CO2 emissions in the urban areas[1], so the second part of this chapter illustrates every section in the new cities that is responsible for the carbon emission, these sections divide into three groups, the first group highlights on living territories and land uses carbon emission, the second group highlights on transportation system carbon emission, the last group highlights on industrial zones carbon emission. Finally this chapter reviews the natural and built ecological system in urban environment using a network of green areas.

Redeveloping and planning green spaces and urban structure are among the essentials of mass planning of a city. Accurate planning with the help of GIS is willing to be a big step in the physical and social development of the cities. The systematic view towards the subject of city planning, has not found its specific position in many countries. Most of our cities are designed, planned and administrated by inexpert individuals. It will be right if the skillful experts with the help of technical and scientific tools bring an end to the disordered state of most cities[2]. There for, redeveloping and planning green spaces using new methods and techniques is going to be illustrated in the next chapter.

<u>Chapter Four:</u> Land Suitability Modeling for Urban Green Areas

Placing value on land and space within a city is an essential part of urban planning. "Placing values is important in urban planning because it shows community support" (Johnson, 1989). An example, if a community places high value on increasing its economy, the community may promote and support industrial or other business growth within the community. Community residents can show support for urban parks in the same fashion. Those communities that place high value on their park systems will often display and

[1]Anqing Shi (2001). Population Growth and Global Carbon Dioxide Emissions. IUSSP Conference, Brazil, Session-S09.
[2] Nasrin Sesar, (2000), M.A.Architect,M.S.Urban Planner, 26 Greenfield, Irvine CA. 92614

promote their parks with economic support. For this reason, parks and the general welfare of a city can often be related. If a community is growing economically, then that community may provide a fine park system. Supporting to the idea of placing value on land and space, this chapter is going to discusses, urban green areas system and definition, its hedonic value, and the importance of green areas and its benefits to the city. Finally this chapter handles three assumptions for database model one for Hanoi and the other for Serio-Oglio, and a international experience for Masder new City in Dubai

By reviewing the international examples for developing urban green areas within a city using an efficient methodology of structuring of geo-information, the next chapter is going to discusses all the standards that have been gathered from the previous theoretical part to be applied on the case study.

Chapter five: Methods Applied on the Case Study.

After reviewing the, city as an open system, urban and regional planning that underlies the fabric of society as users deal with it today, Cities with differentiated or integrated functions, open or closed structures, monocentric or polycentric, compact or discreet, that acquire a variety of forms according to either the natural conditions surrounding the city, geographic information system as an important tool that deal with new desert cities to convert it to ecological cities, and finally three of the international experiences of the ecological city, this chapter is going to gather all the important standards that have been deducted from the theoretical part to be applied on the practical one.

After gathering all the essential standards, the next chapter is going to discuss an Egyptian case study (10^{th} of Ramadan), using new methods and techniques in order to convert the desert city to ecological city.

Chapter Six: Case Study Results and Discussion.

Urban green spaces, an important component of urban ecosystems, provide many environmental and social services that contribute to the quality of life in cities. One of the key tasks of planners is how to optimize the benefits of urban green spaces. This study introduces a new technique for developing green spaces in urban areas through:

- *Land suitability analysis based on GIS*: identifying suitable sites for conserving and developing green spaces is the first important step to ensure their roles and functions.

- *Quantifying green areas based on the ecological factor threshold method to maintain ecological balance*: Applying the ecological factor threshold method will help quantify how much green area is necessary to maintain an ecological balance in urban areas.
- *Applying landscape-ecology principles in organizing green spaces in urban areas:* the roles and functions of urban green spaces can be enhanced if they are organized by combining a variety of green space types for multiple purposes called a green network or urban green structure.

Chapter Seven: Conclusions and Recommendations.

The research has reached several general conclusions through the use of the theoretical study or the practical one while depicting its various parts. The research also has reached concluded methodology for the urban planner in order to reach a new city with carbon oxygen balance.

Research Structure:

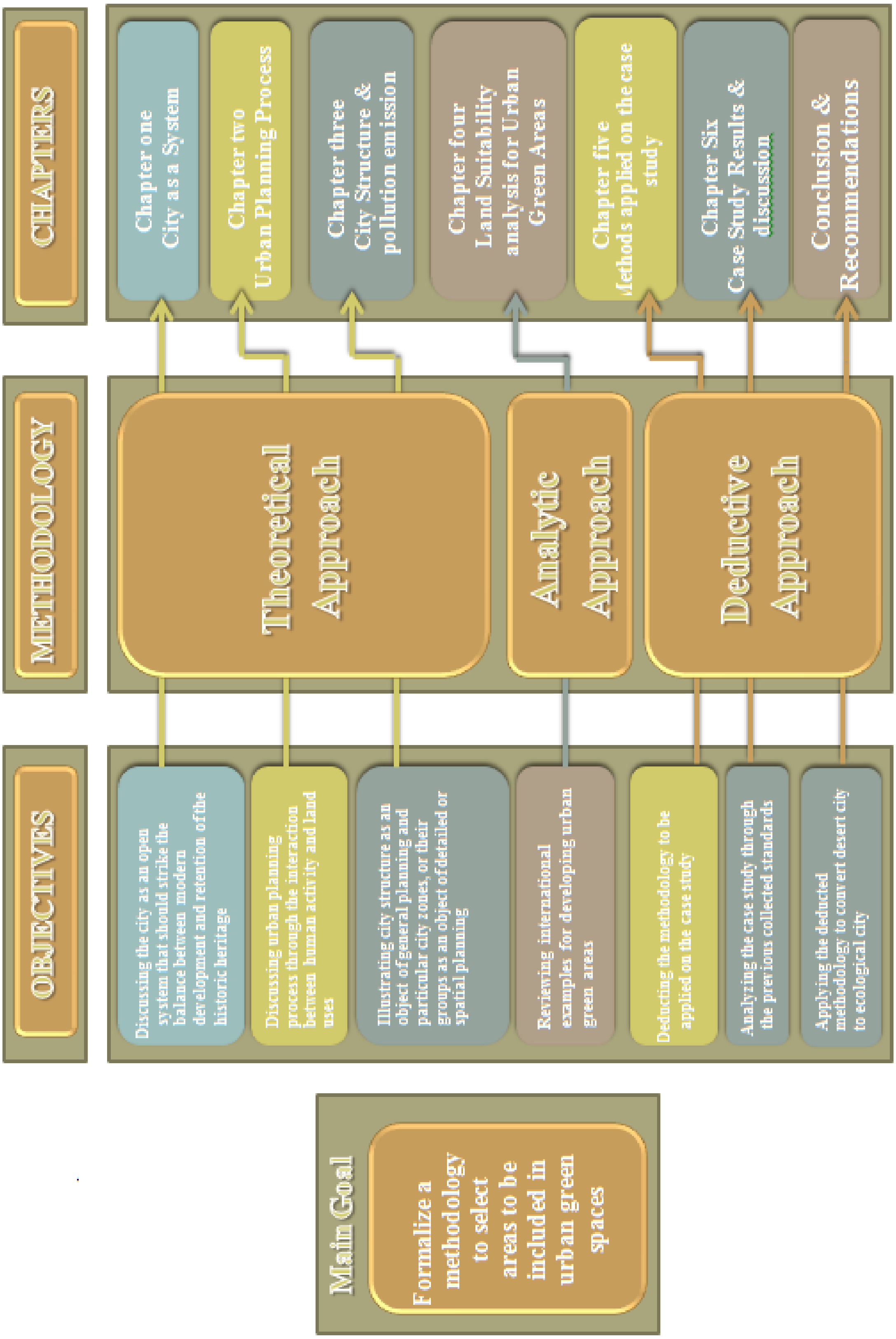

Figure 0-10 Whole Structure of the thesis

(Source: Researcher)

Chapter 1

City as a system

- 1.1. Introduction
- 1.2. Definition of the City
- 1.3. Type of the City
- 1.4. Entireties of the City System
- 1.5.Common Characteristics of Inhabitants
- 1.6. Mobility of Inhabitants
- 1.7. Traffic Safety
- 1.8. City Pollution
- 1.9. Conclusion

1.1. Introduction:

Towns and cities attract people who wish to live there, work there, and go there as tourists or for cultural reasons. It has traditionally been the area for concentration of substantial resources and networks of influence[1]. This chapter reviews a city as an open system that should strike the balance between modern development and retention of the historic heritage, the chapter also discuss the type of the cities, common characteristics of inhabitant and their impact on the different parts in the urban areas within a city, economic basis of the city and its impact on the skilled workforce, the mobility along the cities of the government and the impact of the mobility on the government enterprises, and finally the chapter discus the sources of pollution along the city and the traffic safety.

Beginning in the 19th century, associated with the Industrial Revolution, streams of people migrated into cities, drawn by jobs and wealth, theoretically leaving poverty behind, this was due to the development of urbanization and urban sprawl. The process is still continuing in many European countries. In others, especially in recent years, decentralization or reverse migration from the city towards suburbs has taken place - not only at weekends, but also more permanently by the search for a healthier, less polluted environment, a different job or more amenable surroundings[2].

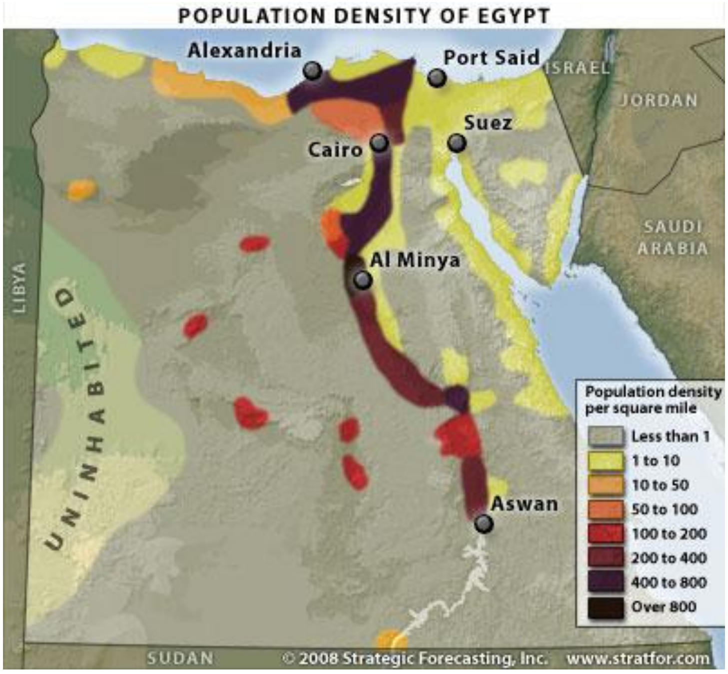

Figure 1-1 Population density in Egypt

(Source: http://www.reddit.com/r/TrueReddit/comments/fcbh6/hyperbole_aside_what_is_the_internet_kill_switch/.)

[1] http://www.eis-africa.org/publications_bestpractices.htm
[2] Leonardo de vinici, (2004), GIS in urban planning, Sweden press

1.2. Definition of a City:

Many pioneers and planners defined the city from different points of view starting from 19th century till now. According to Alan S. Berger 1978, a city is considered as spatially limited of people organized into residential areas that form a larger aggregate, city based on the number of people live in a given area implies the use of legally or politically defined areas in which people are counted[1].

According to Goodall, B. 1987, Cities are considered as advanced systems for sanitation, utilities, land usage, housing, and transportation and more. This proximity greatly facilitates interaction between people and businesses, benefiting both parties in the process[2].

According to Alan Freeman, city cannot be political or take political or administrative boundaries as a starting point, but should instead arise from socio-economic study of what a city actually consists of[3].

While Herbert Girardet, city is organized so as to enable all its citizens to meet their own needs and to enhance their well-being without damaging the natural world or endangering the living condition of other people, now or in the future[4].

Also Brail, R.K. and Klosterman, R.E. 2001, stated that a city definition comprised three subsystems[5], the needs and accomplished functions of inhabitants, enterprises and authorities, preconditions and possibilities essential for the realization of needs and fulfillment of functions, and consequences of the activities of two previous subsystems.

Lately in 2007 Jonas, Andrew and Kevin Ward, stated that cities are increasingly surrounded by suburban communities such as towns and villages that are within commuting distance of the dominant city, rural municipalities that are developing industrial and commercial lands as well as housing tracts, and neighboring cities that are functionally inter-related with the economic sphere of the region. These city regions collectively constitute a regional matrix of residential, industrial, commercial, agricultural, recreational, and municipal services. It is the synergy of a diverse set of elements within a region that creates the ebb and flow of work and leisure, of social and political structures, and of quality of life and the collective health of communities[6].

It can be concluded that cities are places where people can live healthier and economically productive lives while reducing their impact on the environment. They work to

[1] Alan S. Berger, (1978), the city: Urban communities and their problems, Brown, ISBN-10: 0697075559.
[2] Jane Jacobs, (1993), The Death and Life of Great American Cities (Modern Library Series), Modern Library
[3] IBID
[4] Herbert Girardet,(1999), Creating Sustainable Cities (Schumacher Briefing, No. 2.), Chelsea Green Publishing.
[5] Richard Brail and Richard Klosterman, (2001), Planning Support Systems: Integrating Geographic Information Systems, Models, and Visualization Tools, Esri Press; 1st edition.
[6]William Julius Wilson and Henry Louis Gates Jr.(2009), More than Just Race: Being Black and Poor in the Inner City, W. W. Norton & Company; 1 edition

harmonize existing policies, regional realities, economic and business markets with their natural resources and environmental assets. Cities strive to engage all citizens in collaborative and transparent decision making, while being mindful of social equity concerns.

1.3. Type of cities:

A city should strike a balance between modern development and retention of the historic heritage; integrate the new without destroying the old; support the principle of sustainable development. *A town without its past is like a man without memory*[1]. People leave traces of their lives and their work and their personal history in cities, in the form of neighborhoods, buildings, trees, churches, libraries. They constitute the collective legacy of the past, enabling people to feel a sense of continuity in their contemporary lives and prepare for the future[2].

Cities can be classified according to two accepts:

A. The first aspect classified the city according to the various sectors and activities that took place inside the city.
B. The second aspect classified the city according to population based on the national census figures.

1.3.1. The First Aspect:

The first aspect classified the city according to the various sectors and activities that took place inside the city. According to this aspect cities may be divided into three types, ultimate city, traditional city, and nontraditional city[3].

A. Ultimate City:

An ultimate city is one which succeeds in reconciling the various sectors and activities that take place (traffic, living working and leisure requirements); which safeguards civic rights; which ensures the best possible living conditions; which reflects and is responsive to the lifestyles and attitudes of its inhabitants; where full account is taken of all those who use it, who work or trade there, who visit it, who seek entertainment, culture, information, knowledge, who study there.

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[1] Leonardo de vinici, (2004), GIS in urban planning, Sweden press.
[2] IBID
[3] Sedogo, L.G. and Groten, S.M. (2002). Integration of local participatory and regional planning: A GIS data aggregation procedure. Geojournal.

B. Traditional City:

Is a city where the inhabitants engage in a variety of activities rather than in agriculture, forestry and fishery; it is a political, organizational, cultural and provisional center of a certain territory; the residential area exercises the prevalence of anthropogenic milieu and a more intensive utility in comparison to its contiguous areas.

C. Non Traditional City:

Is a city defined in the population census returns suggested by the United Nations Statistical Department, to conceive the concept resident agglomeration. In international terms, an agglomeration is made up of a group of houses with the in-between distance of no more than two hundred meters. On condition that this area houses no fewer than 2,000 residents, it fulfills the requirements of city agglomeration.

1.3.2. The Second Aspect:

The second aspect classified the city according to according to population based on the national census figures. According to this aspect cities may be divided into four classes[1].

A. The First Class:

First class cities are those with more than 100,000 inhabitants. Once a city becomes a first class city, it will not lose that status unless its population decreases by 25 percent from the census figure.

B. The Second Class:

Second Class cities have populations of more than 20,000, but not more than 100,000.

C. The Third Class:

Third Class cities have populations of more than 10,000, but not more than 20,000.

1.4. Entireties of City System:

City system may be divided into three entireties which are elements, communication, and environment[2].

A. Elements: may be considered as community, social, economic and technical systems or subsystems. Parts of the city identified as separate functional zones, districts, complexes or other territorial units.
B. Communication: may be considered as relations, dependencies, influence commonly reveals itself in terms of flows of people, means of transport, information, finance between interior and exterior city elements.

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[1] Sedogo, L.G. and Groten, S, (2002). Integration of local participatory and regional planning: A GIS data aggregation procedure. Geojournal.

[2] http://mis.ucd.ie/staff/pkeenan/gis_as_a_dss.html

C. Environment: may be considered as natural and anthropogenic (organic and artificial) interior milieu, in which the majority of city processes take place, as well as the exterior of the city vital to the very existence of the city life.

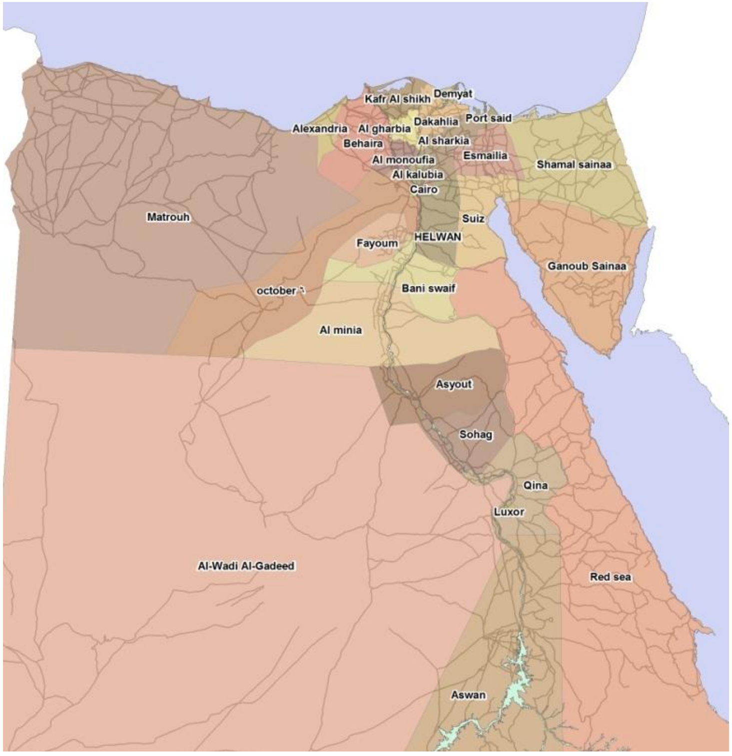

Figure 1-2 Government's boundaries of Egypt

(Source: Researcher)

Communication and elements are therefore greatly influenced by- not every entirety but only the one pertaining all essential features could take the name of a system, the change of any city element (subsystem) causes the changes in other elements (subsystems), their interrelations and the relations with the exterior of the city[1].

A city system can be divided into inferior territorial subsystems, the latter subsequently being split into smaller units (zone-district-groups of buildings-sole building) this could be the subsystem of the lowest position. If necessary, a building can be regarded as a separate system. City subsystems follow a hierarchical pattern. A city system can also be divided into functional subsystems, e g social, transportation, green areas, water supply and etc.

It can be concluded that the performance of a city system is not predestined in advance. The system functions under the influence of a range of accidental factors, city management among them. However, this does not deny common truth that the city is a

[1] Richard K. Brail, (2008), Planning Support Systems for Cities and Regions, Lincoln Institute of Land Policy.

manageable system. The processes of analysis and planning contain all defined features and factors pertinent to a city system[1].

1.5. Inhabitants:

The size of the population in a city is generally the outcome of long lasting processes[2] as the development of economic basis, natural increase in population (birth and death ratio) and finally the mechanical increase in population (the ratio of those who moved in and those who moved out). The change in the administrative boundaries of a city is considered as a process not only taking place in the city but also on the national scale.

1.5.1. The Common Characteristics of Inhabitant Structure:

The common characteristics of inhabitant structure differentiation in urban areas are considers as[3]:

A. Legal and illegal economic migrants from poorly developed countries. They usually concentrate in central city parts, dilapidated and the cheapest.

B. Young unemployed and permanently jobless people migrating from villages to countries usually sit together in rented apartments in economic districts.

C. Asocial families and individuals, drug-users, the homeless, vagrants also rally in the premises of railroad and coach stations, market places communal places and warehouses, in neglected or poorly supervised houses and buildings.

D. National minorities quite regularly form local, isolated communities.

E. Prestige city districts, residential estates of embassies, rich and famous people, intellectuals and civic servants, emerge.

F. Special projects are made; separate housing estate districts or large groups of estates are built and utilized exceptionally by the rich in the suburbs or city vicinity, physically isolated from the outside and well-guarded.

In its complexity the city community exceeds the description in terms of age, marital status, gender, income and other traditional features; it is closely linked to specific problem groups of people.

[1] Richard K. Brail, (2008), Planning Support Systems for Cities and Regions, Lincoln Institute of Land Policy.

[2] Brail, R.K. and Klosterman, R.E.(2001). Planning Support Systems - Integrating geographic information systems, models and visualization tools. Esri Press, Readlands.

[3] IBID

1.5.2. The Employment of Inhabitants:

Both the employment and the level of unemployment of inhabitants are significant features of welfare standards of the city. The unemployment rate of 3-5 % is usually considered to be a normal, even an economically auspicious phenomenon. The higher the unemployment rate, the more acute social problems, which, in their turn reflect poor economic situation within both the city and the country[1].

In terms of employment, such characteristic groups of inhabitants are: all inhabitants, able bodied inhabitants, workforce, engaged (employed) inhabitants, jobless people.

A. Able-bodied population: The proportion of able-bodied population is bigger in the cities, which are younger due to higher birth rate and immigration of young people.
B. Workforce: Comprises all potential employees, with the exception to those still studying and able bodied, unemployed inhabitants due to various reasons (physical disability, engaged in personal household chores, housewives; parasites and etc.)
C. Engaged: Employed inhabitants encompass the ones employed by private and public sectors and municipal departments; freelance professionals (e g writers, artists, who make a living from author’s emoluments) and those who work under license.
D. Unemployed: The unemployed include the ones who have been made redundant or are at the initial stage of their employment, town people in search of a suitable job.

It could be concluded that employment survey is one of the components of the planning process. It could aid in the identification of a city as economic basis and its vitality, functional type, specialization and autonomy and finally the levels of industry novelty.

1.5.3. Health of Inhabitants:

The health of inhabitants depends on a variety of factors. A part of them can be called environmental factors, such as apartment and back yard; work, study, rest and other milieu, which surround any inhabitant at any period of his lifespan[2].

Urban environment, if compared to rural is in many respects far more hazardous because of high concentration of pollutants, excessive noise pollution, vibrations, electromagnetic waves, dust and etc. Urban environment involves stressful situations, tension and conflict probability.

The concept of healthy environment is continuously changing. Formally it is defined by standardized pollution, noise, insulation, hygiene and similar norms. The limits are indicators and show when certain measures should be taken to reduce a negative impact of

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[1] Richard K. Brail, (2008), Planning Support Systems for Cities and Regions, Lincoln Institute of Land Policy.
[2] Brail, R.K. and Klosterman, R.E. (2001). Planning Support Systems - Integrating geographic information systems, models and visualization tools. Esri Press, Readlands.

polluted environment on human health. The best way is to destroy the source of pollution; another and less effective is to eradicate the consequences; and the most passive one is to take away the source of air, noise or some other type of pollution, which has a negative impact, from the residential area[1].

It can be concluded that, the concept of healthy environment associates with sufficient living space, and attempts are to avoid congestion. Healthy environment is impossible without good quality drinking water, network of gutter and cleaning systems, waste disposal and adequate maintenance of private and public spaces, green network spaces.

1.5.4. Economic Development:

The economic basis of a city contains those enterprises, those work places, to be more precise, the output and services of which are exported.Agriculture and forestry, fishery and hunting, mining industry (the primary sector), these are the activities uncharacteristic of cities; people, who are employed in these spheres, number in only a few percent. In all cities there is also a reduction in employment figures for traditional industrial and construction spheres, substituted by services and a wide range of work places in enterprises producing modern technologies, information technologies among them[2].

So it may be considered that economic development is a process in which services are provided, produced goods are sold, and in this way wealth is established. It is created mainly by the private sector. By the end of the millennium economic activity was highly concentrated geographically. This reflects differences in policies across countries, natural geographic advantages and disadvantages, and agglomeration and scale economy effects.

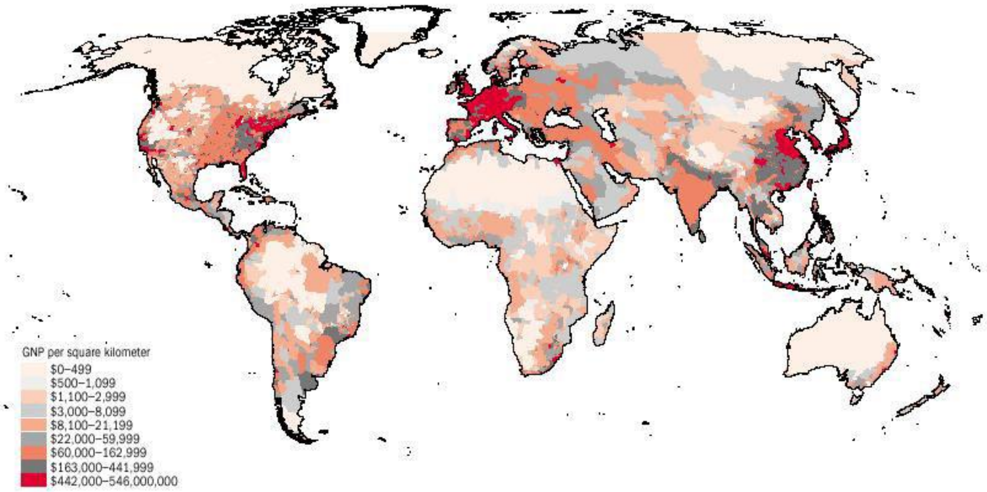

Figure 1-3 GNP density

(Source: Malczewski, (1999). GIS and multicriteria decision analysisInc.NewYork.)

[1] Leonardo de vinici,(2004), GIS in urban planning, Sweden press.
[2] Malczewski, J. (1999). GIS and multicriteria decision analysis. John Wiley and sons, Inc.NewYork.

Urban economic development is in need of certain conditions. The most essential are related with:

A. Workforce: Skilled workforce gains an extreme significance, as it is capable of analyzing and problem solving; it is easily retrained or improved. The supply of such workforce is an urban merit, which provides the probability of investment. Strange as it might seem, mobility is one of the qualities of workforce, except for the cases, which involve brain drain - specialist emigration to richer countries. It is therefore in the interests of the city is to maintain highly modern educational and vocational training systems[1].

B. Technologies: These are extremely rapidly changing and provide for higher labor productivity and quality. Science, knowledge and analysis is of utmost importance. Its costs usually exceed those of production. Technological innovations make enterprises more competitive. It is in the interests of every city to possess personal successfully operating scientific laboratories, universities, to support their co-operation with business and similar enterprises[2].

C. Social and technical infrastructures: The urban supply of infrastructure services is evaluated in terms of three main aspects: quality, reliability and accessibility. Traditionally important is technical infrastructure: streets, roads, railways, ports, stations, network system of electric power, water, drainage, gas and heating; water reservoirs; cleaning, solid and hazardous waste collection and storage (utilization) systems; public transport system. Unconventional infrastructure: mobile telecommunication network, satellite communications, the Internet and etc; science parks, technological centers. Social infrastructure: nursery and primary schools, medical, cultural and educational establishments and etc[3].

D. Financial: Capital is essential to launch and develop business. It can be either private or borrowed. The capital should be accessible, without it the possibilities for the urban economic development are scarce. It should be the focus of the national government interests, whose objective should also be the establishment of a positive legal basis, local municipalities also rendering considerable indirect assistance in the process[4].

[1] Malczewski, J. (1999). GIS and multicriteria decision analysis. John Wiley and sons, Inc.NewYork.
[2] IBID
[3] Leonardo de vinici, (2004), GIS in urban planning, Sweden press.
[4] IBID

E. Management: Efficient management is crucial for the success of both business and city. City management can virtually predetermine not only whether the business environment is favorable or not, but also the entire development of urban economy[1].

1.5.5. Security of Urban Inhabitants.

In the process of the arrangement of the city structure, its supervision and reconstruction, such well-established crime prevention means could be recommended according to the following points[2]:

A. Special attention should be given to city supervision (residential areas especially). This should be done in order to prevent the debasement of territories as well as the buildings located in them as it could give rise to the concentration of asocial people.
B. Residential areas and districts with integrated functions should be small. Huge, 150-200- hectare districts are quite inappropriate.
C. Design variety of a residential area (types of houses and apartment blocks and their status rented private and municipal apartments) should be sought for. This would help to avoid the concentration of age, social and ethnic groups in big territories. The probability of confrontation of such territories would be much scarcer, too,
D. Residential areas of integrated functions should be promoted. Houses, employment and service enterprises, located in an integral way, limit the interests of inhabitants and enhance their interrelations as well as their bond to the place, stimulate patriotism and consequently unofficial surveillance of the territory. Functional integration of the area should be used for as even as possible a serviceability of the territory in daytime and, in the absence of other obstacles, late in the evenings.
E. In order to strengthen the inhabitants' union with their district, the boundaries of the territories serviced by post, bank, school, police and other establishments should match those of the residential district.
F. District boundaries should possess obvious visual identification signs. Relief or other natural characteristics could be employed for this purpose; a street, a railway, a green belt could run the boundary.
G. Functional organization of a city center should provide the possibility for the city residents and visitors to enjoy its benefits both in the daytime and at night. The activities in the city center or its part should escape a specialized nature, which would

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[1] Brail, R.K. and Klosterman, R.E. (2001). Planning Support Systems - Integrating geographic information systems, models and visualization tools. Esri Press, Readlands.

[2] Sedogo, L.G. and Groten, S.M. (2002). Integration of local participatory and regional planning: A GIS data aggregation procedure. Geojournal.

mean rallying in the center only one single inhabitant group and thus assisting its domination there.

1.6. Mobility:

City dynamics is an emergent state of citizen's microscopic movements in an evolving environment. The urban mobility modeling is a paradigmatic problem due to the implications for the life quality. The citizen's propensities are the real causes of mobility, whereas the transportation networks allow realizing the mobility request[1].

However, in recent decades, mobility has become a value in itself. Travel distances have increased along with travel speeds and people generally now have to cover greater distances than they used to in order to fulfill the same needs as before in getting to school and to work, doing the shopping, visiting friends and family, etc.

Internal migration is responsible for redistribution of nearly 25 percent of Egypt's population and for the rapid growth of Egypt cities specially Cairo and Alexandria. Internal migration in Egypt has generally been from south to north or from south and north to Cairo and Alexandria[2].

There are two types of mobility along cities and villages, localization and communicational:

1.6.1. Localization:

While selecting the place of residence, accidentally or purposely an individual assesses job possibilities, healthy environment, access to service centers and schools and etc; career promotion and status acquisition chances and the like. This feature of mobility is equally pertinent to enterprises, but not to all, only to small-sized, modern ones, engaged in technologies.

The supply of more favorable business conditions, lower costs and a wide range of technical, economic, environmental and similar factors encourage benefiting from the advantages of mobility. Localization argumentation is also decisive on an investor's choice to invest in one place but not in another[3].

There are Three Types of Localization Mobility:

A. Inhabitant Migration: The most common direction is from rural areas to smaller towns, followed by further movement to bigger towns, cities and the final settlement

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[1] John Urry,(2007), Mobilities, Polity, ISBN-10: 0745634192.

[2] Jailan Zayan, (2007), Egypt - Culture Smart!: the essential guide to customs & culture, Kuperard, P 120-143

[3] John Urry, (2007), Mobilities, Polity, ISBN-10: 0745634192.

in one or other most prestigious cities or due to social, economic or political reasons result in emigration to other countries.

B. Seasonal Migration: Two of them are most common: a temporal change of the place of residence by workforce and pensioners and the seasonal migration of workforce related to the sectors of construction industry, agriculture and forestry.

C. Internal City Migration: It is caused by the change in life conditions (family size increase or decrease, decline in the environment quality), financial prospects, and office dislocation.

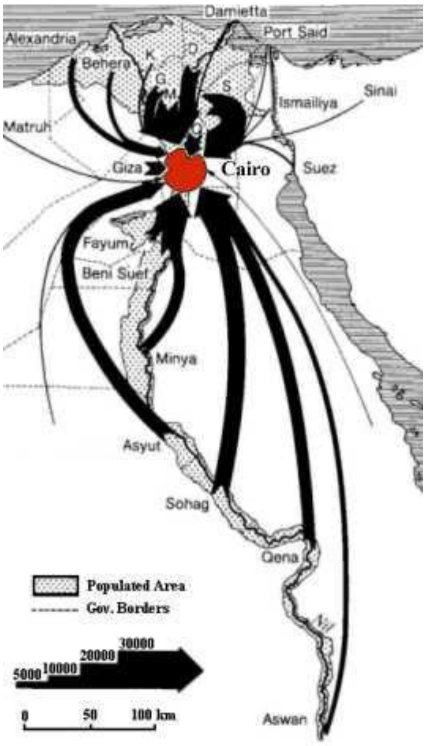

Figure 1-4 Migration directions in Egypt

(Source: John Urry, (2007), Mobilities, Polity.)

It can be concluded that localization mobility is considered as the main feature that gives information about a city status, its rate of growth, possible investment and problems, so the policy challenge is not how to keep households from moving, but how to keep them from moving for the wrong reasons. Instead of trying to fight the pull of agglomeration economies on workers and their families, governments should work to eliminate the factors that push people out of their home areas. By doing so they can improve the quality of migration and encourage economic growth. Labor mobility driven by economic reasons leads to greater concentration of people and talent in places of choice and adds more to agglomeration benefits in these places than to congestion costs.

1.6.2. Communicational:

An individual's mobility in search of a job, an assignment, rest, services by various means of transport, namely, by plane, bus, train, on a bicycle, or on foot. The concept of communicational mobility can also be applied to cargoes (raw materials, industrial output and goods, rubbish and etc.).[1]

Types of Communicational Mobility (It means the business trips to other cities and countries).

A. Pendulum Migration: job related or with other purposes trips from surrounding areas to the city and vice versa, one-day trips from a city to other cities or villages. Its intensity is measured by the number of arrivers per 1,000 permanent inhabitants. The main reasons are lack of jobs and a shortage of adequate services.
B. Inhabitant Mobility inside the City: It is measured by the number of trips per day per one statistical inhabitant (over seven years of age).

It can be concluded that communicational mobility is considered as a feature that gives information about the importance of the city to the settlement system, the significance of communication network, types of transport and the development of street system.

During the recent ten decades the inhabitant mobility has increased ten times and still shows an upward trend. High-rate inhabitant mobility is a feature of modern civilization caused by a variety of factors, such as industrial changes and new tendencies in business sectors (specialization, concentration, co-operation), territorial development of a city, the advancement of means of transport, cars especially, recovery in the standard of living and etc.

1.7. Environmental Pollution.

Pollution is a feature of modern civilization. To present, man has been incapable of creation of waste-free technologies. The more advanced countries, the higher pollution emission, though living conditions there are far better than in poorer countries[2].

Most Important Sources of Pollution:

A. Products of any human activity (economic, industrial and the like), administered materials, processes present in agriculture, forestry, mining, energetic, processing industry, construction, crafts, communication, commerce and etc.
B. Any product (whole or its part) sooner or later becomes waste / pollutant (car, building, food item, petrol and etc).

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[1] John Urry, 2007, Mobilities, Polity, ISBN-10: 0745634192, p 250-280
[2] Rod Mollise, (2006), The Urban Astronomer's Guide: A Walking Tour of the Cosmos for City Sky Watchers (Patrick Moore's Practical Astronomy Series), Springer; 1 edition.

C. Rubbish in dumps or other locations (air, soil…) produce new types of pollution products.
D. Every residential house and its plot as well as public areas in a city are the producers of pollutants[1].

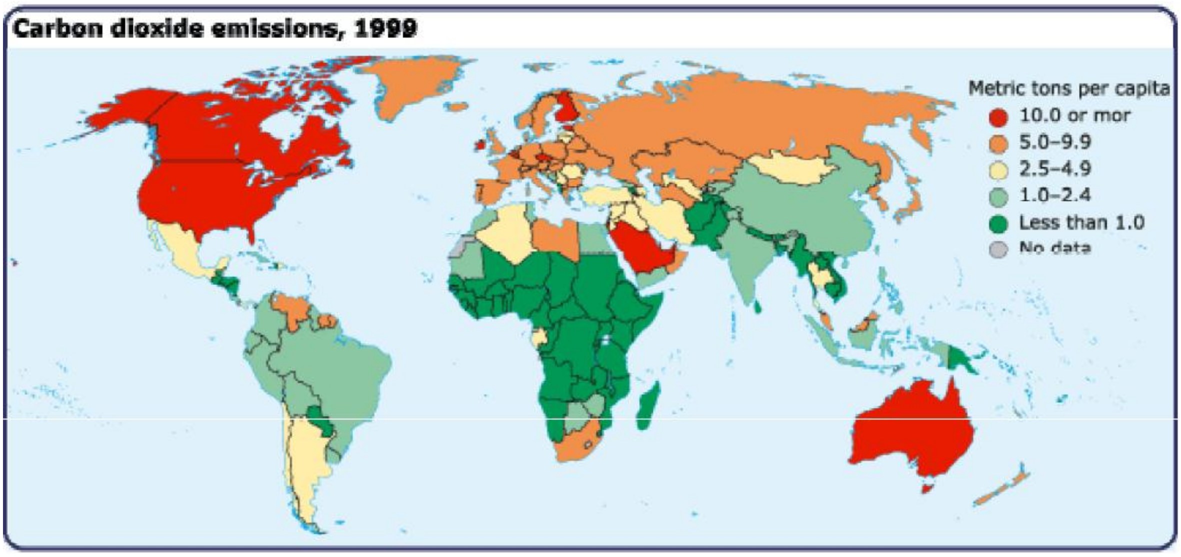

Figure 1-5 Carbon dioxide emission along the world

(Source: Leonardo de vinici, 2004, GIS in urban planning, Sweden press.)

Environment pollution has reached dangerous proportions and can predestine human health and life, vitality and declension of natural complexes. The prognosis on continuous pollution is poor, making an assumption of possible global ecological catastrophe. Its main characteristics are the ozone layer disintegration and climate warming. In 2001, the Council of the United Nations declared that the climate is warming on a faster scale than expected, human activity (burning of natural resources, industrial pollution, deforestation) being the main cause. The average temperature could possibly increase by 5.8ºC, whereas the sea level by 88 centimeters, which could have a irreversible impact on a number of earth systems[2].

Conversely, optimists find the evidence for express catastrophic climate warming ungrounded and believe that mankind will succeed not only in the restriction of climate warming consequences but also in their clever utilization[3]. International agreements, declarations, recommendations and other documents focused on the solution to the problems related to global environment pollution are legion and still show a growing tendency. One of them suggests that European countries apply such means:

[1] Leonardo de vinici, (2004), GIS in urban planning, Sweden press.
[2] Rod Mollise, (2006), The Urban Astronomer's Guide: A Walking Tour of the Cosmos for City Sky Watchers (Patrick Moore's Practical Astronomy Series), Springer; 1 edition.
[3] IBID

A. Benefit from economic checks and balance system, financial resources, such as tax proceeds for carbon monoxide emission and power consumption including.
B. Eliminate hindrances to economical power consumption for building heating needs.
C. Employ modern renewable energy sources.
D. By the year 2010, achieve an optimal level of energy consumption in all European countries.
E. Diminish the exhaust-induced greenhouse effect in the transport sector.
F. Increase the potential of farming and forestry to absorb carbon dioxides.
G. Rectify dump management strategy with a goal to reduce methane emission amidst.

Such means are important for every town but an individual town has its special characteristics of environment pollution[1].

It can be concluded that urban planning decisions could suggest possible ways of the reduction of pollution impact which could be:

A. Development of functional and physical urban structure.
B. Proper land usage.
C. Rendering the preserved territory status.
D. Establishment of sanitary zones.
E. Sustainability of adequate proportional balance between natural and anthropogenic environment.

1.8. Traffic safety:

The primary objective of urban planning is to evaluate the problem of traffic safety and suggest the solutions, which would assist in the elimination of unfavorable factors as well as in the establishment of safe traffic conditions by pursuing the following patterns[2].

1.8.1. Types of Street Modeling:

There are three types of traffic pattern as traffic segregation, complete traffic segregation, and traffics integration[3].

A. Traffic segregation: horizontal (plane-based) and vertical (spatial), the former being much simpler but less effective in comparison to the latter (though much more costly). A combination of both is also possible.

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[1] Rod Mollise, (2006), The Urban Astronomer's Guide: A Walking Tour of the Cosmos for City Sky Watchers (Patrick Moore's Practical Astronomy Series), Springer; 1 edition.
2Organization for Economic Cooperation,(1990) Integrated Traffic Safety Management in Urban Areas (Road Transport Research), Organization for Economic Cooperation.
[3] IBID

B. Complete traffic segregation: is an intentionally created space only for pedestrians and cyclists. Underground space or elevated platforms or similar erections could be designed only for pedestrian traffic. The territories with complete segregation usually take up small space, most frequently in city centers or around them or other in conflict areas with high-scale congestion of people and transport.

Complete traffic segregation in residential territories can be reached in two efficient ways, either by forming closed areas (small or large backyards) with the help of construction design or other means, or by integrating in the fragments of a residential territory two junction-free networks separate for pedestrians and for means of transport.

Figure 1-6 Two separate junctions one for pedestrians and the other for means of transportation

(Source: URL http://wn.com/segregated_cycle_facilities)

C. Traffic integration: The principles of integration are based on the following peaceful coexistence of traffic users like the functioning of boundaries for pedestrian use and those related to public transport system, the certain limited-size territory usually in C or higher category streets used by pedestrians and “local” cars and finally the cul-de-sacs employed by pedestrians and cars, used for car parking or by children as a playground.

1.8.1. Types of Street Modeling:

A. The most dangerous are the streets with houses on both sides, especially with shops, offices, service centers and similar buildings - the objects to attract pedestrians[1].

Figure 1-7 a street with houses on both sides

(Source: URL http://www.historyofpia.com/forums/viewtopic.php?f=3&t=10658&start=60)

B. Much safer are streets having only one side lined with buildings, except those, on the other side of which objects of attraction (parks, recreational territories playgrounds for children's leisure and sport) are located[2].

C. Relatively safest are streets free from buildings, to be more precise, those with the buildings located 100 or more meters away from them[3].

Figure 1-8 Building located away from street

(Source: URL http://www.tourism-review.com/10-places-to-see-before-they-disappear-news1409)

[1] Leonardo de vinici,(2004), GIS in urban planning, Sweden press
[2]Organization for Economic Cooperation,(1990) Integrated Traffic Safety Management in Urban Areas (Road Transport Research), Organization for Economic Cooperation
[3] IBID

It can be concluded that the dangerousness or safety of streets depends on the intensive or low transversal flow of pedestrians and its induced conflict with the flow of means of transport, so modeling streets design should be performed in a way that provide safety for the users either by using the segregation or integration pattern

1.9.Conclusion:

A. Cities are considered as places where people can live healthier and economically productive lives while reducing their impact on the environment. They work to harmonize existing policies, regional realities, economic and business markets with their natural resources and environmental assets. Cities strive to engage all citizens in collaborative and transparent decision making, while being mindful of social equity concerns.

B. To perform the city system in an efficient way several of factors should be taken into consideration by the urban planner, these factors are:

- City is a manageable system, which consist of three important entireties elements, communication, and environment.

- City complexity structure for inhabitant's distribution not only deepened on age, marital status, gender, income and other traditional features; but also it is closely linked to specific problem groups of people.

- Employment of inhabitants in a city aid to the identification of economic basis and vitality of the city, functional type of the city, specialization and autonomy of the city, and levels of industry novelty of the city.

- Sufficient living space , avoid congestion inside the city, and offering good quality drinking water, network of gutter and cleaning systems, waste disposal and adequate maintenance of private and public spaces leads to a concept of having healthy environment.

- City economic development depend on the presence of four important elements should be present within a city to ensure this development; these elements are skilled workforce, technologies, social and technical infrastructures, financial, and management.

- localization mobility is considered as the main feature that gives information about a city status, its rate of growth, possible investment and problems, so the policy challenge is not how to keep households from moving, but how to keep them from moving for the wrong reasons.

- The significance of communication network, types of transport and the development of street system, are considered the most important factor that affect the communicational mobility, and gives information about the importance of the city to the settlement system.

- Development of functional and physical urban structure, proper land usage, rendering the preserved territory status, establishment of sanitary zones, and sustainability of adequate proportional balance between natural and anthropogenic environment, are considered as a possible ways of the reduction of pollution.

- Dangerousness or safety of streets depends on the intensive or low transversal flow of pedestrians and its induced conflict with the flow of means of transport, so modeling streets design should be performed in a way that provide safety for the users either by using the segregation or integration pattern.

In order to reach the pervious points within a city, the next chapter is going to deal with the urban planning process which is considered as a way used to reach these points to have an efficient city system.

Chapter 2

Urban Planning Processes

2.1. Introduction:

In planning, urban planner should consider the interaction between human activities and land uses, including those factors producing pollution and stress. This approach should be focused on sustainable policies supporting clear environmental, social and economic objectives; as cities reflect both the best and worst of human aspirations, as the 'Gaia Atlas of Planet Management' states the sheer pressure of people living together always creates problems: *" … poverty as well as wealth, crime as well as justice, disease as well as medicine"*[1].

Urban and regional planning underlies the very fabric of society as users deal with it today. Without planning and foresight, cities, towns, rural areas, and residential communities will not run efficiently. While communities today face many challenges, some of them, such as pollution and traffic, can be addressed by careful and creative planning. It is the planner's job to address such problems and provide viable solutions for today and the future[2].

Along with the development of digital city, traditional urban planning is surely going to be developed to digital urban planning. But there is no authoritative definition of digital urban planning till now, so this chapter is going to define digital urban planning, and discus the territory planning as a preventive measures rather than investment, urban planning goals from the point of view that urban planning is not a onetime action but a continuous process, urban planning participant, and finally discuss the stages and actions that follow by urban planner in order to evaluate the general and detailed planning[3].

2.2. Definition of Traditional, Digital Urban Planning, Territory Planning, and Spatial Planning:

Cities are dynamic living organisms that are evolving through interplay of regulatory and entrepreneurial activities. Thus city planning has always been difficult. Today the rapidly changing society makes the job of predicting future needs of city dwellers, and those who depend on the services cities provide, even more problematic. Particular problems include: transport, pollution, crime, conservation and economic regeneration. In addressing the complexities of city planning it is important to consider the physical structure of the city alongside less tangible economic, social, environmental and cultural factors[4]. Urban planning

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[1] Norman Myers, (2004), The Gaia Atlas of Planet Management, Humanities Press Intl; 4th edition.
[2] Spector, L., and Hendler, J. 1994. The use of superve- nience in dynamic-world planning. In Hammond, K., ed., Proceedings of The Second International Confer- ence on Arti_cial Intelligence Planning Systems.
[3] IBID
[4] Norman Myers, (2004), The Gaia Atlas of Planet Management, Humanities Press Intl; 4th edition.

is designed to regulate the use of land and other physical resources in the public interest and can make a tremendous difference in the quality of life[1].

2.2.1. Traditional Urban Planning:

According to the European: Traditional urban planning is the science of assessment by professionals and analysts of projects, programmers, strategies or plans shaping the physical, social, economic and environmental structures within a city. It should be based on balance, between growth and conservation; the achievement of sustainable development and the resolution of conflict[2].

Figure 2-1 Gulf Urban layouts

(Source: URL http://www.catnaps.org/islamic/islaurb1.html)

According to John Stillwell: Traditional urban planning process should be divided into two parts; the first is a strategic planning, and the second is physical planning[3].

A. The strategic planning contains the awareness of the processes taking place in the city, their importance and consequences both for the present and for the future, societal needs, development objectives, possibilities and ways for process regulation.

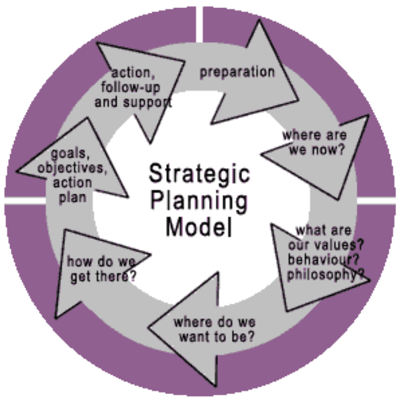

Figure 2-2 Process of Strategic Planning Model

(Source: URL http://www.informaworld.com/smpp/section~fulltext=713240928~dontcount=true~content=a918403302)

[1] Norman Myers, (2004), The Gaia Atlas of Planet Management, Humanities Press Intl; 4th edition.
[2] Yasser Elsheshtawy, (2008), The Evolving Arab City: Tradition, Modernity and Urban Development (Planning, History and Environment Series, Routledge; 1 edition
[3] John Stillwell and Graham Clarke, (2003), Applied GIS and Spatial Analysis, Wiley; New > edition.

B. The physical planning (with reference to norms, analogs, requirements, though leaving room for creativity) of everything formally covered by the notion physical environment (houses, streets, other structures and other spaces, green areas) having in mind the idea that planned environments are adequate for urban communities in terms of both present day needs and strategic objectives.

It can be concluded that traditional urban planning should always be associated with a process of evaluation, assessing what is proposed, reviewed and analyzed, after the event, whether predictions and decisions were justified. Such evaluation thus concerns feasibility, political acceptability, and conformity with higher levels of policy.

2.2.2. Digital Urban Planning:

According to Haoying Han c, Lei Wu: Digital Urban Planning is a new kind of urban planning based on information of infrastructure, spatial data infrastructure, planning and managing system of digital city. During the process of digital urban planning, all the basic materials of the city are digital information. The purpose of digital urban planning is to determine the development goals, urban land use, urban spatial pattern, information infrastructure, spatial data infrastructure, and other integrated construction project of both realistic city and digital city[1].

Figure 2-3 Gwanggyo city centre

(Source: URLhttp://myportfolio.usc.edu/retherfo/2010/09/pinpointing_the_downfalls_of_our_cities_enlightening_resources.html)

Two key-points need to be considered in the definition of digital urban planning:

A. One is that digital urban planning is related to digital city. All the planning process is based on digital city system, which includes information about infrastructure, spatial data infrastructure, planning and managing system of digital city. And during the

[1] Anrong Dang a *, Huizhen Shi b, Haoying Han c, Lei, (2005), Paper of study on the system of technical methods for digital urban planning,.

whole planning process, digital information will be the agent object which makes digital urban planning is different from traditional urban planning in all the aspects of technical method application, information processing procedure, and results expression style.

B. The second key-point is that the purpose of digital urban planning determines its contents, which not only include the physical and social planning related to realistic city, but also include technical and information planning related to digital city. Therefore, digital urban planning is really refers to the future urban planning based on the digital city. And those current urban planning which use some kinds of technology, such as GIS and CAD, partially based on digital map, and only for physical planning is not belong to digital urban planning.

The contents of digital urban planning can be deduced as two aspects. One is Physical and Social Planning which is pay more attention to the realistic city, while the other is Technical and Information Planning which is mostly concern to digital city

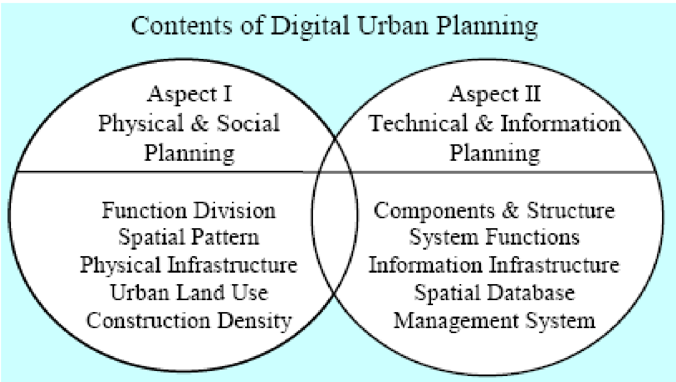

Figure 2-4 Contents of digital urban planning

(Source: Paper of study on the system of technical methods for digital urban planning.)

The contents of physical and social planning of digital urban planning should not only include the whole contents of current urban planning but also need to be expanded according to the development of digital city[1].

The contents of technical and information planning are related to and focused on the digital city. Basically, the technical and information planning should depend on the existing status and development trends of digital city. The development of spatial information technology, computer science, internet technology, digital communication technology, and

[1] Anrong Dang a *, Huizhen Shi b, Haoying Han c, Lei, (2005), Paper of study on the system of technical methods for digital urban planning.

database management technology are all need to be considered during the digital urban planning process[1].

It can be concluded that, three important points should worked out.

A. First one is that the digital urban planning is the future urban planning along with the development of digital city.
B. Second one is that digital urban planning is a newly urban planning for digital city supported by information infrastructure, spatial data infrastructure, urban planning and managing information system of digital city.
C. Third one is the content of digital urban planning, which includes two aspects, physical and social planning for realistic city, technical and information planning for digital city.

2.2.3. Territory Planning:

According to Anrong Dang, Territory planning is the planning of preventive measures rather than investments; it is the instrument of management not an objective. Rational land uses and the need for it, are based on territory planning; it attempts to encourage both the economic development of society and preservation of the natural environment; it should also foster the curtailment of the differences among regions on an economic scale as well as preserve and guarantee sensible consumption of natural resources[2].

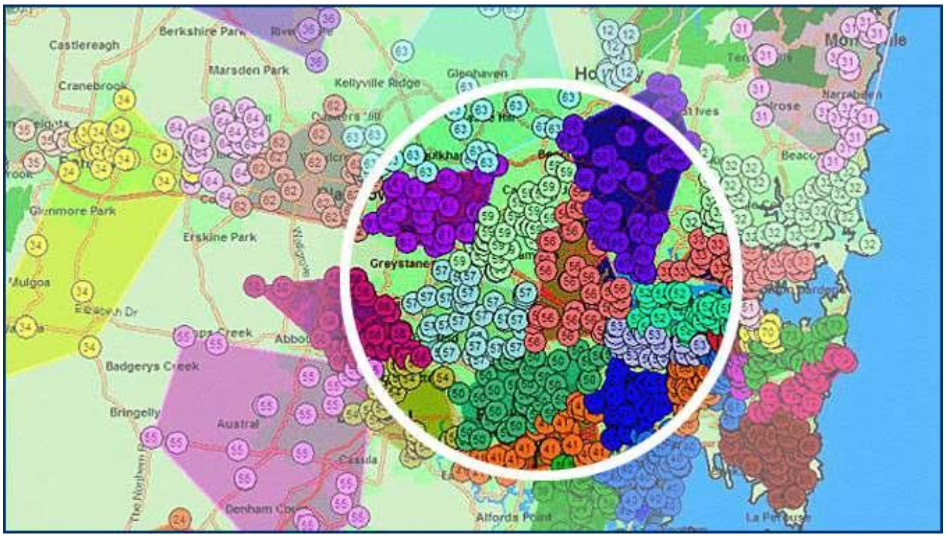

Figure 2-5 Application of customer service model

(Source: URL http://www.marketmotion.com.au/map_detail.html)

[1] Anrong Dang a *, Huizhen Shi b, Haoying Han c, Lei, (2005), Paper of study on the system of technical methods for digital urban planning.

[2]Erera (2000). Design of Large-scale Logistics Systems for Uncertain Environments, Ph.D. Dissertation, University of California, Berkeley.

According to Rick Phillip: Territory planning is usually a long term planning, it helps to maximize the user's time and ensure their consistently build territory revenue by calling on a good mix of new prospects and existing customers[1].

While Freddy M.E. Jacobs, the main purposes of territory planning can be gathered in four points; the first point is the balanced economic and social development of regions and zones by keeping their specificity, the second point is the improvement of the people's life quality, the third point is the management in a liability way of the natural resources and environment protection, and the fourth point is the reasonable territory utilization[2].

Keith Hoggart (2005) stated that, the documentation for territory planning can be reviewed according to the design of the planning territory, whether this design concerns the national territory, or the zone territory, or the country one[3]:

A. Design of planning national territory; it has director character and means the synthesis of segmental strategic programs with medium and long term for entire territory of the country. The Design of planning national territory sections are: Communication ways, Waters, under protection zones, Localities network, Zone with natural risk, Tourism, Rural development. Other sections can be approved according to law.
B. Design of planning zone territory; it has director role and it is conceived concerning to solve specific problems of some territories. These territories can be between localities or intercity, consisted of basis administrative territorial units, localities, cities; between countries, including country segments or whole countries; regional, consisted of several countries.
C. Design of planning country territory; it has director character and represents the geographical view of the social and economic development program of the country. The design of planning country territory is correlated with the design of planning national territory, the design of planning zone territory, segmental governmental programs, as well as with other development programs.

It can be concluded that territory planning is considered as the general interest complex activity systems that contribute to balance spatial development, natural and built

[1] Campbell, L. Clarke, and M.W.P. Savelsbergh (2002). Inventory Routing in Practice: The Vehicle Routing Problem, SIAM Monographs on Discrete Mathematics and Applications, (P. Toth, D. Viego, Eds.).
[2] IBID
3 Keith Hoggart (2005). The City's Hinterland: Dynamism And Divergence in Europe's Peri-urban Territories (Perspectives on Rural Policy and Planning), Ashgate Publishing.

inheritance protection as well as the improvement of the life quality in urban and rural sites.

2.2.4. Spatial Planning:

In Poland the main stream for the science of spatial planning illustrates that spatial planning is an activity, whose aim is to analyze the existing situation, create the theory of this process as well as to define its trends and essence in physical terms related to social and economic issues. The main task of spatial planning is a rational reconstruction and employment of spatial structures with an eye on established natural, social, economic and cultural conditions in spaces under consideration[1].

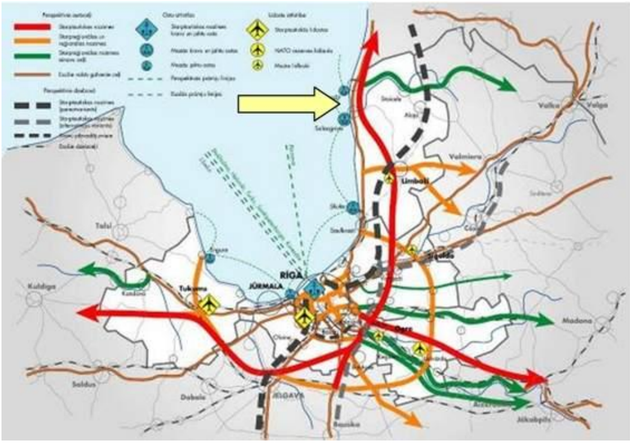

Figure 2-6 Riga Spatial Planning

(Source: URL http://www.gsf.fi/projects/astra/02_latvia_salaca_river_basin.html)

According to John Stillwell: A spatial planning outcomes are wide range of plans, surveys, and conception. The most specific feature of spatial planning is that it has to perform the functions of coordination of divergent economic sectors (branches) and the assessment of hierarchical subordination of different spaces.[2]

While Louis Albrechts stated that spatial planning is not a single concept, procedure or tool. It is a set of concepts, procedures and tools that should be tailored to whatever situation is at hand if desirable outcomes are to be achieved. Spatial planning making is as much about the process, institutional design and mobilization as about development of substantial theories. This broad area is reflected in the place and the role of planners in spatial planning[3].

Lately Portuguese Constitution illustrated that spatial planning aiming to ensure the adequate location of activities, a balanced social and economic development and the enhancement of the landscape, is an essential responsibility of the State, to be carried out with

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[1] Wang Kanghong, Liu Li, (2003). Analysis of Digital Urban Planning System Technological. Journal of Geomatics,

[2] John Stillwell, StanGeertman, Stian Openshaw(eds.), (2004), Geographic information and planning, Berlin: Springer.

[3] Louis Albrechts and Mandelbaum Seymour, (2006), The Network Society: A New Context for Planning (Networked Cities Series), Routledge; 1 edition

citizen participation, in a framework of sustainable development. The definition of spatial planning policy is a competence of the government, the autonomous regions and the local authorities[1].

It can be concluded that, the objective of spatial planning is to safeguard the correct development of the country, its regions, cities and municipalities in terms of a rational consumption of land and environments as well as social and economic potentials.

2.2.5. The Functions of the Master Plan / Development:

Urban, territory, and spatial planning all guides to master plan, the functions of the Master Plan / Development are as follows,[2] to guide development of a city in an orderly manner so as to improve the quality of life of the people, to organize and coordinate the complex relationships between urban land uses, to chart a course for growth and change which be responsive to change and maintain its validity, over time and space, and be subject to continual review, to direct the physical development of the city in relation to its social and economic, characteristics based on comprehensive surveys and studies on the present status and the future growth prospects, and to provide a resource mobilization plan for the proposed development works.

2.3.Urban Planning Objectives and Objects:

Urban planning is not a onetime action but a continuous process, so urban planning objective can be as follows[3]:

A. Cater for the basic needs of people, businesses and other activity structures.
B. Guarantee the reliability of the functioning of urban systems.
C. Provide favorable conditions for urban development.
D. Encourage the creation of new job positions for employees with different skills, both for men and women, especially the ones related to modern technologies.
E. Provide conditions for buying, renting, building, reconstructing of a place of residence or equip with a rescue place corresponding to both personal and municipal possibilities.

[1] Wang Kanghong, Liu Li, (2003). Analysis of Digital Urban Planning System Technological. Journal of Geomatics.
[2] American Planning Association, Frederick R. Steiner, and Kent Butler, (2006), Planning and Urban Design Standards (Ramsey/Sleeper Architectural Graphic Standards Series, Wiley.
[3] IBID

F. Create a convenient city: comfortable and accessible public transport; sufficient permeability of streets, crossroads and car parks; qualified and easily accessible cultural, medical, social and other services.

G. Preserve the sustainability of a secure city, i.e. guarantee the protection of a person and property, keep safe from the dangers of natural and techno-related disasters.

H. Create and sustain healthy environment: clean air, water, soil, acoustic comfort and etc.

I. An open city: convenient local transport services and international links with other towns and countries; easily accessible information on any issue related to urban matters; open to innovations and co-operation with partner-cities.

J. Well-balanced social and economic development of the environment, i.e. the development allowing the satisfaction of present needs but also maintaining a sensible approach towards the potential in view of future generations.

The object of urban planning and its scope are mainly based on planning objectives. With respect to planning objectives, planning objects can be as follows[1]:

A. **City as a system,** in such a case, by means of research and analysis, non-formal urban system boundaries are established (e.g. the limits of dominant influence, urban agglomeration and urban region). The urban system frequently is the object of general planning.

B. **Subsystem of a city,** e. g. subsystems of transport, green areas, etc.

C. **Element of a city,** e. g. separate structures (bridge, complex of buildings, etc), among them rectilinear constructions (streets, engineering networks, etc) with their land parcels and the spaces designed for green areas, parks, etc.

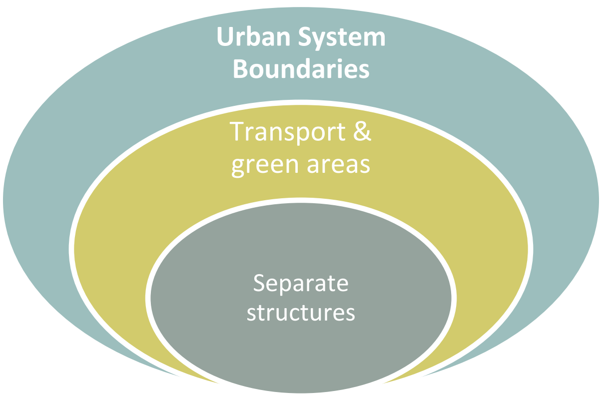

Figure 2-7 Planning object Digram

(Source: Researcher)

[1] American Planning Association, Frederick R. Steiner, and Kent Butler, (2006), Planning and Urban Design Standards (Ramsey/Sleeper Architectural Graphic Standards Series, Wiley.

It can be concluded that any object of urban planning is a stable part of the system; every element of higher or lower rank is always analyzed and planned in relation to its environment and connections. Thus, a conclusion can be drawn that it is possible to define the significance of every separate element in the total functioning of the city, I.e. a formal urban element, indicated in the planning task like bridge, can cause the revision of a much broader and more complex object, the entire urban system or subsystem for a bridge like the entire transport system or the functioning of the total street network with its consequences.

2.4.Urban Planning Goals:

Since urban planning is not a onetime action but a continuous process, so urban planning goals can be as follows[1]:

A. Propose a plan to the urban community, integrated a well-balanced development solutions or their alternatives adequate for the known or presumed needs and interests of inhabitants, private and administrative institutions.
B. The full assent of the inhabitants and the approval by municipal politicians, development decisions (in general, strategic and detailed plans) become the guidelines for strategic management and practical actions on the part of the executive bodies.
C. Whereas for private structures, development decisions are the requirements or conditions information about possible conditional changes in future business or other activities.
D. Inhabitants should see it as a basis for their personal assessment of closer or more remote urban future and plan their actions.

Urban planning goals should present the following rights for the citizens[2]:

A. Security: to a secure and safe town, free, as far as possible, from crime, delinquency and aggression.
B. An unpopulated and healthy environment: to an environment free from air, noise, water and ground pollution and protective of nature and natural resources.
C. Employment: to adequate employment possibilities; to a share in economic development and the achievement thereby of personal financial autonomy.

[1]American Planning Association, Frederick R. Steiner, and Kent Butler, (2006), Planning and Urban Design Standards (Ramsey/Sleeper Architectural Graphic Standards Series, Wiley.
[2] IBID

D. Housing: to an adequate supply and choice of affordable, salubrious housing, guaranteeing privacy and tranquility.
E. Mobility: to unhampered mobility and freedom to travel; to a harmonious balance between all street users public transport, the private car, the pedestrian and cyclists.
F. Health: to an environment and a range of facilities conducive to physical and psychological health.
G. Sport and leisure: to access for all persons, irrespective of age, ability or income, to a wide range of sport and leisure facilities.
H. Culture: to access to and participation in a wide range of cultural and creative activities pursuits.
I. Multicultural integration: where communities of different cultural, ethnic and religious backgrounds co-exist peaceably.
J. Good quality architecture and physical surroundings: to an agreeable, stimulating physical form achieved through contemporary architecture of high quality and retention and sensitive restoration of the historic built heritage.
K. Harmonization of functions: where living, working, traveling and the pursuit of social activities are as closely interrelated as possible.
L. Participation: in pluralistic democratic structures and in urban management characterized by co-operation between all the various partners, the principle of subsidiary, information and freedom from over-regulation.
M. Economic development: where the local authority, in a determined and enlightened manner, assumes responsibility for creating, directly or indirectly, economic growth.
N. Sustained development: where local authorities attempt to achieve reconciliation of economic development and environmental protection.
O. Services and goods: to a wide range of accessible services and goods, of adequate quality, provided by the local authority, the private sector or by partnerships between both.
P. Natural wealth and resources: to the management and husbanding of local resources and assets by a local authority in a rational, careful, efficient and equitable manner for the benefit of all citizens.
Q. Personal fulfillment: to urban conditions conductive to the achievement of personal well-being and individual social, cultural, moral and spiritual development.
R. Equality: where local authorities ensure that the above rights apply to all citizens irrespective of gender, age, origin, belief, social, economic or political position, physical or psychological handicap.

It can be concluded that, the all above described goals are the collections of problems, which can be characteristic of the urban wholeness. Every single city is, however, exceptional thereby the uniqueness of the entirety of its urban planning objectives not necessarily only for financial reasons or the opinion of urban community. Some specific objectives, closely linked to the city history, its cultural heritage; urban functions and competition, co-operation with other cities in one or another field, are frequently present.

2.5.Types of Urban Planning:

Many of the problems faced by cities such as rural-urban migration cannot be solved within cities alone. The population living in rural areas should also be taken into account. Urban planners need new ways of thinking about the interrelation between rural and urban areas, especially with respect to planning issues. Today, from a strategic planning perspective, it can be realized that urban centers are not only focal points for their own economic growth but also service centers for surrounding areas. The relationship between urban centers and surrounding areas is one of interdependence rather than competition or struggle[1].

In most countries, rural areas have been excluded from the planning process even though cities depend on surrounding areas for natural resources. Although this fact has been recognized, the value of rural areas as a natural environment which contributes to bettering the quality of life of a territory has not always been appreciated. Moreover, the role of rural areas in local, regional and global economies is of utmost importance since productive and natural rural areas are necessary for achieving sustainable development. In order to create an interconnected, unified territory, planners should take into account the interdependence of rural areas and urban hubs[2]. These considerations force the planners to re-think about the role of cities in global planning processes. There are three types of urban planning process, strategic planning, physical planning, and general planning.

2.5.1. Strategic planning:

Strategic planning is a process of identification of urban development objectives and tasks in all urban sectors. Municipality usually has here an exceptional interest; therefore it is the body, which, in most cases, initiates such planning. Municipal staff, experts and specialists in

[1] Tanyer, A. M., Tah, J. H. M., Aouad, G. (2005). Towards n-Dimensional Modelling in Urban Planning. Innovation in Architecture, Engineering & Construction (AEC), Rotterdam.
[2] IBID

strategic planning also participates in the process, the result being the collective product of their creative thinking[1].

Figure 2-8 A picture shows that strategic planning is a collective product of creative thinking

(Source: URL http://www.columbiabusinessresources.com/services.html)

Urban strategic planning is a specific instrument of management which encourages citizen participation in local policy decisions. The partnerships which emerge from urban strategic planning are especially created for designing and managing sustainable projects for the city. But these processes of citizen involvement are not spontaneous: it is the local government which is primarily responsible for fostering opportunities for civil society organization participation. Furthermore, the process of participations should include actors with a strong technical orientation who have the capacity for dealing with the needs and requirements of society. This kind of public-private partnerships requires clearly established rules so that collective and individual benefits are produced which in turn strengthen the actors' motivation for continuing to participate in a project[2].

Figure 2-9 A picture shows the citizen participation in strategic planning

(Source: URL http://www.melanoandassociates.com/services/group-facilitation-and-strategic-planning)

[1] American Planning Association, Frederick R. Steiner, and Kent Butler, (2006), Planning and Urban Design Standards (Ramsey/Sleeper Architectural Graphic Standards Series, Wiley.
[2] IBID.

Urban strategic planning allows local governments to enlist the participation of social actors, to achieve consensus about policies and projects and to encourage partnerships aimed at proposing, implementing and evaluating projects. Urban strategic planning is only possible, however, if the government is willing to share the power and respect the decisions which emerge from the process of negotiation. There are three basic sources of input: political decisions and the know-how of both professionals and social actors.

During the stages of a strategic plan (Diagnosis, Planning, Strategic Management, Monitoring and Evaluation) social and political actors work together using a specific methodology. In the Strategic Management stage of the plan, the actors define their own responsibilities in the projects and design monitoring systems such as Urban Indicators Systems. Depending on the changes in the social context, the agenda is adapted to suit different conditions or circumstances[1].

2.5.2. Physical planning:

Physical planning is the transfer of concrete decisions of strategic planning onto the cartographic material of an urban plan (or onto a digital city map) or a search for a particular decision in a city, its fragment or plot plan with reference to previously formed principles.

Physical planning is the most vivid and inevitable display of planning decision. In these planning physical objects, huge territories and plots; buildings, structures, networks are being operated with. By this and by close follow-up of regulatory norms, analogues, the professional know-how, mathematical and other models, it is possible to create independent products design plans of cities, districts, streets and etc. A part of them are proximate to those or the designs, under which construction works are performed[2].

Figure 2-10 Brown University Campus

(Source: URL http://www.brown.edu/Administration/cpab/)

[1] Tanyer, A. M., Tah, J. H. M., Aouad, G. (2005). Towards n-Dimensional Modelling in Urban Planning. Innovation in Architecture, Engineering & Construction (AEC), Rotterdam.

[2] American Planning Association, Frederick R. Steiner, and Kent Butler, (2006), Planning and Urban Design Standards (Ramsey/Sleeper Architectural Graphic Standards Series, Wiley.

2.5.3. General planning:

General planning is most developed in width and in depth; it also possesses the elements of all other types (strategic, physical) of planning. There are three main parts of general planning, [1] the first part is considered as identification of development tasks and objectives (strategic planning), and the second part is considered as a search ways and means for the realization of objectives, investigation of agreeable location possibilities for planned objects, financing resources and investors among them. Verification modules, business plans, possibility studies, investment projects can go along with such planning; studies of legal aspects of investments are made; institutions for the investment implementation are sought, and finally the third part is considered as an arrangement of the urban plan structure and other planning tasks directly related to the objectives of the development and ways (means) of their realization.

Figure 2-11 Oregon state plan

(Source: URL http://arcweb.sos.state.or.us/state/planbd/pics/bandon.htm)

It can be concluded planning of a city passes through three respective stages, strategic, physical and general planning.

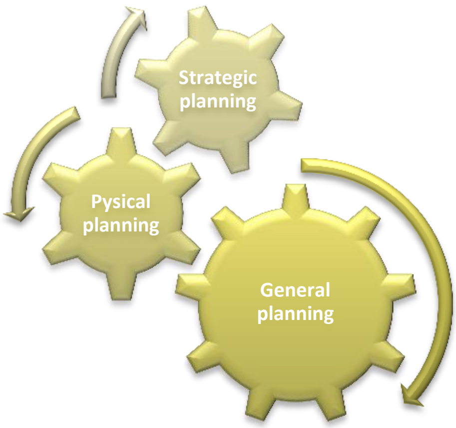

Figure 2-12Stages of urban planning

(Source: Researcher)

[1]American Planning Association, Frederick R. Steiner, and Kent Butler, (2006), Planning and Urban Design Standards (Ramsey/Sleeper Architectural Graphic Standards Series, Wiley.

Urban strategic planning involves long term projects and generates sustainable development through careful investment in and management of public and private resources for infrastructure. Urban strategic planning helps enable cities to meet their needs and improve the quality of life. In order to build sustainable environmental services and infrastructure, local governments must have tools of management, financing and control over these services.

The second stage after strategic planning comes the physical planning which is considered as a form of urban land use planning that attempts to achieve an optimal spatial coordination of different human activities for the enhancement of the quality of life.

The thirds stage after physical planning comes the general planning which is considered as a plan of a city, county or area that establishes zones for different types of development, uses, traffic patterns, and future development.

2.6. Urban Planning Participants:

There are two groups of planning participants, the first group comprises all those, who reveal their needs and interests, and the second group encompasses professional planners, whose main objective is to create a model of an urban system adequate to the obvious needs and interests for a shorter or longer future[1].

2.6.1. The first group of planning participants:

The first group of planning participant consists of three categories of participants which are municipal authorities, private structures, and inhabitants.

A. **Municipal authorities:** (governmental alongside) and similar structures, which perform the functions ascribed to them (urban development, public utilities, transport, education, health care, protection of people, preservation of the environment and public structures, services of technical infrastructure and etc.)

The functions, which are the object of municipalities, predetermine their role in urban planning: organize planning process, consideration and approval of planning documents and their close follow-up in the process of implementation. Governmental institutions set the planning requirements (laws, regulations, norms and the like)

[1] John Stillwell, StanGeertman, Stian Openshaw(eds.), (2004) Geographic information and planning, Berlin: Spring.

B. **Private structures**: Their presence and role in urban planning is predetermined by one single factor which is profit. In its absence the nature of activity is usually changed, an enterprise closed or transferred to another location and etc. Private structures attempt to escape risk but are greatly interested in beneficial and stable business conditions, current and future, effective technical and engineering infrastructure, skilled workforce, favorable legal and financial business facilities.

C. **Inhabitants:** who are interested in concrete things: housing, employment, health care, education and other pursuits; agreeable and healthy environments, leisure facilities, quality of public services. Laws guarantee every single citizen's right to participate in and influence urban planning process. This right is normally exercised in several ways: planning of personal grounds is in the competence of the owner; he/ she has easy access to plans and can make suggestions or express disagreement. Informal factors, such as a response of inhabitants to a particular urban or local situation, i.e. change of workplace or residence and etc., are also present[1].

Figure 2-13 A picture for inhabitants

(Source: URL http://www.melanoandassociates.com/services/group-facilitation-and-strategic-planning)

2.6.2. The second group of Planning Participants:

The second group of planning participant consists of two categories of participants which are professional planners and community participation.

A. Professional planners:

Their work scope basically depends on municipal and governmental authorities, private structures and inhabitants, i.e. on the customer of the service as well on those who regulate the process. And also mutual contractor-planner effort. They both create the ordered product plans, which after their approval become obligatory or at least recommended documents. The work performed by professional planners serves as an informative feedback for the

[1] John Stillwell, StanGeertman, Stian Openshaw(eds.), (2004) Geographic information and planning, Berlin: Springer.

government, private structures and individuals and consequently has great impact on their decision-making. Efficient planning is possible only if it is a mutual effort of professionals in a variety of spheres: economists, sociologists, civil and other engineers, architects, system managers, geologists, geographers, demographers, specialists of informational technologies and etc. Experience and skills of every single specialist in these or other fields suits best in the processes of analysis and forecast or in specific planning (e.g. demographic, social, transport, environmental and the like), the latter being of secondary importance for the assessment of the nature and aims of the urban system and related integrated planning. The key objective is to find a solution, i.e. a city plan. This process is in need of specialists-planners of a different sort.

B. Community participation:

In the planning process community participation is perceived in the following manner, Open information to the community on a launched plan and its goals; access to documents under preparation and those already approved as well as the availability of their copies; access to arranged plans displayed publicly, Public discussion of arranged documents, The right to make suggestions, express opinion or complaints, The right to lodge a complaint to the planning supervisory institutions if suggestions, complaints or ideas were ignored, Free distribution of general plans or their briefs, and finally the right to lodge a claim if the introduction of a detailed or a general city plan has to some extent restricted the benefits of real estate[1].

It can be concluded that planning participation divided into two main teams the first team mainly has the authority of the money and giving the rights to the planners to go on working their plans, the second team is the one responsible for creating the ideas to have an integrated planning related to the surrounding urban system.

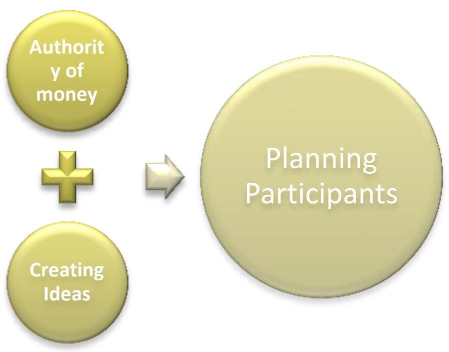

Figure 2-14 Second group of planning participant

(Source: Researcher)

[1] John Stillwell, StanGeertman, Stian Openshaw(eds.), (2004), Geographic information and planning, Berlin: Springer.

2.7. Evaluation of General and Detailed Plan:

The evaluation of both a general and a detailed plan of the city undergo several stages and follows different actions[1].

2.7.1. Feasibility of a Plan:

The feasibility of a plan is the total of the planner's arguments, which is made available for other evaluation stages and which testify to an assumption that plan decisions will:

A. Improve living conditions and employment benefits.
B. Provide diversification and quality of services.
C. Be beneficial to economic development and business.
D. Enhance sensible land consumption and etc.

Feasibility criteria are the same planning objectives, whereas the decisions, with a certain probability, will make their exact implementation possible.

2.7.2. Governmental Supervision of Planning:

Governmental supervision of planning is the control of a timely performance of all procedures, contained in the law on territorial planning and other by-laws; whether planning decisions are in accordance with the government prescribed norms.

2.7.3. Societal & Financial Evaluation:

Societal evaluation includes opinions, proposals and complains of various forms. They can be set forth by individuals, public organizations and professional associations. The community being active, proposals and advice can be legion; statistically every fiftieth suggestion is usually of considerable value.

Financial (economic) evaluation is an assessment of the financial capacity of the town to implement into practice the decisions contained in the general or detailed plan; whether the planning decisions would attract private investment; whether the charges for urban services are in accordance with inhabitant solvency.

2.7.4. Organizational & Political Evaluation:

Organizational evaluation is an assessment of whether the municipality and its enterprises and agencies have sufficient expertise and are capable of the implementation of planned decisions.

Political evaluation is the final evaluation of the designed plan, made by municipal authorities, council, board, and mayor (based on: feasibility arguments, governmental

[1] American Planning Association, Frederick R. Steiner, and Kent Butler, (2006), Planning and Urban Design Standards (Ramsey/Sleeper Architectural Graphic Standards Series, Wiley.

planning supervision material, societal, expert and evaluation). Once authorized, planning decisions become obligatory and valid to a contrastive political resolution.

2.8. Conclusion:

A. Planning is the science responsible for designing an efficient city system, it has been concluded that there are several types of planning each has its own responsibilities and characteristics.

- Traditional urban planning is the science of assessment by professionals and analysts of projects, programmers, strategies or plans shaping the physical, social, economic and environmental structures within a city, and it should be associated with a process of evaluation, assessing what is proposed, reviewed and analyzed, after the event, whether predictions and decisions were justified or not.
- Digital urban planning is a kind of urban planning based on spatial information and managing system of digital city, and considered as future urban planning along with the development of digital city, and includes two aspects, physical and social planning for realistic city, and technical and information planning for digital city
- Territory planning is considered as the general interest complex activity systems that contribute to balance spatial development, natural and built inheritance protection as well as the improvement of the life quality in urban and rural sites.
- Spatial planning is to safeguard the correct development of the country, its regions, cities and municipalities in terms of a rational consumption of land and environments as well as social and economic potentials.

B. Any object of urban planning is a stable part of the system; every element of higher or lower rank is always analyzed and planned in relation to its environment and connections. Thus, a conclusion can be drawn that it is possible to define the significance of every separate element in the total functioning of the city, I.e. a formal urban element, indicated in the planning task like bridge, can cause the revision of a much broader and more complex object, the entire urban system or subsystem for a bridge like the entire transport system or the functioning of the total street network with its consequences.

C. There are three main respectively stages in urban planning process:

- **Urban strategic planning** involves long term projects and generates sustainable development through careful investment in and management of public and private resources for infrastructure.
- **Physical planning** which is considered as a form of urban land use planning that attempts to achieve an optimal spatial coordination of different human activities for the enhancement of the quality of life.
- **General planning** which is considered as a plan of a city, county or area that establishes zones for different types of development, uses, traffic patterns, and future development

D. Planning participation divided into two main teams the first team mainly has the authority of the money and giving the rights to the planners to go on working their plans, the second team is the one responsible for creating the ideas to have an integrated planning related to the surrounding urban system.

E. Finally to evaluate any general and detailed plan the evaluation should pass by different organizations to reach a plan for an efficient city system, these evaluations are:

- Governmental evaluation.
- Societal evaluation.
- Financial evaluation.
- Organizational evaluation.
- Political evaluation.

Since city structure is considered as an object of general planning, and the pervious chapters deal with urban planning process in order to reach an efficient city system. So the next chapter is going to deal with structure of particular city zones, plot fragment, or their groups as an object of detailed or spatial planning and the pollution emitted from the city structure.

Chapter 3

City Structure and Pollution Emission

3.1. Introduction

3.2. City Structure and Planning

3.3. City Development

3.4. Living Territory and Land Uses Carbon Emissions

3.5. Transport System Carbon Emission

3.6. Industrial Zones Carbon Emission

3.7. Global CO2 Emission by Sector

3.8. Improving the Natural and Built Ecological System

3.9. Conclusion

3.1. Introduction:

The urban process is largely characterized by the urban function and unless one perceives the city as one specialized part of the larger economy he falls to understand its essential character. Hence in order to understand a city, it is necessary to focus on the basis on which the city operate and try to look on its social structure[1]. So this chapter is going to examine the nature of the city in relation to its function and social structure.

The function of the city is interrelated with various factors such as social structure, technology, ect. Nevertheless one can treat the function, as the starting point to trace the paths of urban phenomena and proceed towards understanding the urban social structure[2].

The ecosystem is a multifaceted concept that can be applied to a variety of different situations. In very fundamental senses, ecosystems are the planet's life support systems for the human species and for all other forms of life. Urban green spaces are an important component of the complex urban ecosystem, which makes significant contributions to the environment, ecology, and cultural and economic life. The human population derives direct and indirect benefits from ecosystem functions of spaces. Urban green spaces can sequester carbon dioxide emissions and produce oxygen, purify air and water, regulate microclimate, reduce noise, protect soil and water, maintain biodiversity, and have recreational, cultural and social values. Therefore urban green spaces improve the urban environment, contribute to public health and improve the quality of urban life[3].

Landscape ecology views large land areas in terms of the distribution of energy, material, and species as they relate to the sizes, shapes, numbers, kinds and configuration, of component ecosystems. The planning and management of urban green space development is of significance to urban sustainable development. Leitao and Ahern (2002) argued for common framework that applies ecological knowledge in landscape and urban planning[4]. Jin and Chen (2003) applied landscape ecology principle to the green spaces planning of Nanjing city and Beijing city, China[5]. Pauleit et al. (2003) proposed a more flexible approach named the accessible natural green space standard model to promote the natural green environment of towns and cities, and devised a decision support framework for its

[1] John Stillwell, StanGeertman, Stian Openshaw(eds.), (2004), Geographic information and planning, Berlin: Springer.
[2]Gillian Mary Hanson, (2004), City and Shore: The Function of Setting in the British Mystery, McFarland.
[3]Wang, R.S., Chi, J., Ouyang, Z.Y. (Eds.), (2001), Eco integration for sustainable development of middle and small sized towns. Meteorologic Press, Beijing (in Chinese).
[4]Leitao, A.B., Ahern, J., (2002), Applying Landscape ecological concepts and metrics in sustainable planning, Landscape and Urban Planning.
[5]Jim, C.Y., Chen, S.S., (2003), Comprehensive green space planning based on the landscape ecology principles in compact Nanjing City, China. Landscape and Urban Planning.

implementation[1]. Li and Wang (2003) proposed a method for the evaluation, planning and prediction of ecosystem services of urban green spaces, taking Yangzhou city in China as the case study[2].

The basic amount of green space required in planning can be obtained by the principles of ecological balance. There are three methods of controlling the amount of green space, namely the recreation space ration method, the ecological factor plat method, and the ecological element threshold method. The recreation space ration method pursues the function of recreation and came from the former Soviet Union. It did not take the limit of land resources into account in most developing countries. The ecological factor plat method is widely employed in Landscape planning or landscape ecological planning in western developed countries. By contrast, the ecological factor plat method is applicable merely for the environment areas of biodiversity where habitats are less distributed by human activities. This is not the case in most countries. Based on the situation of China, the ecological threshold method is in practice the best way to control the amount of green spaces.[3]

This chapter divide into two main theoretical parts, the first part reviews city structure as an object of general planning and the structure of particular city zones, plot fragment, or their groups as an object of detailed or spatial planning, this part also discus city development concepts from the point of view of functional zones concept and functional integration concept, and city development structure in terms of city development concept.

As urban planners play the roles of developing functional and aesthetically pleasing cities with the highest and best use of land, and at the same time ensure that they are ecological friendly. It is important to develop low carbon cities to ensure low CO2 emissions in the urban areas[4], so the second part of this chapter illustrates every section in the new cities that is responsible for the carbon emission, these sections divide into three groups, the first group highlights on living territories and land uses carbon emission, the second group highlights on transportation system carbon emission, the last group highlights on industrial zones carbon emission. Finally this chapter reviews the natural and built ecological system in urban environment using a network of green areas.

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[1]Pauleit,,S., Slinn, P., Handley, J., Lindley, S., (2003). Promoting the natural greenstructure of towns and cities; English nature's accessible natural green space standard model. Bulletin Environnement.
[2]Li, F., Wang, R.S., (2003), Evaluation, Planning and prediction of ecosystem services of urban green space: a case study of Yangzhou city. Acta Ecologica Sinica.
[3]Lutz, M., Bastian, O., (2002), Implementation of Landscape planning and nature conservation in the agricultural landscape – a case study from Saxony. Agriculture, Ecosystems & Environment.
[4]Anqing Shi (2001). Population Growth and Global Carbon Dioxide Emissions. IUSSP Conference, Brazil, Session-S09.

I. **First Part of the Chapter** is going to review the component of the city structure and its development concepts and its relation with urban planning.

3.2. City Structure and Planning:

City structure is an object of general planning; the structure of particular city zones, plot fragments or their groups is the object of detailed or special planning.

3.2.1. Component of City Structure

City structure is predetermined by the following components, Natural environment and manmade environment. Natural environment consist of forests, groves, parks and other plantations; rivers, lakes, ponds, bays, islands, hills, hollows, swamps, and etc. Manmade Environment consists of zones, districts, linear structure, and transport structure[1].

Zones may consist of residential area, city center, business area, industrial area, protective center, cultural center, educational area, scientific area, training center, storage center, transport area, recreational area, sport area, and etc. Districts are considered as smaller-size zone segments, zones may consist of a number of districts. Linear structures and their networks may consist of streets of divergent hierarchical importance and category, roads, energy transmission lines, railways, canals and etc. Transport structures are considered as, air, sea ports, wharves, stations, and stops, of international, national, regional, urban or local importance[2].

It can be concluded that both natural and manmade environment are considered as the component of any city structure.

3.2.2. Relation between City Structure and Planning:

City structure follows the general planning to make it more beneficial for the accomplishment of strategic objectives, which determine the principles of functional organization of the city, and its conception. Physical city structure follows the detailed or special planning, it consists of city zones, districts, linear structures and their networks, large transport or other physical structure components, arranged in some particular order or randomly in the natural or modified environment[3].

To make the city structure function more effective, it is necessary to ensure, the compatibility of neighboring zones and districts, the harmonization of the zone's purpose, districts, and other structural components with natural conditions, and finally the evaluation

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[1] Raphael J. Ph.D., (2006), Los Angeles: structure of a city government, The League of Women Voters of Los Angeles; Softcover edition.
[2] IBID
[3] Frederick R. Steiner, (2006), planning and Urban Design Standards, Wiley; 1 edition.

in normative terms for the zone, district or structure arrangement in accordance to safety of people, noise reduction, reduction of air, water, soil pollution, fire precautions, energy (fuel) consumption and conservation, and people's leisure[1].

It can be concluded that city as a whole structure is related to the general planning and the physical structure of the city is related to the detailed planning where it can work efficiently by harmonization between the different elements of the city.

3.3. City Development:

City development plans are considered as a primary role to provide cities with means to build and maintain strategic partnerships for health, and to develop a platform to encourage all sectors to focus their work on health and quality of life. The city development planning process is therefore the key tool of the healthy city project in working towards the goals and aspirations to reach the ecological city.

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3.3.1. City Development Concepts:

Two concepts of city development or functional organization were prevalent in the previous century, which are functional zoning, and functional integration[2].

The concept of functional zoning is based on the principle of dissociation**,** the division of city entirety into parts, zones, districts, in which an attempt to purify separate functions is made.

Figure 3-1 Moscow functional zoning plan

(Source: URL http://www.stroi.ru/eng/default.aspx?m=31&d=31)

[1] Raphael J. Ph.D., (2006), Los Angeles: structure of a city government, The League of Women Voters of Los Angeles; Softcover edition.
[2] Frederick R. Steiner, (2006), Planning and Urban Design Standards, Wiley; 1 edition.

The other concept is functional integration which is the antonym of dissociation. It is the combination of functions into one entirety, examples of which can be a building, their group, a quarter, a city fragment or a whole city, the activity of which is always related with that of adjacent territories. The aim of functional integration concept is to make every city part, zone, district, even a separate building function as a multi-functional totality, become autonomous, independent of services, employment possibilities provided by other city parts. It also means to be independent of the means of transport, for integration relies, to a greater extent, on the pedestrian possibility. The planner's aim is to plan in such a way that in the city and in every separate element of city structure all necessary conditions for integrated structures to be created.

3.3.2. City Development Structure:

To maintain the functional and physical structure of city development concepts, city structure can be divided according to five main theories which are open and closed structure theory, monocentric and polycentric structure theory, compact and discreet structure theory, new cities structure theory, and finally cities of mixed structure theory[1]:

A. Open and closed structures:

Irrespective of the development intensity, the city of an open structure can retain its structure in case there are no natural or other hindrances in the territory under development.

The development of the city with closed structure changes its structure not only because of the takeover of new territories but also due to the need to reorganize the structure of the original/previous part of the city[2].

B. Monocentric and Polycentric Structure:

In terms of the type of functional relations, such structures can be presented. The Centre in such cases is usually understood as a traditional city center, its sub-center (center of a city part) or the so-called peripheral center, which owing to their attraction dominate over individual service enterprises or their groups[3].

According to Bertaud (2004): "As cities grow in size, the original monocentric structure of large metropolises tends to dissolve progressively into a polycentric structure

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[1] Frederick R. Steiner, (2006), Planning and Urban Design Standards, Wiley; 1 edition.

[2] Gillian Mary Hanson, (2004), City and Shore: The Function of Setting in the British Mystery, McFarland.

[3] Brail, R.K. and Klosterman, R.E. (200)1. Planning Support Systems - Integrating geographic information systems, models and visualization tools. Esri Press, Readlands.

over time. Large cities are not born polycentric; they may evolve in that direction. Monocentric and polycentric cities are animals from the same species observed at different times during their evolutionary process. No city is ever 100% monocentric, and it is seldom 100% polycentric (i.e., with no discernable "downtown"). Some cities are dominantly monocentric, others are dominantly polycentric and many are in between. Some circumstances tend to accelerate the mutation toward polycentricism, a historical business center with a low level of amenities, high private-car ownership, cheap land, flat topography, grid street design, and others tend to retard it, a historical center with a high level of amenities, rail-based public transport, radial primary road network, and difficult topography preventing communication between suburbs.[1]"

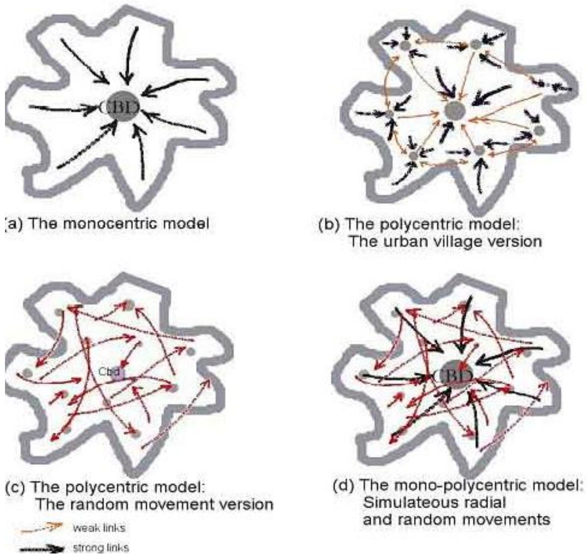

Figure 3-2 Schematic representation of trips patterns within a metropolitan area

(Source: Brail, 2001, Planning Support Systems, Esri Press.)

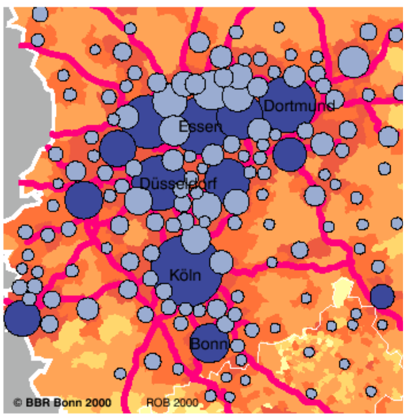

Figure 3-3 Rhein-Ruhr Polycentric structure

(Source: Brail, 2001, Planning Support Systems, Esri Press.)

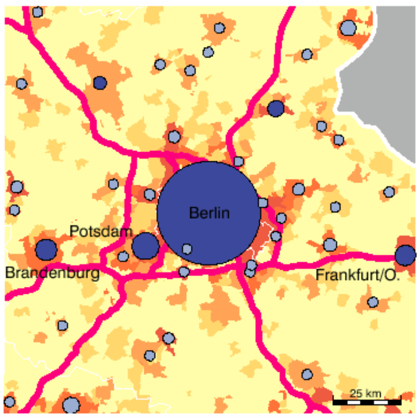

Figure 3-4 Berlin-Brandenburg monocentric structure

(Source: Brail, 2001, Planning Support Systems, Esri Press.)

[1]Brail, R.K. and Klosterman, R.E. (200)1. Planning Support Systems - Integrating geographic information systems, models and visualization tools. Esri Press, Readlands.

It can be concluded that, no city is purely monocentric or purely polycentric, no city spatial structure is permanent, monocentric and polycentric cities are different and both type of structure have advantages and disadvantages, and finally different municipal objectives might fit better the monocentric or the polycentric model.

C. Compact and Discreet Structure:

A significant feature of this structure is its building integrity. These structures can be the result of natural processes, i.e. having been fostered by environmental conditions and land value. Or it is a planned and completed structure. Cities-satellites or new cities around London, Moscow, Paris, Helsinki and other megalopolises, dating from approximately fifty years before, all make a discreet structure. It is also the concept of the city development regulation[1].

D. New Cities Structure:

Cities of various forms and different characteristics are seldom of a pure structure. It is specified only to newly built cities or their parts[2].

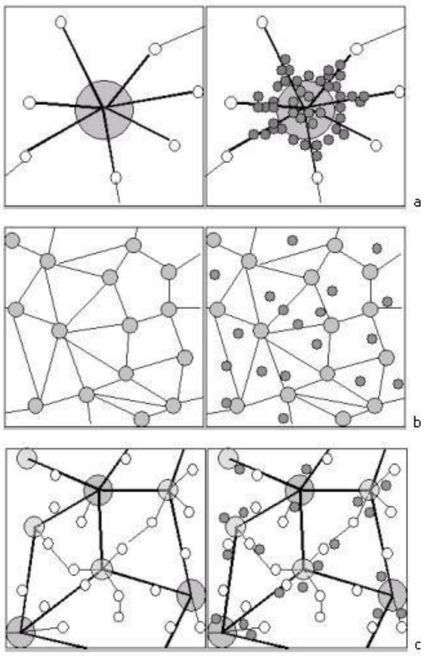

Figure 3-5 Urban structure models: a – centralized, b – decentralize, c – decentralize concentration

(Source: Frederick Turner, 2010, Turner's guide to and description of Philadelphia's new city, Nuba Press.)

[1] Brail, R.K. and Klosterman, R.E. (2001). Planning Support Systems - Integrating geographic information systems, models and visualization tools. Esri Press, Readlands.

[2] Frederick Turner, (2010), Turner's guide to and description of Philadelphia's new city hall or public buildings, the largest and grandest structure in the world, Nabu Press.

E. Cities of Mixture Structure:

The majority of cities have a mixture of structures. In them, divergent structure types and forms have been combined in varying proportions, original city parts, lacking clear structure, among them[1].

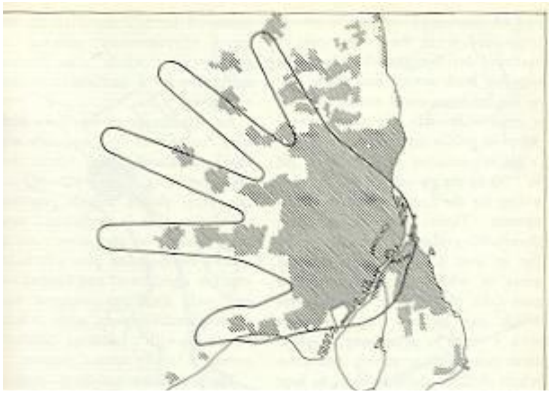

Figure 3-6 The "finger plan" for the Copenhagen region

(Source: Frederick Turner, 2010, Turner's guide to and description of Philadelphia's new city, Nuba Press.)

It can be concluded that cities with differentiated or integrated functions, open or closed structures, monocentric or polycentric, compact or discreet can acquire a variety of forms, according to either the natural conditions surrounding the city, or the planning form of it.

II. **Second Part of the Chapter** is going to discuss every section in the new cities that is responsible for the carbon emission.

3.4. Living Territories and Land Uses Carbon emissions:

Urban planners play the roles of developing functional and aesthetically pleasing cities with the highest and best use of land, and at the same time ensure that they are ecological friendly. It is important to develop low carbon cities to ensure low CO2 emissions in the urban areas[2]. This section is going to state several theories for calculating CO2 emitted for different land uses along the city that has been used before in several countries.

[1] Frederick Turner, (2010), Turner's guide to and description of Philadelphia's new city hall or public buildings, the largest and grandest structure in the world, Nabu Press.

[2] Anqing Shi (2001). Population Growth and Global Carbon Dioxide Emissions. IUSSP Conference, Brazil, Session-S09.

A. Energy Consumption and CO2 Forecasts Obtained from the Department of Energy:

Energy forecasts were obtained from the Department of Energy, Energy Information Administration's publication Annual Energy Outlook 1995. The percentage increases for each fossil fuel category were extrapolated from national averages, based on population, and are not Colorado-specific[1].

Table 3-1 Forecast for Carbon Dioxide Emissions from Fossil Fuel Use

(Source: Colorado Department, 2002, Colorado Greenhouse Gas, Denver)

Sector/Fuel	Energy Consumption (million BTU)	CO2 Emissions (tons)
RESIDENTIAL		
Distillate Fuel	193,844.35	15,480.41
LPG	8,389,219.08	575,559.15
Kerosene	153,742.05	12,138.32
Bituminous Coal	588,888.50	59,854.63
Natural Gas	116,791,700.00	6,796,216.08
Biomass	1,984,168.84	1,555.09
Total		**7,460,803.68**
COMMERCIAL		
Gasoline	1,785,778.36	138,722.83
Distillate Fuel	3,290,344.45	262,766.91
LPG	1,550,199.36	106,354.53
Kerosene	73,290.42	5,786.46
Bituminous Coal	1,173,452.91	119,269.75
Anthracite	0.00	0.00
Natural Gas	87,870,948.00	5,113,291.01
Total		**5,746,191.50**
UTILITIES		
Bituminous Coal	540,659,105.21	54,952,591.45
Natural Gas	7,319,180.00	425,909.79
Total		**55,378,533.80**

[1]Colorado Department of Public Health and Environment, (2002), Colorado Greenhouse Gas Emission Inventory & Forecast, Denver.

B. Emissions Associated with the Construction of Buildings:

The manufacture of the materials required for the construction of buildings uses energy and, consequently, emits CO2. The following table shows the aggregate emissions of a conventional building built using the most common construction system. It consists of a reinforced concrete structure, a layer of exterior walls, flat roofing and bricks interior partitions[1].

Table 3-2 Aggregate emissions of a conventional building.

(Source: Anna Pagès Ramon, (2008), moving the entire building sector towards low CO2 Emissions, Technical University of Catalonia)

	kg CO2 / m2	(%)
Foundation	93.67	16.9
Structures	168.88	30.4
Exterior walls and Roofs	102.99	18.5
Interior walls	25.54	4.6
Exterior cladding	9.84	1.8
Interior cladding	35.94	6.5
Doors and windows	58.40	10.5
Services	56.92	10.2
Other	3.20	0.6

C. CO2 Emissions Associated with the Use of Different Types of Buildings::

The energy consumption and emissions associated with the use of various types of buildings. The following table, convert energy consumption into CO2 emissions, and the following factors were applied[2]:

Gas: 1 kWh = 204 g CO2

Electricity: 1 kWh = 501 g CO2

These factors show that gas is 2.5 times more efficient than electricity for a given quantity of energy consumed.

[1]Anna Pagès Ramon, Albert Cuchí Burgos, (2008), 399: Moving the entire building sector towards low CO2 Emissions, Technical University of Catalonia

[2]IBID

Table 3-3 Energy consumption and CO_2 emissions associated with the use of different types of buildings

(Source: Anna Pagès Ramon, (2008), moving the entire building sector towards low CO2 Emissions, Technical University of Catalonia)

Building type	Electricity (%)	Fuel (%)	kWh / m2	Kg CO2 / m2
Multi-storey Residence	25	75	107	30
Detached house	25	75	43	12
Office	86	14	145	67
Hospital	50	50	251	88
Commercial Space	100	0	327	164
Hotel	52	48	403	144
School	31	69	43	13
Sports centre	20	80	303	80
Sports centre with swimming pool	45	55	31	10

D. CO2 Emissions Associated with the Land uses:

There are different land uses along the city emit CO2, from these land uses that the research is going to deal with, oxidation lakes, agriculture land, forests, and public dumps[1].

Table 3-4 CO2 Emitted According to Land Uses

(Source: Chang, T.C., 2000. Determination of greenhouse gases by open-path gas-type FTIR spectroscopy. Food Sci. Agric. Chem.)

Land Use	CO2 Emission
Oxidation Lakes	1300 mg/ m2 * H
Agriculture Land	11.2 Kg/ m2
Forests	52 gm / m2
Public Dumps	220 mg/ m2 * H

[1]Chang, T.C., Leo, Y.C., Yang, S.S., (2000). Determination of greenhouse gases by open-path gas-type FTIR spectroscopy. Food Sci. Agric. Chem.

3.5. Transport System Carbon Emission:

Transportation sources emit several different gases that contribute to global warming, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and hydro fluorocarbons (HFCs). Carbon dioxide is by far the most prevalent GHG emitted by transportation sources. According to the U.S. Green House Gases Inventory, nationally over 95 % of transportation Green House Gases Inventory emissions were in the form of CO_2 in 2004. The remainders of transportation GHG emissions were in the form of N_2O, 2.2 %; CH_4, 0.1 %; and HFCs, 2.3 %. Given the importance of CO_2, it is usually appropriate and acceptable for transportation Green House Gases analyses to focus solely on this gas[1].

3.5.1. Methodologies of Calculating CO2 Emissions:

This section is going to state several ways of calculating CO_2 emissions for different type of transportation according to different theories that has been used before in several countries.

A. CO2 Emitted in Direct Proportion to Fuel Consumption:

Calculating the CO_2 emissions associated with transportation is conceptually quite simple. CO_2 is emitted in direct proportion to fuel consumption, with some variation by type of fuel. As a result, estimating the GHG implications of transportation projects primarily involves estimating the amount of fuel – gasoline, diesel, jet fuel, and other fuels – used by motor vehicles and other transportation sources[2].

There are two ways used for calculating CO_2 according to the fuel consumed:

The First way:

The amount of CO_2 produced is a product of the amount of fuel combusted, the carbon content of the fuel, and the fraction of carbon that is oxidized when the fuel is combusted. A simple formula for the calculation of CO_2 for each fuel is as follows:

CO2 emitted = Fuel Combusted x Carbon Content Coefficient x Fraction Oxidized x (44/12)

Fuel combustion (in gallons for liquid fuels or cubic feet for natural gas) is converted into units of energy (Btus). The carbon content of fuel varies by type of fuel, and is usually expressed in terms of units of carbon per Btu. The fraction of the carbon oxidized is a lesser consideration since it has traditionally been assumed to be 99 percent for all fossil fuel

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[1] American Association of State Highway and Transportation Officials (AASHTO), (2006), Assessment of Greenhouse Gas Analysis Techniques for Transportation Projects, Standing Committee on Environment

[2] IBID

combustion.3 The factor 44/12 is the weight of CO2 in relation to the amount of carbon in the fuel, assuming all carbon burned eventually oxidizes to form CO2. Consequently, the key analysis that needs to be conducted to estimate CO_2 is to determine the amount of fuel consumed by fuel type (e.g., motor gasoline, diesel, jet fuel, compressed natural gas, etc.)[1].

Consequently, the key analysis that needs to be conducted to estimate CO2 is to determine the amount of fuel consumed by fuel type (e.g., motor gasoline, diesel, jet fuel, compressed natural gas, etc.), so the previous equation can be much more accurate.[2]

Table 3-5 Fuel Types Commonly Used by Different Transportation Modes

(Source: I.J. Lu, 2005, Energy Policy, Elsevier)

	Light-duty vehicles	Heavy-duty vehicles	Buses	Rail	Aircraft	Maritime vessels	Other Non-road
Motor gasoline	√	√	√			√	√
Diesel (Distillate)	√	√	√	√		√	√
Jet fuel					√		
Aviation gasoline					√		
Residual fuel						√	
Electricity				√			
Other fuels*	√	√	√				

*Other fuels include: compressed natural gas (CNG), liquefied petroleum gasoline (LPG), and other alternative fuels.

The previous table identifies the following transportation mode:

Light-duty vehicles (e.g., passenger cars, light-duty trucks), Heavy-duty trucks (e.g., freight trucks), Buses (e.g., transit buses, as well as school buses or intercity buses), Rail (e.g., transit, passenger rail, or freight), Maritime vessels (e.g., Boats and ships), Other non-road mobile sources (e.g., airport ground service equipment, construction equipment, agricultural equipment).

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[1] American Association of State Highway and Transportation Officials (AASHTO), (2006), Assessment of Greenhouse Gas Analysis Techniques for Transportation Projects, Standing Committee on Environment

[2] I.J. Lu, S.J. Lin, and C. Lewis, (2007), Decomposition and decoupling effects of carbon dioxide emission from highway transportation in Taiwan, Germany, Japan and South Korea [An article from: Energy Policy], Elsevier

The Second way:

The specific numbers are referring to diesel fuels[1].

General formula:

$$cc \times T \times X\ [kg/l] = [kg\ CO_2/liter\ of\ fuel]$$

Values for diesel fuel:

cc = carbon content in fuel in mass percentage = 86 % = 0.86

T = fuel density = 0.820 [kg/l]

X = molecular weight relation for CO2 = (12 u + (2 × 16 u))/12 u = 44/12

Result for diesel fuel:

0.86 × 0.82 × (44/12) [kg/l] = 2.6 [kg CO2/liter of fuel]

It can be concluded that, this calculation in practice is quite complex since transportation agencies do not typically collect data to track vehicle fuel consumption by fuel type. In a limited number of cases, fuel data are available and can be used directly in calculating CO2. The availability of direct measures of fuel consumption, however, is generally limited for transportation agencies, and fuel consumption estimates may not be available at all for project-level, corridor, or regional analysis.

B. CO2 Emitted according to Vehicle Type:

This analysis is intended to evaluate the environmental performance of Highway Motor Coach operations, by comparing the energy use and carbon dioxide (CO2) emissions of motor coaches with the energy use and CO2 emissions of other common transportation vehicles/modes[2].

For all modes both energy use and CO2 emissions are expressed in terms of units per passenger mile operated. The metrics used for energy intensity are passenger miles per diesel-equivalent gallon (pass-mi/DEG) and btu2 per passenger mile (btu/pass-mi). The metric used for CO2 emissions is grams of emissions per passenger mile (g/pass-mi). Carbon dioxide is a greenhouse gas that has been linked to global warming. The transportation sector is a significant contributor to total man-made CO2 emissions from the burning of fossil fuels. For the transportation sector fuel use and CO2 emissions are linked and are generally proportional for each travel mode[3].

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[1] Helen Lindblom & Christian Stenqvist, (2007), SKF Freight Transports and CO2 emissions a Study in Environmental Management Accounting, ISSN 1404-8167

2M.J. Bradley & Associates 1000 Elm Street, (2007), Comparison of Energy Use & CO2 Emissions From Different Transportation Modes, Manchester, NH 03101.

[3]IBID

Including motor coaches, a total of twelve transportation modes are included in the analysis, as follows in the following table.

Table 3-6 Average energy use and CO2 emissions by mode

(Source: M.J. Bradley, (2007), Comparison of Energy Use & CO2 Emissions, Manchester)

Mode	Pass-mi/Gal	Btu/Pass-mi	CO2 g/pass -mi	Description
Motor Coach	184.4	749	56	Motor coach fleets are designed for long-distance travel.
Van pool	101.9	1354	101	A transit mode that uses vans, small buses and other vehicles, to provide transportation to a group of individuals.
Heavy Rail	155.3	889	156	A transit mode that uses self-propelled electric-powered passenger cars operating on an exclusive rail right-of-way.
Commuter Rail	85.8	1608	177	A transit mode that uses electric or diesel-powered locomotives pulling passenger cars, and operating on an exclusive rail right-of-way, for local short-distance travel.
Intercity Rail	66.0	2091	179	A transit mode that uses electric or diesel-powered locomotives pulling passenger cars, and operating on an exclusive rail right-of-way, for long distance travel between cities.
Car Pool 2 person	55.4	2492	185	The private automobile mode includes all use of a personally-owned car or light truck for commuting and other travel.
Light Rail	120.5	1146	202	A transit mode that uses self-propelled electric-powered passenger cars operating on an exclusive or shared above-ground rail right-of-way to provide scheduled service within an urban
Trolley bus	104.4	1321	233	A transit mode that uses electric powered rubber-tired vehicles for fixed route scheduled service within an urban area.
Car–Avg Trip	43.8	3154	235	The private automobile mode includes all use of a personally-owned car or light truck for commuting and other travel.
Transit Bus	32.5	4245	299	A transit mode that includes the use of primarily diesel-powered, rubber-tired vehicles for fixed route scheduled service within an urban area.
Car 1person	27.7	4983	371	The private automobile mode includes all use of a personally owned car or light truck for commuting and other travel.
Ferry Boat	12.6	10987	818	A transit mode that uses marine vessels to carry passengers and/or vehicles over a body of water.

Pass-mil/Gal = Passenger Miles per Diesel Equivalent Gallon

C. CO_2 Emitted According to Total Annual Fuel Used by Each Mode of Transportation:

The first step in this analysis is to convert Total Annual Fuel used by each mode to units of Diesel Equivalent Gallons (DEG), using Equation 1 for liquid fuels and Equation 2 for electricity[1]:

Equation 1

Annual DEG = Fuel Energy Content (btu/gal) ÷ Diesel Energy Content (btu/gal) x Annual Fuel (gal)

Equation 2

Annual DEG = Annual Energy (kwh) x 3,412 btu/kwh ÷ Diesel Energy Content (btu/gal)

The second step is illustrating the energy content of the relevant fuels as shown in the following table[2].

Table 3-7 Fuel Properties Used in the Analysis

(Source: Alsema EA, (2000), Energy pay-back time and CO2 emissions, Research Application)

Fuel	Energy (Btu/ gal)	Density (lb/gal)	Weight % Carbon	CO_2 g/gal
Diesel	138000	7.1	87%	10274
Gasoline	114000	6.0	85%	8482
LPG	91330	4.4	82%	6042
LNG	73500	3.2	75%	4017
Kerosene	135000	6.9	86%	9935
B20 Biodiesel	135613	7.0	84%	9748

The third step is calculating the energy intensity metrics presented in the analysis using Equations 3 and 4:

Equation 3

Passenger Miles per DEG (Pass-mi/DEG) = Annual Passenger Miles ÷ Annual DEG

Equation 4

Btu per Passenger Mile (btu/pass-mi) = Annual DEG x 138,000 btu/DEG ÷ Annual Passenger Miles

[1]Alsema EA, (2000), Energy pay-back time and CO2 emissions of PV Systems. Progress in Photovoltaic Research Applications.

[2] IBID

The forth step is calculating all the liquid and gaseous fuels carbon dioxide emissions per gallon of fuel burned using Equation 5 and also calculating total carbon dioxide emissions for each mode using Equation 6. The fuel properties used in Equation 5 are shown in the previous table.

Equation 5

CO_2 (g/gal) = 44 (CO_2mw) ÷ 12 (Cmw) x 453.6 g/lb x Fuel Density (lb/gal) x Fuel Wt % Carbon

Equation 6

Total CO_2 (g) = Sum (CO_2 (g/gal) x Annual Gallons)All fuels + Electricity (kwh) x 600.6 g CO_2/kwh5

The fifth step is calculating the Carbon dioxide emissions per passenger mile using Equation7.

Equation 7

CO_2 per Passenger Mile (g/pass-mi) = Total CO_2 (g) ÷ Annual Passenger Miles

D. Energy Consumption and CO2 Forecasts Obtained from the Department of Energy:

Energy forecasts were obtained from the Department of Energy, Energy Information Administration’s publication Annual Energy Outlook 1995. The percentage increases for each fossil fuel category were extrapolated from national averages, based on population, and are not Colorado-specific[1].

Table 3-8 Forecast for Carbon Dioxide Emissions from Fossil Fuel Use

(Source: Colorado Department, 2002, Colorado Greenhouse Gas, Denver)

Sector/Fuel	Energy Consumption (million BTU)	CO2 Emissions (tons)
Gasoline	252,915,896.83	19,647,012.70
Distillate Fuel	58,010,592.50	4,632,725.92
LPG	417,545.10	28,646.52
Aviation Gasoline	1,170,106.21	88,347.70
Jet Fuel	48,077,585.64	3,795,845.58
Lubricants	3,468,306.64	280,755.95
Natural Gas	12,866,760.00	748,728.56
Ethanol	86,955,424.00	6,597,047.15
Total		**35,819,110.08**

[1]Colorado Department of Public Health and Environment, (2002), Colorado Greenhouse Gas Emission Inventory & Forecast, Denver.

E. CO2 Emitted in Direct Proportion to Its impact per km (or passenger-km, tone-km)

Emissions factors are required to estimate the CO2 impact per km (or passenger-km, tone-km) from passenger and freight transport. The Annexes to the Defra Company Reporting Guidelines (CRG), released in July 2005. The factors derived refer to CO2 emissions per km and are derived from speed emission curves also used by the UK's National Atmospheric Emissions Inventory (NAEI) / Greenhouse Gas Inventory (GHGI)[1].

This part is going to state the CO2 emission of the ground based transportation according to the vehicles type and size, (Petrol and diesel cars, Regular taxis and taxi Cairo cap, Petrol and diesel vans, Local buses and long distance coaches, Motorcycles, Railways.)

Petrol and Diesel Cars.

Defra Company Reporting Guidelines has categorized petrol cars engine size into three categories small (<1.4), medium (1.4 – 2.01), and large (>2.01), the CO2 emission per Km for these type of cars respectively are 180.9, 213.9, 295.8 grams, and the consumption of petrol per km for these type of cars respectively are 12.8, 10.8, 7.8 liter.

Diesel Cars has been categorized according to engine size into three categories small (<1.7), medium (1.7 – 2.01), and large (>2.01), the CO2 emission per Km for these type of cars respectively are 151.3, 188.1, 258.0 grams, and the consumption of diesel per km for these type of cars respectively are 17.4, 14.0, 10.2 liter.[2]

Regular taxis and taxi Cairo cap.

Defra Company Reporting Guidelines has reported CO2 emission for taxi and Cairo cap per passenger Km respectively 161.3, 175.7 grams.[3]

Petrol and diesel vans.

Defra Company Reporting Guidelines has reported CO2 emission per Km for petrol van size up to 1.25 tone 224.4 grams, and CO2 emission per Km for diesel van size up to 3.5 tone 271.8 grams.[4]

Local buses and long distance buses.

Defra Company Reporting Guidelines has reported CO2 emission per passenger Km for local bus 115.8 grams, and CO2 emission per passenger Km for long distance bus 81.8 grams.

1 Guidelines to Defra's GHG Conversion Factors, (2008), Methodology Paper for Transport Emission Factors
2 IBID
3 IBID
4 IBID

Motorcycles.

Defra Company Reporting Guidelines has categorized petrol motorcycle engine size into three categories small (up to 125 cc), medium (125 to 500 cc), and large (over 500 cc), the CO2 emission per Km for these type of motorcycle respectively are 72.9, 93.9, 128.6 grams, and the consumption of petrol per km for these type of cars respectively are 31.6, 24.5, 17.9 liter.

Railways.

Defra Company Reporting Guidelines ha reported CO2 emission per passenger Km for Railways, with average passenger occupancy 901.

3.5.2. Transportation Green House Gases (GHG) Analysis Tools:

A range of tools are available that can be used to analyze GHG emissions from the transportation sector. These tools, however, vary significantly in their capabilities and ease of use for transportation GHG analysis. Most of them were not designed primarily for transportation GHG analysis, and as a result, the methodologies and procedures employed are not always easy to use for transportation GHG analyses and do not always account for the full range of factors that influence GHG emissions[1].

This section identifies tools or methods that can be used to analyze the GHG implications of transportation projects. The following tools are grouped into three categories, based on their primary function, Transportation GHG calculation tools; Transportation strategy analysis tools; and Energy-focused forecasting tools.

A. Transportation GHG Calculation Tools

These tools are designed to develop emissions estimates based on user-provided inputs, such as vehicle miles traveled (VMT) and/or fuel consumption (or to develop emission factors that can be combined with VMT estimates to develop emissions estimates). Some tools are designed with VMT as a primary input, while others are designed with fuel consumption as the primary input. They vary in terms of the transportation sources they address, level of sophistication, and ability to address a range of different types of inputs and analyses. Many of these tools were developed by the U.S. Environmental Protection Agency (EPA), and several have common methodologies or build upon each other[2].

These tools are divided into three sub-groups.

[1]American Association of State Highway and Transportation Officials (AASHTO), (2006), Assessment of Greenhouse Gas Analysis Techniques for Transportation Projects, Standing Committee on Environment
[2]IBID

1. Multi-sector Inventory Tools: These tools are designed to develop GHG inventories or projections for all economic sectors, including transportation:

State Inventory Tool (SIT): Developed by the U.S. EPA, the SIT is designed to develop a comprehensive GHG inventory (CO_2, CH_4, N_2O, and HFCs) at the state level, using a combination of state-specific inputs and default data. It requires inputs of transportation fuel consumption and VMT.

State Inventory Projection Tool (SIPT): Developed for the U.S. EPA, the State Inventory Projection Tool builds on inventory estimates from the SIT by allowing users to forecast GHG emissions through 2020. Projections are based in part on projected fuel consumption reported by the U.S. Energy Information Administration.

2. Direct GHG Emission Calculation Tools: These tools focus solely on transportation sources, and are designed to develop emission factors or emission estimates for gases emitted during vehicle use:

MOBILE6 Model: This is the EPA-approved model that generates on-road motor vehicle emission factors for use in transportation analysis at the state, region, or project level. In addition to criteria pollutants, the model generates CO_2 emission factors, which can be combined with VMT data to estimate CO_2 emissions. The CO_2 emission factors only account for vehicle type and model year; the emission factors do not account for impacts of vehicle operating conditions (e.g., travel speeds) on CO_2 and expected changes in future vehicle fuel economy.

NONROAD Model: This EPA-approved emissions model is used to develop estimates of criteria pollutant and CO_2 emissions estimates for non-road sources, such as recreational vehicles, agricultural equipment, construction equipment, lawn and garden equipment, recreational boats, airport ground support equipment, railroad maintenance equipment and others. NONROAD does not address commercial marine vessels, locomotives, or aircraft.

National Mobile Inventory Model (NMIM): EPA developed NMIM to integrate the input data requirements, model runtimes, and post-processing requirements for MOBILE6 and NONROAD models into a single package.

EMFAC: The California Air Resources Board (CARB) developed EMFAC as the California version of MOBILE6. Using emission factors and vehicle activity inputs, EMFAC develops emission estimates for on-road vehicles to be used in developing emission inventories, projections, and other project level analyses. The CO_2 emission rates vary by vehicle speed.

3. Life-cycle GHG Emission Calculation Tools: Greenhouse Gases, Regulated Emissions, and Energy use in Transportation (GREET) Model - Developed by the Argonne National Laboratory (sponsored by U.S. DOE),

GREET: is designed to fully evaluate the energy and emission impacts of advanced vehicle technologies and new transportation fuels (considering the fuel cycle from wells to wheels and the vehicle cycle through material recovery to vehicle disposal).

Lifecycle Emissions Model (LEM): Developed by Mark Delucchi at the University of California, Davis, LEM estimates energy use, criteria pollutant emissions, and CO_2-equivalent greenhouse-gas emissions from transportation and energy sources.

Motor Vehicle Emissions Simulator (MOVES): Being developed in stages by the U.S. EPA, MOVES is eventually intended to replace MOBILE6, NONROAD, and NMIM. The existing version of MOVES estimates energy consumption (for use in calculating CO_2), N_2O, and CH_4 from on-road vehicles from 1999 to 2050, and accounts for the impacts of vehicle speeds, age, and stock on emissions. It also includes estimates of direct and upstream emissions, based on the GREET model. MOVES can be used to develop regional, statewide, and national GHG emissions estimates, and can be used to generate emissions factors for project-level analyses.

B. Transportation/Emissions Strategy Analysis Tools

These tools are designed to estimate the travel and emissions impacts of specific types of transportation strategies, based on inputs about the transportation programs or strategies (e.g., type of strategy, other parameters of specific strategies). Most of the analytical strength of these tools is in the estimation of travel impacts; the user does not need to calculate a change in VMT or speeds, since the model performs that analysis. The CO_2 calculation procedures are generally very simple, and often do not account for complex implications of vehicle operating characteristics on emissions[1].

These tools include:

COMMUTER Model: Developed by the U.S. EPA, the COMMUTER Model is designed to analyze the impacts of transportation control measures (TCMs), such as transit employer-based transportation demand management programs and transit improvements, on VMT, criteria pollutant emissions, and CO_2. The CO_2 calculations are simple, and based on default emission factors from MOBILE6.

Intelligent Transportation Systems Deployment Analysis System (IDAS): The Federal Highway Administration (FHWA) developed IDAS as a sketch planning tool to estimate the impacts, benefits, and costs resulting from the deployment of ITS components; it estimates emissions of CO_2 and criteria pollutants.

C. Energy/Economic Forecasting Analysis Tools

These tools are designed to forecast energy consumption, typically based on economic factors such as economic growth and fuel prices. Most of these tools are designed for national-level analysis, and cannot be readily used for metropolitan area or project-level analyses. Although these tools have strengths in terms of examining the implications of economic factors on transportation energy consumption, they typically are not geared toward analyzing the impacts of transportation investments and rely on data inputs that are not typically used in the transportation planning process.[2]

These tools include:

National Energy Modeling System (NEMS): Developed by the Energy Information Administration (EIA) within the U.S. Department of Energy (DOE), NEMS represents the behavior of energy markets and their interactions with the U.S. economy to develop annual projections and evaluate national energy policies. A transportation demand module (TRAN) within the model forecasts the consumption of transportation sector fuels, which can be used to calculate CO_2.

[1]American Association of State Highway and Transportation Officials (AASHTO), (2006), Assessment of Greenhouse Gas Analysis Techniques for Transportation Projects, Standing Committee on Environment

[2]IBID

VISION: Developed by the Argonne National Laboratory (sponsored by U.S. DOE), VISION is an excel-based model that provides estimates of the potential energy use, oil use, and carbon emission impacts to 2050 of advanced light- and heavy-duty highway vehicle technologies and alternative fuels.

World Energy Protection System (WEPS) Transportation Energy Model (TEM): Developed by U.S. DOE, as a component of WEPS (a world energy consumption model), the Transportation Energy Model (TEM) generates forecasts of transportation sector energy use by transport mode at a national and multi-national region level. The WEPS accounting framework incorporates assumptions about the future energy intensity of economic activity (ratios of total energy consumption divided by gross domestic product [GDP]), and about the rate of incremental energy requirements met by different energy sources.

Systems for the Analysis of Global Energy Markets (SAGE): Developed by the U.S. DOE to replace WEPS, SAGE develops projections of energy consumption to meet energy demand, estimated on the basis of each region’s existing energy use patterns, the existing stock of energy using equipment, and the characteristics of available new technologies, as well as new sources of primary energy supply.

According to the previous stated model, the following table is concluded to state the applicability of tools for transportation of greenhouse gases analysis.

■ Designed for this type of analysis.

□ Not designed for this type of analysis but could potentially be applied.

- Not applicable.

Table 3-9 Applicability of Tools for Transportation GHG Analysis.

(Source: Researcher)

Model	Geographic Level of Analysis				Type of Analysis			Transportation mode						
	State	Region	Local	Project	Inventory Develop-ment	Project	Strategy Analysis	Light-duty Vehicles	Heavy-duty Trucks	Buses	Rail	Maritime	Aviation	Other non-road
MOBILE6	■	■	■	■	■	■	■	■	■	■	-	-	-	-
NONROAD	■	■	-	■	■	■	■	-	■	-	-	■	-	■
NMIM	■	■	■	-	■	■	■	■	■	■	-	-	-	■
SIT	■	-	-	-	■	-	-	■	■	■	■	■	■	■
SIPT	■	-	-	-	-	■	-	■	■	■	■	■	■	■
CLIP	-	-	■	-	■	-	■	■	■	■	-	■	-	■
MOVES	■	■	■	■	■	■	■	■	■	■	-	-	-	-
COMMUTER	□	■	■	■	-	-	■	■	-	-	-	-	-	-
IDAS	□	■	■	■	-	■	■	■	■	■	■	-	-	-
NEMS	□	-	-	-	-	■	■	■	■	■	■	■	■	■
VISION	□	-	-	-	-	■	■	■	■	-	-	-	-	-
WEPS	□	-	-	-	■	■	■	■	■	■	■	■	■	■
SAGE	□	-	-	■	■	■	■	■	■	■	-	-	-	-
GREET	■	■	■	■	■	■	■	■	-	-	-	-	-	-
LEM	□	-	-	-	■	■	■	■	■	■	■	■	-	■
EMFAC	■	■	■	■	■	■	■	■	■	■	-	-	-	-
NYSDOT	■	■	■	■	-	■	■	■	■	■	■	-	-	■

3.6.Industrial Zone Carbon Emission:

Greenhouse gas emissions are produced as a by-product of various non-energy-related industrial activities. That is, these emissions are produced from an industrial process itself and are not directly a result of energy consumed during the process. For example, raw materials can be chemically transformed from one state to another. This transformation can result in the release of greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), or nitrous oxide (N_2O). This section is going to present different CO_2 emission for different industries in different countries. This section is going to state several theories for calculating CO_2 emitted for different industries along the city that has been used before in several countries.

A. Industrial Carbon Emission in U.S.:

The processes addressed in this paragraph include iron and steel production, cement manufacture, ammonia manufacture and urea application, lime manufacture, limestone and dolomite use (e.g., flux stone, flue gas desulfurization, and glass manufacturing), soda ash manufacture and use, titanium dioxide production, phosphoric acid production, ferroalloy production, CO_2 consumption, aluminum production, petrochemical production, silicon carbide production and consumption, lead production, zinc production, nitric acid production, and adipic acid production[1].

In 2005, industrial processes generated emissions of 333.6 Terragram of CO_2 equivalent (Tg CO_2 Eq.), the following table is going to summarize CO_2 emission in year 2005.

[1] http://www.eia.doe.gov/oiaf/1605/ggrpt/carbon.html. Accessed (2011)

Table 3-10 CO2 emission for different industries

(Source: http://www.eia.doe.gov/oiaf/1605/ggrpt/carbon.html)

Industry Type	CO2 Emission in Year 2005 (Tg CO2 Eq.)
Cement Manufacture	45.9
Iron and Steel Production	45.2
Ammonia Manufacture & Urea	16.3
Lime Manufacture	13.7
Limestone and Dolomite Use	7.4
Soda Ash Manufacture and Consumption	4.2
Aluminum Production	4.2
Petrochemical Production	2.9
Titanium Dioxide Production	1.9
Ferroalloy Production	1.4
Phosphoric Acid	1.4
Zinc Production	0.5
Lead Production	0.3

B. Industrial Carbon Emission in Netherlands:

During the second half of the twentieth century the Netherlands transformed from a low-energy economy into an economy that is known for its high level of energy use. The most important changes took place between 1960 and 1975, just after the newly found natural gas reserves started to be exploited. Of course, the increase in fossil fuel use also caused a large increase in the CO2 emissions and the associated damages[1].

The following table in going to state energy used and the CO2 emitted for year 2008 for the industrial process in Netherland.

[1] Ruben van der Helm, Rutger Hoekstra and Jan Pieter Smits, (2008), Economic growth, structural change and carbon dioxide emission: The case of Netherlands, Paper prepared for the 18th International Input-Output Conference, June 20-25th, Sydney, Australia

Table 3-11 Energy used and CO2 emitted for different industries and activities in Netherland

(Source: Ruben van der Helm, 2008, Economic growth, structural change and carbon dioxide emission, Australia)

Activity Type	Detailed Classification	Energy Used PJ	CO2 emission MTone CO2
Agriculture	Agriculture, forestry and fishery	139.9	8.4
Mining	Mining and quarrying	31.0	5.0
Food	Food, beverages and tobacco	52.8	0.8
Textiles	Textiles and leather	-10.3	-1.0
Paper and publishing	Paper and publishing	14.9	-0.7
Oil refineries	Oil refineries	100.9	7.3
Chemical industry	Chemicals, rubber and synthetic fibers	245.9	8.5
Basic Metals	Basic Metals	17.0	0.8
Metal products, etc.	Metal products, electronics and transport equipment	24.5	0.4
Other industry	Wood and wood products, building materials and other industry	26.9	0.1
Utilities	Energy and water supply	249.3	34.9
Air and water transport	Air and water transport	211.8	16.1
Road transport	Road transport and transport services	118.3	8.0
Others	Construction, government and other services	477.9	17.8

C. Energy Consumption and CO2 Forecasts Obtained from the Department of Energy:

Energy forecasts were obtained from the Department of Energy, Energy Information Administration's publication Annual Energy Outlook 1995. The percentage increases for each fossil fuel category were extrapolated from national averages, based on population, and are not Colorado-specific[1].

[1]Colorado Department of Public Health and Environment, (2002), Colorado Greenhouse Gas Emission Inventory & Forecast, Denver.

Table 3-12 Forecast for Carbon Dioxide Emissions from Fossil Fuel Use

(Source: Colorado Department, 2002, Colorado Greenhouse Gas, Denver)

Sector/Fuel	Energy Consumption (million BTU)	CO2 Emissions (tons)
Kerosene	135,099.09	10,666.41
Distillate Fuel	20,687,411.78	1,652,096.70
LPG	5,171,318.12	354,788.62
Other Liquids	11,134,038.98	889,164.35
Bituminous Coal	23,053,300.53	2,343,137.47
Lubricants	1,958,891.90	158,570.34
Asphalt and Road Oil	28,609,727.08	2,362,662.79
Natural Gas	89,985,126.00	5,236,316.97
Total		**13,007,403.65**

D. Non-combustion, On-site Fossil Fuel Combustion, and Purchased Electricity CO2 Emissions:

CO2 emissions in this part are estimated in units of MMTCO2E, a unit of measurement that takes into account the relative potency of the gas by applying global warming potentials (GWPs) of each gas. For example, the GWP of CO2 is 1, while the GWPs of CH4 and N2O are 21 and 310, respectively. For a listing of GWPs for other GHGs and a full explanation of GWPs. Each sector of industry, emission estimates are provided per year in the following table, for which a complete dataset is available to estimate emissions for fossil fuel combustion, non-combustion activities, and electricity purchases[1].

[1]Working Draft, (2008), Quantifying Greenhouse Gas Emissions from Key Industrial Sectors in the United States, Sectors Strategies.

Table 3-13 CO2 Emissions for Key Industrial Sectors (MMTCO2E)

(Source: Working Draft, (2008), Quantifying Greenhouse Gas Emissions, Sectors Strategies)

Emission Source	CO2 Emission (MMTCO2E)
Alumina and Aluminum	51
Fossil Fuel Combustion	11
Non-Combustion	5
Electricity	36
Cement	83
Fossil Fuel Combustion	32
Non-Combustion	43
Electricity	8
Chemicals	322
Fossil Fuel Combustion	203
Non-Combustion	18
Electricity	101
Construction	131
Fossil Fuel Combustion	100
Electricity	31
Food and Beverages	100
Fossil Fuel Combustion	51
Electricity	49
Forest Products	120
Fossil Fuel Combustion	62
Electricity	58
Iron and Steel	114
Fossil Fuel Combustion	22
Non-Combustion	55
Electricity	37
Lime	23
Fossil Fuel Combustion	9
Non-Combustion	12
Electricity	1
Metal Casting	18
Fossil Fuel Combustion	7
Electricity	11
Mining	41
Fossil Fuel Combustion	15
Electricity	27
Oil and Gas	349
Fossil Fuel Combustion	276
Non-Combustion	30
Electricity	43
Plastic and Rubber Products	44
Fossil Fuel Combustion	8
Electricity	36
Semiconductors	9
Fossil Fuel Combustion	1
Electricity	8
Textiles	32
Fossil Fuel Combustion	10
Electricity	21

E. CO2 Emissions According to the Type and Quantity of Industrial Product:

Manufacturing is the single largest source of energy-related carbon dioxide emissions, one of the ways of calculating CO2 emitted from manufacturing is relating the emission to the quantity and type of industry product, the following table is going to summarize CO2 emitted for some of the industrial products[1].

Table 3-14 CO2 emitted according to industry quantity &type

(Source: International Energy Agency (IEA), (2002), Energy balances of OECD and non-OECD countries. Paris, France)

Element	Value in [kg CO2 / t]	Included
CO2 emissions from paper manufacturing	23	Direct emissions from the mill, internal transports, chemical pulp, DIP-rejects
CO2 emissions from fiber production	4	Emissions from forestry, recovered paper processing
CO2 emissions from other raw materials	98	Manufacturing of Filler - PCC, manufacturing of paper chemicals
CO2 emissions from purchased energy	519	Electrical energy, thermal energy (steam)
CO2 emissions from transports	32	Transport of raw materials to the mill, transport of finished products to printer

F. CO2 Emissions According to the Number of Factories & Type of Industrial Products:

Manufacturing is considered as a complex process, whether in its consuming energy or emitting carbon dioxide, so the following table is going to state the CO2 emission for each type of industry related to the number of factories producing each industrial product, considering that the areas of these factories and their production capacity is average in comparison to others. The following table shows CO2 emission and the number of factories concerning the industrial products, based on the latest end-use energy consumption statistics from EIA’s and Manufacturing Energy Consumption Survey (MECS)[2].

[1]International Energy Agency (IEA), (2002), Energy balances of OECD and non-OECD countries. 2002 ed. Paris, France;
[2]Mark Schipper, (2006), Energy-Related Carbon Dioxide Emissions in U.S. Manufacturing, Energy Information Administration (EIA)

Table 3-15 Carbon Dioxide Emissions from Manufacturing by Industry and Industry Group.

(Source: Mark Schipper, (2006), Energy-Related Carbon Dioxide Emissions in U.S. Manufacturing, Energy Information Administration)

Industry and Industry Group under North American Industry Classification System (NAICS)	Carbon Dioxide Emissions (Million Metric Tons)	Number of Factories
Petroleum	**304.8**	**799**
Petroleum Refineries	**277.6**	**1,778**
Chemicals	**311.0**	**799**
Other Basic Organic Chemicals	**80.5**	**1,408**
Plastics Materials and Resins	**63.3**	**1,747**
Other Basic Inorganic Chemicals	**23.9**	**2,043**
Industrial Gases	**17.0**	**1,157**
Nitrogenous Fertilizers	**12.4**	**386**
Carbon Black	**5.3**	**52**
Cyclic Crudes and Intermediates	**5.1**	**100**
Noncellulosic Organic Fibers	**5.0**	**229**
Synthetic Rubber	**3.5**	**229**
Phosphatic Fertilizers	**2.5**	**109**
Primary Metals	**212.8**	**3,096**
Iron and Steel Mills	**126.0**	**944**
Alumina and Aluminum	**48.0**	**154**
Iron Foundries	**10.2**	**517**
Nonferrous Metals, less Aluminum	**10.8**	**283**
Electrometallurgical Ferroalloy	**3.1**	**65**
Paper Mills, except Newsprint	**44.4**	**2,294**
Paperboard Mills	**31.8**	**808**
Wet Corn Milling	**18.9**	**146**
Sugar	**5.3**	**47**
Fruit and Vegetable Canning	**3.4**	**1,227**
Cements	**39.0**	**628**
Glass Products	**16.2**	**1,641**
Glass Containers	**5.2**	**229**
Flat Glass	**4.0**	**772**
Lime Manufacturing	**10.3**	**202**
Mineral Wool	**4.7**	**322**

3.7. Global CO2 Emission by Sector:

Climate change is caused by the emission of greenhouse gases. There are six greenhouses gases recognized under the Kyoto Protocol, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydro fluorocarbons (HFC), per fluorocarbons (PFC), and sulphur hexafluoride (SF6), that are released through various anthropogenic activities such as power generation, wastewater treatment, landfills, industrial processes, and fuel for transportation. Power generation for electricity, heat, and industrial activities makes up the bulk of global emissions, followed by land use change (e.g., deforestation and burning), agriculture (including livestock and use of fertilizers), and transportation (fossil fuels for automobiles)[1].

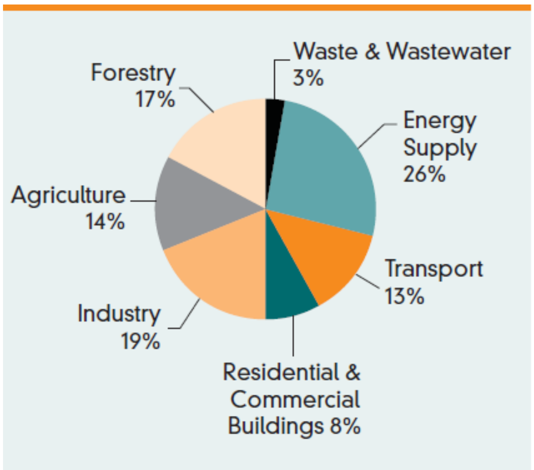

Figure 3-7 Global CO2e emissions by sector, (2004).
(Source: Rogner et al. 2007)

In Colorado emitted over 85 million tons of carbon dioxide from fossil fuel combustion. Fossil fuel consumption accounts for 98% of all carbon dioxide emissions[2].

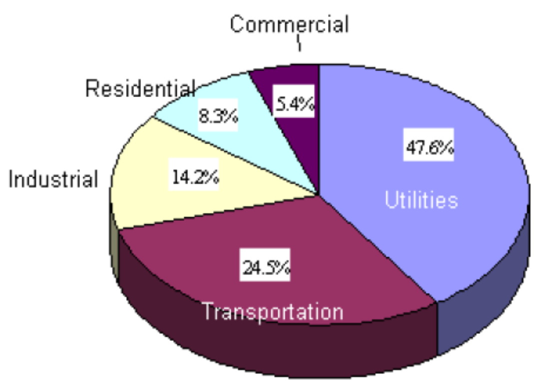

Figure 3-8 CO2 Emissions from Fossil Fuel Consumption by Sector

(Source: Colorado Department, 2002, Colorado Greenhouse Gas, Denver)

[1] Carbon Partnership Facility Innovation Series, (2010), A city wide approach to carbon finance, Washington.
[2] Colorado Department of Public Health and Environment, (2002), Colorado Greenhouse Gas Emission Inventory & Forecast, Denver.

In U.S. emission estimates in this part may vary from EPA emission estimates for other purposes. Further, these emission estimates may be improved upon in the future as more GHG emissions are reported, and other estimates may be developed to incorporate additional life-cycle activities such as transport of materials into and out of the sector[1].

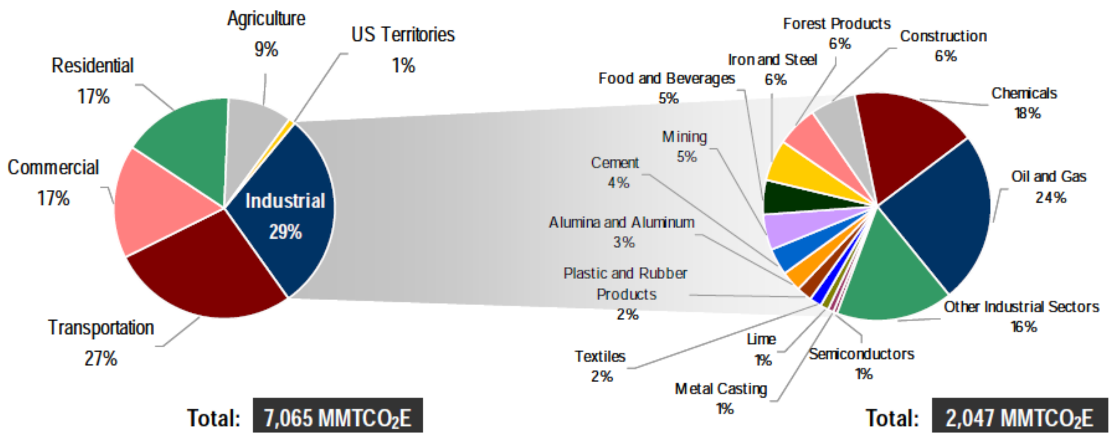

Figure 3-9 Total 2002 U.S. CO2 Emissions from Industrial Sources, by Sector (MMTCO2E).

(Source: Working Draft, (2008), Quantifying Greenhouse Gas Emissions, Sectors Strategies.)

Planning of low carbon cities involves creation of low carbon society by promoting low carbon emission. In order to achieve a low carbon emission, effort to reduce CO2 emission is most important as CO2 is the most significant anthropogenic greenhouse gas (GHG) emitted in urban areas. The increases of CO2 concentration are due primarily to fossil fuel use and land use change. Urban planning through land use planning and planning control can play vital role in implementing the idea of low carbon cities, particularly during the formulation of development plans. The following figure shows Malaysian carbon dioxide emissions according to the city sectors[2].

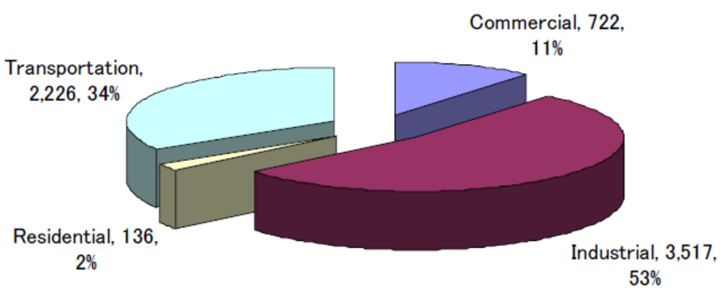

Figure 3-10 CO2 Emission by Sector in Malaysia.

(Source: Ho Chin Siong , (2007), Planning for Low Carbon Cities, Sustainable Urban Development Institute)

1Working Draft, (2008), Quantifying Greenhouse Gas Emissions from Key Industrial Sectors in the United States, Sectors Strategies.

[2] Ho Chin Siong , Fong Wee Kean, (2007), Planning for Low Carbon Cities The case of Iskandar Development Region, Malaysia, Sustainable Urban Development Institute.

The net annual emission of greenhouse gases in Australia was 402.4 million tons of CO_2 equivalents, of which Agriculture activity contributed 18% and Land Use Change and Forestry 12%, Industrial Process 2%, Waste 3%, and finally total energy 65%[1].

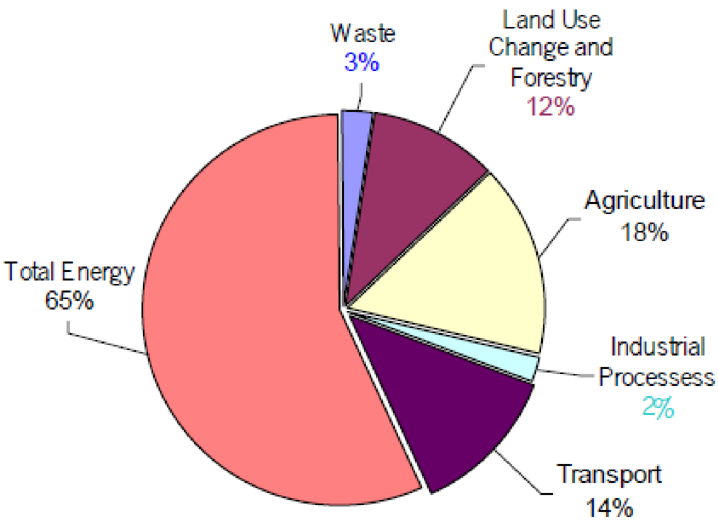

Figure 3-11 Contribution to total CO_2 – Equivalent Emission by Sector

(Source: H.B. So, Potential of Conservation Tillage Reduce Carbon Dioxide emission in Australian soils)

3.8.Improving the Natural and Built Ecological Systems in an Urban Environment by Green Network:

The ecological approach to landscape planning and the concepts of designing and implementing ecological systems have gained increasing attention in the last two decades. This approach could help in defining sustainable landscape development, aiming for a balance between both physical and natural systems in urban areas. The spatial structure of green and natural areas are studied and categorized based on the patch-corridor-matrix model[2]. The urban ecological systems can bridge the conflict between reserve conservation, fixing nature in space and time and development. They help to focus on an effective spatial scale as well[3].

As the coherence of an ecological system is based on ecological processes it may be single purpose or multipurpose (Jongman, 1995). The multi-objective systems go beyond ecological improvements of the city and habitat needs of wildlife, to address recreation and beautification, promoting urban flood damage reduction, enhancing water quality and other

[1] H.B. So, R.C. Dalal; K.Y. Chan, Potential of Conservation Tillage Reduce Carbon Dioxide emission in Australian soils.

[2] Cranz, G. and Boland, M. (2005), Defining the Sustainable Park: A Fifth Model for Urban Parks. Landscape Journal.

[3] Fabos, J. G. (2004). Greenway planning in the United States: its origins and recent case studies. Landscape and Urban Planning.

urban infrastructure objectives[1]. Extending the ecological system concept with multifunctional indicators is a promising step towards sustainable city. Ecological systems, as natural or built potentials, play a leading role in achieving sustainable urban environment. By focusing on structures, functions and transformations of the environment, landscape ecology approach is an attempt to find patterns and interrelations between landscape elements, built and natural patches, corridors and the matrix (Forman, 1995; Ingegnoli, 2002)[2]. Ideas such as urban open space network (Turner, 1995; Cranz & Boland, 2004), park systems (Jongman & Pungetti, 2004; Maruani & Cohen, 2007) and greenway networks (McHarg, 1969; Ahern, 1995; Little, 1999; Fabos, 2004; Turner, 2006) are developed as initiatives to interweave the natural and built systems in ecological landscape design and planning (Makhzoumi & Pungetti, 1999)[3].

3.8.1. Ecological View in Designing New York Green Space System:

Adopting a new ecological view of the metropolitan landscape in designing New York green space system (Flores et al., 1998) suggests a framework that emphasizes a dynamic view of a biologically rich urban environment with a focus on interactions among multiple sites across temporal scales. This approach is defined by presenting five key ecological principles as follows[4]:

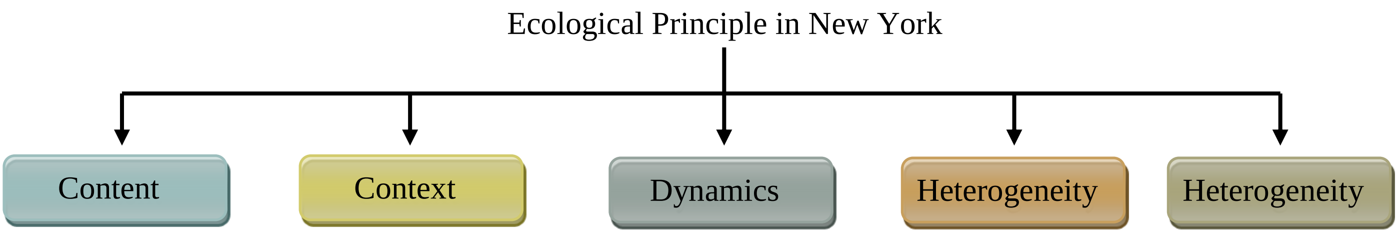

Figure 3-12 Ecological principle in New York

(Source: Researcher)

A. Content: a wide spectrum of ecosystem functions that are strongly linked to ecosystem structure
B. Context: a combination of localities that results in considerable variability in the kind of ecological context specific to each site
C. Dynamics: suggests that with structural changes, ecosystem function also changes

---

[1] Jongman R. and Pungetti G. (2004). Ecological networks and greenways concept, design, implementation. Cambridge University Press, UK.

[2] Ingegnoli, V. (2002). Landscape ecology: A widening foundation. Springer, Berlin.

[3] Maruani, T. and Cohen, I. (2007). Open space planning models: A review of approaches and methods. Landscape and Urban Planning.

[4] Micarelli, R., Irani Behbahani, H. and Shafie, B. (2007), River-valleys as intra-city natural feature. Int. J. Environ. Res.

D. Heterogeneity: means ecosystems need not be pristine, only flexible, connected, and diverse with complement of species to generate the genetic, biological, and biogeochemical capacity to adapt and respond to a changing environment

E. Hierarchy: help manage ecological complexity by organizing it into discrete functional components operating at different scales.

3.8.2. Ecological View in Designing Beijing, China Green Space System:

Comprehensive concept plan of urban greening based on ecological principles, a case study in Beijing, China (Li et al., 2005) attempts to answer how to establish an urban greening plan at the regional, city and neighborhood levels to achieve long-term sustainability. This three-level system constitutes an integrated ecological network for urban sustainable development of Beijing. For future development of the city, urban parks, forestry, agriculture, water and infrastructure should be planned and designed in an integrated way. It has the prospect of achieving the long-term goal of developing Beijing towards an Eco- City. Ecological principles and requirements for urban greening of Beijing define the temporal and spatial scale of green space planning[1]. Three spatial scales have to be considered. At the regional scale, the entire area of Beijing Province is considered. Even the relationship to the neighbor-city Tianjin is included in the plan. At the city scale, the urban area of Beijing with its suburbs and the surrounding peri-urban zone is taken into account, and at the neighborhood scale, some selected and typical areas within the fourth ring road are considered. The plan distinguishes between three time-scales for implementation. The ecological principles and requirements for the urban greening in Beijing are as follows[2]:

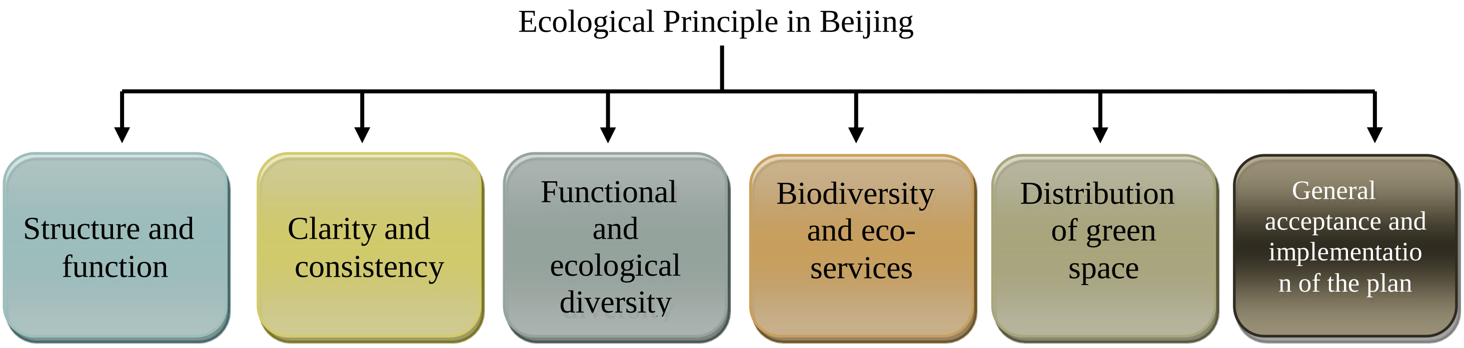

Figure 3-13 Ecological principle in Beijing

(Source: Researcher)

[1] Li, F.,Wang, R., Paulussen, J. and Liu, X. (2005). Comprehensive concept planning of urban greening based on ecological principles: a case study in Beijing, China. Landscape and Urban Planning.

[2] IBID

A. Structure and function: changing the function of fragmented and isolated green space.

B. Clarity and consistency: an easily-communicable long-term vision and an integrated green space

C. Functional and ecological diversity: combining several ecological functions and are not nonfunctional.

D. Biodiversity and eco-services: enhancing ecosystem services by high green space quality and diversity and improve specific conditions for endangered species

E. Distribution of green space: creating public parks close to high-density residential areas and no pollution in fresh air-generation zones and fresh air corridors, establishing big forest areas and ecological buffer belts at the regional scale and vertical greening for high-density settlement.

F. General acceptance and implementation of the plan: publicizing the concept through the media, involving decision makers and the public as a strong driving force to promote green space development.

3.8.3. Ecological View in Designing London Green Space System:

Emphasis has been placed on planning vegetated urban fields in London. Other types of green space have been neglected (Turner, 1995). This attempt has distracted planners' attention from the vital task of creating networks of environmentally pleasant open spaces. The only continuous ecological corridors in London are the rivers, which constitute another layer to the Green Strategy. As London is conceived to have webs of public open space, it would have been possible to plan for more diverse habitats and natural processes. The greenway theory and parkways are introduced as parts of this ecological system and urban rivers are converted into blue-ways, by opening up access to the banks of rivers. Eco ways are established networks of ecological space in cities by using and merging urban water courses, public utility corridors, parklands and private gardens into a single integrated system of ecologically important components[1]

[1] Turner, T. (2006). Greenway planning in Britain: recent work and future plans. Landscape and Urban Planning,

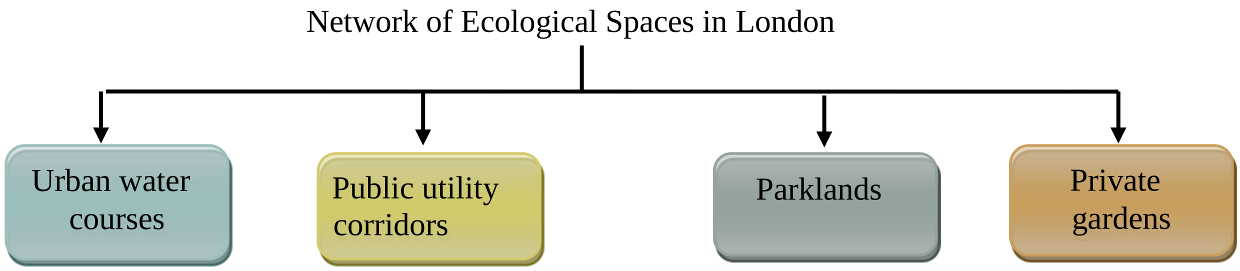

Figure 3-14 Ecological principle in Beijing

(Source: Researcher)

The following is concluded table to review the natural and built ecological systems in three metropolitan areas, (New York, Beijing, and London).

Table 3-16 The natural and built ecological systems in 3 metropolitan areas

(Source: Researcher)

Region	Ecological Principles	Strategies
New York (Flores et al., 1998)	Content Context Dynamics Heterogeneity Hierarchy	• Creating regional reserves • Invigorating green spaces in highly urbanized • Environments creating a regional network of green spaces
Beijing (Li et al., 2005)	Spatial Scales Time Scales	• Integrating isolated green space into network clarity and consistency of green space system enhances ecosystem services. • Bridge separating elements.
London (Turner, 1995)	Connectivity Connectedness	• Creating networks of open space and ecological corridors establish networks of ecological space, greenways and parkways

3.8.4. Role of Ecological Patches and Corridors in the Sustainability of Urban Environments:

Urban ecological systems can link terrestrial ecological, physical, and socioeconomic components of metropolitan areas (Pickett et al., 2001) in an ecological approach to landscape planning (Sanderson & Harris, 2000; Steiner, 2000) in urban environment. The experiences and theories demonstrate that ecological patches and corridors play a crucial role in the sustainability of urban environments and their transformations directly influence the ecological functions of the city. Some general points for structural and functional improvement of patches and corridors in the urban context are categorized in the following figure[1].

[1] Pickett S. T. A., Cadenasso M. L., Grove J. M., Nilon C. H., Pouyat R. V., Zipperer W. C. and Costanza R. (2001), Urban ecological systems: Linking terrestrial ecological, physical, and socioeconomic components of metropolitan areas. Annual Review of Ecology and Systematics.

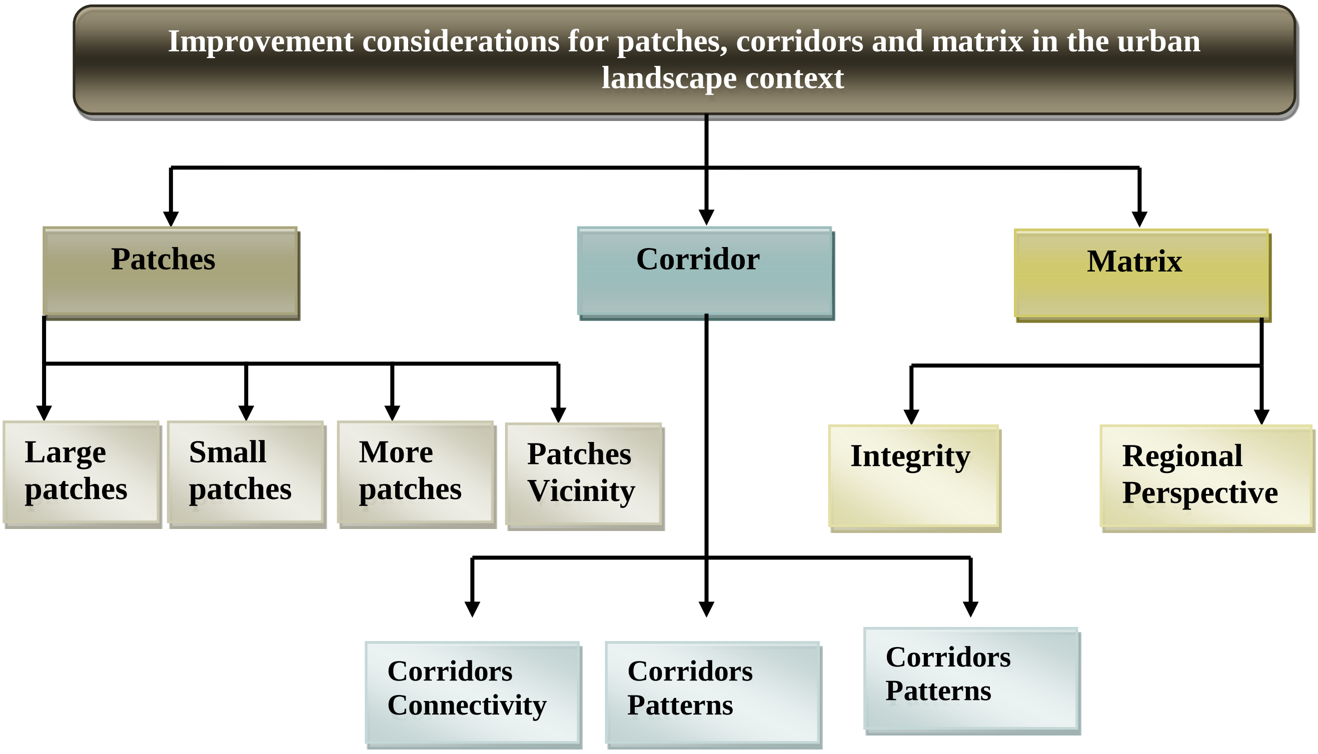

Figure 3-15 Considerations for structural and functional improvement of patches, corridors and matrix

(Source: Pickett S, (2001), Annual Review of Ecology and Systematics.)

It can be concluded that the existing natural patches and corridors in the urban environment are to be preserved and restored to increase the ecological functions of the city so that the natural flows can continue and penetrate into the built environment. The built patches and corridors within the urban context can act as main elements to make an ecologically functional system. The built patches are most influential factor in the densely built-up and populated city regions, and the built corridors can act as main connecting elements between the natural and built patches. Protecting the integrity between structural elements, preserving the original pattern of ecological systems, will help to establish and enhance the ecological processes and flows in the urban and suburban environment.

3.9.Conclusion:

A. Natural and manmade environment are considered as a component of any city structure. Whole structure of a city is related to the general planning, and the physical structure of a city is related to detail planning where it can work efficiently by harmonization between the different elements of the city.

B. Cities with differentiated or integrated functions, open or closed structures, monocentric or polycentric, compact or discreet can acquire a variety of forms, according to either the natural conditions surrounding the city, or the planning form of it. Important facts concluded according to the form of a city, these facts are:

- No city is purely monocentric or purely polycentric. Some cities are dominantly monocentric or dominantly polycentric and other are in between.
- No city spatial structure is permanent.
- Monocentric and polycentric cities are different and both type of structure have advantages and disadvantages.
- Different municipal objectives might fit better the monocentric or the polycentric model.
- Cities which is mono-functional or its functions are highly-integrated, its structures are then defined by the street network, which can be: rectangular, multiangular, radial, irregular and etc.

C. Climate change is caused by the emission of greenhouse gases. There are six greenhouse gases recognized under the Kyoto Protocol, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFC), per fluorocarbons (PFC), and sulphur hexafluoride (SF_6), that are released through various activities that take place inside the city. The second part in this chapter has divided the activities that are responsible for CO_2 emissions into three main sections:

- Living Territory and Land Use Carbon Emission.
- Transport System Carbon Emission.
- Industrial Carbon Emission.

D. Three ways are concluded for calculating living territory and land use carbon emission:

- **1st way**
  - Depend on Calculating CO_2 according to the energy consumption of the living territories and land uses.
- **2nd way**
  - Depend on Calculating CO_2 according to the Construction of Buildings.
- **3rd way**
  - Depend on Calculating CO_2 according to the area and different uses of the Buildings.

E. Five ways are concluded for calculating Transportation System carbon emission:

- **1st way**
  - Depend on Calculating CO_2 according to the fuel consumed.
  - Fuel based: (Liter of fuel) x (kg CO_2/ liter of fuel) = kg CO_2
- **2nd way**
  - Depend on Calculating CO_2 according to the vechile type.
- **3rd way**
  - Depend on Calculating CO_2 according to the Total Annual Fuel Used by Each Mode
  - Tonne-km based: (l of fuel/km) x (kg CO_2/l of fuel) * (tonne-km) / [(Cargo capacity of the transport) x (fill rate)] = kg CO2f Transportation.
- **4th way**
  - Depend on Calculating CO_2 according to the Forecasts Obtained from the Department of Energy.
- **5th awy**
  - Depend on Calculating CO_2 according to its impact per km (or passenger-km, tone-km)
  - Vehicle-km based: (Number of vehicles) x (km one way) x (l of fuel/km) x (kg CO_2/l of fuel) = kg CO_2

F. Six ways are concluded for calculating industrial zones carbon emission:

- 1st way: Identify the carbon emission of the Industrial zones in U.S.
- 2nd way: Identify the carbon emission of the Industrial zones in in Netherland
- 3rd way: Depend on Calculating CO2 according to the Forecasts Obtained from the Department of Energy.
- 4th way: Depend on Calculating CO2 according to non-combustion, On-site Fossil Fuel Combustion, and Purchased Electricity.
- 5th way: Depend on Calculating CO2 according to the Quantity and type of Industrial Product.
- 6th way: Depend on Calculating CO2 according to the number of factories & type of industrial product.

G. There is a strong link between urbanization, economic growth, and greenhouse gas emissions. Cities are engines of economic growth that contribute to a country's development and hence improve the standard of living of the country's citizens. Urban areas contribute to a significant portion of a country's GDP through industrialization, manufacturing activities, and provision of services, the same activities that result in the creation of greenhouse gases. Urban areas also concentrate people and as their affluence increases GHG emissions are further driven up by people's consumption patterns and lifestyle choices. On the other hand, a compactly designed city may well result in a lower volume of GHG emissions than would otherwise be obtained, it has been concluded the most important sector that is responsible for emitting GHG is the industrial activity, followed by utilities and transportation, then finally the living territories activities, and if the industrial activity is not one of the main activities in the city, then Utilities and transportation ranked as one of the main activities that is responsible for GHG emissions.

H. To provide a model for urban ecological systems based on landscape ecology approach, urban planners should take all natural and built structural elements into consideration. The remnant natural patches and corridors in the urban environment are to be preserved and restored to increase their ecological functions of the city so that the natural flows can continue and penetrate into the built environment. The built patches and corridors within the urban context can act as main elements to make an ecologically functional system. The built patches are most influential factor in the densely built-up and populated city regions, and the built corridors can act as main connecting elements between the natural and built patches. Protecting the integrity between structural elements, preserving the original pattern of ecological systems, will help to establish and enhance the ecological processes in the new cities.

I. Some of the activities are considered as the major problems that the city faces, for improving their ecological systems, these activities are:

- Restoring the natural form and structure of the river valleys, natural matrix connectivity, and sensitive built areas such as roads crossing the river valleys.
- Cultivating vegetation and penetration of the natural and built ecological patches and corridors into the urban fabric as ecological rehabilitation activities.
- Improving rules and regulations against the alterations of ecologically important features for preservation purposes.
- Removing the pollutants through physical, chemical and biological processes and assisting vegetation growth through bioremediation techniques to mitigate some of environmental problems.
- Naturalizing the environment and optimizing the microclimatic conditions, providing the basis for the natural systems to thrive and flourish.
- Creating new or ecologically important features such as small green patches in the urban fabric establishing greenways along main roads and a hierarchical system of linear parks in the urban context.

Chapter 4

Land Suitability Modelling for Urban Green Areas.

4.1. Introduction

4.2. Urban Green Areas.

4.3. City's Benefit from City Green Areas.

4.4. Assumptions for the Database Model Design (1)

4.5. Assumptions for the Database Model Design (2)

4.6. Conclusion

4.1.Introduction:

Redeveloping and planning green spaces and urban structure are among the essentials of mass planning of a city. Accurate planning with the help of GIS may bring about a big step in the physical and social development of the cities. The systematic view towards the subject of city planning it still has not found its specific position in many countries. Most of the Egyptain cities are designed, planned and administrated by inexpert individuals. It would be right if the skillful experts with the help of technical and scientific tools bring an end to the disordered state of most cities.[1]

Environmental protection is undoubtedly one of the most important areas where GIS technologies are the most extensively used. Geographic Information Systems for environmental protection, due to their complexity and importance, require large number of diversified data. Consequently, quality of spatial data is fundamental for proper functioning of GIS. The data of highest possible accuracy and quality are being crucial for the offered system functions. Describing a model GIS for urban green areas, particular attention has been paid to the issue of standardization. Increasingly popular in many aspects of life, often global in scope applications of GIS providing various kinds of spatial data were forced to set and introduce standards for development of such systems. The standards for GIS for National green spaces are based, inter alia, on guidelines developed within the EU INSPIRE (Infrastructure for Spatial Information in Europe) initiative. Therefore the goals of the system creation include, between others, common data availability and easy data exchange between systems, the features demanded by the community of users and limited only by existing legal restrictions (e.g. special data protection).[2]

Urban green areas and open spaces have always been a valuable asset to human communities. They are multi-faceted in the kind of value that they have provided to local communities. For this reason, parks and open space have been given much attention during the planning processes in the urban environment. Urban green areas have not only provided recreation benefits to communities, but have provided much economic wealth to local communities. Community residents have noted the benefits of urban green areas. In many urban environments, residential property values have increased near urban green spaces as a direct result.[3]

It may be concluded that, placing value on land and space within a city is an essential part of urban planning. *Placing values is important in urban planning because it shows*

[1] Nasrin Sesar,(2000), M.A.Architect,M.S.Urban Planner, 26 Greenfield, Irvine CA.

[2] Leszek Litwin1, Marcin Guzik2, (2002), Institute of Spatial and Cadastral Systems, Gliwice, Poland, Tatra National Park, Zakopane, Poland

3 Berry, Joseph K. Dec., (1998). “How Do You Measure Spatial Dependency?” GeoWorld. Vol. 11.

community support (Johnson, 1989). An example, if a community places high value on increasing its economy, the community may promote and support industrial or other business growth within the community. Community residents can show support for urban green areas in the same fashion. Those communities that place high value on their urban green areas systems will often display and promote their urban system with economic support. For this reason, urban green areas and the general welfare of a city can often be related. If a community is growing economically, then that community may provide a fine urban green system.

4.2. Urban Green Areas:

Urban green areas are the most important form of nature protection. Their priority is "to study and protect all environment systems of the area including the conditions of their existence and to reconstruct damaged or destroyed elements of native nature.[1]" The creation of Geographic Information Systems based on spatial databases is without a doubt a necessary condition for the realization of statutory obligations of urban green spaces.

4.2.1. Urban Green Areas System and Definition:

Urban green areas: are territories where there are no populated areas and settlements and which include natural ecological systems with great variety of vegetation, animal kinds and habitats, characteristic and extraordinary landscape and sites of the non-living nature. The purposes of these areas are to maintain the variety of the ecological systems and to protect the wild nature and the biological variety in the ecological systems, and to develop tourism and scientific, educational and recreational activities[2].

The Economic Value of urban green System: Cities are economic entities. They are made up of structures entwined with open space. Successful communities have a sufficient number of private homes and commercial and retail establishments to house their inhabitants and give them places to produce and consume goods. Cities also have public buildings, libraries, hospitals, arenas, city halls for culture, health, and public discourse. They have linear corridors streets and sidewalks for transportation, and they have a range of other public spaces, green areas, plazas, trails, sometimes natural, sometimes almost fully paved for

[1]Dziennik Ustaw nr 114, (1991) "Nature Protection Act" - printed official gazette announcing current legislation
[2] Leszek Litwin1, Marcin Guzik2, (2002), Institute of Spatial and Cadastral Systems, Gliwice, Poland, Tatra National Park, Zakopane, Poland

recreation, health provision, tourism, sunlight, rainwater retention, air pollution removal, natural beauty, and views.[1]

Urban green spaces: are outdoor places with significant amounts of vegetation, which exist mainly as semi-natural areas, or are viewed as last remnants of nature in urban areas.[2]

4.2.2. Increasing Hedonic (Property) Value:

More than 30 studies have shown that green areas have a positive impact on nearby residential property values. Other things being equal, most people are willing to pay more for a home close to a nice green space. Economists called this phenomenon **"hedonic value."** (Hedonic value also comes into play with other amenities such as schools, libraries, police stations, and transit stops. Theoretically, commercial office space also exhibits the hedonic principle; unfortunately, no study has yet been carried out to quantify it.)[3]

Figure 4-1 Meridian Hill Park in Washington, D.C. provides extra value to the thousands of dwelling units surrounding it, and to the city itself through higher property tax receipts.

(Source:http://www.expressnightout.com/content/2008/10/rating_dogfriendly_dc_parks_for_human_pi.php)

4.2.3. Importance of Green Areas:

Green areas are considered as urbanized environment which provide people with a feeling of place and identity. Green areas also can instill pride for a community or city, and often give a city an identity. Central Park in New York City is well recognized, and gives the city a unique character. Rochester is also known for its beautiful downtown park system, but at a much smaller scale. Visitors to the area often notice the city urban green space system immediately. Indeed, part of Rochester's character and standard of living can be seen

[1] Bedimo-Rung, A. L., A. J. Mowen, and D. Cohen. (2005). The significance of parks to physical activity and public health: A conceptual model. *American Journal of Preventive Medicine* 28(2S2): 159–168.

[2] Bonsignore, R.E., (2003). The diversity of green spaces. Design, Center for American urban Landscape. Design Brief, number 2/August.

[3] Center for Urban Forest Research. Collection of "Benefits and Cost" Research. U.S. Forest Service. Davis, California. http://www.fs.fed.us/psw/programs/cufr/research/studies.php?TopicID=2.

through its city park system.[1] Green areas play an important part of urban ecosystems; play a pivotal role in preserving biodiversity in urban areas. Moreover, green spaces sequester CO2 and produce O2, they reduce air pollution and noise, regulate microclimates, and reduce the heat island effect in cities affect house prices maintain diversity; have recreational and social values and produce a vitamin ‘‘G’’ for health, well-being and social safety.[2] Green areas can provide many opportunities to a community. Not only have urban green spaces provided a retreat from the noise and bustle of traffic and crowds, they have also provided a stage for a whole range of social activities.

Green areas often provide excellent areas for the public to socialize. They often provide a place for enjoyment, recreation, relaxation, family affairs, socialization, communication areas, and a place for gathering. Urban parks also provide aesthetic beauty and natural resource protection.[3] Green areas offer much to everyone. Many types of people frequent green areas, including developers, property owners, children, businesses, students, government officials, homeless, the elderly and children. However, green areas should be properly planned and maintained in order for them to be successful. If green spaces are not properly planned, it can often bring negative factors into the area. Negative factors often associated with poorly planned urban green spaces include crime, noise and congestion. Poorly planned green spaces can also limit certain types of people from accessing it, such as the elderly or children.Green areas users show the social values that they put on local green spaces, and what those spaces bring to the standard of living through their support. People and society put high values toward green spaces that offer them satisfaction. They feel that a jog in the green space, a tennis match with a friend, and a neighborhood softball game are all appreciated, and see these urban spaces amenities as factors that improve and strengthen one’s standard of living.[4]

From previous it has been concluded that identifying suitable sites for conserving and developing green spaces is the first important step to ensure their roles and functions. Site information can be gained by using land suitability analysis based on GIS which is a strong, efficient and effective application within land-use planning, habitat analysis, etc.[5] Applying the ecological factor threshold method will help quantify how much green area is necessary

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[1]Chezick, Jan. Interview. 25 Jan (1999).
2 Kong, F., Yin, H., Nakagoshi, N., (2007). Using GIS and landscape metrics in the hedonic price modeling of the amenity value of urban green space: a case study in Jinan City, China. Landscape and Urban Planning.
[3] Garris, Ed. Interview. 20 Jan 1999.
[4] Kong, F., Yin, H., Nakagoshi, N., (2007). Using GIS and landscape metrics in the hedonic price modeling of the amenity value of urban green space: a case study in Jinan City, China. Landscape and Urban Planning.
[5] Gillenwater, D., Granata, T., Zika, U.,(2006). GIS-based modeling of spawning habitat suitability for walleye in the Sandusky River, Ohio, and implications for dam removal and river restoration. Ecological Engineering.

to maintain an ecological balance in urban areas.[1]Using an urban forest effects model will help quantify key values of urban green spaces such as carbon storage and sequestration.[2] More importantly, the roles and functions of urban green spaces can be enhanced if they are organized by combining a variety of green space types for multiple purposes called a green network or urban green structure.

4.3.City's Benefit from City Green Areas:

A lot of researches ask a very important question, "How much value does an excellent city green areas system bring to a city?" the research is trying to answer this question by summarizing the city green areas network benefit in five points:

A. Income from Out-of-Town City Green network Visitor Spending (Tourists).
B. Direct use value.
C. Health value.
D. Reducing the Cost of Managing.
E. Removal of Air Pollution by Vegetation.

4.3.1. Income from Out-of-Town City Green Network Visitor Spending (Tourists):

Green areas play a major role in a city's tourism economy. Some such as Independence National Historic Park in Philadelphia, Central Park in New York, Millennium Park in Chicago, or Balboa Park in San Diego are tourist attractions by themselves. Others are simply great venues for festivals, sports events, even demonstrations[3].

Figure 4-2 National Historic park in Philadelphia

(Source :http://www.expressnightout.com/content/2008/10)

Figure 4-3 Central Park in New York

(Source: http://www.visitingdc.com/new-york/central-park-picture.asp)

[1] Zhang, L., Liu, Q., Hall, N.W., Fu, Z., (2007). An environmental accounting framework applied to green space ecosystem planning for small towns in China as a case study. Ecological Economics.

[2] Nowak, D.J., Crane, D.E., Stevens, J.C., Hoeln, R.E., (2003). The Urban Forest (UFORE) Model: Field Data Collection Manual. USDA Forest Service, Northeastern Research Station, Syracuse

[3] Stynes, D. J. (1997). Economic Impacts of Tourism: A Handbook for Tourism Professionals. Urbana: University of Illinois, Tourism Research Laboratory.

4.3.2. Direct Use Value:

While city green areas provide much indirect benefit, they also provide huge tangible value through such activities as team sports, bicycling, and skateboarding, walking, picnicking, bench sitting, and visiting a flower garden. Economists call these activities “direct uses.”

Most direct uses in city green areas are free of charge, but economists can still calculate value by knowing the cost of a similar recreation experience in the private marketplace. This is known as “willingness to pay.” In other words, if green areas were not available in a city, how much would the resident (or “consumer”) pay in a commercial facility? (Thus, rather than income, this value represents savings by residents.) [1]

It may be concluded that while some might claim that direct use value is not as “real” as tax or tourism revenue, it nevertheless has true meaning. Certainly, not all green areas activities would take place if they had to be purchased. On the other hand, city dwellers do get pleasure and satisfaction from their use of green areas. If they had to pay and if they consequently reduced some of this use, they would be materially “poorer” from not doing some of the things they enjoy.

Figure 4-4 The Frog Pond in the Boston Common is but one of the numerous park facilities that provide Bostonians with hundreds of millions of dollars of direct use value.

(Source : http://www.travelpod.com/travel-photo/jamiemeasures/1/1252903660/frog-pond-boston-common.jpg/tpod.html)

4.3.3. Health Value:

Several studies have documented the economic burden of physical inactivity. Lack of exercise is shown to contribute to obesity and its many effects, and experts call for a more active lifestyle. Recent research suggests that access to green areas can help people increase their level of physical activity.

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[1] Crompton, J. L. (2004). The Proximate Principle: The Impact of Parks,Open Space and Water Features on Residential Property Values and the Property Tax Base. Ashburn, VA: National Recreation and Park Association.

Figure 4-5 McKinley Park, Sacramento.

(Source: http://www.flickr.com/photos/aarongershfield/2275386162/)

4.3.4. Community Cohesion:

Numerous studies have shown that the more webs of human relationships a neighborhood has, the stronger, safer, and more successful it is. Any institution that promotes this kind of community cohesion whether a club, a school, a political campaign, a religious institution to a neighborhood and, by extension, to the whole city.

This human web, which Jane Jacobs termed "social capital," is strengthened in some cities by green areas. From playgrounds to sports fields to park benches to chessboards to swimming pools to ice skating rinks to flower gardens, parks offer opportunities for people of all ages to interact, communicate, compete, learn, and grow. Perhaps more significantly, the acts of improving, renewing, or even saving green areas can build extraordinary levels of social capital. This is particularly true in a neighborhood suffering from alienation partially due to the lack of safe public spaces. While the economic value of social capital cannot be measured directly, it is instructive to tally the amount of time and money that residents devote to their green spaces.[1]

Figure 4-6 "Friends of parks", Philadelphia park.

(Source: http://www.flickr.com/photos/wallyg/sets/72057594130539111/detail/)

[1] Miller, A. R. (2001). Valuing Open Space: Land Economics and Neighborhood Parks. Cambridge: Massachusetts Institute of Technology Center for Real Estate.

4.3.5. Removal of Air Pollution by Vegetation:

Air pollution is a significant and expensive urban problem, injuring health and damaging structures. The human cardiovascular and respiratory systems are affected, and there are broad consequences for health-care costs and productivity. In addition, acid deposition, among, and ozone increase the need to clean and repair buildings and other costly infrastructure[1].

Trees and shrubs remove air pollutants such as nitrogen dioxide, sulfur dioxide, carbon dioxide, ozone, and some particulates. Leaves absorb gases, and particulates adhere to the plant surface, at least temporarily. Thus, vegetation in city green spaces network plays a role in improving air quality and reducing pollution costs[2].

It can be concluded that, while reams of urban research have been carried out on the economics of housing, manufacturing, retail, and even the arts, there has been until now no comprehensive study of the worth of a city's green space system, although green space can be assigned the kind of numerical underpinning long associated with transportation, trade, housing, and other sectors. The research will be able to obtain a major piece of missing information about how cities work and how green space fit into the equation.

4.4.Assumptions for the Database Model Design (1):

The purpose of this study is to answer the question of how to apply land suitability analysis modeling, the ecological factor threshold method, and landscape-ecology principles in planning comprehensive green structure. A case study was made for Hanoi, Vietnam and its results show that most of the planned green spaces in the 2020 Hanoi Master Plan are suitable for development. However, the recommended 18m2 green area per capita seems not to be enough to maintain ecological balance and organization of the green spaces in the 2020 plan seems to lack a theoretical basis, or a holistic framework, at different scales. From this perspective, this study propose that Hanoi should set aside an extra green area from 6842 to 10,228 ha, and that the 2020 Hanoi green structure plan at regional, city and neighborhood scales includes three green wedges, one green belt, various parks and other green ways to create a green network ecologically more effective than the sum of the individual green spaces[3].

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[1]Crompton, J. L. (2004). The Proximate Principle: The Impact of Parks,Open Space and Water Features on Residential Property Values and the Property Tax Base. Ashburn, VA: National Recreation and Park Association.
[2]IBID
[3]Pham Duc Uy, Nobukazu Nakagoshi, (2008), Application of land suitability analysis and landscape ecology to urban green space planning in Hanoi, Vietnam, Urban Forestry and urban greening.

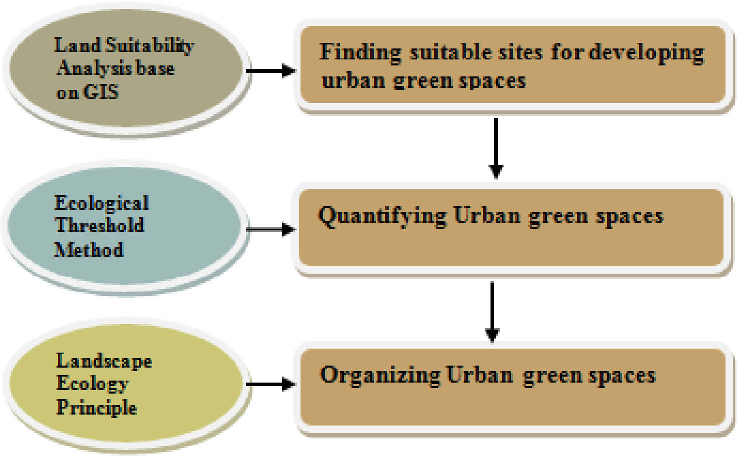

Figure 4-7 The steps involved in the development of green spaces

(Source: P.D. Uy, N. Nakagoshi , (2008) , Urban Forestry & Urban Greening.)

4.4.1. Land Suitability Analysis:

Land suitability analysis for building a green space map was carried out based on, air pollution maps, water body system maps, existing land-use maps, maps of valuable historical and cultural landscapes, and Standards for planning and designing urban and industrial areas[1].

The Land suitability analysis was supported by the spatial analysis functions of GIS through steps including, identification and collection of spatial data, weighting with the analytic hierarchy process, data integration and GIS analysis, and finally output evaluation[2].

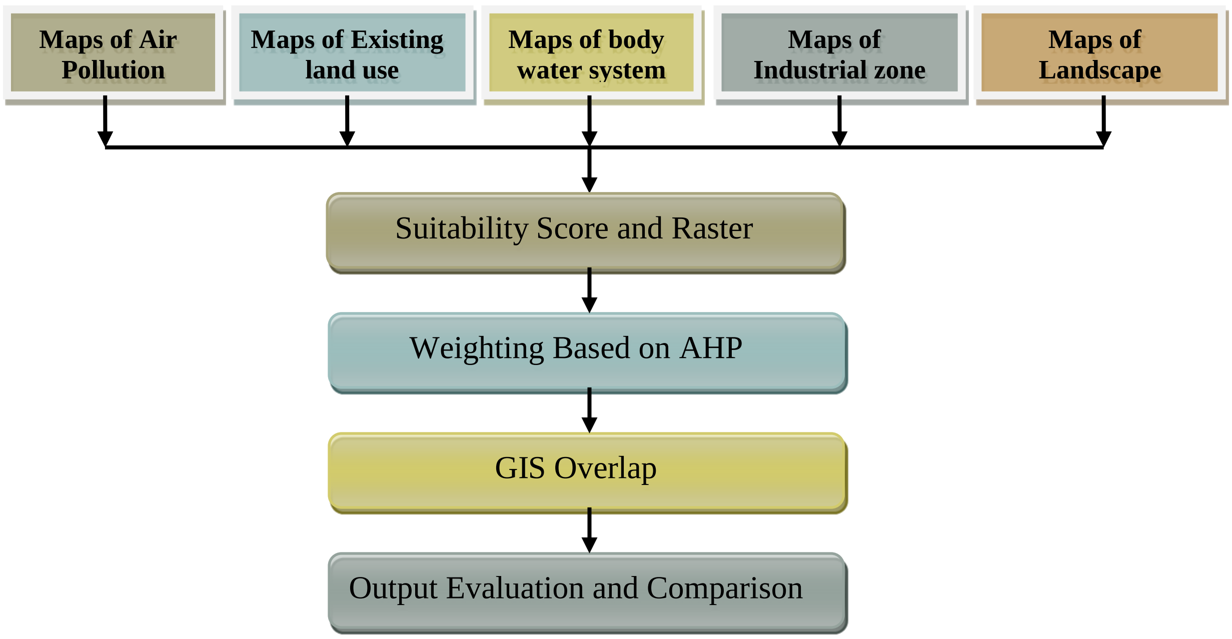

Figure 4-8Flowchart indicating the land suitability analysis for urban green space development

(Source: P.D. Uy, N. Nakagoshi , (2008) , Urban Forestry & Urban Greening.)

[1] : P.D. Uy, N. Nakagoshi , (2008) , Urban Forestry & Urban Greening.
[2] IBID

Among the environmental functions of urban green spaces, the previous five maps have been chosen because of the following reasons[1]:

A. Air quality was selected because of its importance and availability of data.
B. Land use system is a significant input because it expresses the human impact, and influences the feasibility of developing urban green spaces. The existing land use, which includes basic habitat information, has been classified into real green spaces or evergreen spaces (parks, public green spaces, riverside green spaces, roadside green spaces, attached green spaces), non-real green spaces or open green spaces (agricultural land, cultivated alluvial land), built-up areas.
C. Water body systems. Regarding water body systems and valuable landscapes (historic, cultural sites such as temples, palaces, etc. with reference to the traditional Egyptian way of life), almost all green spaces such as parks and public green spaces have been developed in conjunction with water bodies or historical and cultural sites.
D. Vietnam regulations and standards also play an important part in developing urban green spaces and they decide how green spaces will be developed.

In land suitability analysis, determining the suitability scores for each factor is a compulsory step, and in this study they were regulated from 1 to 3 as in the following figure where a higher score indicates an area more suitable for developing green spaces. In the land use map, for example, real green spaces receive the score 3 (highest suitability), open green spaces score 2, and others are attributed score 1 (lowest suitability)[2].

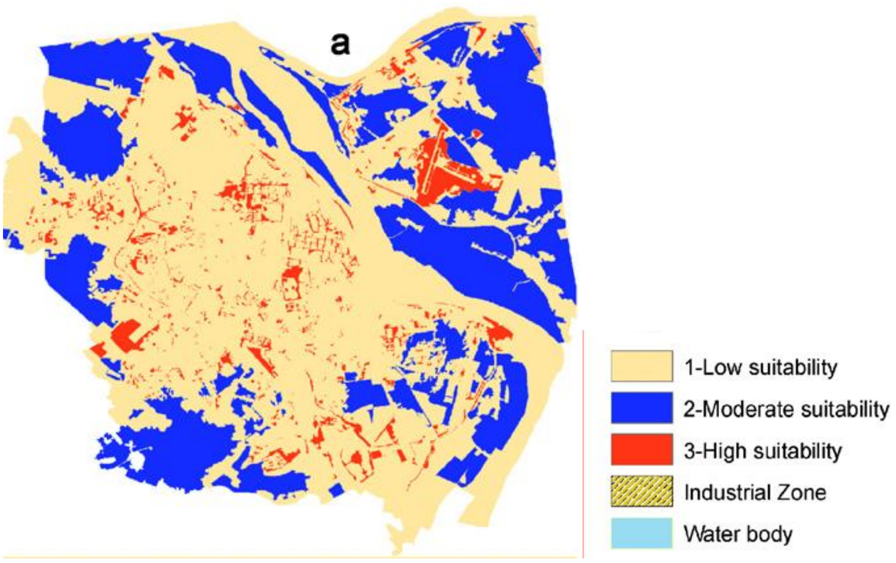

Figure 4-9 The land suitability in Hanoi.

(Source: Pham Duc, (2008), Application of land suitability analysis and landscape ecology to urban green space planning, Vietnam)

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[1] Pham Duc Uy, Nobukazu Nakagoshi, (2008), Application of land suitability analysis and landscape ecology to urban green space planning in Hanoi, Vietnam, Urban Forestry and urban greening.
[2] IBID

Weighting is one of the most important steps in suitability analysis, as it precisely affects the output, and is complicated by interacting of factors with each other[1]. Analytic hierarchy process and pair wise comparison of the criteria are widely used to identify weighting scores, and they were applied in this study. The MATLAB 5.3 software was used to solve the matrix which results from analytic hierarchy process and pair wise comparison; and the spatial function of the Arc GIS 9 (Arc/Info, release version 9.3, ESRI, Redlands, CA 92373-8100, USA) platform was used to overlay the factors to make composite map which acts as a suitable green map.[2]

4.4.2. The Ecological Factor Threshold Method:

The ecological factor threshold method is implemented based on the principles of ecological balance. Thus, the purpose of this step was to quantify how much green area is needed for the area of study in terms of maintaining ecological balance. Zhang et al. (2007) applied this method for planning urban green space systems based on analyzing the key ecological elements including: the population carrying capacity, carbon–oxygen balance, and the supply demand equilibrium of the water resources[3].

As shown by Zhang et al. (2007) the population carrying capacity is the largest number of people that food and energy produced by ecosystems can support based on stated production conditions, land productivity, standard of living, and so forth.

In Hanoi, this has been identified in the 2020 Master Plan. The carbon– oxygen balance is the most influential factor. It relates to the total of carbon emission by human as well as natural activities, and to absorbing carbon dioxide and releasing oxygen in photosynthesis of green plants. In green space planning, the carbon–oxygen balance is carried on the basis of constant adjustment of green plants of green spaces and various kinds of oxygen consuming activities[4].

Water resources are an essential factor for all creatures to exist and develop. Thus, the supply–demand equilibrium of water resources, which presents to an equilibrium of demands (domestic, industrial agricultural consumptions) and supplies (rainfall, groundwater, etc.) is important for sustainable development of human in general and vegetation or green spaces in particular.

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[1] Banai-Kashani, R, (1989). A new method for site suitability analysis: the Analytic Hierarchy Process. Journal of Environmental Management.
[2] IBID.
[3] Zhang, L., Liu, Q., Hall, N.W., Fu, Z., (2007). An environmental accounting framework applied to green space ecosystem planning for small towns in China as a case study. Ecological Economics.
[4] IBID

4.4.3. Landscape Ecology Concepts for Green Structure Planning:

Landscape ecology has opened the door to and provides a basis for planning landscapes in general and green networks in particular. Forman and Godron (1986) proposed the model of patch, corridor and matrix as the three basic components of any landscape, and state that landscape ecology deals with the effects of the spatial configuration of mosaics on a wide variety of ecological phenomena[1].Landscape-ecology concepts and applied metrics are likely to be useful in addressing the spatial dimension of sustainable planning and they provide a theoretical basis for landscape and urban planning[2]. The landscape-ecology principles used in planning land use and landscape architecture are patch size, number and location; edge parameters (i.e. the boundary with edge structure, and shape); corridors and connectivity; and network mosaics[3].

Jim and Chen (2003) who applied comprehensive green space planning to compact Nanjing city, China have shown that island biogeography theory (MacArthur and Wilson, 1967) and landscape ecology (Forman and Godron, 1986) provide fundamental strategies for green space system design. They comprise a network of greenways, green wedges and green extensions, which linked isolated green patches within and outside the city at three scales (metropolis, city and neighborhood). Li et al. (2005) also showed that according to the principles of landscape ecology, green wedges and green corridors may comprise a suitable green network system in planning urban greening in Beijing, China. Yokohari. Amati (2005) proposed that urban parks need to be regarded as core areas in the city, that an outer green belt is to surround the city; and that green corridors along rivers and streets will connect the cores and the outer areas. Thus, an organization of urban green spaces based on landscape-ecology principles, in respect to using linear (e.g., greenways) and non-linear elements (e.g., parks), encompasses the connectivity and networking of green spaces in urban areas better than considering them separately[4].

It is concluded that, ecological values of a green network are better than those of the sum of the green spaces individually, and the results of green structure planning based on landscape-ecology principles (connectivity, corridors, patch arrangement, network mosaics) are a connected green network including green wedges, green belts, green ways, green cores, green extensions, etc. These are more likely to resist uncontrolled urban development than

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[1] Forman, R.T.T., Godron, M., (1986). Landscape Ecology. Wiley, New York.

[2] Leita˜ o, A.B., Ahern, J., (2002). Applying landscape ecological concept and metrics in sustainable landscape planning. Landscape and Urban Planning .

[3] Dramstad, W.E., Olson, J.D., Forman, R.T.T., (1996). Landscape Ecology Principles in Landscape Architecture and Land-use Planning. Island Press, Washington, DC.

[4] Pham Duc Uy, Nobukazu Nakagoshi, (2008), Application of land suitability analysis and landscape ecology to urban greenspace planning in Hanoi, Vietnam

individual green spaces and enhance biodiversity. Moreover, applying landscape-ecology principles to green structure planning also conforms to four planning strategies which are protective, defensive, offensive or opportunistic[1]; and to two patterns: nature in city and city in nature[2].

4.4.4. Constructing a Green Map Based on Land Suitability Analysis on Hanoi:

Based on the analytic hierarchy process and pair wise comparison, with the support of MATLAB software, the weighting score acquired for each factor and then used spatial analysis function of GIS to produce a composite map, the following table and figure shows Hanoi composite map[3].

Table 4-1 The weighting score for each factor to develop the composite map

(Source: Pham Duc, (2008), Application of land suitability analysis and landscape ecology to urban green space planning, Vietnam)

Factor	Air pollution	Water systems	Industrial zones	Existing land use	Valuable landscape	Overlaying to create the composite map
Weighting score	0.2506	0.2555	0.1544	0.02959	0.0437	

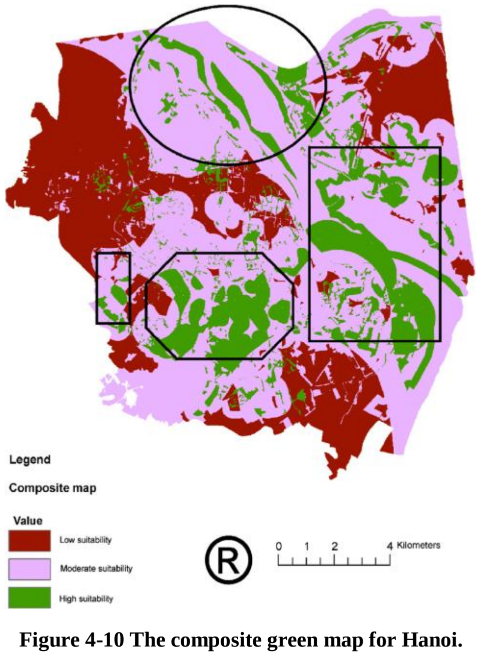

Figure 4-10 The composite green map for Hanoi.

(Source: Pham Duc, (2008), Application of land suitability analysis and landscape ecology to urban green space planning, Vietnam

[1] Ahern, J., (1999). Spatial concepts, planning strategies and future scenarios: a framework method for integrating landscape ecology and landscape planning. In: Klopatek, J., Gardner, R. (Eds.), Landscape Ecological Analysis: Issues and Applications. Springer, New York.

[2] Yokohari, M., Amati, M., (2005). Nature in the city, city in the nature: case studies of the restoration of urban nature in Tokyo, Japan and Toronto, Canada. Landscape and Ecological Engineering .

[3]Pham Duc Uy, Nobukazu Nakagoshi, (2008), Application of land suitability analysis and landscape ecology to urban green space planning in Hanoi, Vietnam, Urban Forestry and urban greening.

A comparison of the composite map and the Hanoi Master Plan showed that there is compatibility between the two maps. It means that almost all the sites planned for developing green spaces in the 2020 Hanoi Master Plan are suitable.

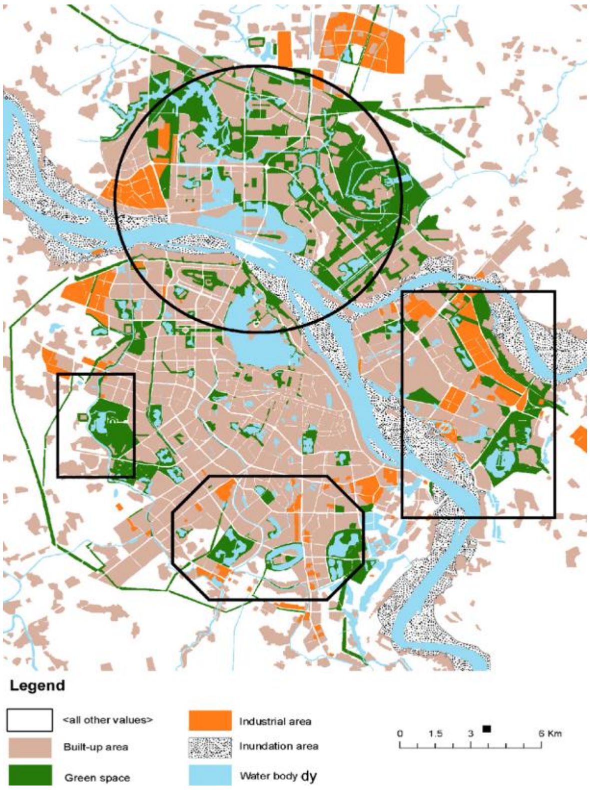

Figure 4-11 2020 Hanoi Master Plan.

(Source: Pham Duc, (2008), Application of land suitability analysis and landscape ecology to urban green space planning, Vietnam)

4.4.5. Applying the Ecological Factor Threshold Method on Hanoi:

Regarding population capacity, according to the 2020 Hanoi Master Plan, Hanoi population will reach 4.5–5 million, of which the urban population would be around 2–2.5 million. This will be considered the population carrying capacity for the city. According to the Human Development Report 2006 (UNDP, 2006), the per capita carbon dioxide emission of Vietnam is 0.9 tons per year (equally: 0.6 tons of O2 consumption)[1].

Therefore, the total oxygen consumption by the urban population will reach around 1.2–1.5 million tons, with an assumption that there would be no change of this index until 2020. Regarding the supply–demand equilibrium for water resources, some studies have shown that the total amount of water supply in Hanoi is enough to match the development of the city until the year 2020[2].

[1] Pham Duc Uy, Nobukazu Nakagoshi, (2008), Application of land suitability analysis and landscape ecology to urban greenspace planning in Hanoi, Vietnam

[2] Ngoc, N.K., Canh, D.V., Lam, N.V., Dan, N.V., Anh, T.N., Binh, D.T., Chi, N.V., Hien, N.T., Quang, N.T., Thanh, T.N., Thuy, N.T., Chien, V.V., Khoi, N.D., An, N.T.T., Anh, K.V., (1997). Surveying, Assessing and Building Countermeasures to Protect Ground Water in Hanoi from Depletion and Pollution. Hanoi University of Mining and Geology, Hanoi (in Vietnamese).

The carbon–oxygen balance was analyzed based on the carbon dioxide consumption of trees. Tung (2002) estimated that in urban areas, there were around 500,000 trees over an area of 354.52 ha or an equivalent of 1321 trees per ha. The per capita green area in the 2020 Hanoi Master Plan in downtown areas is 18m2 a total of 3600–4500 ha. Based on an estimate of Zhang et al. (2007), for 'good' green spaces (forests, parks, etc.), the annual per hectare O2 production of trees is around 70 tons. Therefore, the total oxygen production up to 2020 equals to 252,000–315,000 tons. Considering the carbon–oxygen balance, a serious imbalance is readily apparent[1].

To retain a balance, downtown Hanoi needs support from outside ecosystems with a green area from 13,542 to 16,928 ha. At present, in the suburban areas, Hanoi has a forestry area of 6700 ha. Therefore, Hanoi needs to develop an extra green area from 6842 to 10,228 ha. The next step would be to consider how to organize urban green spaces to optimize their benefits by using landscape-ecology principles.

4.4.6. Application of Landscape Ecology Principles on Hanoi:

A review of green structure in Hanoi. At present, Hanoi city resembles a hybrid of the basic forms (linear, centralized and gridiron), which express physical and cultural influences through time. According to the 2020 Hanoi Master Plan, the city will be planned and developed following a centralized form where the city center is marked by the ancient quarter[2]. The Hanoi government will control the urban sprawl process by constraining the development of the downtown area and by developing satellite cities. A review of the 2020 Hanoi Master Plan uses urban population density targets set at an average of 100 m2/ person, and includes an allocation of 18 m2/person (around 4500 ha) for green spaces, parks and sporting facilities. A greenbelt will be created with a width of 1–4km for natural and ecological preservation[3].

In 2005, green structure planning was studied for a 150km2 area of downtown Hanoi with the regional, city, and neighborhood scales. These studies were projected to the 2020. The 2020 green structure plan in Hanoi is thus a combination of linear and non-linear elements.

A. Green structure at region scale

Green wedges. ''The green wedge is composed of parks, gardens, farmlands, rivers and wetlands. Green wedges and green corridors form an integrated ecological network by

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[1] Zhang, L., Liu, Q., Hall, N.W., Fu, Z., (2007). An environmental accounting framework applied to green space ecosystem planning for small towns in China as a case study. Ecological Economics 60, 533–542.

[2] Pham Duc Uy, Nobukazu Nakagoshi, (2008), Application of land suitability analysis and landscape ecology to urban greenspace planning in Hanoi, Vietnam

[3] IBID

connecting the urban center, forest parks, mountains and the outer regional spaces''. Jim and Chen (2003) have shown that it is necessary to limit or prohibit the development activities inside and near green wedges. Based on the 2020 Hanoi Master Plan, landform data, landscape ecology principles, and an assessment of the planned green spaces, three green wedges were proposed to connect outer green spaces and inner green spaces as shown in the following figure. This is regarded as an offensive strategy of green structure planning, and brings nature into the city[1].

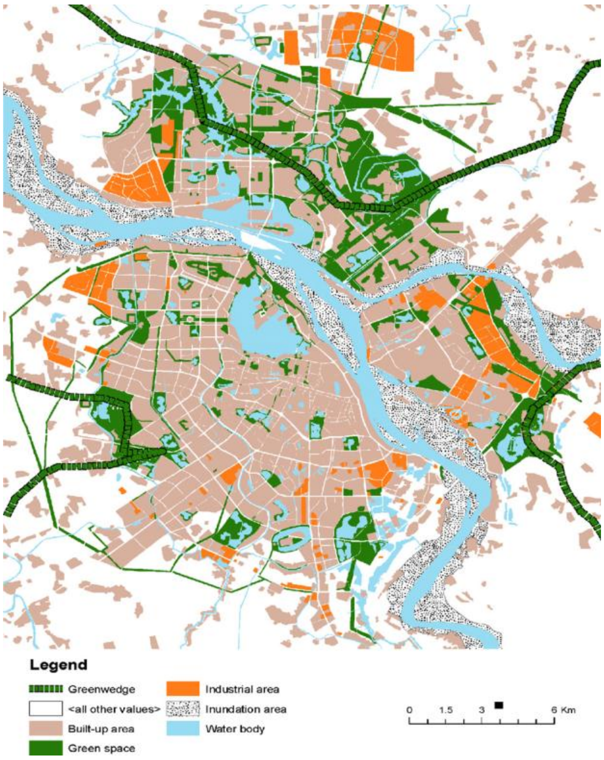

Figure 4-12the proposed green wedges for Hanoi.

(Source: Pham Duc, (2008), Application of land suitability analysis and landscape ecology to urban green space planning, Vietnam)

B. Green structure at the city scale:

Greenbelts can be understood to be narrow strips of parkland more or less encircling part of a built-up metropolitan area or large urban area.[2] As mentioned above, Hanoi intends to develop a greenbelt with a width from 1 to 4 km. However, it is difficult to use one green belt to resist urbanization because it is easily encroached on by the urban sprawl process and easily breached by urban leapfrog growth. Li et al. (2005) have pointed out the limitations of greenbelt planning in Beijing, China. Taylor et al. (1995) have presented the influence of greenbelts adjacent to urban area, in cases that have been ineffective in controlling urban growth outside of the greenbelt. From this perspective, the green structure of Hanoi should

1 Li, F., Wang, R., Paulussen, J., Lui, X., (2005). Comprehensive concept planning of urban greening based on ecological principles: a case study in Bejing, China. Landscape and Urban Planning.

2 Osborn, F.J., (1969). Green Belt Cities. Evelyn, Adams & Mackay, London.

be augmented by an inner greenbelt at the present per-urban areas as shown in the following figure[1].

Figure 4-13 The proposed greenbelt for Hanoi.

(Source: Pham Duc, (2008), Application of land suitability analysis and landscape ecology to urban green space planning, Vietnam)

This greenbelt is to be based on graph theory and gravity modeling with 33 green nodes, representing not only a zone for conservation but also a transitional zone with the function of resisting the urban sprawl, constraining the urban development, maintaining biodiversity, and enhancing recreation. Moreover, almost all industrial zones in Hanoi are mainly concentrated in this belt area including Caudien, Namthanglong, Thuongdinh, Vandien, Giapbat, Vinhtuy, Saidong, and Ducgiang. These industrial zones are embedded in Hanoi as a belt and make air pollution more serious. Therefore, maintaining this proposed greenbelt is necessary not only for the above benefits but also for improving the urban environment as required in the Vietnamese standard (TCVN 4616, 1987) for planning industrial zones[2].

[1] Osborn, F.J., (1969). Green Belt Cities. Evelyn, Adams & Mackay, London.
[2] Pham Duc Uy, Nobukazu Nakagoshi,(2008), Application of land suitability analysis and landscape ecology to urban greenspace planning in Hanoi, Vietnam

Parks and other public green spaces. At present, there are 54 important green spaces in the Hanoi downtown area. In fact, it is hard to expand them or build new ones in the built-up areas. As a result, maintaining them is very important in retaining nature in the city. Maintaining an inner green belt with 33 green nodes will help provide good opportunities to develop parks and other public green spaces. Planning parks and other public green spaces at the city scales reflects a defensive strategy for planning green structure. Such parks and public green spaces can be connected by corridors such as road greenways. According to the Vietnamese standard TCXDVN 362 (2005), the per capita area for parks and flower gardens is about 7–9 and 3–3.3m2, respectively or equivalent to a total of 2500–3075 ha[1].

C. Green structure at the neighborhood scale:

Attached green spaces. Each part of downtown Hanoi is a mixture of residential, industrial, business and organization-owned areas where each of them is allocated a plot of land with scant space for developing green space. These green spaces are distributed unevenly and are somewhat isolated. Attached green spaces are composed of organization-owned green spaces, residential green spaces, etc., which play an important role in providing opportunities for residents to get in contact with nature. Besides this, their function is to enhance local beauty, and to act as ecological stepping stones. One solution is to restore and insert these green spaces in built-up areas such as rooftop greening, balcony greening, sidewall greening. The development of this green space type represents an opportunistic strategy of sheltering trees in green structure planning[2].

Road greenways are an important component of greenway networks in urban areas. In Hanoi there are some species which have been associated with some roads for a long time and have become a symbol of these roads such as Alstonia scholaris (L.) R.One of the typical characteristics of roads in Hanoi is that they are narrow with scant space for pavement, especially in the ancient quarter. It is hard to plant or expand the area for trees in the available roadside settings; however the construction of new roads or reconstruction of old roads will give opportunity to develop greenways.

Riparian green spaces. As a result of landform or watershed development there are many lakes, rivers, creeks and canals in Hanoi. They play an important role in maintaining the urban environment, providing recreational areas, and in acting as corridors with functions that includes habitat, conduit, filter, source and sink[3]. Riparian areas also play an important

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[1] Pham Duc Uy, Nobukazu Nakagoshi,(2008), Application of land suitability analysis and landscape ecology to urban greenspace planning in Hanoi, Vietnam IBID

[2] IBID

[3] Forman, R.T.T., Godron, M., 1986. Landscape Ecology. Wiley, New York.

role in controlling floods and supplying an important habitat area for wildlife. Therefore, the proposed riparian green spaces would follow along riverbanks or flood places of the Hong River, which are cultivated sometimes in the year as shown in the following figure.

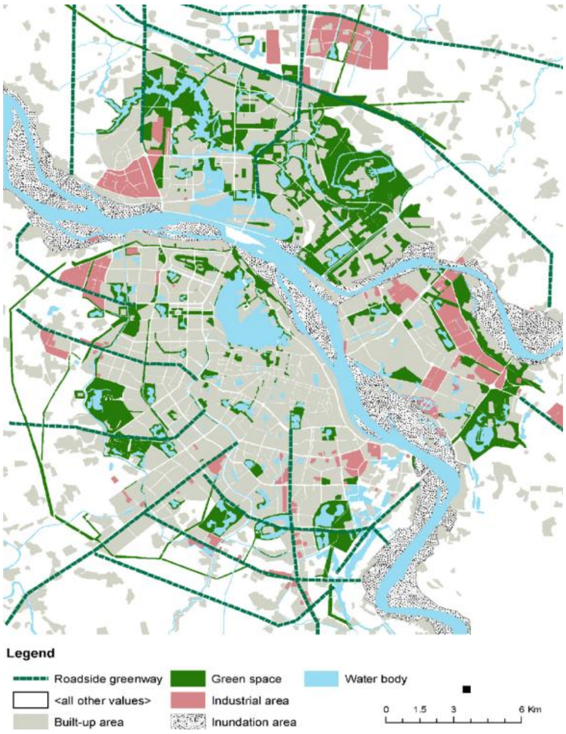

Figure 4-14The proposed greenways for Hanoi.

(Source: Pham Duc, (2008), Application of land suitability analysis and landscape ecology to urban green space planning, Vietnam)

D. Results of Hanoi Model:

The previous model has introduced a useful, effective and efficient method for identifying suitable sites for developing green spaces in urban areas.

The combination of various green spaces to make a green network is very important in planning green structure because it is very difficult to use only one, or few different, kinds of green spaces to maintain all the benefits of greening in urbanized areas.

In the proposed Hanoi green structure at the regional scale, three green wedges play a pivotal role in bringing nature into the city and maintaining biodiversity. At the city scale, an inner greenbelt was proposed which offered the best potential for supporting an eco-network. Moreover, it can be combined with the planned outer greenbelt to control the urban sprawl process more effectively and efficiently. Planning green wedges and greenbelts represents offensive and defensive strategies in green structure planning, respectively. At the neighborhood scale, a network of road greenways and riparian green spaces was proposed. The greenways play a role as corridors in wildlife movement, and in bringing nature to move deeply into the city.

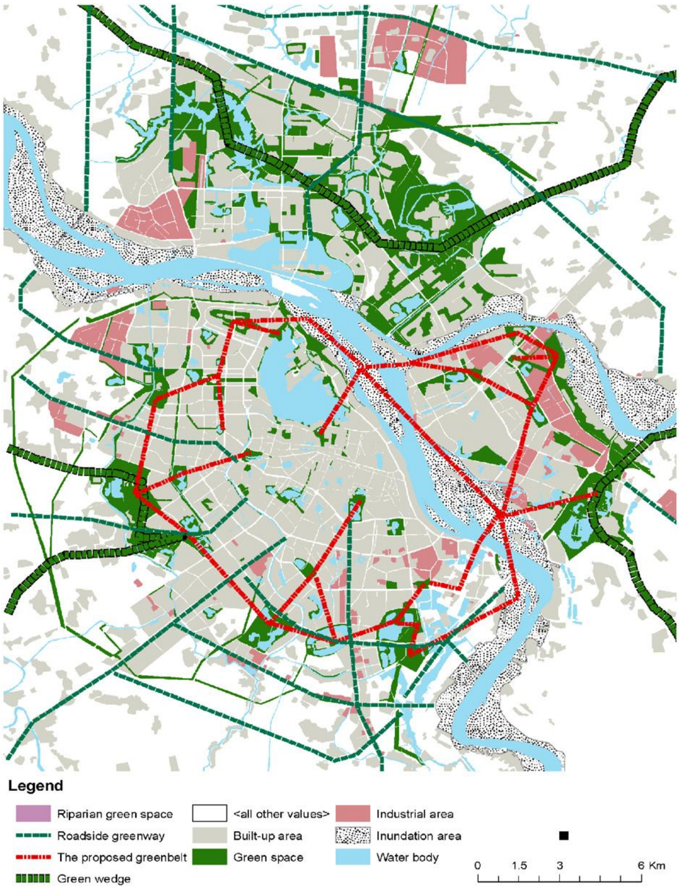

Figure 4-15The proposed comprehensive green structure for Hanoi.

(Source: Pham Duc, (2008), Application of land suitability analysis and landscape ecology to urban green space planning, Vietnam)

Taylor et al. (1995) have shown that the reason for failure of greenbelts in Canada was that the ecological principles of maintaining connectivity by providing spatially continuous corridors were not employed in the greenbelt approach in Ottawa. Thus the approach lacked many of the features inherent in more contemporary greenways[1]. In the other words, this green space system is facing with some obstacles such as rapid urbanization, weakness in controlling and managing urban development, land use change, and economic growth. However, such pressures can be managed if planners and decision makers, i.e. Hanoi government, understand the roles and importance of these green spaces in developing a sustainable urban area.

Finally, it is concluded that green network helps green patches enhance the connectivity and reduce fragmentation and isolation through the linked and integrated greenway system. This improves different attributes of fragmentation of green patches such as density, isolation, size, shape, aggregation, and boundary characteristics, and can act as a catalyst to preserve existing green spaces and generate new ones.

[1] Taylor, J., Paine, C., FitzGibbon, J., (1995). From greenbelt to greenways: four Canadian case studies. Landscape and Urban Planning.

4.5. Assumptions for the Database Model Design (2):

The second assumption database model is going to discuss an application of spatial multiple criteria decision analysis (SMCDA). An introduction to this field can be found in Malczewski (1999), who contributed to bridging the gap between geographical information systems, GIS, and multi-criteria decision analysis, MCDA. SMCDA was applied here in support of a real management problem[1].

The process considered was a complex decision problem, which involved multiple criteria and dealt with a large number of environmental factors and socio-economic constraints. Such factors and constraints were mainly site-specific; therefore the geographic attribute of various locations was to play a major role in site selection.

Moreover, the process that led to the final decision had to be as clear and transparent as possible to the municipal Councils and to the relevant stakeholders. This data base model briefly presents the procedure developed and applied in support of the design and the evaluation phases of this type of park. The methodology used benefited from multi criteria decision analysis and spatial multi-criteria evaluation (or SMCE) and made the process more rational and transparent.

4.5.1. Case Study Application according to Database Model (2):

The Serio-Oglio study area is located in the Province of Bergamo in a plane between two rivers, the Serio River to the west and the Oglio River to the east. The size of the area is approximately 153km2 and includes 13 municipalities, with a total of 49,650 inhabitants. The main land use is agricultural and the area falls between two parks of regional relevance, the Serio River Regional Park and the Oglio River Regional Park. A great variety of cultural, historic and architectural assets are disseminated over the entire area. In the southern part it is still possible to find many active fountainheads. These are water resurgences springing in the transitional area between the higher part and the lower part of the Po River Plain, where the terrain porosity decreases and the groundwater gets spontaneously to the surface creating wet zones with flora and fauna typical of marshlands. This natural phenomenon has been largely utilized in the past to supply irrigation canals and to grow fodder plants even in winter, because the temperature of the water is persistently between 101 and 151. The fountainheads are an important cultural heritage to be preserved and even if they are not completely natural, they represent a unique ecological environment[2].

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[1] Malczewski, J., (1999). GIS and Multicriteria Decision Analysis. Wiley, New York.

[2] A. Zucca et al, (2008), Journal of Environmental Management 88

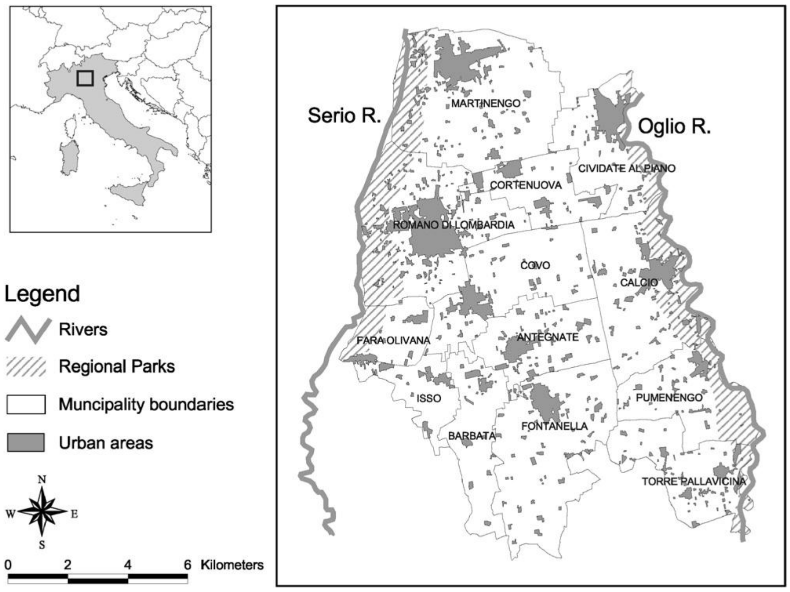

Figure 4-16 Serio-Oglio study area in the Province of Bergamo, northern Italy.

(Source: A. Zucca et al, (2008), Journal of Environmental Management 88)

4.5.2. Methodology applied in the case study:

Decision making is a process involving a sequence of activities that starts with recognition of a decision problem and ends with recommendation for a decision. The quality of the decision depends on the sequence and quality of the activities that are carried out[1].

According to Keeney (1992), two major approaches can be distinguished[2]:

A. The alternative-focused approach which starts with development of alternative options, proceeds with the specification of values and criteria and then ends with evaluation and recommendation of an option.

B. The value-focused approach on the other hand, considers the values as the fundamental element in the decision analysis. Therefore, it first focuses on the specification of values (value structure), then considering the values, it develops feasible options to be evaluated according to the predefined value and criteria structure.

This implies the order of thinking is focused on what is desired, rather than on the evaluation of alternatives. Naturally in decision problems, in which alternative options have to be developed first and then evaluated, the value-focused approach can be much more effective. However, if the decision problem starts with a choice of options, the alternative-focused approach seems more relevant.

[1] A. Zucca et al, (2008), Journal of Environmental Management 88

[2] Keeney, R.L., (1992). Value-focused Thinking. Harvard University Press, Cambridge.

In this case study a value-focused approach was applied that was guided by the framework for planning and decision making developed by Sharifi et al. (2004). The approach included the sequence of activities shown in following table[1].

Table 4-2 A table shows the sequence of activities performed in this study

(Source: Sharifi, (2004). Evaluating rail network options using multicriteria decision analysis. Islamic University of Malaysia.)

Phase	Activities
Intelligence	a. Development of a conceptual framework including: • Identification of the main objective, the sub-objectives and the contents of the local green spaces. • Definition of the criteria structure: development of a criteria tree that can be used to assess the satisfaction of each sub-objective. • Definition of constraints or characteristics of areas unsuitable for green spaces.
	b. Verification of the criteria tree through: • Analysis of the existing green spaces. • Verification through field visits and discussions with green spaces authorities.
Design	c. Design of proper locations for the green spaces by: • Performing a spatial multi-criteria evaluation using the criteria structure and the set of constraints to produce a suitability map. • Designing primary green space elements, using the suitability map together with the topographic map, the aerial photographs and the expert's knowledge. • Designing alternative urban green spaces based on the field work.
Choice	d. Evaluation and ranking of the designed alternatives: • Definition of a new criteria structure for the evaluation phase, including environmental, social and economic criteria. • Performing spatial multi-criteria evaluation with ILWISs SMCE using the new criteria tree. • Identification of the most appropriate locations for the park.

[1] Sharifi, M.A, Boerboom, L., Shamsudin, K., (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia. In: Application of Planning and Decision Support Systems, International Islamic University of Malaysia.

From the previous table it has been concluded that:

A. The problem formulation phase (intelligence): has led to the definition and specification of the green spaces.

B. The design phase has led to the identification of few potential sites based on the specified characteristics. This was obtained in three steps: first, using a criteria structure, a suitability map was generated; then primary green spaces elements were identified using the suitability map, expert’s knowledge together with other relevant ancillary information such as topographic maps, land-ownership and land-use maps, aerial photographs, and satellite images.

C. The choice phase has led to the final location for the urban green spaces. The costs and benefits of each site were analyzed and the potential green spaces were compared and ranked on the basis of their overall attractiveness (utilities).

In a spatial decision problem like the one considered here, options can be described by a defined set of maps providing information on each criterion. Therefore, the spatial decision problem can be visualized as a ‘‘table of maps’’, or ‘‘map of tables’’[1], which has to be transformed into one final ranking of alternatives. Thus it is necessary to aggregate not only thematically but also spatially. The aggregation function can be simplified by distinguishing two operations:

A. Aggregation in the spatial dimension.

B. Aggregation in the thematic space.

These two operations can be performed either simultaneously or in successions as shown in the following figure.

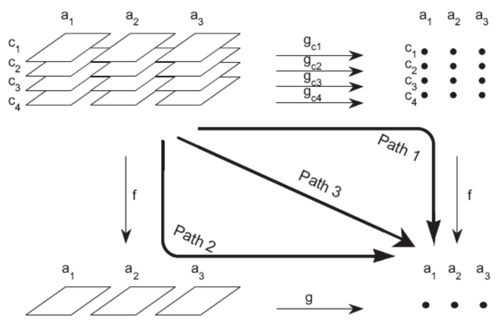

Figure 4-17 Decision paths in spatial decision problems described as ‘‘table of maps’’ or ‘‘map of tables’’ in van Herwijnen (1999).

(Source: Sharifi, (2004). Evaluating rail network options using multicriteria decision analysis. Islamic University of Malaysia.)

In the first case, represented as Path 3 in the figure, all the information is processed by the decision maker alone and converted in a ranking. The other two options shown in the

[1] Sharifi, M.A, Boerboom, L., Shamsudin, K., (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia. In: Application of Planning and Decision Support Systems, International Islamic University of Malaysia.

figure are Path 1 and Path 2. Following Path 1, the spatial information is firstly aggregated to a non-spatial value for each theme separately. Then, traditional techniques of multi-criteria evaluation (MCE) can be used to derive the final utility for each alternative. Following Path 2 instead, first the theme maps are combined through MCA techniques to obtain a suitability map for each alternative, thus reflecting the performance of the alternative across the space. Then each map is aggregated to a single non-spatial value. Advantages and disadvantages of the two paths are described in detail by van Herwijnen (1999) and Sharifi et al. (2006). In general, the final result might be the same or it might be different, depending on the aggregation methods applied. Nevertheless, following Path 2 it is possible to perform a multi-criteria evaluation using spatial criteria along with non-spatial criteria, and that is done without losing the spatial dimension. In this study it has preferred to follow Path 2. This was in order to preserve as long as possible throughout the decision process the spatial information given by the spatial distribution of the values[1].

4.5.3. Problem Formulation of Current Land use:

A. Development of a conceptual framework:

The Park Office of the Province of Bergamo needed to select the most suitable sites to build a green spaces of extra-municipal character (Parco Locale di Interesse Sovracomunale, or PLIS). To define the criteria structure for the design of suitable sites in the study area and establish a.PLIS, it was first necessary to identify the main objectives of the green spaces. Consideration was given to the laws issued (L.R. 30 November 1983, n. 86, L.R. 5 gennaio 2000, n. 1), the literature (Di Fidio et al., 2001; Mauri, 2000; Provincia di Milano, 2002) and the previously established PLIS[2].

The protection and improvement of the environmental quality of the territory appeared to be the main goal of urban green spaces. The goal could be met through the following objectives:

<u>Protection of valuable areas was measured through the following criteria[3]:</u>

Protection of agricultural areas: from a sustainable development point of view, it was not enough to protect single assets. It was also necessary to reduce pressures on the environment related to the human activities, and to enhance the regeneration capability of natural resources, favoring more sustainable forms of utilization. Agricultural areas could

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[1] van Herwijnen, M., (1999). Spatial Decision Support for Environmental Management. Faculty of Economical Sciences and Econometrics, Free University of Amsterdam, Amsterdam.
[2] A. Zucca et al. , (2008), Journal of Environmental Management 88.
[3] IBID

play an important role in this. Moreover, they could have a connective function between natural areas.

Protection and enhancement of rural, historical and architectural assets: in a territory characterized by a strong human influence, the presence of some heritage elements could contribute to the environmental quality.

Protection of assets of high natural value: to protect biodiversity it was important to preserve the existing natural values, e.g., forests, geologic and geomorphologic assets, by including them in the park. It was also important to preserve the ecological corridors, and in some cases the urban green spaces as a whole could function as a connection belt between valuable natural areas of higher order.

Restoration of degraded situations was measured through the following criteria[1]:

Restoration of degraded urban areas: the establishment of a PLIS could offer a good opportunity to restore degraded situations that are resulting from some particular human activities, such as quarry areas or former industrial areas.

Mitigation of and environmental compensation for impacts of new infrastructures: the green spaces could be a good opportunity to mitigate or to compensate for a new unavoidable human impact, such as a new motorway.

The formulation of objectives and their related criteria led to the identification of the characteristics and, as a result, to the definition of the green spaces.

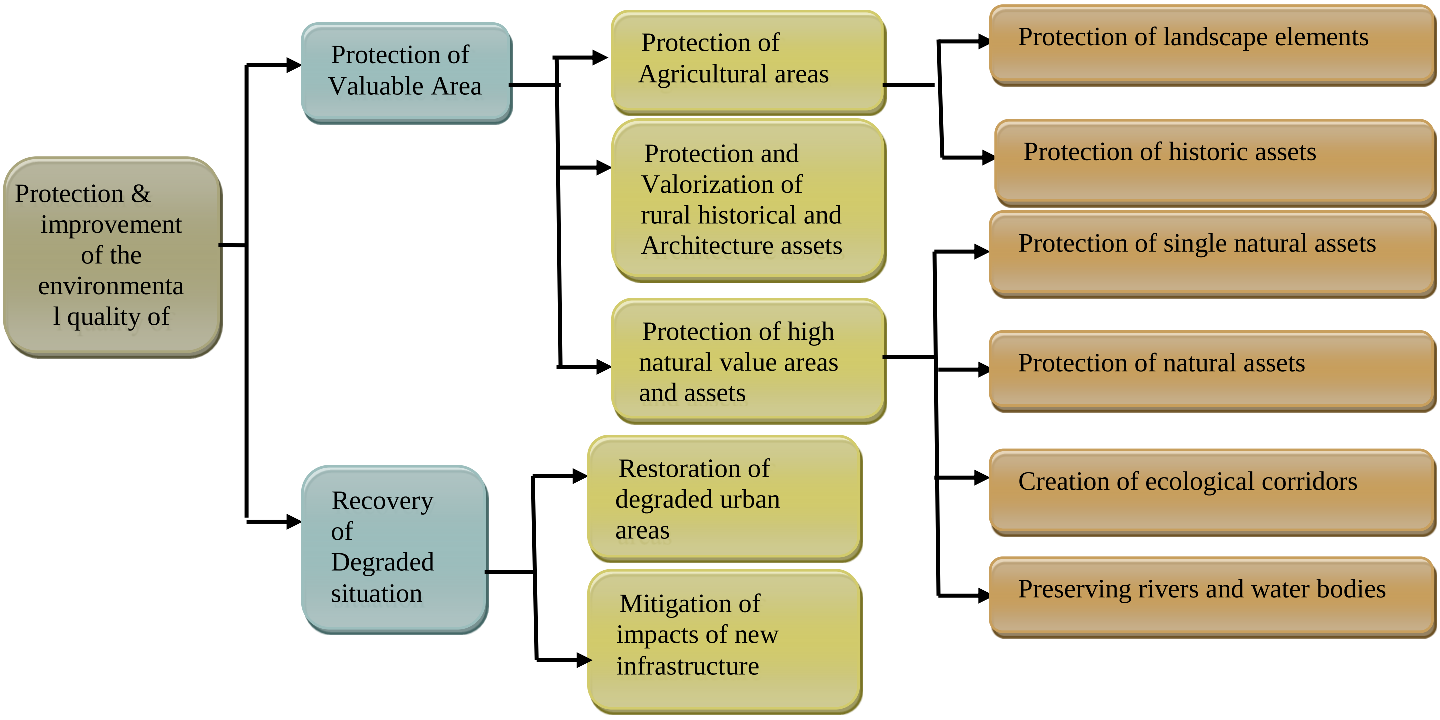

Figure 4-18 The criteria tree constructed for assessing the suitability of each area considered for the green spaces in the Serio-Oglio

(Source: Sharifi, (2004). Evaluating rail network options using multicriteria decision analysis. Islamic University of Malaysia.)

[1] A. Zucca et al., (2008) Journal of Environmental Management 88.

B. Verification of the criteria tree:

In order to test the functionality of the criteria tree constructed, 32 previously established PLIS were analyzed to verify whether the framework developed is capable of describing them. According to the description of the existing green spaces available in Di Fidio et al. (2001) and after some field visits, this was measured through the counting of the number of objectives fulfilled by each park[1]. The result is summarized in the following figure.

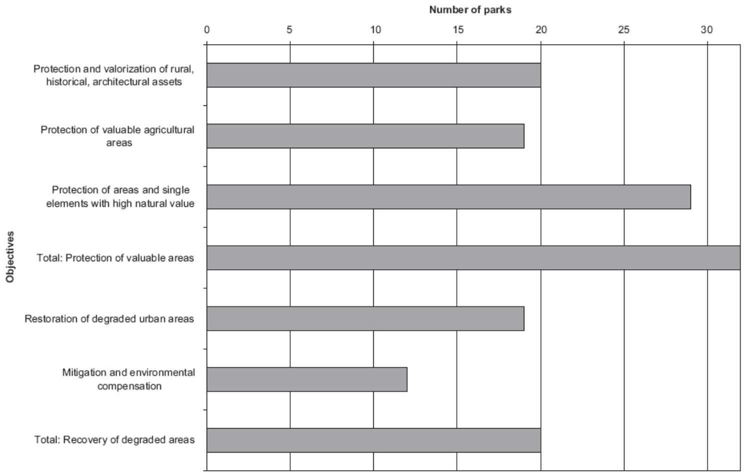

Figure 4-19 Histogram synthesizing the result of comparing 32 established PLIS green spaces according to 7 groups .

(Source: Di Fidio, (2001). I Parchi Locali di Interesse Sovracomunale in Lombardia. Fondazione Lombardia per l'Ambiente, Milano.)

From the previous graph it can be concluded that all the parks satisfied one criterion or more criteria related to the protection of valuable areas. In particular, 29 green spaces (90%) aimed to the protection of natural areas, 20 green spaces (60%) included rural, historical and architectural assets, and 19 green spaces (about 60%) intended to preserve valuable agricultural areas. Moreover, 20 green spaces satisfied one or more criteria related to the recovery of degraded areas. In particular, 19 green spaces included former degraded urban areas and 12 green spaces (40%) provided a mitigation/compensation function.

4.5.4. Design of Potential Locations for Urban Green Spaces:

The design of potential urban green spaces was carried out through the following two steps[2], which can be found through the development of a suitability map, and the design of alternative locations for urban green spaces.

A. Development of suitability map:

To develop the suitability map, the theoretical framework described was directly converted into the branches and leaves of a criteria tree. For this the interaction and processing capabilities were exploited of a relatively new version of the software package ILWISs 3.3

[1] Di Fidio, M., Ferrari, A., Lazzeri, O. (Eds.), (2001). I Parchi Locali di Interesse Sovracomunale in Lombardia. Fondazione Lombardia per l'Ambiente, Milano.

[2]A. Zucca et al., (2008) , Journal of Environmental Management 88.

(ILWIS 3.3, 2005), the SMCE module for spatial multi criteria evaluation. The ILWIS SMCE criteria tree constructed is the following figure.

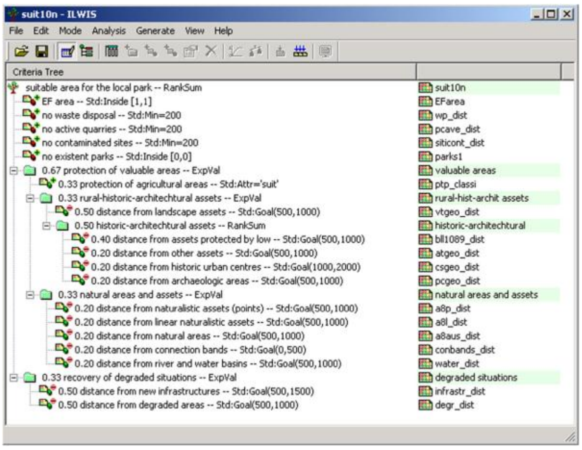

Figure 4-20The criteria tree used in the analysis of the Serio-Oglio study area. On the left are constraints, factors and associated weights with descriptors. On the right the corresponding file names of the digital maps spatially representing constraints and factors. The interaction structure is from the ILWIS SMCE module (ILWIS 3.3, 2005), that introduces multi-criteria evaluation in a GIS environment

(Source: A. Zucca et al., (2008) , Journal of Environmental Management 88.)

The previous figure included the concepts that follow[1]:

Constraints: A constraint is a hard criterion that determines which areas should be excluded from or included in the suitability analysis. The excluded areas will get a nil (0) performance value in the composite index map, while the remaining areas will obtain a value between 0 and 1.

Table 4-3 Maps and Standardization methods used to represent the constraints.

(Source: A. Zucca et al., (2008) Journal of Environmental Management 88.)

Constraint	Source Data	Derived Map	Standardization
E & F areas	City Master Plans	-	E and F areas are standardized to 1, all the others to 0.
Existing Green Spaces	Map of Protected Areas	-	Green spaces are standardized to 0, all the others to 1.
Waste Disposal	Map of Waste Disposals	Distance Map	Distance < 200 is standardized to 0; all other values are standardized to 1.
Active Quarries	Map of Active Quarries.	Distance Map	Distance < 200 is standardized to 0; all other values are standardized to 1.
Contaminated Sites	Map of Contaminated Sites.	Distance Map	Distance < 200 is standardized to 0; all other values are standardized to 1.

- E and F denominations in the City's Master Plan correspond to green areas, agricultural areas, woodlands, water bodies and water meadows.
- A distance map is a derived raster map where each pixel has a value correspondent to the distance from source pixels in the original map.

[1] A. Zucca et al., (2008) Journal of Environmental Management 88.

The following table presents the hierarchical structure of objectives and criteria and the factors which indicate the achievement of each criterion For each factor, this table shows the related criterion, the available source maps used to represent the factor, the derived maps, and the standardization methods applied to derived or source maps. All factors represented were considered as costs, except for the presence of agricultural areas, which was assumed to be a benefit[1].

Factors: A factor is a soft criterion that contributes to a certain degree to the output (suitability). There are two types of factors, (i) benefit criteria and (ii) cost criteria.
A benefit criterion contributes positively to the output (the higher are the values, the better it is), while a cost criterion contributes negatively to the output (the lower are the values, the better it is). As opposed to constraints, which cannot be compensated, poor performance of a factor can be compensated by good performance of another factor. Using compensatory decision rules, such as a weighted sum, 2 this can still lead to good overall performance in the composite index map.

Group of factors: A group of factors defines an intermediate or a partial goal, given by a combination of factors.
The result of this process is shown in the following figure. A higher weight was attributed to the protection of the valuable areas with respect to the recovery of degraded situations. Further, to all branches and leaves, equal weights were assigned as no further information was available to differentiate them.

[1]Sharifi, M.A, Boerboom, L., Shamsudin, K., (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia. In: Application of Planning and Decision Support Systems, International Islamic University of Malaysia.

Table 4-4 weights assigned to each factor and group in the design phase

(Source: Sharifi, (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia).

<table>
<tr><th>W</th><th>Group Factor</th><th>W</th><th>Group Factor</th><th>W</th><th>Group Factor</th><th>W</th><th>Group Factor</th></tr>
<tr><td rowspan="11">0.67</td><td rowspan="11">Protection of Valuable Areas</td><td colspan="6">0.33 Protection of Agricultural Areas</td></tr>
<tr><td rowspan="5">0.33</td><td rowspan="5">Protection of high natural areas and assets</td><td>0.2</td><td colspan="3">Distance from natural assets (point)</td></tr>
<tr><td>0.2</td><td colspan="3">Distance from natural assets (line)</td></tr>
<tr><td>0.2</td><td colspan="3">Distance from natural assets (area)</td></tr>
<tr><td>0.2</td><td colspan="3">Distance from connection bands</td></tr>
<tr><td>0.2</td><td colspan="3">Distance from water bodies</td></tr>
<tr><td rowspan="5">0.33</td><td rowspan="5">Protection of rural historic architectural assets</td><td>0.5</td><td colspan="3">Distance from landscape assets</td></tr>
<tr><td rowspan="4">0.5</td><td rowspan="4">Protection of rural historic architectural assets</td><td>0.4</td><td>Distance from assets protected by law</td></tr>
<tr><td>0.2</td><td>Distance from other assets</td></tr>
<tr><td>0.2</td><td>Distance from historic urban centers</td></tr>
<tr><td>0.2</td><td>Distance from archaeological areas</td></tr>
<tr><td rowspan="2">0.33</td><td rowspan="2">Restoration of degraded situation</td><td>0.5</td><td colspan="5">Distance from new infrastructure</td></tr>
<tr><td>0.5</td><td colspan="5">Distance from degraded areas</td></tr>
</table>

Once all the maps were converted to partial suitability, and standardized to the same value range, their corresponding relative importance weights were assigned. The partial suitability maps were then combined applying the weighted sum method to derive the overall suitability index. This was facilitated by combining the various attributes of each pixel to derive the suitability index map as shown in the following figure.

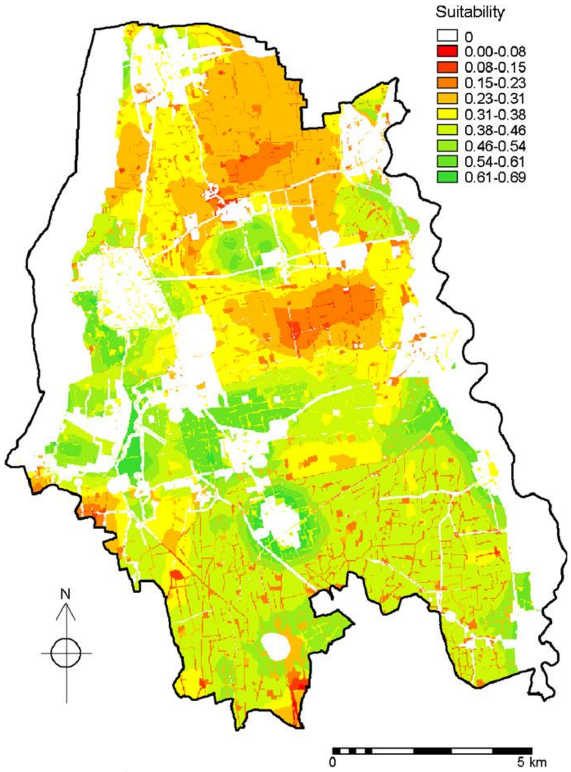

Figure 4-21 The composite suitability index map of the Serio-Oglio study area, obtained combining the attributes of each pixel using SMCE. The higher are the values of overall performance, the higher is the suitability.

(Source: Sharifi, (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia).

B. Design of alternative sites for the park:

The suitability map was then used, together with the topographic base map, aerial photographs, and other related information, to manually design PPEs. In this process, considering the physical (natural and artificial) boundaries, the areas with the highest suitability were included in a PPE; as specifically dictated by law (L.R. 5 gennaio 2000, n. 1), existing physical (natural and artificial) boundaries were considered in delimiting the PPE. Afterwards, in a participatory process with the Park Officer of the Province, the 11 PPEs were combined into four alternative options for the park. The boundaries of the alternatives designed are presented in the follwing figure[1].

[1]Sharifi, M.A, Boerboom, L., Shamsudin, K., (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia. In: Application of Planning and Decision Support Systems, International Islamic University of Malaysia.

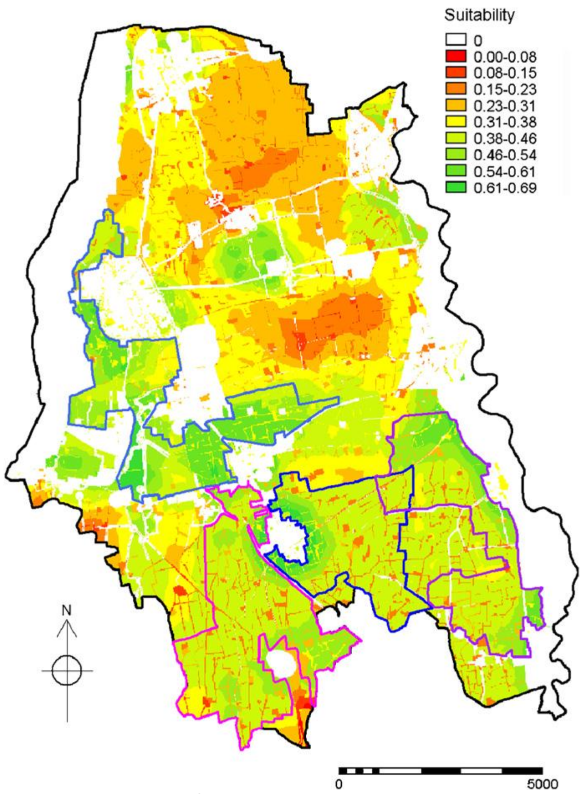

Figure 4-22 The boundaries of the four alternative options of the local park overlaid on the suitability index map of the Serio-Oglio study area.

(Source: Sharifi, (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia)

The boundarie can be briefly described as follows:

Alternative 1 is located close to the Serio River Regional Park, as a protection buffer. It extends between three inhabited centres, limiting the urban sprawl and the risk of conurbation. The southern part of the park could also represent a mitigation band for the new highway and the new railway that will cross the area from the West to the East.

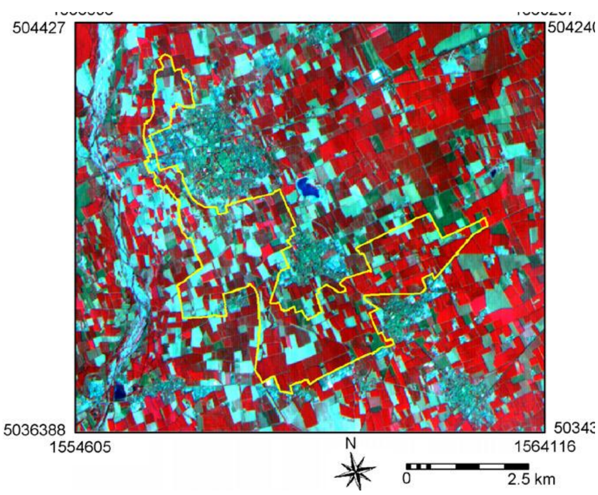

Figure 4-23 The first alternative

(Source: Sharifi, (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia)

Alternative 2 is located in the southern part of the study area, characterized by extensive agricultural activities and small scattered settlements; in this area there still are a lot of active fountainheads.

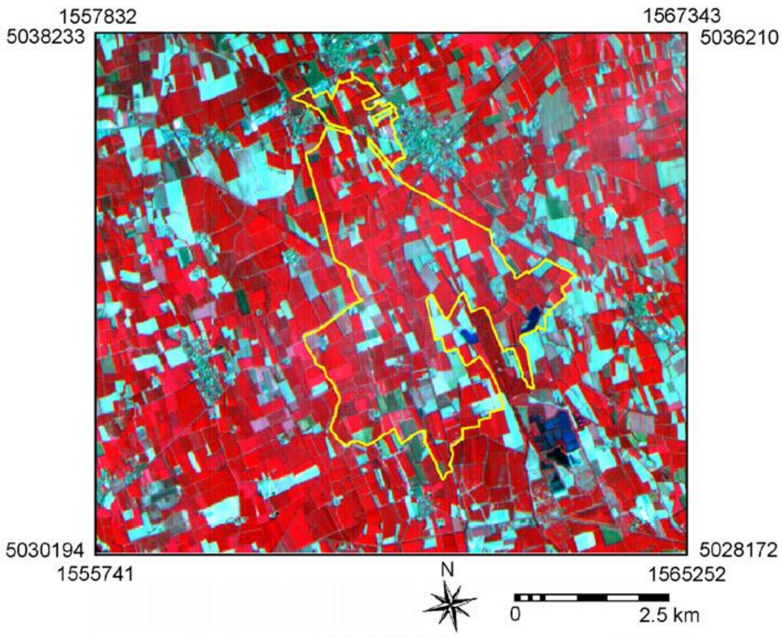

Figure 4-24 The second alternative

(Source: Sharifi, (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia)

Alternative 3 is located in the southern-central part of the study area. It represents a mainly agricultural area, with scattered small settlements and some active fountainheads. This is a bit smaller than the other alternatives but includes five municipalities. It is positioned in a strategi location.

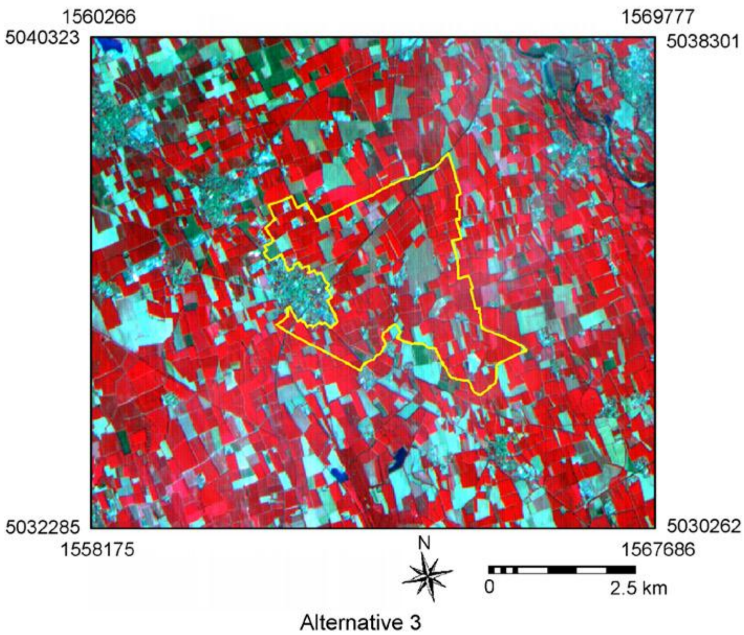

Figure 4-25 the third alternative

(Source: Sharifi, (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia)

Alternative 4 is located in the eastern part of the study area, very close to the Oglio River Regional Park, for which it could represent a protection buffer. It is mainly an agricultural area, with some active fountainheads and many rural and historic-architectural assets.

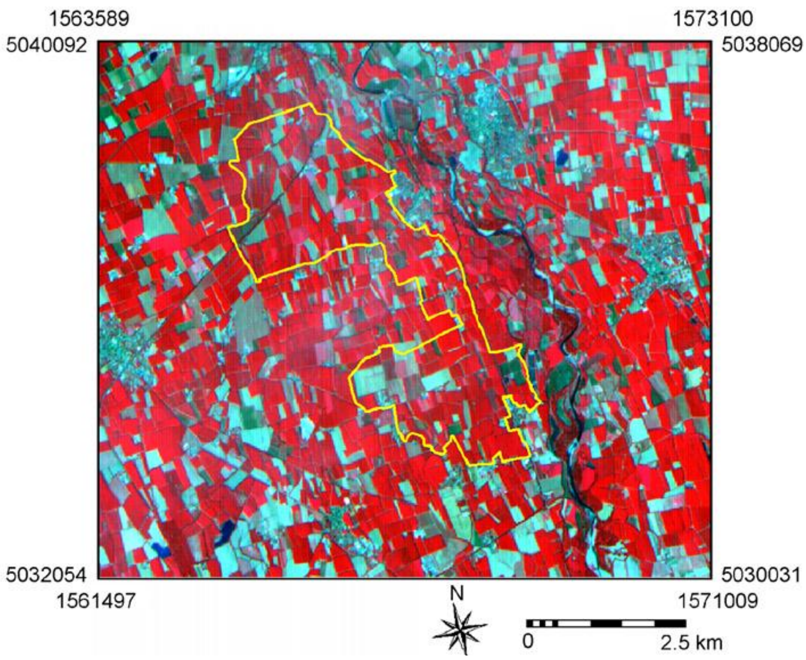

Figure 4-26 The forth alternative.

(Source: Sharifi, (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia)

4.5.5. Evaluation and Ranking of Alternative Sites:

A. Definition of a new criteria structure

The last phase of decision making is the evaluation and choice of alternative options. The four alternative sites for the urban green areas were evaluated using a different criteria structure. Besides the suitability index, resulting from the first urban green areas of the analysis, environmental-ecological, social and economic criteria were used for this part of the study. Differently from the indicators used to build the suitability map, the indicators selected for the evaluation phase are depending on the boundaries of the urban green areas[1].

For this last phase the following aspects have been considered:

1. Degree of suitability.
2. Environmental-ecological effects.
3. Social effects.
4. Economic effects.

[1] A. Zucca et al, (2008), Journal of Environmental Management 88.

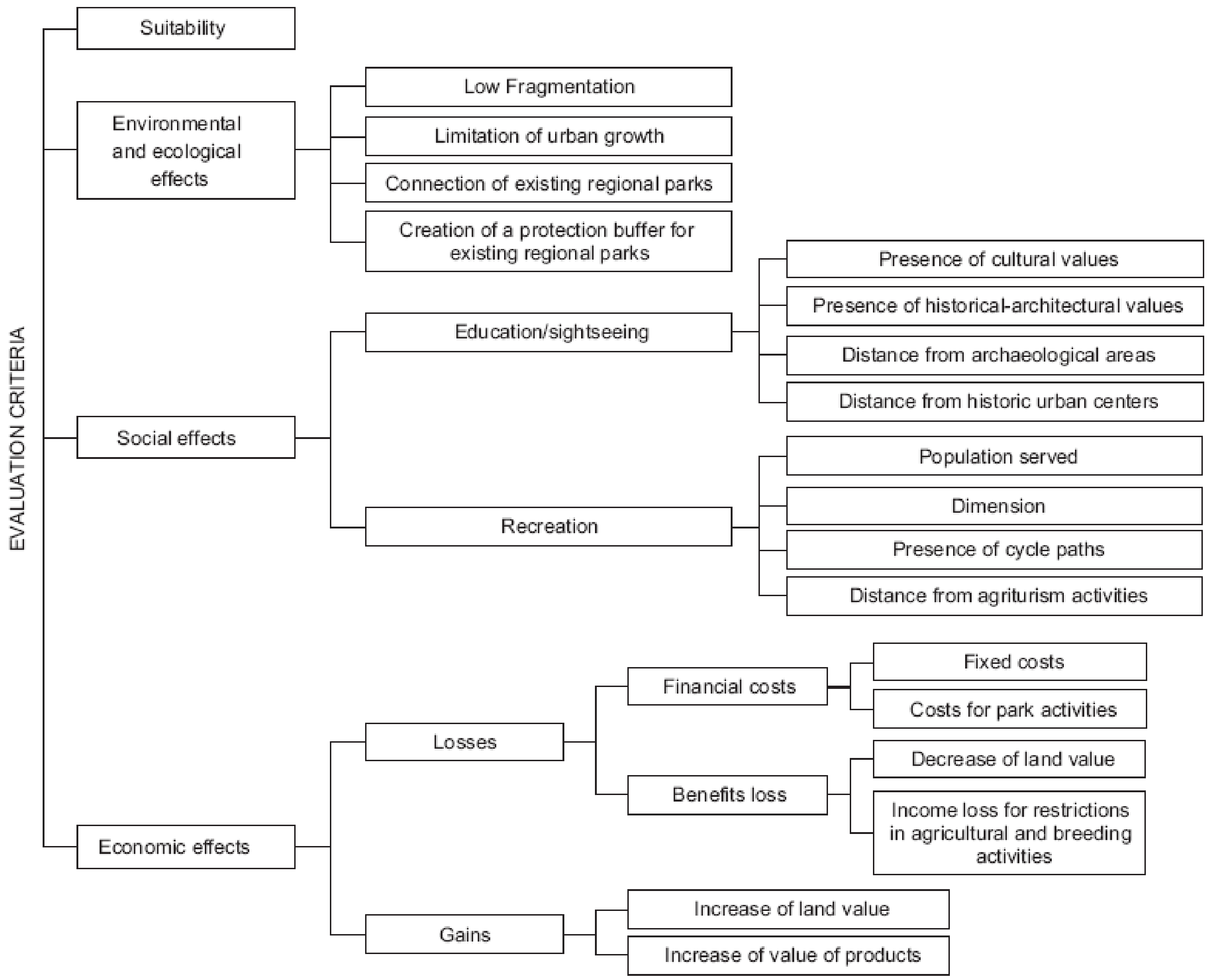

Figure 4-27 The criteria tree structure used for the evaluation and choice phase of alternative options in the Serio-Oglio study area.

(Source: Sharifi, (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia)

1. Degree of suitability:

The area selected for the urban green areas might have a high suitability Index. The higher is the value of this Index, the higher is the performance of the potential urban green spaces[1].

2. Environmental-ecological effects:

Considering the environmental-ecological function of the urban green spaces, the following criteria were used for the evaluation of the alternatives[2]:

The fragmentation due to the presence of roads inside the green areas.

The capabilities of the urban green spaces are to limit the urban sprawl, or the risk of conurbation between two or more municipalities.

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[1] Store, R., Kangas, J., (2001). Integrating spatial multi-criteria evaluation and expert knowledge for GIS-based habitat suitability modelling. Landscape and Urban Planning.

[2] van Herwijnen, M., (1999). Spatial Decision Support for Environmental Management. Faculty of Economical Sciences and Econometrics, Free University of Amsterdam, Amsterdam.

The role of connection between the existing regional urban green spaces, and the protection role with respect to the existing regional green spaces.

To estimate the urban green spaces role on limiting the urban sprawl, a pair-wise comparison technique was used. Looking at their spatial location, pairs of alternatives were compared with respect to their capability to limit the urban growth. Next, verbal comparisons were converted to a numerical Saaty scale, as shown in the following table[1].

Table 4-5 A table shows Pair-wise comparison matrix, expressing the capability of each alternative in limiting the urban sprawl

(Source: Sharifi, (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia)

	ALT 1	ALT 3	ALT 2	ALT 4	Score
ALT 1	1.00	5.00	7.00	9.00	4.21
ALT 3	0.20	1.00	6.00	7.00	1.70
ALT 2	0.14	0.17	1.00	6.00	0.61
ALT 4	0.11	0.14	0.17	1.00	0.23

Concerning the functions of connection and protection with respect to the existing regional urban green spaces, two distance maps have been used with a different standardization. The result is shown in the following figure.

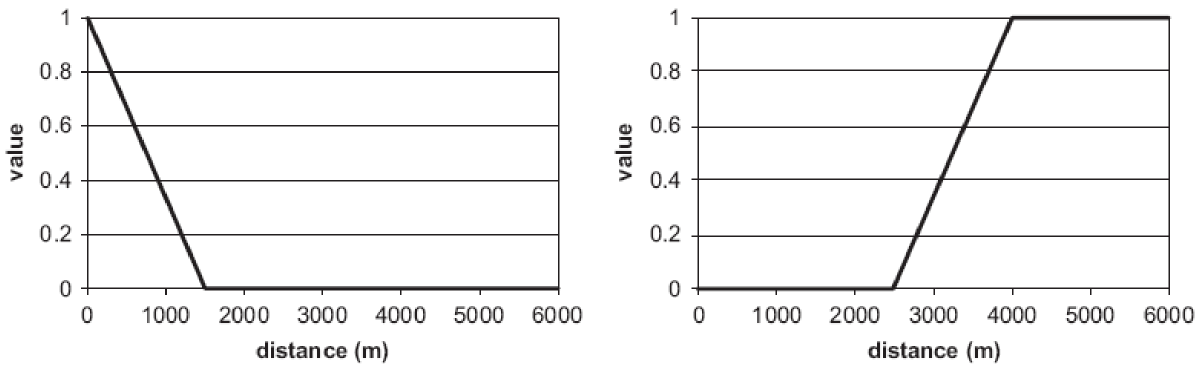

Figure 4-28 A figure shows Standardization functions of two distance maps expressing the protection (left) and the connection (right) utility of potential PLIS for the existing regional parks.

(Source: Sharifi, (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia)

In practice, the standardized pixel scores decrease between 0 and 1500m of distance from the existing regional urban green spaces and they are nil between 1500 and 2500m (left diagram), or they increase again between 2500 and 4000m of distance (right diagram). The average distance is in fact 4000m[2].

[1] Saaty, T.L., (1980). The Analytic Hierarchy Process. McGraw-Hill, Inc., New York.
[2] A. Zucca et al, (2008) Journal of Environmental Management 88.

1. Social effects:

The social function of the urban green spaces was assessed by two types of indicators: the educational and the recreational indicator. For the educational indicator, the same factors were used as considered in constructing the suitability map, such as the presence of cultural values, of historic-architectural values, of archaeological areas and of historic urban centers. For the recreational aspect, the presence of facilities such as cycling paths or agri-tourism activities, and other factors such as the dimension of the green spaces and the population served were considered for the evaluation[1].

2. Economic effects:

Many authors dealt with the problem, referred to the Italian situation, of the economic value of the protected areas[2], of the economic impacts on the local community of green areas establishment and of the development of economic activities in the national green spaces[3].

A set of generic criteria have been laid down, after some interviews with a number of technical personnel working in the existing urban green spaces. For costs, the financial costs were considered, split in fixed costs (personnel and office maintenance costs) and variable costs related to the activities carried on in the urban green spaces, and the losses caused by the regulation imposed on the land use after the establishment of the urban green spaces.

For benefits, the possible positive consequences were considered of the green spaces establishment on the neighboring areas on the areas inside the urban green spaces, and on the value of the agricultural and handicraft products coming from the area inside the green spaces.

In addition, the economic activities related to a given land use will be affected by the urban green spaces establishment. In some cases the effect will be positive, for instance for handicraft or specialized agriculture activities, in other cases it will be negative, as for manufacturing activities[4].

B. Weight assignment:

As previously discussed for the suitability map, the weights were assigned, using the rank order method, by the Park Officer supported by a group of experts. The result is the following figure.

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[1] Phua, M., Minora, M.,(2004). A GIS-based multi-criteria decision making approach to forest conservation planning at a landscape scale: a case study in the Kinabalu Area, Sabah, Malaysia. Landscape and Urban Planning 71.

[2] Diviacco, G., (1994). Il valore delle aree protette. Rivista del Coordinamento Nazionale dei parchi e delle Riserve Naturali no. 11/1994.

[3] Bernetti, I., and E. Marone., (2000). La valutazione dell'impatto sull'economia locale derivante dall'istituzione di un'area protetta. Una metodologia di analisi ex-ante. In: Atti del XXXVII Convegno SIDEA, Bologna.

[4] A. Zucca et al., (2008) Journal of Environmental Management 88

Table 4-6 Weights assigned to each factor and group of factors in the evaluation phase

(Source: A. Zucca et al., (2008) Journal of Environmental Management 88)

W	Group Factor	W	Group Factor	W	Group Factor	W	Group Factor
0.25	Suitability						
0.25	Environmental and ecological effects.	0.15	Low Fragmentation				
		0.35	Limitation of urban growth				
		0.35	Connecting existing regional green spaces				
		0.15	Creating a protection band for existing regional green spaces				
0.25	Social Effects	0.5	Education site seeing.	0.35	Presence of cultural values		
				0.35	Presence of historic architectural assets		
				0.15	Protection of historic architectural		
				0.15	Distance from historic urban centers		
		0.5	Recreation	0.35	Population Served		
				0.35	Size		
				0.15	Presence of bicycle path		
				0.15	Presence of agri-tourism activities		
0.25	Economic Effects	**0.5**	Losses	0.67	Financial Costs	0.25	Fixed Costs
						0.75	Costs from green areas activities
				0.33	Loss of benefits	0.75	Decreasing land value (inside green areas)
						0.25	Income Loss for restriction in economic activities
		0.5	Gains	0.5	Increasing land value (inside green areas)		
				0.17	Increasing land value (outside green areas)		
				0.33	Increasing value of products		

Equal priority was given to the four main branches of the criteria tree: the suitability value, the environmental ecological effects, the social effects, and the economic effects related to the urban green spaces establishment. Regarding the environmental-ecological effects, a higher importance was attached to the role played by the potential green spaces in limiting the urban sprawl and in connecting the existing regional green spaces, rather than to the low fragmentation and to the protection function of the urban green areas.

It can be concluded that these preferences reflect the main concerns of the Park Office about the consequences on the study area of the increasing human pressures. As concerns the social effects, a higher preference was attributed to the presence of cultural and historic-architectural values, to the amount of population served and to the size of urban green spaces. In fact to the Park Office these criteria appeared more relevant than the other ones in selecting the best alternative for the green areas. As to the economic effects, the assigned weights reflect both the provincial Park Office view and the impressions collected by talking with the technical personnel working in the existing local green spaces. The financial costs of green spaces, and in particular the costs related to the green areas activities, seemed to be the higher economic charge in managing a local green spaces, while the loss of benefits is considered less important. The gains deriving from the urban green spaces establishment might be related mainly to increasing the land value inside it, secondarily to the higher value gained by the products of the economic activities carried out inside the green spaces and just in minimal part to the increasing land value around the urban green spaces.

4.5.6. Evaluation results:

Once all criteria maps were in a form representing the degree of suitability of each picture element or pixel of the park from different aspects and perspectives, the evaluation of alternatives could proceed. As shown in the following figure for every alternative the result was a map (utility map) in which the value of each pixel represented the overall suitability of that pixel for the park.

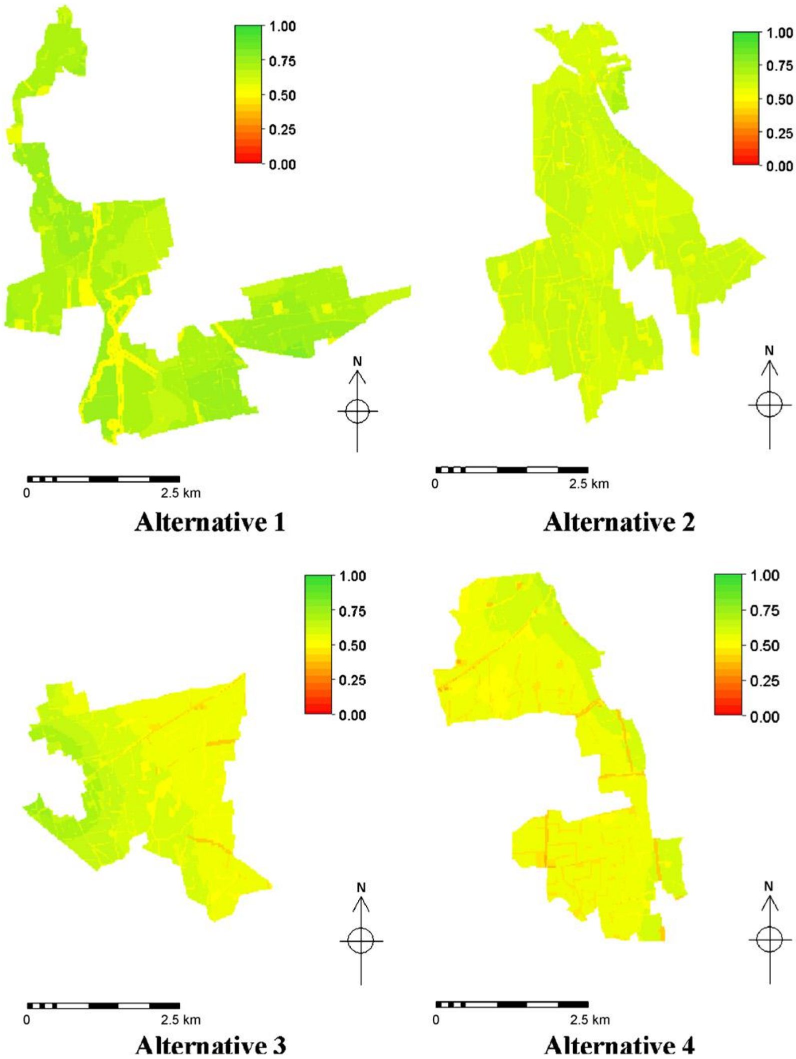

Figure 4-29 The comparison of the four alternative choices of the Serio-Oglio study area. The colours indicate utility values.

(Source: Sharifi, (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia)

To compare the alternatives it was necessary to aggregate the pixel values. One of the simplest and often-used non-spatial aggregation methods is taking the average or the sum of pixel values. Combined with other descriptive statistical parameters, such as minimum and maximum values, the average and the sum were used to describe the overall performance of each alternative. The results are shown in the following table.

Table 4-7 A table shows the results of the evaluation phase

(Source: Sharifi, (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia)

	Area (km2)	Perimeter (Km)	Number of Pixel	Average	Sum	Max Value	Min Value
ALT 1	11.64	37.49	29080	0.68	17036.09	0.78	0.50
ALT 2	12.68	31.84	31686	0.62	15836.63	0.71	0.44
ALT 3	8.99	19.94	21504	0.58	10457.41	0.73	0.39
ALT 4	10.05	25.01	25112	0.54	11379.98	0.64	0.37

As it is presented in the previous table, alternative 1 appears to be the most attractive site for the green areas. The methodology that was developed and applied in this study combined a value-focused approach with spatial multi-criteria evaluation techniques in supporting a land management problem: the selection of the most suitable site for the establishment of a new local urban green spaces. Moreover, spatial multi-criteria evaluation has been used either for design purposes or for the evaluation of different alternatives. The processing was supported by the ILWISs SMCE module, GIS software that demonstrated to be an effective tool for managing and combining a large amount of spatial and non spatial information. Further it facilitated processing ‘‘tables of maps’’, as well as ‘‘map of tables’’ (Sharifi et al., 2006). The main advantages of the methodology used in this study are the efficient structuring of geo-information, and processing large data sets to support management activities. This process proposed permits the efficient combination of multi-criteria evaluation with spatial data analysis tools that support a sustainable land management and provide a logical and scientific foundation into which the values of decision makers and stakeholders can be integrated[1].

[1] Sharifi, M.A, Boerboom, L., Shamsudin, K., (2004). Evaluating rail network options using multicriteria decision analysis. Case study Klang Valley Malaysia. In: Application of Planning and Decision Support Systems, International Islamic University of Malaysia.

4.6. Conclusion:

A. According to the importance of the urban green spaces, as they are considered the most important form of nature protection, so Geographic Information Systems based on spatial databases is considered with no doubt a necessary condition for the realization of statutory obligations of urban green spaces.

B. Urban green spaces are considered as outdoor places with significant amounts of vegetation, which exist mainly as semi-natural areas, or are viewed as last remnants of nature in urban areas.

C. The purposes of urban green spaces are to maintain the variety of the ecological systems and to protect the wild nature and the biological variety in the ecological systems, and to develop tourism and scientific, educational and recreational activities.

D. Previous studies have shown the positive impact of the urban green spaces on nearby residential property values, which consequently effect on people; desire to pay more for a home close to a nice green space. Economists called this phenomenon “hedonic value.”

E. Green areas are considered as urbanized environment which provide people with a feeling of place and identity. Green areas play an important part of urban ecosystems; play a pivotal role in preserving biodiversity in urban areas. Moreover, green spaces sequester CO_2 and produce O_2, they reduce air pollution and noise, regulate microclimates, and reduce the heat island effect in cities affect house prices maintain diversity; have recreational and social values and produce a vitamin ‘‘G’’ for health, well-being and social safety.

F. Reams of urban research have been carried out on the economics of housing, manufacturing, retail, and even the arts, there has been until now no comprehensive study of the worth of a city’s green space system, although city gains a big benefit from green spaces, these benefits can be compromised in the following main points, which are, increase income from tourists that target urban green areas, increase community cohesion between residents, removed air pollution from the city, and increase the level of resident physical activity.

G. The previous database model design (1) has introduced a useful, effective and efficient method for identifying suitable sites for developing green spaces in urban areas, as it is the first important step to ensure their roles and functions. Site information can be gained by using land suitability analysis based on GIS which is a strong, efficient and effective application within land-use planning, habitat analysis. Applying the ecological factor threshold method will help quantify how much green area is necessary to maintain an ecological balance in urban areas. Using an urban forest effects model will help quantify key values of urban green spaces such as carbon storage and sequestration. More importantly, the roles and functions of urban green spaces can be enhanced if they are organized by combining a variety of green space types for multiple purposes called a green network or urban green structure.

H. The previous database model design (2) has introduced three phases for identifying suitable sites for developing green spaces in urban areas, the first phase is considered as the problem formulation phase (intelligence) that led to the definition and specification of the green spaces, the second phase has led to the identification of few potential sites based on the specified characteristics, this was obtained in three steps: first, using a criteria structure, a suitability map was generated; then primary green spaces elements were identified using the suitability map, expert's knowledge together with other relevant ancillary information such as topographic maps, land-ownership and land-use maps, aerial photographs, and satellite images, and the third phase has led to the final location for the urban green spaces. The costs and benefits of each site were analyzed and the potential green spaces were compared and ranked on the basis of their overall attractiveness (utilities).

Chapter 5

Methods Applied on Case Study.

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5.1. Introduction

5.2. Practical Model Detected from the Theoretical Part

5.3. Development of a Conceptual Framework

5.4. Land Suitability Analysis Based on GIS

5.5. Calculation of Co2 Emitted from Different Land Uses along New City

5.6. Landscape Ecology Principle

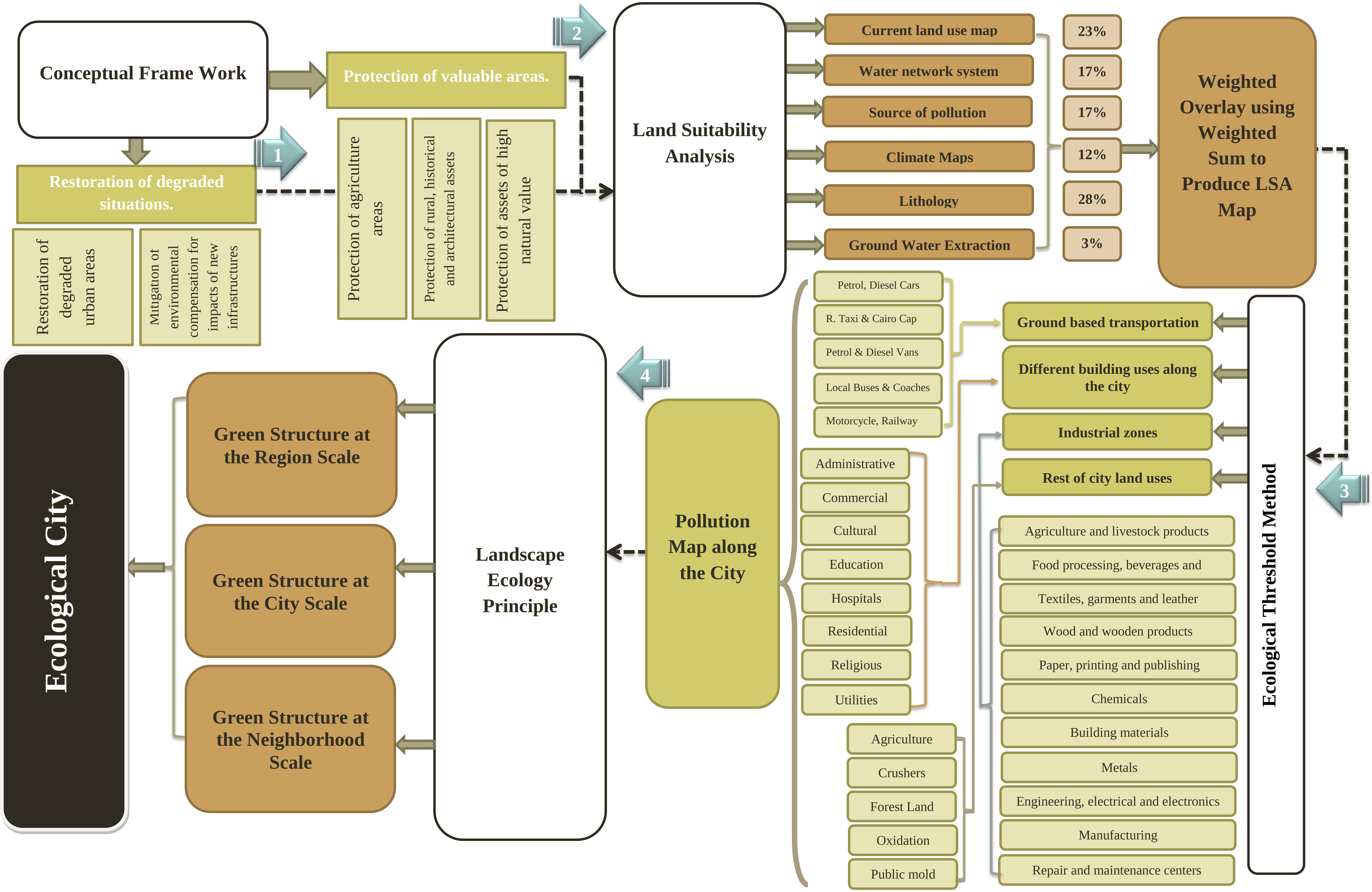
5.1.Introduction:

Climate change is caused by the emission of greenhouse gases. There are six greenhouse gases recognized under the Kyoto Protocol— carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFC), per fluorocarbons (PFC), and sulphur hexafluoride (SF_6)—that are released through various anthropogenic activities such as power generation, wastewater treatment, landfills, industrial processes, and fuel for transportation. Power generation for electricity, heat, and industrial activities makes up the bulk of global emissions, followed by land use change (e.g., deforestation and burning), agriculture (including livestock and use of fertilizers), and transportation (fossil fuels for automobiles).

After reviewing the, city as an open system, urban and regional planning that underlies the fabric of society as users deal with it today, Cities with differentiated or integrated functions, open or closed structures, monocentric or polycentric, compact or discreet, that acquire a variety of forms according to either the natural conditions surrounding the city, geographic information system as an important tool that deal with new desert cities to convert it to ecological cities, and finally two of the international experiences of the ecological city, this chapter is going to gather all the important standards that have been deducted from the theoretical part to be applied on the practical one. The standards that have been gathered from the previous theoretical chapters is summarized into four main steps that the case study will pass through, these steps are:

A. Development of Conceptual Frame Work.
B. Land Suitability Analysis Based on GIS.
C. Calculation of Co_2 Emitted from Different Land Uses within the City.
D. Landscape Ecology Principle.

5.2. Practical Model Detected from the Theoretical Part



5.3. Development of a Conceptual Framework:

To develop a framework for the case study, it is necessary to identify the main goal of urban green spaces which is considered as the protection and improvement of the environmental quality of the territory. This goal could be met through the following objectives to identify the conceptual framework:

A. Protection of valuable areas.

B. Restoration of degraded situations.

The degree of satisfaction of the first objective, ‘‘protection of valuable areas’’, was measured through the following criteria, Protection of agriculture area, Protection rural, historical and architectural assets, and finally Protection of high natural value.

The degree of satisfaction of the second objective, ‘‘Restoration of degraded situation’’, was measured through the following criteria, Restoration of degraded urban areas, and finally Protection of high natural value.

5.4. Land Suitability Analysis Based on GIS:

Land Suitability Analysis is going to be applied in the case study using a new technique in the GIS called weighted sum; that is used for applying a common scale of values to diverse and dissimilar input to create an integrated analysis. Geographic problems often require the analysis of many different factors. For instance, choosing the site suitable for green areas development means assessing such things as Current land use map, Type of existing green areas, Water network system, Source of pollution, Climate maps (Mean monthly maximum temperatures, Mean monthly minimum temperature, Wind speed, Wind direction, Average annual rain fall, and Humidity), Lithology, and Ground water extraction. This information exists in different raster layers with different value scales: degree Celsius, m3/year, and so on. The planner can't be able to add a raster of Climate (degree Celsius) to a raster of Ground water extraction (m3/year) and obtain a meaningful result.

Additionally, the factors in the analysis may not be equally important. For example the lithology is more important in suitability to green areas than the Climate. Within a single raster layer, the planner should usually prioritize values from 0 to 4 representing the degree of suitability of each constrain to green areas.

Weighted sum only accepts integer raster as input, such as a raster of land use or soil types. Generally, the values of continuous raster are grouped into ranges. Each range should be assigned a single value before it can be used in the weighted sum tool. The cells in the raster will already be set according to suitability to green areas. The steps for running weighted sum are:

A. In the Weighted sum dialog box, select an evaluation scale to use. Values at one end of the scale represent one extreme of suitability; values at the other end represent the other extreme. The default evaluation scale is from 0 to 4 (not suitable 0, most suitable 4).
B. Click the Add raster row button to open the Add Weighted Sum dialog box. Click the Input raster drop-down arrow and click a raster, or click the Browse button to browse to an input raster and click Add. Click the Input field drop-down arrow to change the field if desired. Click OK. The raster is added to the Weighted Sum table. Click the Add raster row button again to enter the next raster, and so on.
C. The cell values for each input raster in the analysis are assigned values from the evaluation scale. This makes it possible to perform arithmetic operations on raster that originally held dissimilar types of values. The default values can be changed to be assigned to each cell according to suitability. For instance, a land-use raster added has values representing the land-use type (current land use = 0, vacant land = 4, desert land= 4).
D. Each input raster can be weighted, or assigned a percentage influence, based on its importance. The total influence for all rasters must equal 100 percent.
E. The cell values of each input raster are multiplied by the raster's weight (or percent influence). The resulting cell values are added to produce the final output raster suitability map.

If the tool was used for suitability modeling (to locate suitable areas), higher values generally indicate that a location is more suitable, and lower values indicate that a location is not suitable.

Based on the theoretical part in the thesis this analysis is going to depend on the following maps, Current Land use Map, Type of existing green areas, Water network system, Source of pollution, Climate maps (Mean monthly maximum temperatures, Mean monthly minimum temperature, Wind speed, Wind direction, Average annual rain fall, and Humidity), Lithology, and finally Ground water extraction.

5.4.1.The prioritize values of each map:

The following table will contain two number 1 and 0, 1 shows the priority of the constrain in the map to the suitability of green areas, and 0 shows that the constrain in the map did not match that type of Suitability

A. The Current Land use:

Table 5-1 Land use suitability

(Source: Researcher)

Values in Map	High Suitable to green areas (4)	Suitable to green areas (3)	Moderate Suitable (2)	Low Suitable to green areas (1)	Not Suitable to green areas (0)
Current land use	0	0	0	0	1
Vacant lands	1	0	0	0	0
Desert land	1	0	0	0	0

B. Lithology:

Table 5-2 lithology suitability

(Source: Researcher)

Values in Map	High Suitable to green areas (4)	Suitable to green areas (3)	Moderate Suitable (2)	Low Suitable to green areas (1)	Not Suitable to green areas (0)
Graded Sand and Gravel Intercalated by clay lenses	1	0	0	0	0
Graded Sand and Gravel Intercalated by some clay	0	1	0	0	0
Sand and Gravel	0	0	1	0	0
Sandy Limestone	0	0	0	0	1
Undifferentiated Quaternary Deposits	0	0	0	1	0

C. Type of Existing Green Areas:

Table 5-3 Existing green areas suitability

(Source: Researcher)

Values in Map	High Suitable to green areas (4)	Suitable to green areas (3)	Moderate Suitable (2)	Low Suitable to green areas (1)	Not Suitable to green areas (0)
Existing green areas	1	0	0	0	0

D. Water Network System:

Table 5-4 water network suitability

(Source: Researcher)

Values in Map	High Suitable to green areas (4)	Suitable to green areas (3)	Moderate Suitable (2)	Low Suitable to green areas (1)	Not Suitable to green areas (0)
Inside Buffer of network	1	0	0	0	0
Outside Buffer of network	0	0	0	1	0

E. Source of pollution:

Table 5-5 Source of Pollution Suitability

(Source: Researcher)

Values in Map	High Suitable to green areas (4)	Suitable to green areas (3)	Moderate Suitable (2)	Low Suitable to green areas (1)	Not Suitable to green areas (0)
Inside Buffer of Pollution	1	0	0	0	0
Outside Buffer of pollution	0	1	0	0	0

F. Climate properties:

Table 5-6 Climate properties

(Source: Researcher)

Values in Map	High Suitable to green areas (4)	Suitable to green areas (3)	Moderate Suitable (2)	Low Suitable to green areas (1)	Not Suitable to green areas (0)
All Climate properties	1	0	0	0	0

G. Ground Water Extraction:

Table 5-7 Ground water extraction suitability

(Source: Researcher)

Values in Map	High Suitable to green areas (4)	Suitable to green areas (3)	Moderate Suitable (2)	Low Suitable to green areas (1)	Not Suitable to green areas (0)
Less than 1 million m3/ year	0	0	0	1	0

5.4.2. Percentage Weight (Influence) Assigned to Each Raster:

The influence of each raster is multiplied by its raster value, then all the raster is added together to create the output weighted overlay.

According to the potentials and constrains of the case study (10th of Ramadan), Lithology plays an important main role in the suitability of green areas, then the current land use takes the second priority as suitability of green areas are high in desert and vacant lands, then water network system takes the third priority in determining the lands that is suitable for green areas as 10th of Ramadan depend mainly on Ismailia Canal as a main feeding source of water, then Source of pollution takes the same influence as water network system, then Climate properties takes the forth priority in determining lands suitable for green areas, and finally comes the ground water extraction in the last priority as the quantity of water that extracted from the soil is too small. The following table is going to show the suitability of each constrain to green areas, and the influence of each map.

Table 5-8 Suitability and influence of each map

(Source: Researcher)

	High Suitable to green areas (4)	Suitable to green areas (3)	Moderate Suitable (2)	Low Suitable to green areas (1)	Not Suitable to green areas (0)	Influence of Raster Map
Lithology	1	1	1	1	1	28%
Current land use map	2	0	0	0	0	23%
Water Network Analysis	1	0	0	1	0	17%
Source of pollution	1	1	0	0	0	17%
Climate properties	1	0	0	0	0	12%
Ground Water Extraction	0	0	0	1	0	3%

5.5. Ways of Calculation of Co2 Emitted from Different Land Uses along New City:

The research is going to divide the new city into a number of sectors that are responsible for Co2 emission; these sectors are ground based transportation, different building uses along the city, Industrial zones, and rest of city land uses.

5.5.1. Ground Based Transportation Sector:

The theoretical part stated five ways of calculating CO2 emitted from ground based transportation, the first way depend on calculating CO2 according to the fuel consumed, the second way depend on calculating CO2 according to the vehicle type, the third way depend on calculating CO2 according to the total annual fuel used by each mode of transportation, the forth way depend on calculating CO2 according to the forecasts obtained from the department of energy, and the fifth way depend on calculating CO2 according to its impact per km (or passenger-km, tone-km).

According the data available for the case study, the fifth way is going to be applied on the 10th of Ramadan. This way divided the ground based transportation emission according to the vehicles type and size.

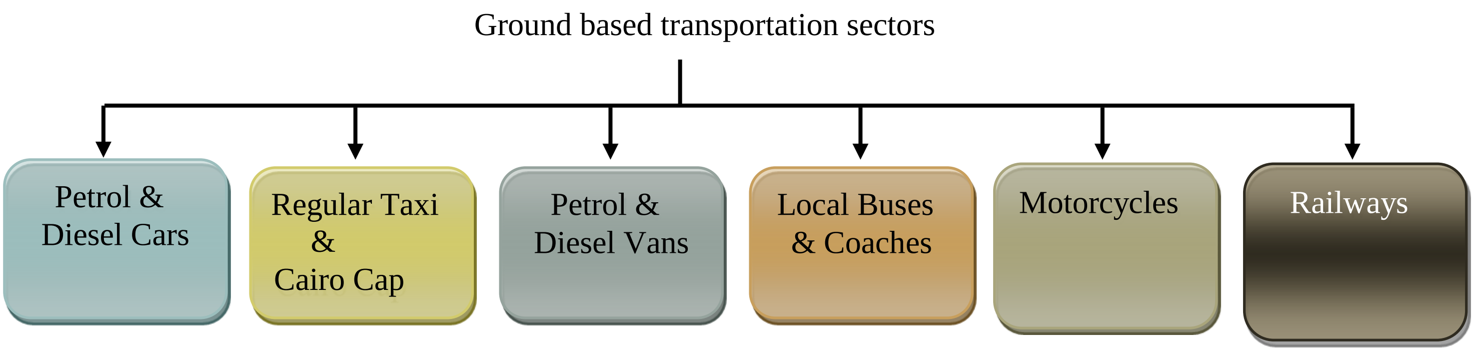


Figure 5-2 Ground based transportation sectors

(Source: Researcher)

A. Passenger Cars Emission Factors by Passenger Car Engine Size:

Table 5-9 Petrol and Diesel Car Emission

(Source: Researcher)

Vehicle Type	Engine Size	Size Label	G.CO2 per Km.	Liter per Km
Petrol car	< 1.4 l	Small	180.9	12.8
	1.4 – 2.0 l	Medium	213.9	10.8
	> 2.0 l	Large	295.8	7.8
Average petrol car			207.0	11.2
Diesel car	< 1.7 l	Small	151.3	17.4
	1.7 – 2.0 l	Medium	188.1	14.0
	> 2.0 l	Large	258.0	10.2
Average diesel car			197.9	13.3

To calculate Co2 emitted for petrol and diesel cars:

CO2 emission = G.CO2 per Km * Length of Street in Km * Number of petrol or diesel cars

B. Regular taxis and taxi Cairo cap.

Table 5-10 Taxi and Cairo Cap Emission

(Source: Researcher)

	Average passenger occupancy	G.CO2 per passenger km
Taxi	1.4	161.3
Cairo Cap	1.5	175.7
Average	1.45	168.5

To calculate Co2 emitted for taxis:

CO2 emission = G.CO2 per passenger km * Length of Street in Km * Average passenger occupancy * Number of taxis

C. Petrol and diesel vans

Table 5-11 Vans Emission

(Source: Researcher)

Van fuel	Van size	G.CO2 per Km.
Petrol	Up to 1.25 tone	224.4
Diesel	Up to 3.5 tone	271.8
Average		266.1

To calculate Co2 emitted for vans:

CO2 emission = G.CO2 per passenger km * Length of Street in Km * Number of Vans

D. Local buses and long distance buses.

Table 5-12 Buses Emission

(Source: Researcher)

Bus type	Average passenger occupancy	G.CO2 per passenger km
Local bus	8.9	115.8
10th of Ramadan bus	13.5	81.8
Average bus	9.7	107.3

To calculate Co2 emitted for buses:

CO2 emission = G.CO2 per passenger km * Length of Street in Km * Average passenger occupancy * Number of buses

E. Motorcycles.

Table 5-13 Motorcycle Emission

(Source: Researcher)

Vehicle Type	Engine Size	Size Label	G.CO2 per Km.	Liter per Km
Petrol Motorcycle	Up to 125 cc	Small	72.9	31.6
	125 to 500 cc	Medium	93.9	24.5
	Over 500 cc	Large	128.6	17.9
	Average		105.9	21.9

To calculate Co2 emitted for petrol motorcycles:

CO2 emission = G.CO2 per Km * Length of Street in Km * Number of petrol motorcycles

F. Railways.

Table 5-14 Railway Emission

(Source: Researcher)

	G.CO2 per passenger km	Average passenger occupancy
Railways	40.2	90

To calculate Co2 emitted for railways:

CO2 emission = G.CO2 per passenger km * Length of Railway in Km * Average passenger occupancy * Number of trips

5.5.2. Different Building uses along the city:

The theoretical part stated three ways of calculating CO2 emitted from different building uses along the city, the first way depend on calculating CO2 according to the energy consumption of the living territories and land uses, the second way depend on calculating CO2 according to the construction of buildings, the third way depend on calculating CO2 according to the area and different uses of the Buildings.

According the data available for the case study, the third way is going to be applied on the 10th of Ramadan. The following table is going to summarize the CO2 emission according to building use and area.

Table 5-15 CO2 emissions associated with the use of different types of buildings

(Source: Researcher)

Building type		G CO2 / m2
Mixed Residential	Above Average	30
	Average	24
	Low	20
Administrative		67
Hospital		88
Commercial		164
Cultural		35
Education		13
Entertainment		80
Religious		56
Utilities		125

5.5.3. Industrial Zones along the city:

The theoretical part stated six ways of calculating CO2 emitted from industrial zones, the first way identify the carbon emission of the industrial zones in U.S, the second way identify the carbon emission of the Industrial zones in in Netherland, the third way depend on calculating CO2 according to the Forecasts Obtained from the Department of Energy, the forth way depend on calculating CO2 according to non-combustion, on-site fossil fuel combustion, and purchased electricity, the fifth way depend on calculating CO2 according to the quantity and type of industrial product, and the last way depend on calculating CO2 according to the number of factories & type of industrial product.

According the data available for the case study, the six way is going to be applied on the 10th of Ramadan. The following table is going to summarize the CO2 emission according to factory type and number putting into consideration that the factories size and production are average

Table 5-16 CO2 emission per factory

(Source: Researcher)

Type of Industry	CO2 emitted per Factory Ton per year
Agriculture and livestock products	310.7
Food processing, beverages and tobacco	303.4
Textiles, garments and leather	277.7
Wood and wooden products	987.6
Paper, printing and publishing	949.9
Chemicals	5977.8
Building materials	2176.5
Metals	10578.2
Engineering, electrical and electronics	789.5
Manufacturing	1767.6
Repair and maintenance centers	473.8

Referring to the previous gathered table for all the type of industries in 10^{th} of Ramadan, the formula of the equations that is going to be used to calculate 10^{th} of Ramadan Industries is going to be illustrated in the following.

A. To calculate Co2 emitted from Agriculture and livestock products:

The Co2 emitted per factory for this type of industry is 310.7 Ton per year

310.7 Ton per year * number of Factories in 10^{th} of Ramadan = CO2 emission.

B. To calculate Co2 emitted from Food processing, beverages and tobacco industry:

The Co2 emitted per factory for this type of industry is 303.4 Ton per year

303.4 Ton per year * number of Factories in 10^{th} of Ramadan = CO2 emission.

C. To calculate Co2 emitted from Textiles, garments and leather:

The Co2 emitted per factory for this type of industry is 277.7 Ton per year

277.7 Ton per year * number of Factories in 10^{th} of Ramadan = CO2 emission.

D. To calculate Co2 emitted from Wood and wooden products:

The Co2 emitted per factory for this type of industry is 987.6 Ton per year

987.6 Ton per year * number of Factories in 10^{th} of Ramadan = CO2 emission.

E. To calculate Co2 emitted from Paper, printing and publishing:

The Co2 emitted per factory for this type of industry is 949.9 Ton per year

949.9 Ton per year * number of Factories in 10^{th} of Ramadan = CO2 emission.

F. To calculate Co2 emitted from Chemicals:

The Co2 emitted per factory for this type of industry is 5977.8 Ton per year

5977.8 Ton per year * number of Factories in 10^{th} of Ramadan = CO2 emission.

G. To calculate Co2 emitted from Building materials**:**

The Co2 emitted per factory for this type of industry is 2176.5 Ton per year

2176.5 Ton per year * number of Factories in 10^{th} of Ramadan = CO2 emission.

H. To calculate Co2 emitted from Metals:

The Co2 emitted per factory for this type of industry is 10578.2 Ton per year

10578.2 Ton per year * number of Factories in 10^{th} of Ramadan = CO2 emission.

I. To calculate Co2 emitted from Engineering, electrical and electronics:

The Co2 emitted per factory for this type of industry is 789.5 Ton per year

789.5 Ton per year * number of Factories in 10^{th} of Ramadan = CO2 emission.

J. To calculate Co2 emitted from Manufacturing:

The Co2 emitted per factory for this type of industry is 1767.6 Ton per year

1767.6 Ton per year * number of Factories in 10^{th} of Ramadan = CO2 emission.

K. To calculate Co2 emitted from Repair and maintenance centers:

The Co2 emitted per factory for this type of industry is 473.8 Ton per year

473.8 Ton per year * number of Factories in 10^{th} of Ramadan = CO2 emission.

5.5.4. Land Uses along the city:

The theoretical part in the research stated several standards for calculation of Co2 emitted from different Land uses along the city, these standards are summarized in the following table:

Table 5-17 CO2 emission for different land uses

(Source: Chang, T.C., 2000. Determination of greenhouse gases by open-path gas-type FTIR spectroscopy. Food Sci. Agric. Chem.)

Land Use	CO2 Emission
Oxidation Lakes	1300 mg/ m2 * H
Agriculture Land	11.2 Kg/ m2
Forests	52 gm / m2
Crusher	0.5 ton
Public Dumps	220/ m2 * H

5.5.5. Green Area Required:

To reach carbon oxygen balance along the city, the theoretical part stated several theories to reach this balance, according to the data available to the case study the following standard is going to be used to reach the balance.

A. Consumption of O2 = Carbon dioxide emission for 10^{th} of Ramadan * 0.6 / 0.9
B. The annual per hectare O2 production of trees is 170 Tons.

By reaching the O2 consumption and the O2 annual production per hectare, area of green can be calculated.

Increasing tree cover by 10% could reduce total heating and cooling energy use by 5 to 10%. Street trees are a major source of building shade. They provide a cooling effect of from 2-7%.

Studies have indicated that increasing tree coverage by 25% can reduce afternoon air temperatures by between 6 to 10 C, and simulations of a 30% vegetation cover reduced temperatures by as much as 6 C. Others have shown that vegetation in streets can reduce temperatures by 2 C. Comparisons of temperatures in city parks and surrounding urban areas in Japan have demonstrated differences of 2.5 to 4 C. Vegetation provides cooling through evapotranspiration which also adds humidity to what is frequently uncomfortably dry city air.

5.6. Landscape Ecology Principle:

Application of landscape ecology principles divided among three scales along the city:

A. Green structure at the region scale.
B. Green structure at the city scale.
C. Green structure at the neighborhood scale.

The experiences and theories demonstrate that ecological patches and corridors play a crucial role in the sustainability of urban environments and their transformations directly influence the ecological functions of the city. Some general points for structural and functional improvement of patches and corridors in the urban context are categorized in the following table.

Table 5-18 Considerations for structural and functional improvement of patches, corridors and matrix in the urban landscape.

(Source: Researcher)

Improvement considerations for patches, corridors and matrix in the urban landscape context	
Patch	**Large patches:** Protecting large patches with high ecological value amid the urban built environment often surrounded by other conflicting land uses.
	Small patches: Integrating the small patches for better functioning of the ecological systems especially in densely built-up and populated areas.
	More patches: Making more patches for facilitate the penetration of the ecological flows into the urban fabric.
	Patches vicinity: Creating close patches for increasing their ecological functions, more convenient and less obstructed flows between the patches.
Corridor	**Corridors Connectivity:** Connectivity of the corridor s will benefit the individual and overall ecologic al functions of them.
	Corridors branching patterns: The interwoven structural pattern of both branching natural and circuit built corridors in their hierarchical order and their interactions directly influence their ecologic al functions.
	Patches and corridors: Connecting patches through natural or manmade corridors for higher ecological performance.
Matrix	**Integrity:** Interconnections between the ecological patches and corridors in the urban natural and built matrix to enhance and protect integrity of the city and ecological flows.
	Regional perspective: Considering the ecological systems beyond the city limits where the ecological flows are continued or originated

Based on landscape ecology approach that should take all natural and built structural elements into consideration. The process of improving the ecological systems is illustrated in the following figure, as the remnant natural patches and corridors in the urban environment are to be preserved and restored to increase their ecological functions of the city so that the natural flows can continue and penetrate into the built environment. The built patches and corridors within the urban context can act as main elements to make an ecologically functional system. The built patches are most influential factor in the densely built-up and populated city regions, and the built corridors can act as main connecting elements between the natural and built patches. Protecting the integrity between structural elements, preserving the original pattern of ecological systems, will help to establish and enhance the ecological processes and flows in the urban and suburban environment.

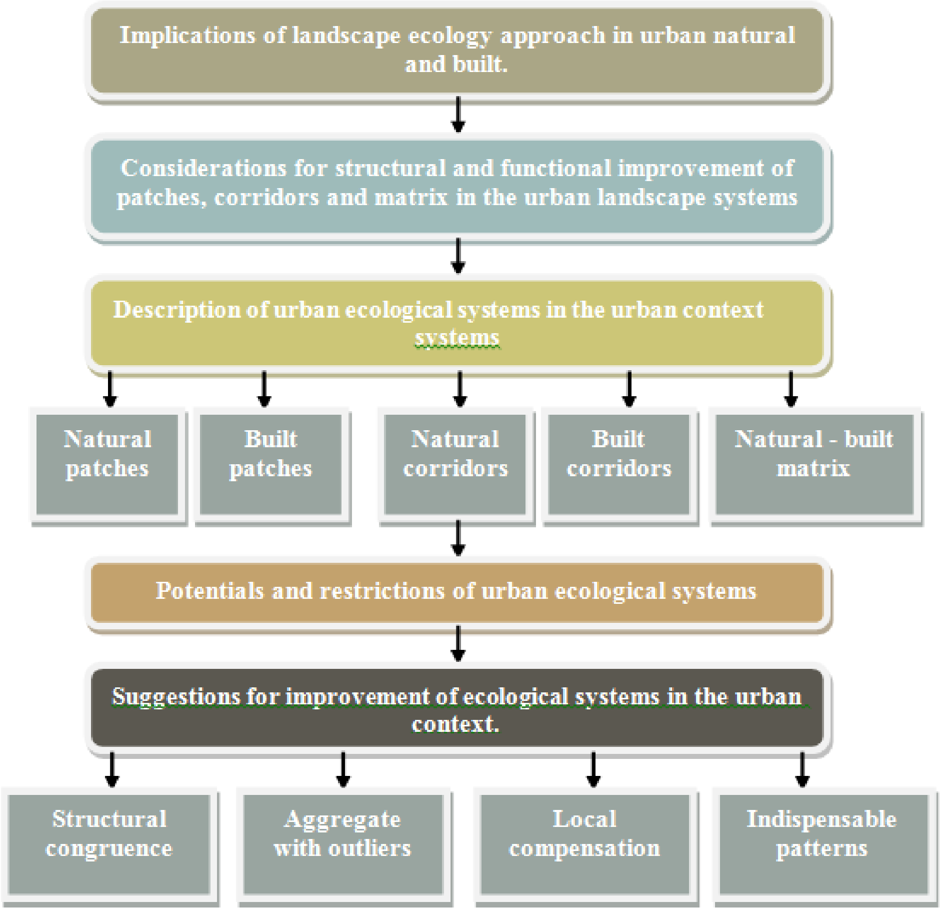


Figure 5-3 The process for improving the natural and built ecological systems in the urban environment based

(Source: Researcher)

Chapter 6

Case Study Results and Discussion.

6.1. Introduction

6.2. Case Study of New City (10th of Ramadan)

6.3. Methodology taken in the case study

6.4. Data Gathering and Preparation

6.5. Data Base Design and System Structure

6.1.Introduction:

Urban green spaces, an important component of urban ecosystems, provide many environmental and social services that contribute to the quality of life in cities. One of the key tasks of planners is how to optimize the benefits of urban green spaces. This study introduces a new technique for developing green spaces in urban areas through

- *Land suitability analysis based on GIS*: identifying suitable sites for conserving and developing green spaces is the first important step to ensure their roles and functions. Site information was supported by a value focused approach and spatial multi-criteria evaluation techniques which can be gained by using land suitability analysis (LSA) based on GIS which is a strong, efficient and effective application within land-use planning, habitat analysis.
- *Quantifying green areas based on the ecological factor threshold method to maintain ecological balance*: Applying the ecological factor threshold method will help quantify how much green area is necessary to maintain an ecological balance in urban areas.
- *Applying landscape-ecology principles in organizing green spaces in urban areas:* the roles and functions of urban green spaces can be enhanced if they are organized by combining a variety of green space types for multiple purposes called a green network or urban green structure

This contribution discusses an application of spatial multiple criteria decision analysis (SMCDA). An introduction to this field can be found in Malczewski (1999), who contributed to bridging the gap between geographical information systems, GIS, and multi-criteria decision analysis, MCDA. SMCDA was applied here in support of a real management problem of identifying the suitable sites for developing green areas to have an ecosystem city.

6.2.Case Study of New City (10 of Ramadan):

A case study has been chosen for 10th of Ramadan City as one of the first New Cities planned in Egypt and has developed over the past 30 years as the largest industrial city in Egypt. 10^{th} of Ramadan City was established in 1977 as an integrated city with easy access to Cairo, Port Said, Ismailia and Suez. It is located between latitude lines 30 degree 20 min N and 30 degree 17 min N, and longitude lines 31 degree 37 min E and 31 degree 50 min E. It is the largest industrial city with about 1400 factories, annual production of more than 75.42 billion LE, employing about 188,166 workers at present. Population estimated to be 260,000.

10RC originally aimed at housing all economic sections of the society, and at increasing the populated land in Egypt, but it has instead developed as an industrial city over time and the housing concentrated on the low cost segment.

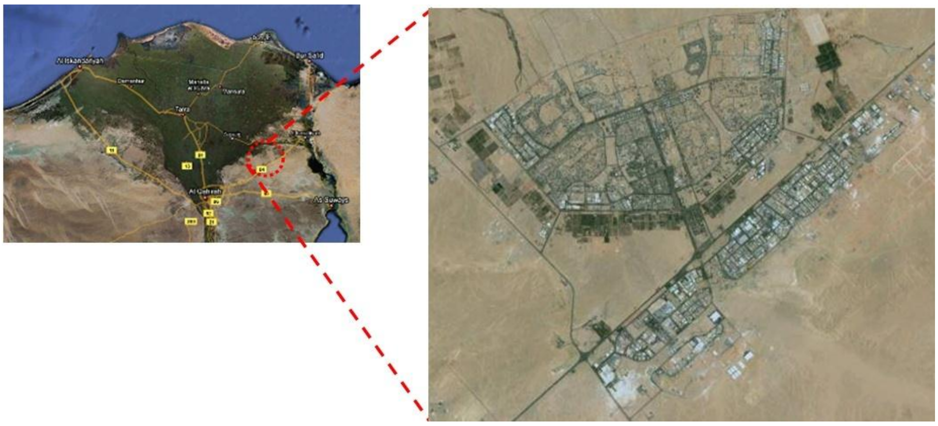


Figure 6-1 shows 10RC location

(Source: Researcher)

The city cordon is determined from General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development with area 9534.88 Fadden, surrounding a city border with an area 18118.144 Fadden. 10th of Ramadan is characterized by hot and arid climate. The operative temperature varies from 37 C to 46 C as the maximum and 13C to 21 C as the minimum during summer months while in winter months the maximum operative temperature varies from 25C to 28C, and minimum temperature varies from 6C to 9C. The humidity level ranges from 32 to 48%. The summer global radiation ranges from 940 to 1050W/m2, while it ranges from 550 to 750 W/m2 in winter.

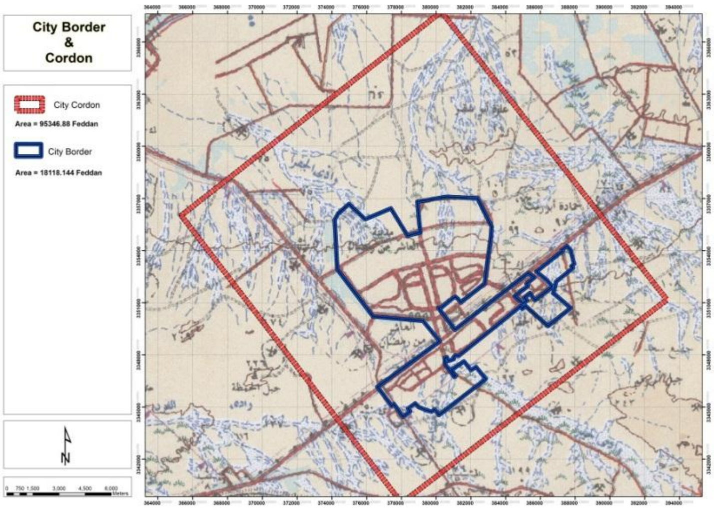


Figure 6-2 City Cordon and Border

(Source: Researcher)

The city did not achieve its population objectives, where the rate of urbanization did not exceed 50% from what was planned to be achieved. Industrial development has exceed the master plan expectations, where the number of labor had reached 60 thousand at the end of planning period in 2002, and this number reached to 225 thousand in 2010, this increase in labor estimated to be more than 300% of what was required to be achieved at the end of planning period in 2002, and the demand on industrial land is still increasing. A small percentage of the green belt had been cultivated and still most of the spaces allocated to green belt are still vacant lands, which encourage the indiscriminate extensions. The following figure shows the current land use for 10^{th} of Ramadan, it contains 11 hospitals and health care, 35 Schools and educational institutes, 1400 factories, 34 commercial centers, 2 telephone centers, 27 social centers, 2 hotels, and 15 banks.

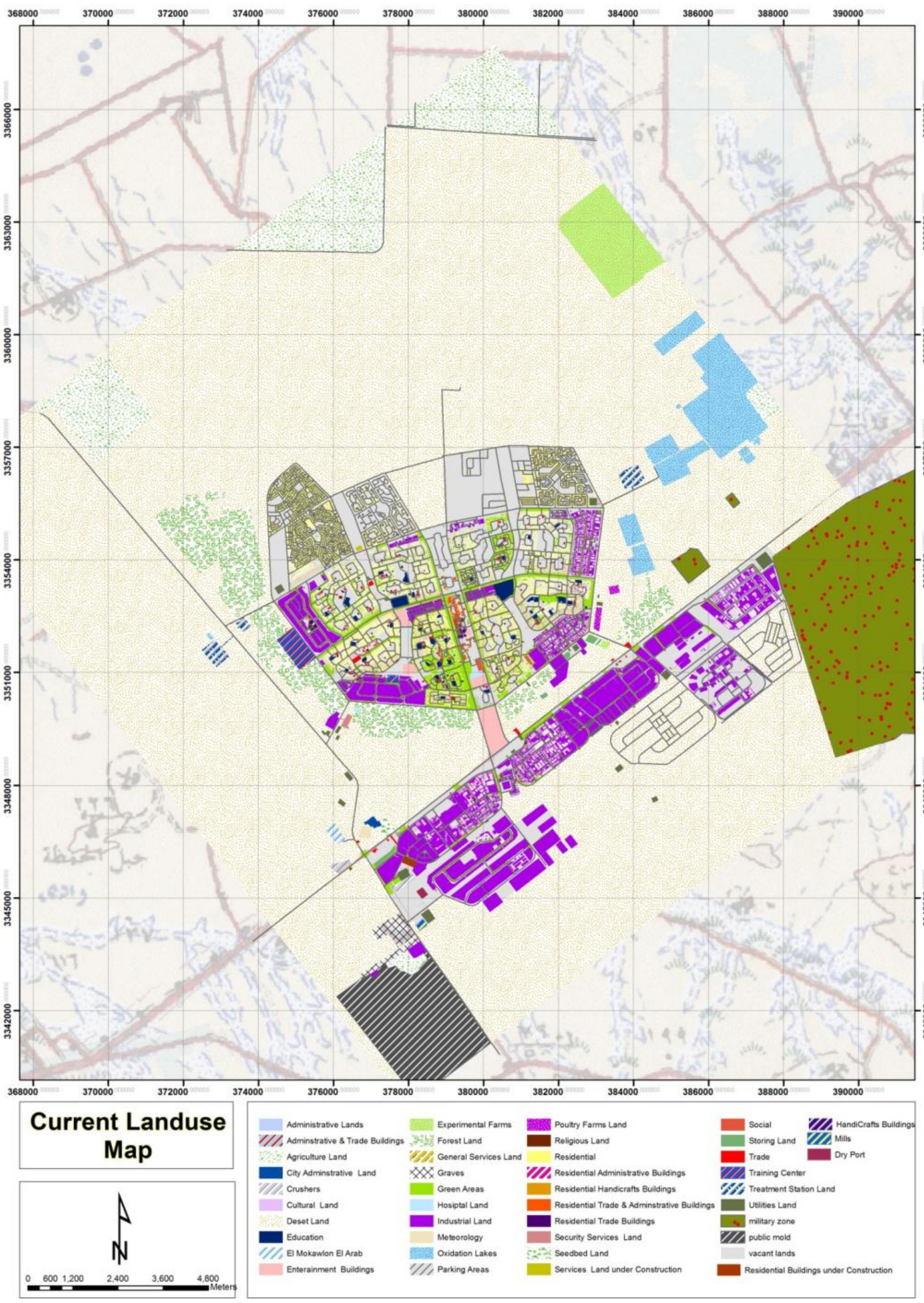


Figure 6-3 Master Current Plan of 10^{th} of Ramadan

(Source: Researcher)

Table 6-1 Estimated area and quantity of the data available.

(Source: General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development)

Available Data	Estimated Area or number
Current population	260 thousand
Current Labor force	225 thousand
Area of City Cordon	9534.88 Fadden
Area of current urban mass (16 District + Main service center + Small and average industrial zones)	12059.97 Fadden – 12.72% from Cordon Area
Area of the existing industrial zone south Cairo-Ismailia Desert road.	6819.10 Fadden – 7.19% from Cordon Area
Area of desert land (future extension) north of Cairo-Ismailia desert road - east Alrubiki road.	34186.95 Faddan – 36.06 % from Cordon Area
Area of other uses (such as forests, woodland, lakes oxidation, the treatment plant, military areas, etc ...)	41751.98 Fadden – 44.03% from Cordon Area
Built up urban area within the boundary of main urban mass	3359.49 Fadden – 27.86% from urban area
Area of roads, parking lots, urban spaces, and vacant lands within the boundary of main urban mass	8700.48 Fadden – 72.14% from urban area

Based on the literature reviewed, the main objectives of this study are:

- Applying landscape ecology approach as could be interpreted in urban ecological planning.
- Determining the current situation and analyze the natural and built elements of the ecological systems of case study which faces numerous environmental problems and pollutions due to its rapid growth.
- Suggesting strategies for structural and functional improvement of natural and built urban ecological systems of the case under study.
- Proposing a model for the application of ecology in landscape scale.

6.3.Methodology taken in the case study:

Decision making is a process involving a sequence of activities that starts with recognition of a decision problem and ends with recommendation for a decision.

- Sequence of activities performed in the study:

Table 6-2 Sequence of Activities performed in the case study

(Source: Researcher)

ID	Phase	Activities
A	Intelligence	Development of a conceptual framework including: • Identification of the main objective, the sub-objectives and the contents of the local park. • Definition of the criteria structure: development of a criteria tree that can be used to assess the satisfaction of each sub-objective. • Definition of constraints or characteristics of areas unsuitable for the park.
B	Design	Design of proper locations for the park by: • Performing a spatial multi-criteria evaluation using the criteria structure and the set of constraints to produce suitability map.
C	Ecological threshold method	Quantifying urban green areas by: • Using the standards that are going to be illustrated in the case study.
D	Landscape ecology principle	Organizing Urban green areas by: • Applying the urban green areas on the regional scale, city scale, and the neighborhood scale.

6.4.Data Gathering and Preparation:

Data gathering means collecting all the maps and the data concerning the area of interest to be used in the following study and gathering all the maps and data that are prepared in the appropriate format to be used in GIS.

6.4.1. Types of maps needed:

To go through the methodology that has been illustrated for the case study, the following maps are going to be gathered and prepared in its appropriate format to be used through geographic information system.

A. Exiting Land use map. (10th of Ramadan):

Existing land use systems is considered as a significant input because it expresses the human impact, and influences the feasibility of developing urban green spaces. The existing land use, which includes basic habitat information, has been classified into real green spaces or evergreen spaces (parks, public green spaces, riverside green spaces, roadside green spaces, attached green spaces), non-real green spaces or open green spaces (agricultural land, cultivated alluvial land), built-up areas, and water body systems.

Built up area of the city is designed in a symmetric form around a linear axis which represents the city center, this symmetry is shown in the number of districts and neighborhood, as the city consist of 16 district and 104 neighborhood. From the first to the eighth district already executed, and the ninth, tenth, twelfth, and fourteenth district are ongoing execution. Current population number ranges from 20 thousands to 37 thousands within a district, with total population 260 thousands within the city from the first to the eighth district.

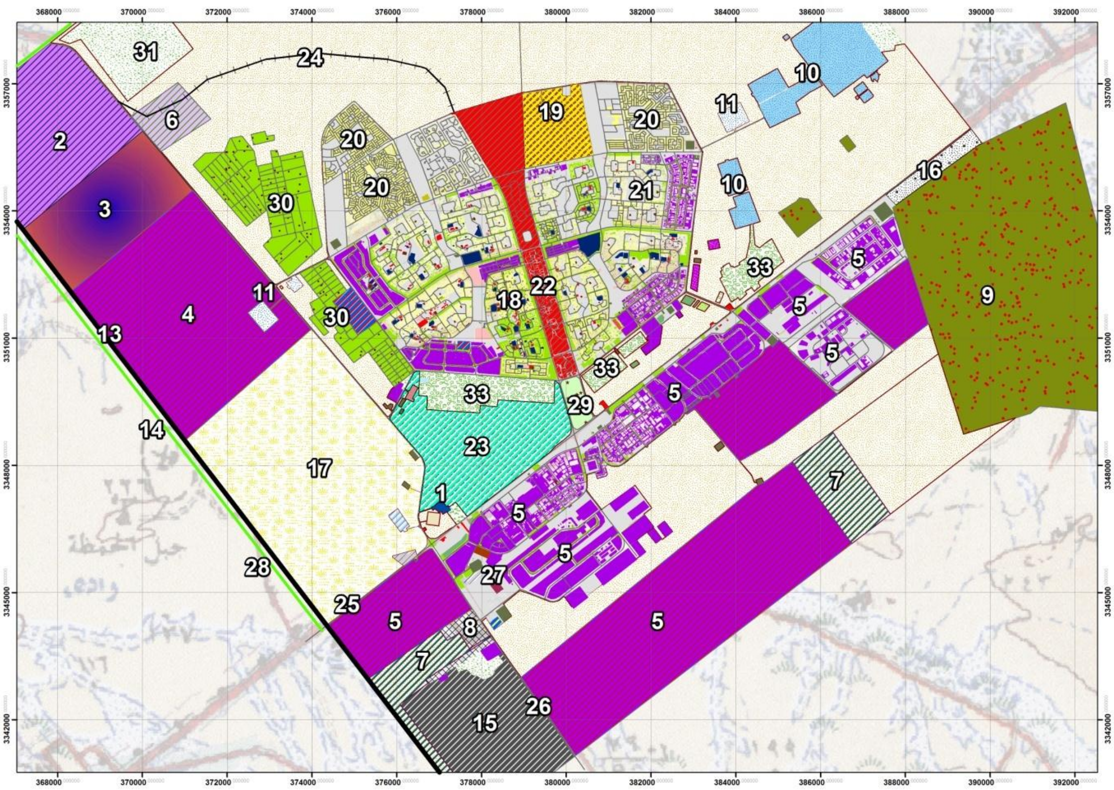


Figure 6-4 Current land use and main landmarks within the city.

(Source: Researcher)

Table 6-3 Main land uses within the city

(Source: General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development) (Source: Researcher)

Name of main Land uses within the city	Description
1- City Administrative Building	More storage areas (Ministry of Trade and Industry)
2- Industrial land	For agricultural and food processing industries (Ministry of Trade and Industry) – 2500 Fadden. Not fully developed.
3- Industrial land	To be developed (Ministry of Investments) – 1600 Fadden. Not fully developed
4- Industrial land	For storage and loading of industrial products (Ministry of Trade and Industry) – 3981 Fadden. Not fully developed
5- Industrial land	Different locations with various sizes of factories. South part of the industrial area not developed yet
6- Industrial land	More storage areas (Ministry of Trade and Industry)
7- Slaughter areas	
8- Graveyards	
9- Military land	The land used to be an industrial area but became a military camp in 2005
10- Oxidation ponds	Sewage from industrial and residential areas are collected and has been experiencing spillovers of excess sewage
11- Treatment plant	Mechanical treatment plant to help improve the sewage situation in the city
12- Land for HCWW	The land has been acquired by the Holding Company for Water and Wastewater on October 2009 (3500 Fadden)
13- Proposed regional ring road	That will improve connectivity of the city with neighboring cities
14- Water line	Water pipes that transfer water from Ismailia Canal located along the West boarders of the city.
15- Public dumps	Solid waste is collected from factories and residential areas and brought to the dump area.
16- Transformers	10RC transformers station for electricity needs of the city. Located closer to the industrial area for energy intensive factories.
17- Residential	Housing for factory workers (City Agency) – 2000 Fad
18- Residential	Villas area
19- Residential	Area not developed yet due to delays in developing 4th phase of the city

20- Residential	Units available from the National Housing Project* and Ibni Baitak "Build your House" in the 10th ,12th and 14th neighborhoods
21- Residential	Housing in neighborhoods from first two phases and some from the third phase
22- City center	
23- Area designated for commercial and tourism projects.	Currently not developed
24- Railway	Proposed railway extension that will pass through the city center
25- Cairo – Ismailia road	connects the two cities and passes through 10RC
26- Robaiki road	Connects the city to Bilbeis
27- Dry port	Facilitate import and export activities (50,000square meter)
28- Greenbelt	The designated area for this project has not been developed
29- Alkafrawi Park	
30- Agricultural land:	Farms for growing banana. Forest 5 and 2
31- Agricultural land	AlRamli Farm – 1722.901871 feddan
32- Agricultural land	Forests and agricultural land that is irrigated using treated sewage water from the oxidation ponds
33- Agricultural land	Various locations of green surfaces

B. Satellite image for 10RC.

For existing land use systems, to be able to determine vacant land from occupied one.

- Satellite image suggests around 50% of development in the residential areas.
- The city has around 95,000 housing units.
- Therefore, keeping the current density levels, the strategic plan area can accommodate at least 180,000 housing units.
- Assuming the family size stabilizes at ~ 4, the strategic plan area can accommodate 720,000 people.
- If residential allocations are further expanded and densities are increased, the city capacity can be increased to a figure in the range of 2-3 million.

Figure 6-5 Satellite image for 10th of Ramadan

(Source: Researcher)

C. Building Height Map in 10RC.

Height map was selected because of its importance in determing the population capacity.

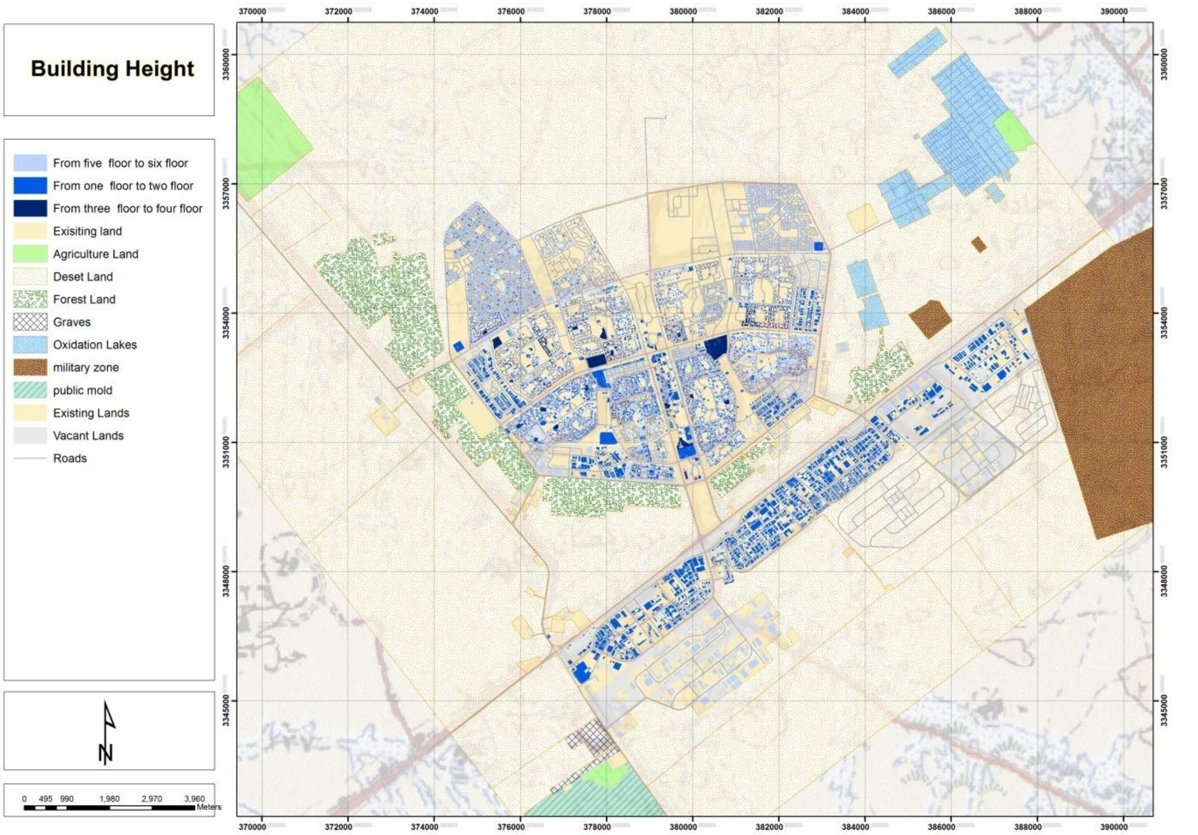


Figure 6-6 Height of the building in 10th of Ramadan

(Source: Researcher)

D. Resdential Patterns in 10RC.

This map was selected because of its importance in determing the population lifestyle.

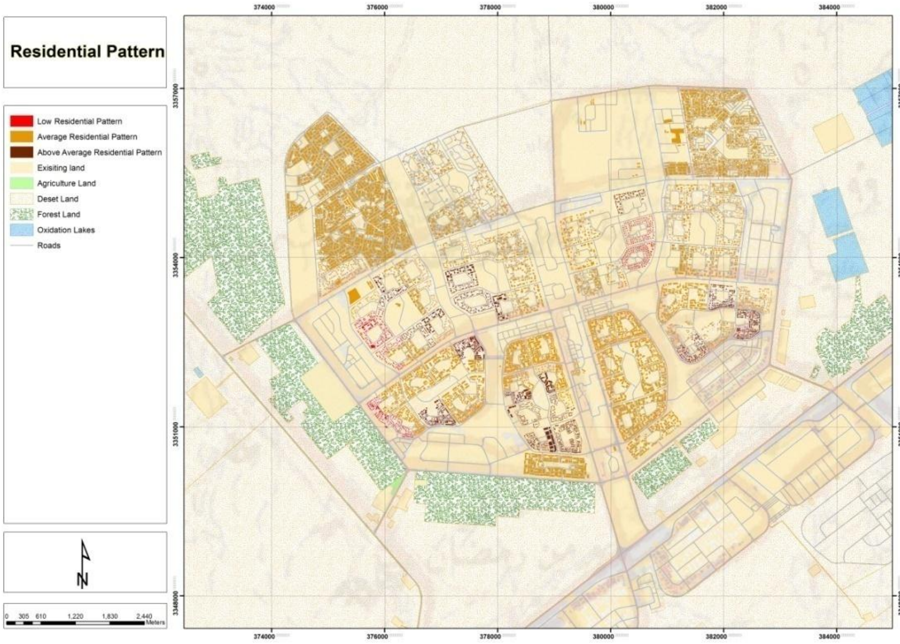


Figure 6-7 Residential Pattern in 10th of Ramadan

(Source: Researcher)

E. Industrial zones maps in 10RC.

The industrial zones map was selected because of the pollution emission that affects the air quality and accordignly increase the Co2 in the air. The industrial zones map in 10RC in divided into three zones, heavy industrial zones average industrial zones, and light industrial zones.

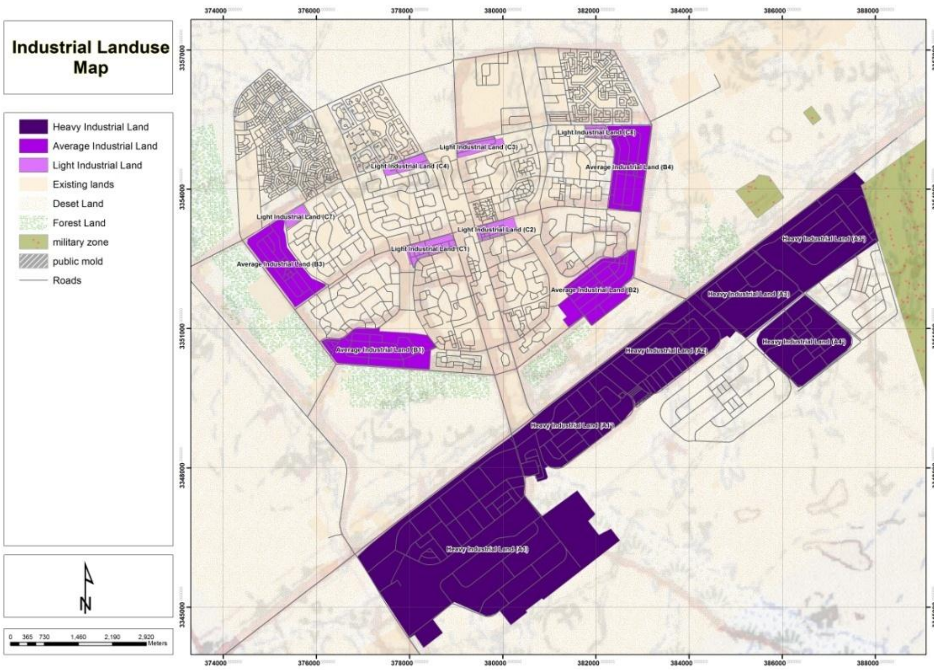


Figure 6-8 Industrial Zones in 10^{th} of Ramadan

(Source: Researcher)

F. Benefits of planning and designing urban green area.

Several studies have established relationships between different urban green structures and improved environmental functions[1]. The evidence is strong enough to make the case for the inclusion of green vegetation in urban planning, especially while planning the expansion of existing towns and in the creation of new urban settlements.

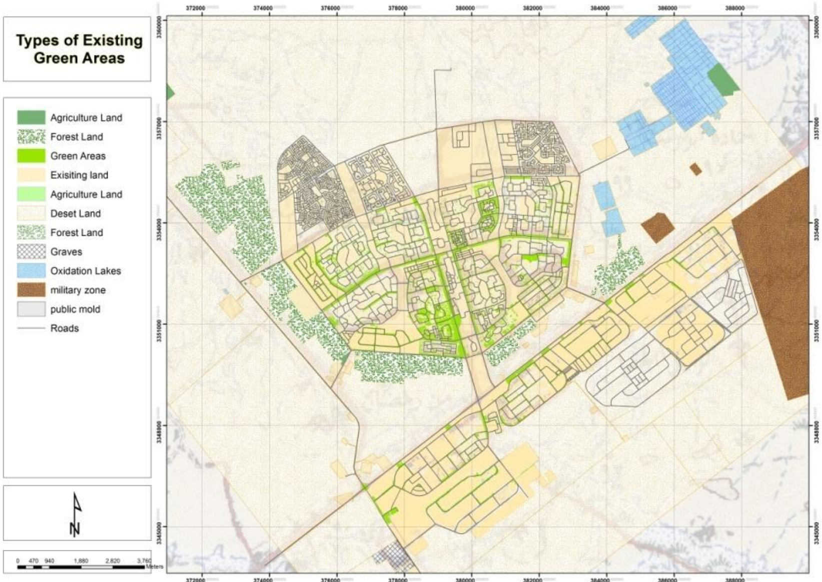


Figure 6-9 Existing green areas

(Source: Researcher)

G. Water network system in 10RC.

Almost all green spaces such as parks and public green spaces have been developed in conjunction with water bodies.

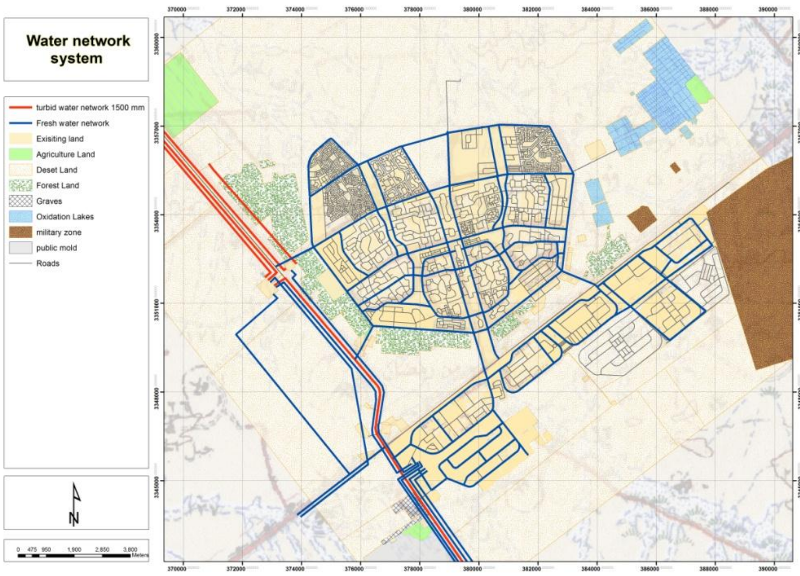


Figure 6-10 Water network system

(Source: Researcher)

[1] Yang, J., Zhao, L., McBride, J. and Gong, P. (2009) 'Can you see green? Assessing the visibility of urban forests in cities', Landscape and Urban Planning, 91, (2).

H. Air pollution maps.

Air quality was selected because of its importance in determining the pollution source and Co2 emission and availability of data.

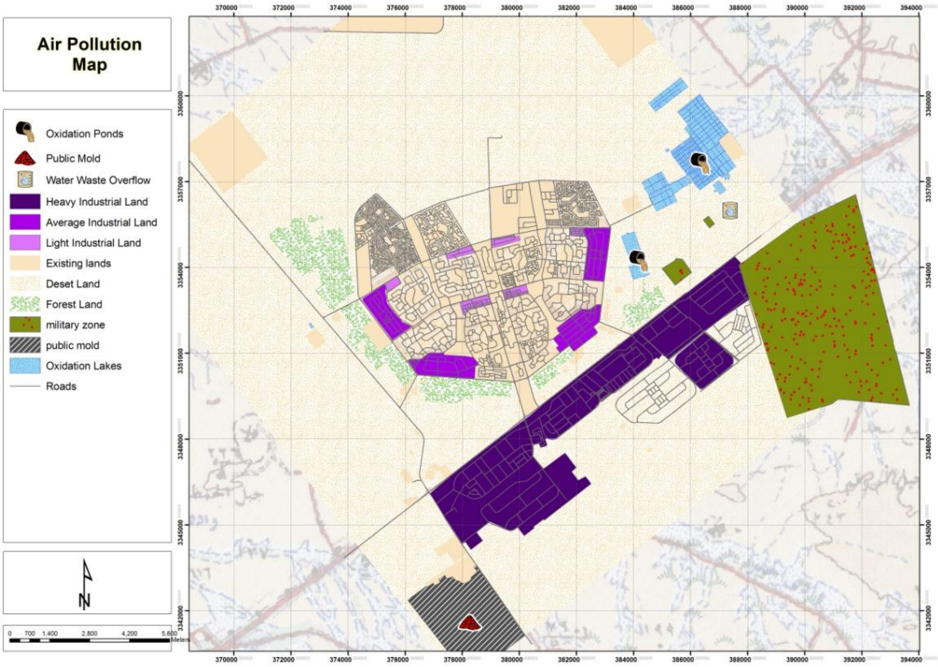


Figure 6-11 Air pollution map source

(Source: Researcher)

I. Current traffic along roads in 10RC.

This map was selected because of its importance in determing the air pollution due to transportation in the city.

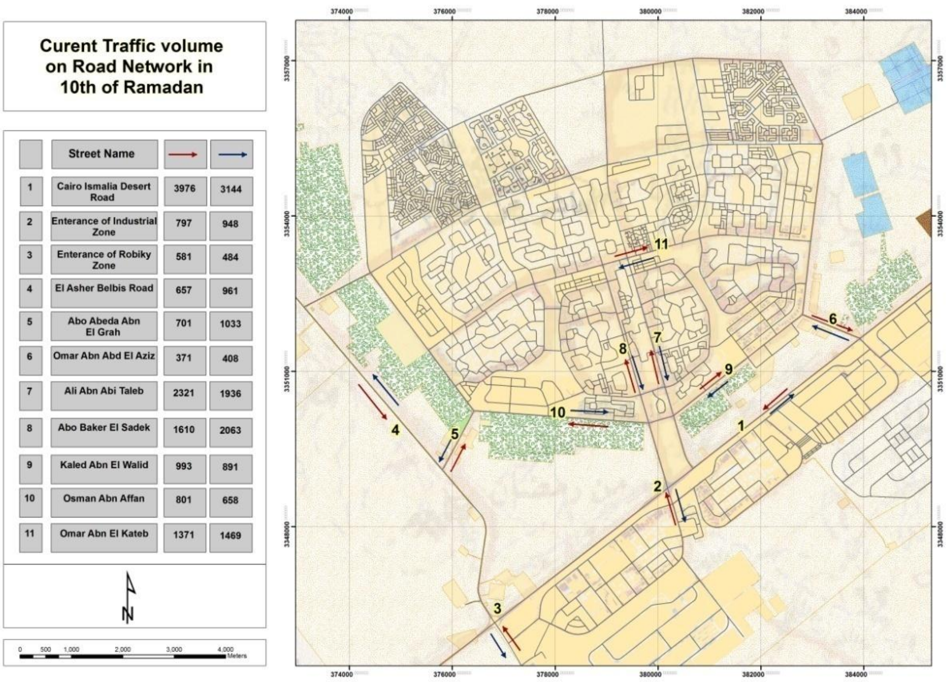


Figure 6-12A Current traffic map

(Source: Researcher)

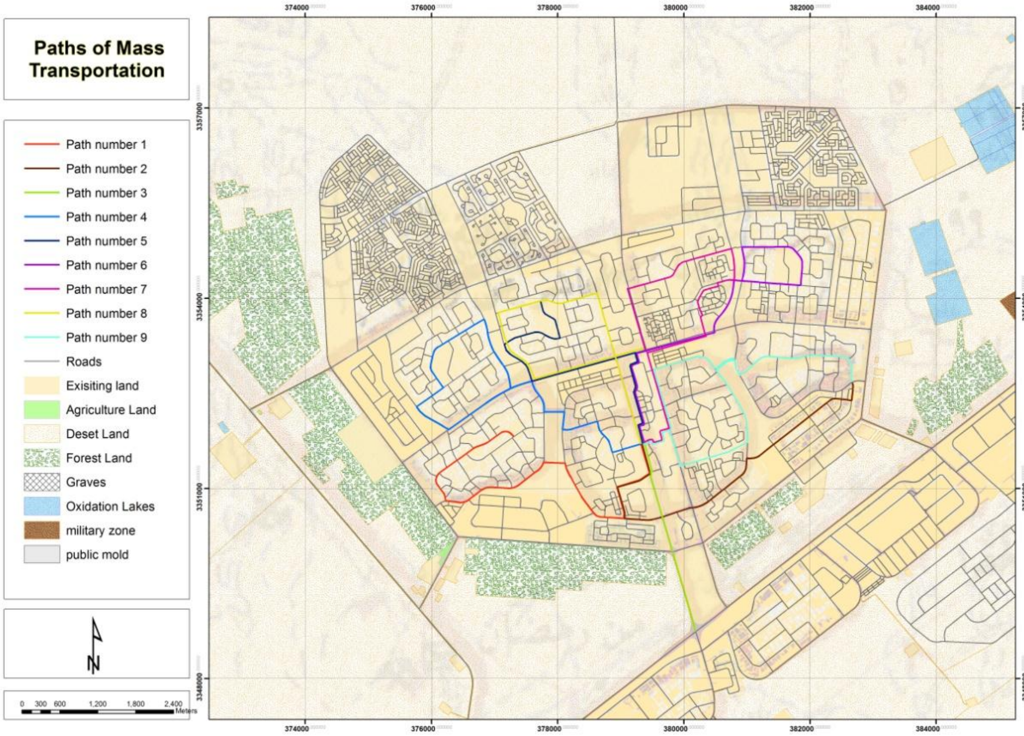


Figure 6-13 Paths of mass transportation map

(Source: Researcher)

J. Lithology (Type of soil).

This map was selected because of its importance in determing the avalibilty of the planting green areas in the soil.

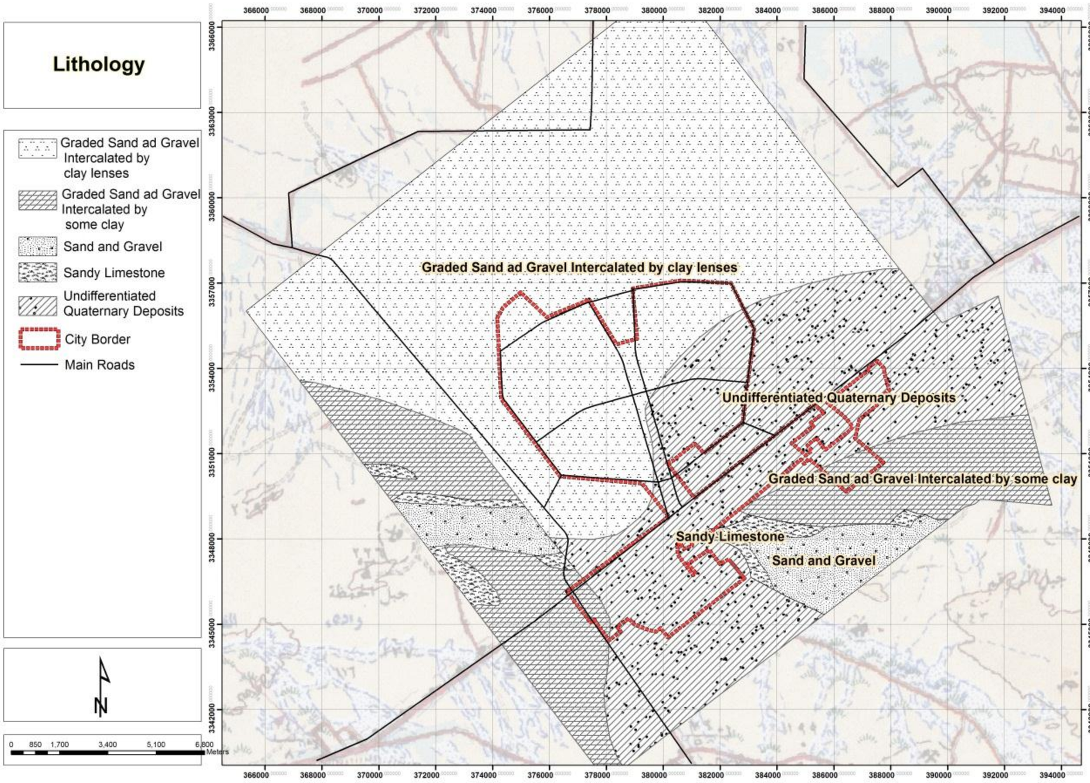


Figure 6-14 Type of soil

(Source: Researcher)

K. Ground Water Extraction:

This map was selected because of its importance in determing amount of water in the soil, and this will affect planting the green areas.

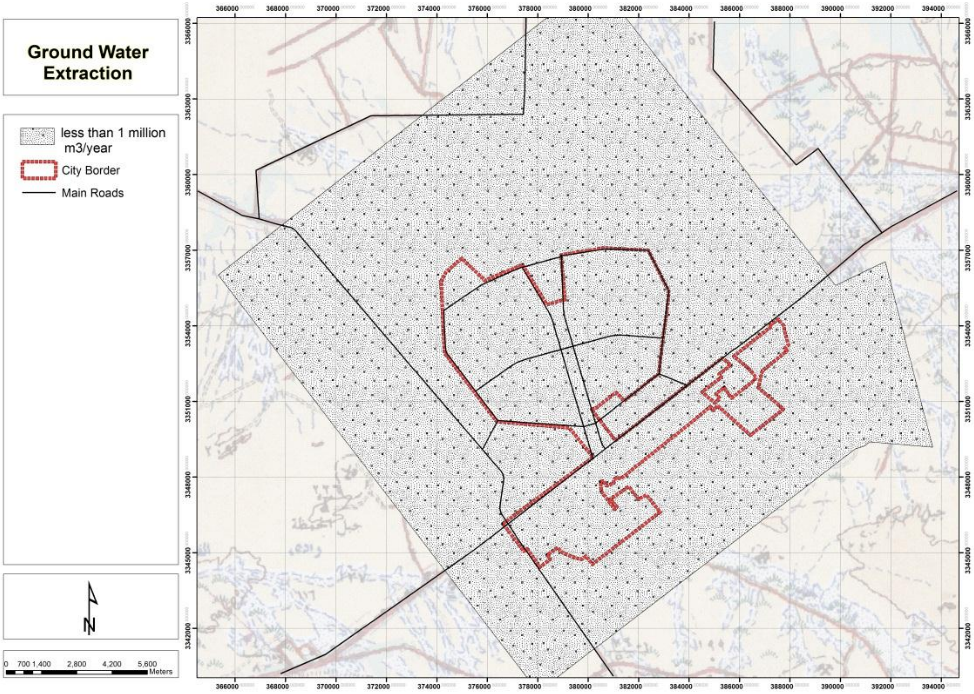


Figure 6-15 Ground water extraction of the soil

(Source: Researcher)

L. Climate Properties:

This map was selected because of its importance in determing Climate properties, and this will affect type of the green areas that will be planted in 10th of Ramadan..

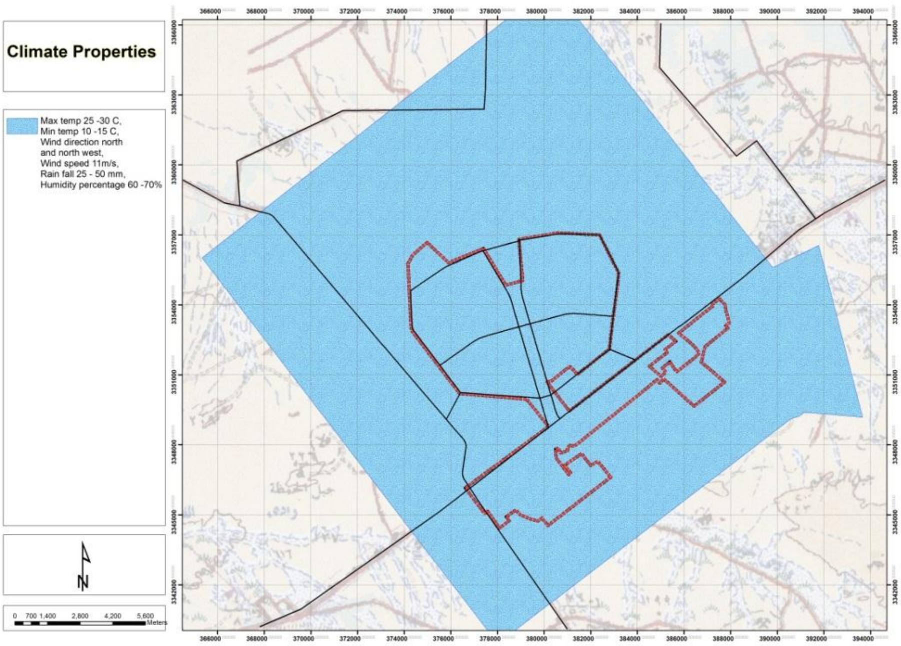


Figure 6-16 Climate properties

(Source: Researcher)

6.4.2. Types of data needed:

This point is going to illustrate all the data that is going to be used in the case study.

A. Area of different Current land use within the city:

Table 6-4 A Main land uses within the city North Cairo Ismalia Road and East El Robiky Road

(Source: General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development)

North Cairo Ismalia Road and East El Robiky Road			
Land Use	**Number**	**Area (m2)**	**Area (Feddan)**
Residential	28213	5951630.9064	1417.054978
Residential Administrative	5	4232.683636	1.007782
Residential Trade	442	127229.8494	30.2928
Residential Administrative &Trade	45	142757.8411	33.9900
Residential Handicraft	85	11183.6514	2.6628
Total Residential	28790	6237034.932	1485.008317
Educational Services	62	828833.6878	197.3414
Health Services	21	118491.3364	28.2122
Trade Services	95	288289.1200	68.6403
Trade Administrative	6	7975.8889	1.8990
Administrative Services	40	65480.7844	15.5907
Social Services	2	38424.0297	9.1486
Cultural Services	1	13871.5051	3.3027
Security Services	10	94020.1389	22.3857
General Services	3	3623.1169	0.8626
Religious Services	78	149468.0576	35.5876
Entertainment Services	13	909371.8203	216.5171
Under Construction Services	11	28695.7135	6.8323
Total Services	342	2546545.2	606.3202
Green Areas	2943	3573469.5096	850.8261
Utilities	40	270001.5265	64.2861
vacant lands	4794	14948033.2061	3559.0555
Parking Areas	447	618841.6038	147.3432
City Administrative Land	1	76172.9073	18.1364
Meteorology	1	89553.8249	21.3223

Storing Land	4	106379.0866	25.3284
Training Center	2	538170.3721	128.1358
Light Industrial Land		1299741.27115	309.462207
Average Industrial Land		5675784.164611	1351.377182
Total Industrial Land		6975525.436	1660.839389
Oxidation Lakes		6803487.8476	1619.8781
Forest Lands		11281921.742379	2686.171843
Agriculture Land		16983113.7936	4043.5985
Treatment Station Land		374913.2306	89.2651
Desert Land		136593338.6343	32522.2235
military zone		592688.2941	141.1163
Seedbed Land		124654.2421	29.6796
Poultry Farms Land		149034.9308	35.4845
Experimental Farms		4462162.7202	1062.4197

Table 6-5 Main land uses within the city North Cairo Ismalia Road and West El Robiky Road

(Source: General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development)

North Cairo Ismalia Road and West El Robiky Road		
Land Use	**Area (m2)**	**Area (Feddan)**
Industrial land for Agriculture and Food Processing Industries. (Desert Land)	10671115.239	2540.741
Industrial land to be developed ministry of investment. (Desert Land)	6743619.626	1605.623
Logistic Land Different locations for different sizes of factories. (Desert Land)	16405838.4982	3906.152
Treatment Planet. (Desert Land)	281289.43207	66.97367
Residential; Housing for factory workers. (Desert Land)	21396796.2967	5094.475
El Mokawlon Company & Crushers	257473.059837	61.303109
Utilities Land, water station	23606.04048	5.620486
Utilities Land, Power Convertor Station	29766.060862	7.087157

Table 6-6 Main land uses within the city South Cairo Ismalia Road and East El Robiky Road

(Source: General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development)

South Cairo Ismalia Road and East El Robiky Road		
Land Use	**Area (m2)**	**Area (Feddan)**
Military Zone	28845061.7046	6867.8718
Utilities Land	48338.027	11.5091
Desert Land	50454621.9025	12013.0052
Heavy Industrial Land	52707.815249	6304.370453

Table 6-7 Main land uses within the city South Cairo Ismalia Road and Westt El Robiky Road

(Source: General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development)

South Cairo Ismalia Road and West El Robiky Road		
Land Use	**Area (m2)**	**Area (Feddan)**
Public mold	8244978.382372	1963.090091
Religious Land	3428.844067	0.816391
Graves	794690.964881	189.212134
Green Areas	978.470217	0.232969
Industrial Land	146532.202195	34.88862
Industrial land: Different locations with various sizes of factories.(Desert Land)	4995192.37384	1189.331518
Slaughter areas. (Desert Land)	2717249.67745	646.964209
Agriculture Land	379555.576184	90.370375

B. Expected land use in 2032:

The expected land use for 10th of Ramadan in 2032 will be 20.9% for industrial use, 16.4% for Commercial/service use, 28.9% for Residential use, 12.0% for Infrastructure and utilities uses, 8.7% for Green belt/ open area, and 13.0% for Future expectations Expected populations in 2032: 2300000 - 2100000 people. It is assumed that 10RC’s gross residential density will gradually increase from the current level of 160 persons/hectare to 320 persons/hectare by 2032.[1]

[1]General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development, (2011), Documentation of 10th of Ramadan

C. Population carrying capacity of 10RC:

The population carrying capacity is the largest number of people that food and energy produced by ecosystems can support based on stated production conditions, land productivity, standard of living, and so on.

Table 6-8 Population carrying capacity along years

(Source: General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development)

Key data points	Estimated values	Key data points	Estimated values
Population (2006)	125,920	Housing units (2006)	95,768
Population (2009)	260,000	Housing units (2009)	118000
Population (2017)	880000	Housing units (2017)	240000
Population (2022)	1400000	Housing units (2022)	400000
Population (2027)	2100000	Housing units (2027)	615000
Population (2032)	2300000	Housing units (2032)	700000

D. Height of building

Building Height data was selected because of its importance in determing the population capacity.

Table 6-9 Building height within the city.

(Source: General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development)

Building Type	Building Height	Number of building
Residential Building	From one to two floor	17575
	From three to four floor	2427
	From five to six floor	8788
Total Services	From one to two floor	227
	From three to four floor	43
	From five to six floor	94
Industrial Building	From one to two floor	1431
	From three to four floor	3063
	From five to six floor	3

E. Residential Pattern:

This data was selected because of its importance in determing the population lifestyle and accordingly determing Co2 emission.

Table 6-10 Building pattern within the city

(Source: General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development)

Building Type	Building Pattern	Number of building
Residential Building	Low Residential Pattern	648
	Average Residential Pattern	25397
	Above Average Residential Pattern	2843

F. Type and area of the industries in 10RC

This data was selected because industrial zones are considered as one of the main activities in the city that produce CO2.

Table 6-11 Industrial zones within the city

(Source: General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development)

	Zone title	Area (Fadden)
Heavy industries zones Industrial zones A	A1	2907.183509
	A1’	746.814706
	A2	734.045602
	A3	545.947704
	A3’	825.38848
	A4’	544.990452
Average industries zones Industrial zones B	B1	374.559515
	B2	361.571335
	B3	298.24172
	B4	317.004612
Light industries zones Industrial zones C	C1	80.984359
	C2	55.601129
	C3	60.191452
	C4	51.485034
	C7	31.876618
	C8	28.323616

Engineering, chemicals, metal-based, textiles and food-processing, together, dominate the industries in 10RC, accounting for over 70% of total production, investments and employment.

Table 6-12 Industries within the city

(Source: General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development)

Industry sector	Average land area / factor (m^2)	Total land area (m2)	Number of Factories
Agriculture and livestock products	523	523	1
Food processing, beverages and tobacco	7,853	1240715	158
Textiles, garments and leather	7,345	2115298	288
Wood and wooden products	4,465	169675	38
Paper, printing and publishing	8,285	679374	82
Chemicals	7,072	2256058	319
Building materials	19,512	2256058	116
Metals	18,649	522163	28
Engineering, electrical and electronics	9,816	4358446	444
Manufacturing	2,305	39192	17
Repair and maintenance centers	400	400	1
Total	8,990	13215952	1492

G. Benefits of planning and designing urban green areas.

10th of Ramadan gets the higher amount of open green areas in Egyptian cities, green areas spreads all over the residential and industrial zones in the city. As (Barker, 1997) outlined, the multiple benefits and uses of green networks have stimulated new approaches to green space planning. Clean air is now regarded as an essential part of a good quality of life. The Department of Environment Transport and the Regions (1997) states that people have the right to expect that the air they breathe will not harm them. Here, there is an explicit assertion of the connection between environment and quality of life. There is a lot more to be done to maximize the health benefits provided by urban green areas.

H. Water Network System The supply demand equilibrium for the water resources in 10RC.

10the of Ramadan depends on two main sources of water supply which are turbid water surface from Ismailia canal (276000 m3 per day) and ground water extraction (20000 m3 per day). The city depends mainly on surface water that comes from Ismailia canal. A water station was established for the purification with production capacity of 226000 m3 per day. This station is currently feeding the city, and Badr, and El shrouk city. Water resources are an essential factor for all creatures to exist and develop. Thus, the supply–demand equilibrium of water resources, which presents to an equilibrium of demands (domestic, industrial agricultural consumptions) and supplies (rainfall, groundwater, etc.) is important for sustainable development of human in general and vegetation or green spaces in particular[1].

Table 6-13 Water sources within the city

(Source: General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development)

Water Sources			
	Ismailia Canal	**Groundwater**	**Comments**
Distance	The canal is located 20 km from the city.	24 wells are located right outside the city near Bilbeis road.	The bulk of the water comes from Ismailia Canal.
Water pumps and stations	Ismailia canal water fed two purification stations through three pumping stations.	The groundwater production field has two pumping stations. No treatment stations are needed.	There is a problem in transporting water pressure to the city
Capacity	The capacity of the water treatment stations has undergone several expansions to reach a level of production of 571,000 m³/day	Estimated production of groundwater in the city is 20,000m³/day.	Expansions to Ismailia canal are crucial to meet expected demand growth.

[1]General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development, (2011), Documentation of 10th of Ramadan

I. Current traffic:

Current traffic in 10th of Ramadan data is selected because traffic is considered as one of the main source of pollution.

Table 6-14 Average traffic volume within the city

(Source: General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development)

Street Name	Average annual daily traffic volume		Average daily traffic volume		First Direction Description	Second Direction Description	Total Average Annual daily traffic volume	Total Average daily traffic volume
	First Direction	Second Direction	First Direction	Second Direction				
Cairo – Ismailia desert road	53013	41923	33133	26202	To Cairo	To Ismailia	94936	59335
10th of Ramadan – Belbis road	8760	12812	5475	8008	Going to Belbis	Coming from Belbis	21572	13483
El Robiki Entrance	7742	6451	4839	4032	To El Swis	To Cairo Ismailia	14193	8871
Entrance of Industrial zone	10623	12644	6640	7903	Coming to industrial zone	Out from industrial zone	23267	14543
Abo Baker El Sadek	25752	33012	16095	20633	To the city	Out from the city	58764	36728
Omar Abn El Kateb	21935	23500	13710	14688	To the east	To the west	45435	28398
Osman Abn Afan	10525	12813	6579	8008	To Abo Baker El sadeek	To Abo Abida abn El grah	23338	14587
Ali Abn Abi Taleb	37141	30974	23213	19359	To the east	To the west	68115	42572
Kaled Abn El waleed	14250	15877	8907	9924	To Omar Abn Abd El Aziz	To Ali Abn Abi Taleb	30127	18831
Omar Abn Abd Elaziz	5927	6521	3711	4076	To the city	Out from the city	12458	7787
Abo Abyda El Grah	16521	11214	10326	7009	To the city	Out from the city	27735	17335

Table 6-15 Different type of average traffic volume within the city

(Source: General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development)

Road Name	Total Average daily traffic volume	Number of average daily cars	Number of average daily taxi	Number of average daily vans	Number of average daily buses	Number of average daily motorcycle
Ossman Abn Afan Street	14587	8462	1370	3768	0	987
Abo Baker El Sadeek Street	36728	20718	7980	5800	0	2230
Kaled Abn El Wleed Street	18831	10968	1768	4865	0	1230
10th of Ramadan - Belbis Street	13483	5573	590	6599	576	145
Misr - Esmalia Street	59335	16878	5789	34788	1100	780
Omar Abn Abd El Aziz Street	7787	2255	1187	2760	598	987
Omar Abn El Kateb Street	28398	8461	6598	11359	0	1980
Enterance of industrial zone	14543	1795	967	10789	598	394
Enterance of Robiki	8871	1133	361	5623	1178	576
Ali Abn Abi Taleb Street	42572	21785	6598	11800	0	2389
Abo Abyda El Grah	17335	7620	2761	5321	743	890

Table 6-16 Number of local buses within the city

(Source: General Organization for Physical Planning Ministry of Housing, Utilities and Urban Development)

Paths number	number of local busses
Path number 6	274
Path number 1	271
Path number 2	215
Path number 3	113
Path number 4	242
Path number 5	251
Path number 7	269
Path number 8	247
Path number 9	284

There is no relation between Cairo railways and 10th of Ramadan except the railway (Ain Shams – El Suez) that passes south the industrial zone which is 120m kilometer in length, and approximately 12 daily working trains (both ways) with a passenger carrying capacity of approximately 600 passenger per trip in summer and 40 passenger per trip in winter, together with strategic goods transportation according to the military requirements.

J. Carbon oxygen balance.

The carbon– oxygen balance is the most influential factor. It relates to the total of carbon emission by human as well as natural activities, and to absorbing carbon dioxide and releasing oxygen in photosynthesis of green plants. In green space planning, the carbon–oxygen balance is carried on the basis of constant adjustment of green plants of green spaces and various kinds of oxygen consuming activities.

K. Climate Changes:

The climate in 10^{th} of Ramadan is characterized by being warm in the summer and moderate in the winter, mean monthly maximum temperatures from 25 to 30 degrees Celsius and minimum temperature between 10 and 15 degrees Celsius. The prevailing wind in the area of study is north and north east, in winter there is the cold North West wind, and in spring the area of study is witnessing the sirocco during the period from March to May, these winds carrying sand and dust from the surrounding desert. By 90% all over the year, the wind speed did not exceed 11m/sec. The average annual rain fall from 25 – 50 mm. The humidity percentage ranges between 60% - 70%.

L. Soil Properties:

The soil in 10^{th} of Ramadan composed of two types of sand, low adhesive and high adhesive particles, these particles size changes from smooth to rough and sometimes it is mixed with clay and small rocks.

It can be concluded that according to the previous overview of the city, it is considered as a leading industrial city, the economy of the city is mainly focused on industrial activities, nearly all employment in the city works is in the industrial sector, and the price of land within the city that is allocated for other uses become very high due to high demand for industrial land.

6.5.Data Base Design and System Structure:

This study introduces a new technique for developing green spaces in urban areas through:

1. Intelligence through Development of a conceptual framework.
2. Design of proper location for the park by land suitability analysis using new methods and technique.
3. Quantifying green areas based on the ecological factor threshold method to maintain ecological balance.
4. Applying landscape-ecology principles in organizing green spaces in urban areas.

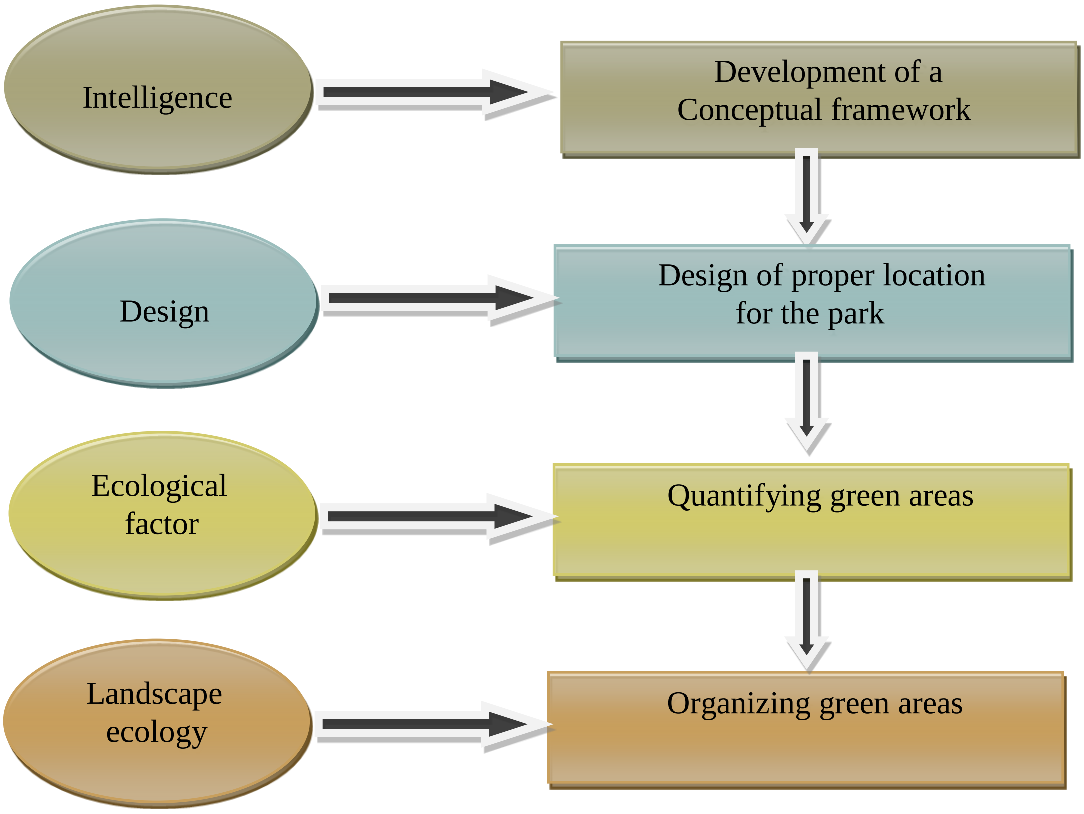


Figure 6-17 The steps involved in the development of green spaces in 10th of Ramadan

(Source: Researcher)

6.5.1. Development of a Conceptual Framework:

To define the criteria structure for the design of suitable sites in the study area, it was first necessary to identify the main goal of urban green spaces. The main goal of the green spaces is considered as the protection and improvement of the environmental quality of the territory. The goal could be met through the following objectives:

A. Protection of valuable areas.
B. Restoration of degraded situations.

A. The degree of satisfaction of the first objective, ‘‘protection of valuable areas’’, was measured through the following criteria:

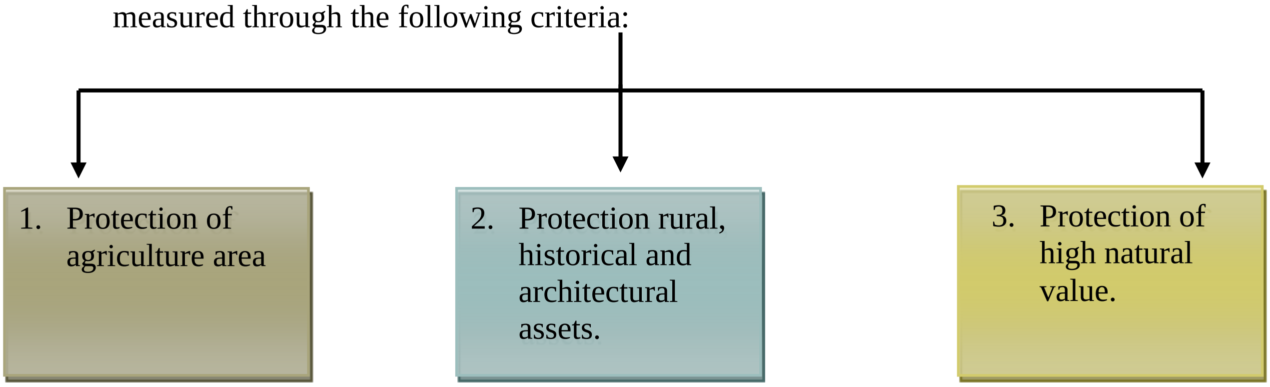


Figure 6-18 Steps of protection of valuable area.

(Source: Researcher)

1. Protection of agricultural areas: from a sustainable development point of view, it was not enough to protect single assets. It was also necessary to reduce pressures on the environment related to the human activities, and to enhance the regeneration capability of natural resources, favoring more sustainable forms of utilization. Agricultural areas could play an important role in this. Moreover, they could have a connective function between natural areas.

2. Protection and enhancement of rural, historical and architectural assets: in a territory characterized by a strong human influence, the presence of some heritage elements could contribute to the environmental quality.

3. Protection of assets of high natural value: to protect biodiversity it was important to preserve the existing natural values, e.g., forests, geologic and geomorphologic assets, by including them in the park.

B. Satisfaction of the second objective, ‘‘restoration of degraded situations’’, was measured through the following criteria:

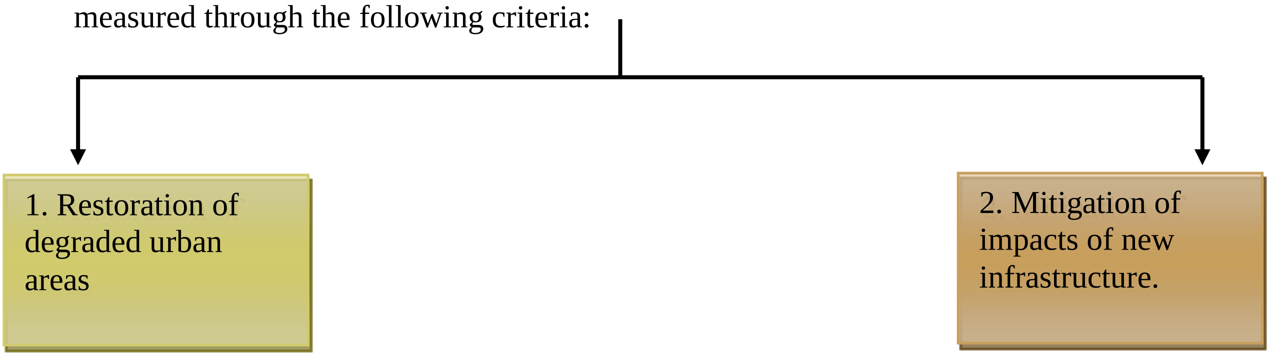


Figure 6-19 Steps of restoration of degraded situation

(Source: Researcher)

1. Restoration of degraded urban areas: the establishment of urban green areas could offer a good opportunity to restore degraded situations that are resulting from some particular human activities, such as quarry areas or former industrial areas.
2. Mitigation of environmental compensation for impacts of new infrastructures: the park could be a good opportunity to mitigate or to compensate for a new unavoidable human impact, such as a new motorway.

The following figure is going to summarize the criteria structure for the design of suitable sites for urban green areas within a new city.

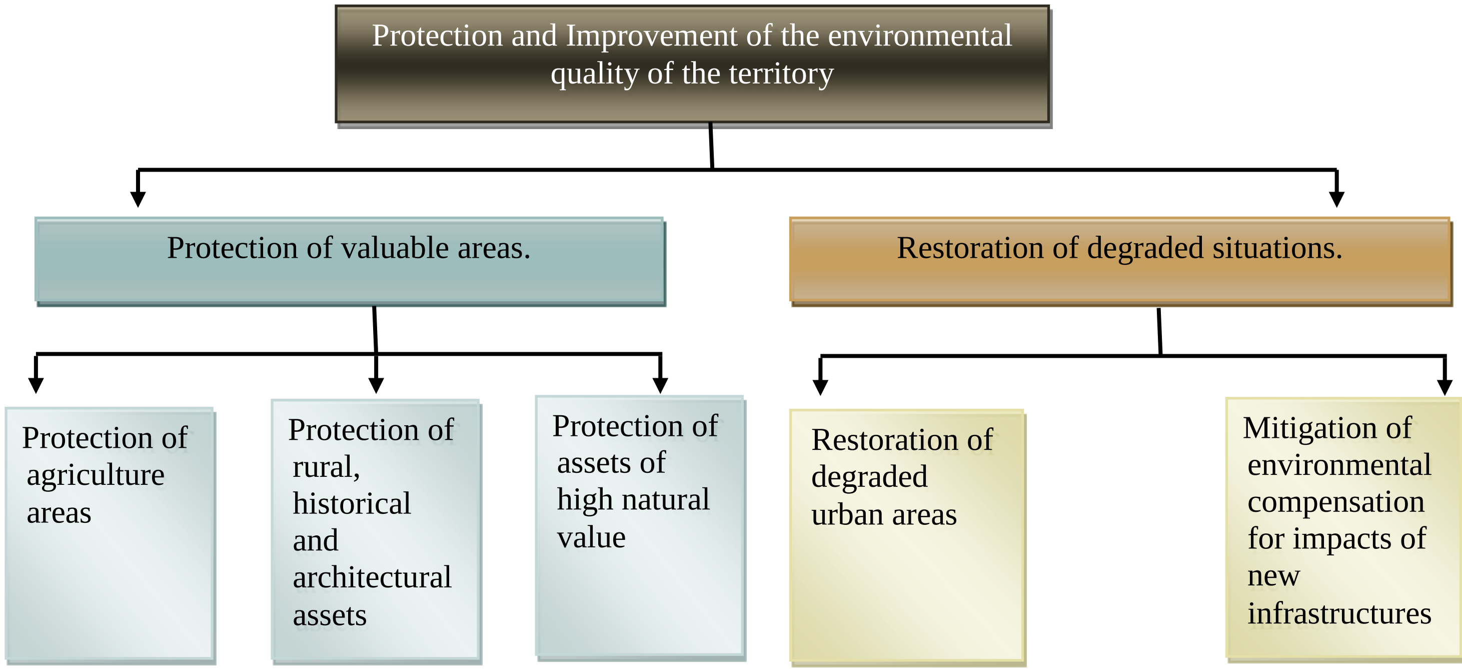


Figure 6-20 A figure shows the criteria tree constructed for assessing the suitability of each area

(Source: Researcher)

6.5.2. Design of Proper Location for Urban Green Spaces.

The research is going illustrate a way that is proposed for the design of proper location for the urban green areas within a city using land suitability analysis based on GIS

A. Land Suitability Analysis Based on GIS.

Land suitability step is going to be applied in GIS through the Raster analysis using the following maps, these maps are (land use, Lithology, pollution, climate properties, ground water extraction, and water network system).

The legend of these maps shows the following suitability for raster maps:

Table 6-17 Suitability Score

(Source: Researcher)

Suitability Score	Description
0	Not suitable
1	Low Suitability
2	Moderate Suitability
3	Suitable
4	High Suitable

The following table shows the raster maps concerning the case study to determine land suitability map of green areas.

Table 6-18 Land Suitability Maps for green areas

(Source: Researcher)

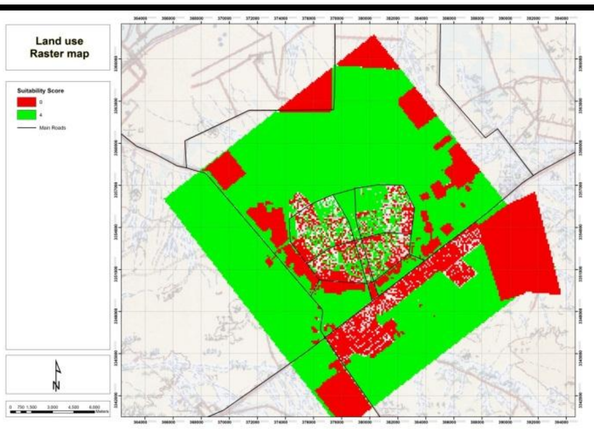


Figure 6-21 Raster Land Use map

(Source: Researcher)

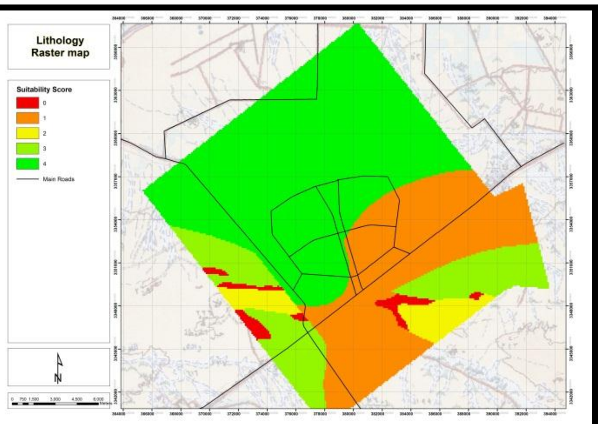


Figure 6-22 Raster Lithology Map

(Source: Researcher)

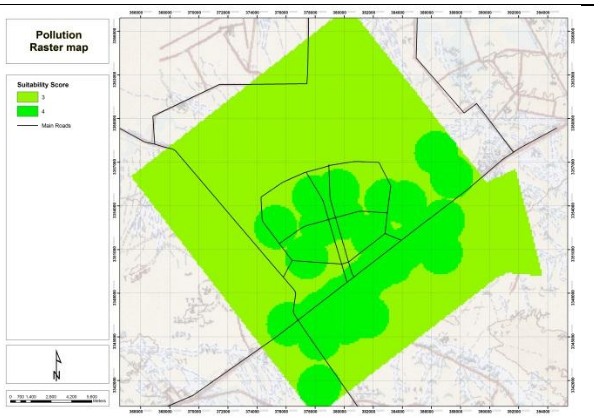


Figure 6-23 Raster Pollution Map

(Source: Researcher)

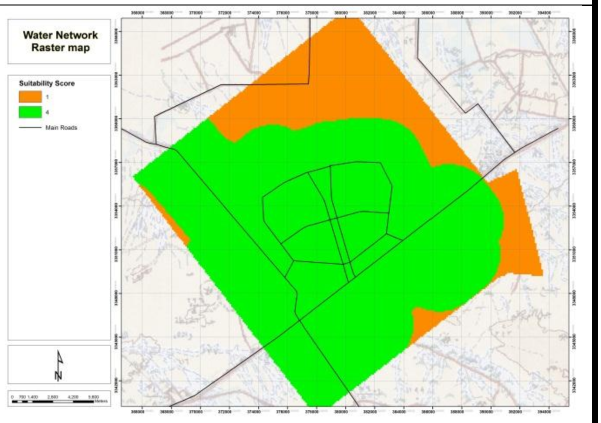


Figure 6-24 Raster Water Network Map

(Source: Researcher)

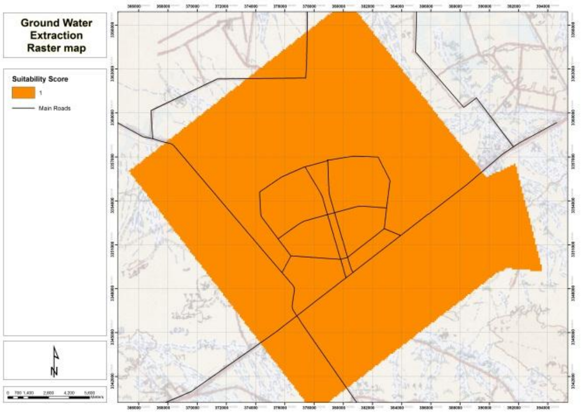


Figure 6-25 Raster Ground Water Extraction Map

(Source: Researcher)

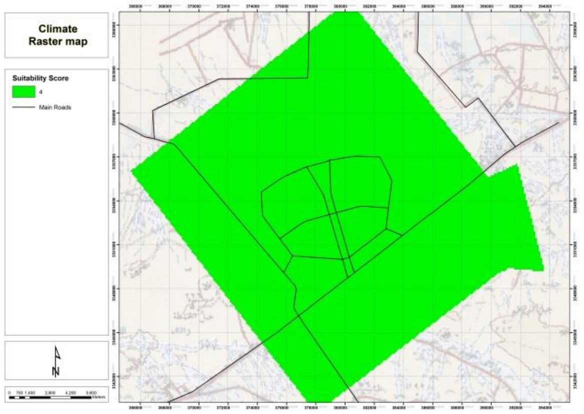


Figure 6-26 Raster Climate Map

(Source: Researcher)

All the previous maps have been gathered by the weighted sum tool in the GIS by taking into consideration all the weights that has been assigned to each map, and also the suitability score of each cell.

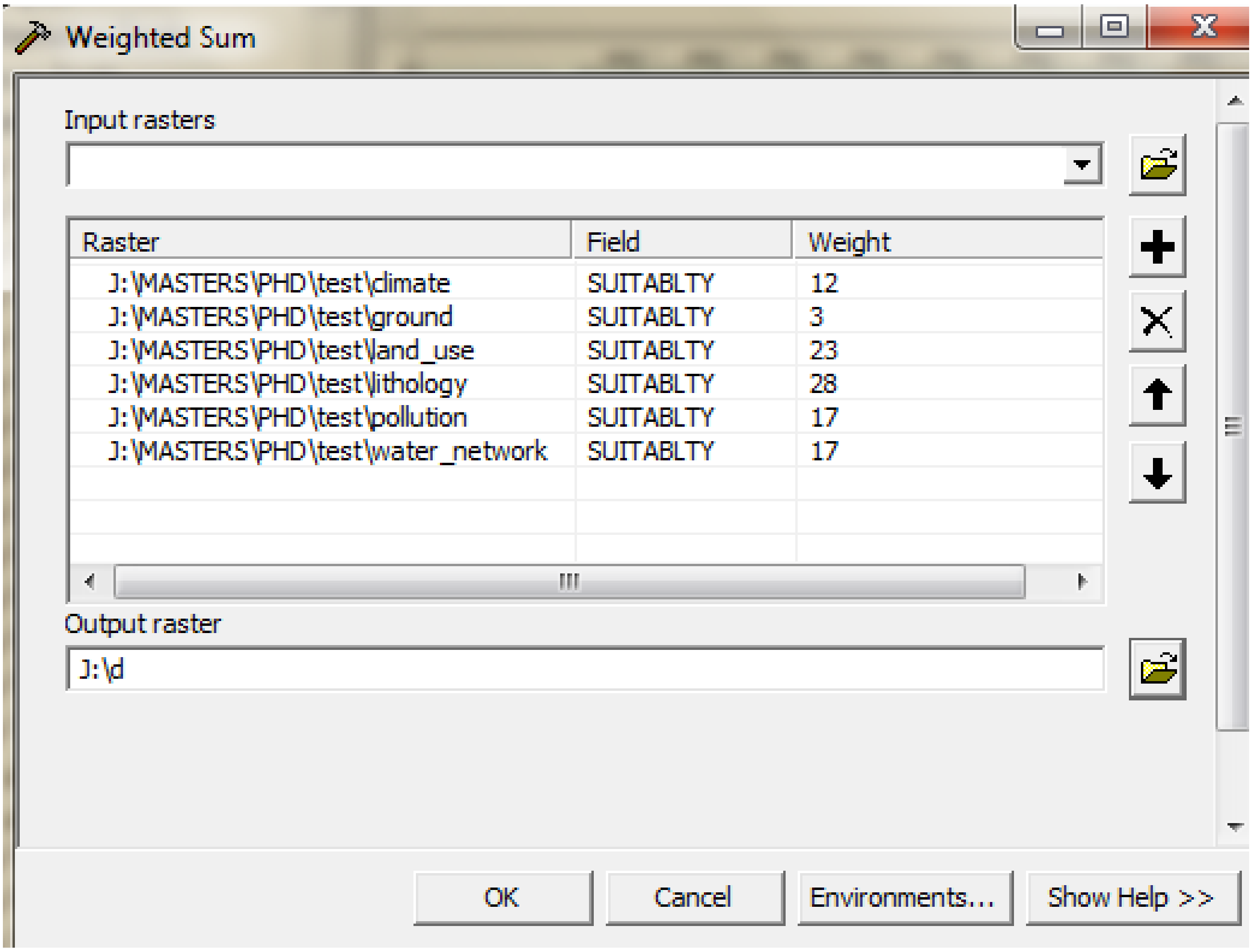


Figure 6-27 Weighted Sum Tool in GIS

(Source: Researcher)

The previous tool will generate the following Suitability map

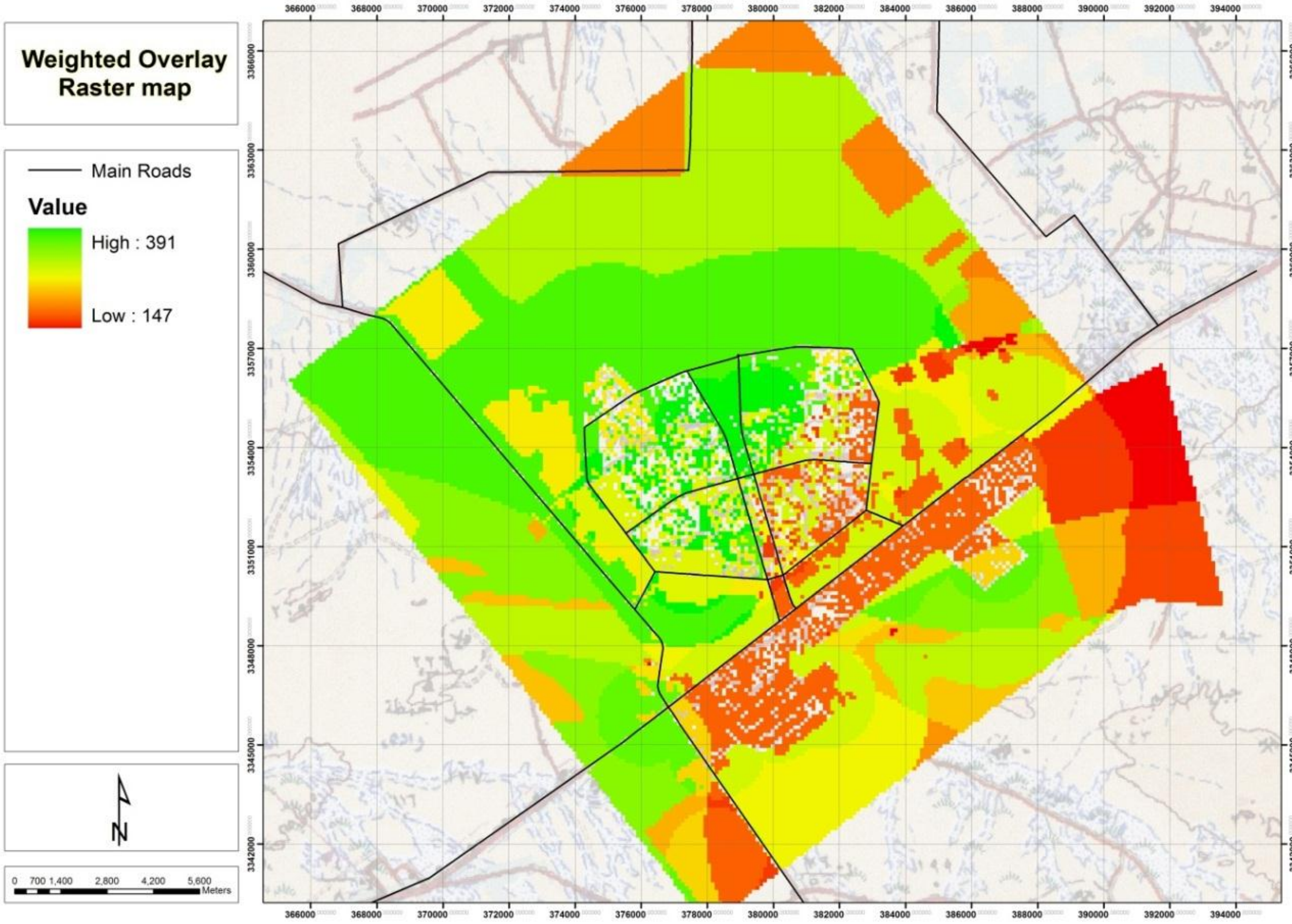


Figure Error! No text of specified style in document.**-2 Land Suitability map**

(Source: Researcher)

6.5.3. The ecological factor threshold method:

The ecological threshold method is going to be calculated through GIS model that is will calculate CO2 emission according to the different uses in the new city.

A. The steps used to calculate CO2 emission for ground based transportation will be applied on the main street in 10th of Ramadan as the numbers of different ways of transportation are available in theses streets:

Here is the model that has been created to be run in GIS to calculate the CO2 emission.

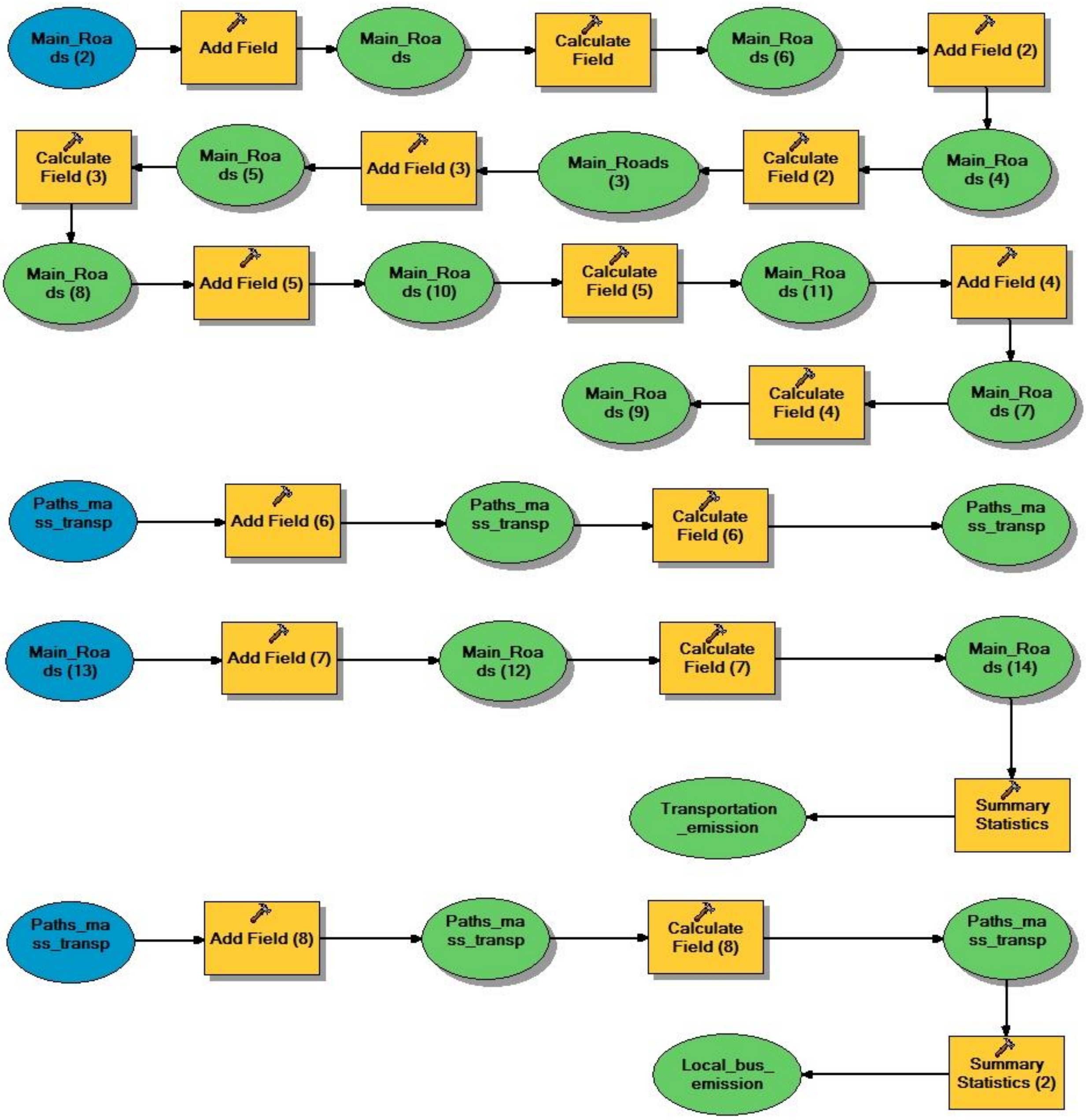


Figure 6-29 GIS Transportation Model.

(Source: Researcher)

The following steps are going to illustrate the previous model:

- Select by attribute all the streets in the main roads, then create a field called named CO2 emission cars and field calculator on this field to write the following equation (Length in KM * number of cars * 207.0 / 1000000).

- Select by attribute all the streets in the main roads, then create a field called named CO2_emission_taxi and field calculator on this field to write the following equation (Length in KM * Number_of_taxis * 168.5 * 1.45 / 1000000).

- Select by attribute all the streets in the main roads, then create a field called named CO2_emission_vans and field calculator on this field to write the following equation (Length in KM * number_of_vans * 266.1 / 1000000).

- Select by attribute all the streets in the main roads, then create a field called named CO2_emission_long_dist_buses and field calculator on this field to write the following equation (Length in KM * Number_of_long_distance_buses * 107.3 * 9.7 / 1000000).

- Select by attribute all the streets in the Path of mass transportation, then create a field called named CO2_emission_local_buses and field calculator on this field to write the following equation (Length in KM * Number_of_local_buses * 107.3 * 9.7 / 1000000).

- Select by attribute all the streets in the main roads, then create a field called named CO2_emission_motorcycle and field calculator on this field to write the following equation (Length in KM * number_of_motorcycles * 105.9 / 1000000).

Finally by running this model the following table is generated:

Table 6-19 CO2 Transportation Emission

(Source: Researcher)

Co2 emission					
Cars Ton / Year	Taxi Ton / Year	Vans Ton / Year	Motorcycle Ton / Year	Long bus Ton / Year	Local bus Ton / Year
232.35	85.05	262.17	11.58	39.98	15.8

The Total Co2 emitted from transportation = 646.93 Ton / Year

B. The steps used to calculate CO2 emission for different building uses along the city will be applied on all the building in the city by categorization the buildings into 11 main types:

Here is the model that has been created to be run in GIS to calculate the CO_2 emission.

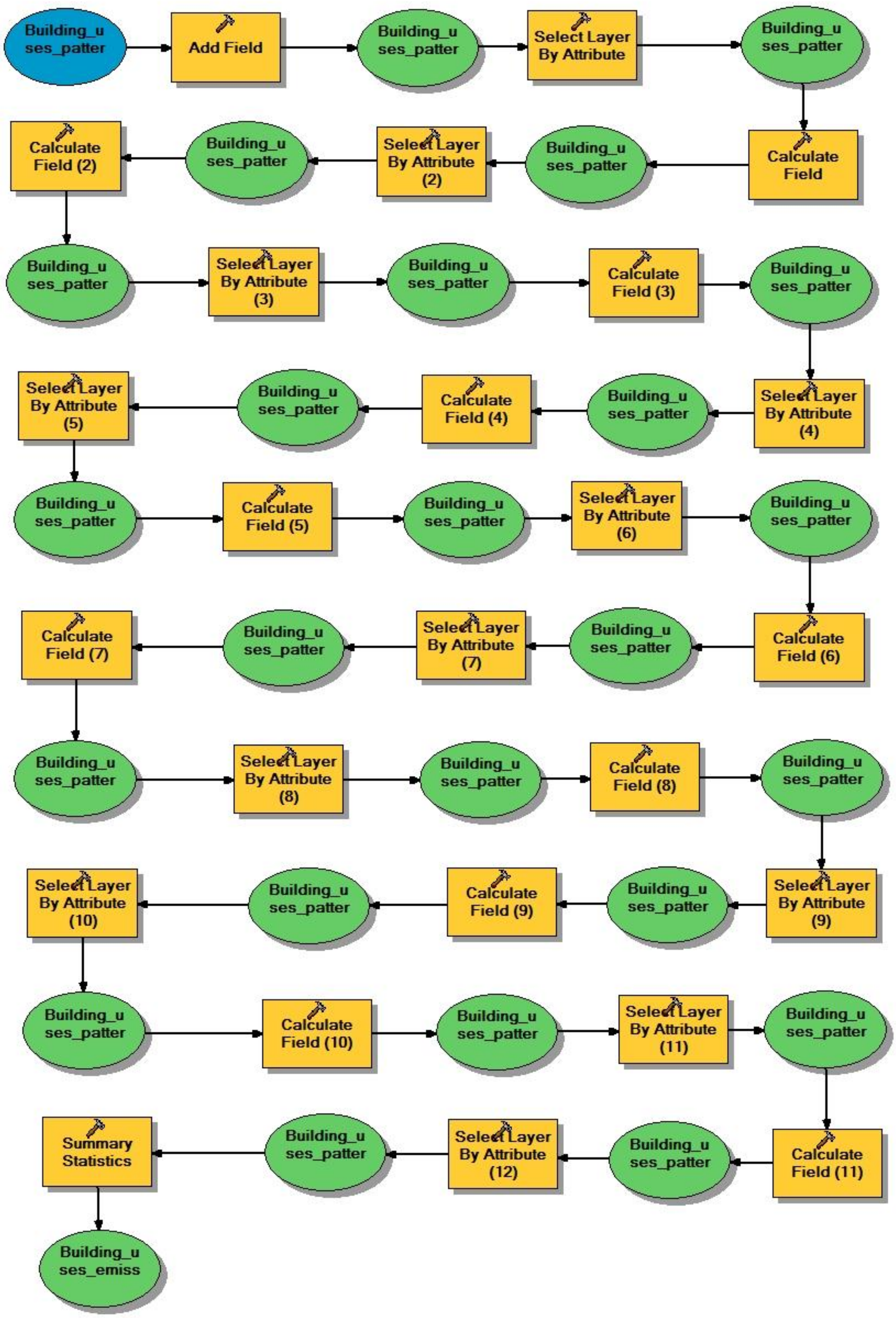


Figure 6-30 The GIS Building use Model

(Source: Researcher)

The following steps are going to illustrate the previous model:

- Create a field (double) named CO2_emission_building_uses in the feature class building_uses_pattern and then select by attribute building_uses_pattern = Mixed Residential above average, then field calculator on the double field to write the following equation = (Shape area in m2 * 30 / 1000).

- In the feature class building_uses_pattern and then select by attribute building_uses_pattern = Mixed Residential average, then field calculator on the double field to write the following equation = (Shape area in m2 * 24 / 1000).

- In the feature class building_uses_pattern and then select by attribute building_uses_pattern = Mixed Residential low, then field calculator on the double field to write the following equation = (Shape area in m2 * 20 / 1000).

- In the feature class building_uses_pattern and then select by attribute building_uses_pattern = Administrative, then field calculator on the double field to write the following equation = (Shape area in m2 * 67 / 1000).

- In the feature class building_uses_pattern and then select by attribute building_uses_pattern = Hospital, then field calculator on the double field to write the following equation = (Shape area in m2 * 88 / 1000).

- In the feature class building_uses_pattern and then select by attribute building_uses_pattern = Commercial, then field calculator on the double field to write the following equation = (Shape area in m2 * 164 / 1000).

- In the feature class building_uses_pattern and then select by attribute building_uses_pattern = Cultural, then field calculator on the double field to write the following equation = (Shape area in m2 * 35 / 1000).

- In the feature class building_uses_pattern and then select by attribute building_uses_pattern = Education, then field calculator on the double field to write the following equation = (Shape area in m2 * 13 /1000).

- In the feature class building_uses_pattern and then select by attribute building_uses_pattern = Entertainment, then field calculator on the double field to write the following equation = (Shape area in m2 * 80 / 1000).

- In the feature class building_uses_pattern and then select by attribute building_uses_pattern = Religious, then field calculator on the double field to write the following equation = (Shape area in m2 * 56 / 1000).

- In the feature class building_uses_pattern and then select by attribute building_uses_pattern = Utilities, then field calculator on the double field to write the following equation = (Shape area in m2 * 125/ 1000).

Finally by running this model the following table is generated:

Table 6-20 CO2 Building Use Emission

(Source: Researcher)

Building use	CO2 Emission Ton/year
Administrative	11.2864
Commercial	28.0114
Cultural	0.0827
Education	1.5287
Entertainment	0.9620
Hospitals	2.7818
Mixed Residential Above Average	17.8647
Mixed Residential Average	129.1622
Mixed Residential Low	3.2087
Religious	2.8658
Utilities	5.7290
Total	203.48

The Total Co2 emitted from building use = 203.48 Ton / Year

C. The steps used to calculate CO2 emission for industrial zones along the city will be applied by categorization according to the industrial types:

Here is the model that has been created to be run in GIS to calculate the CO2 emission.

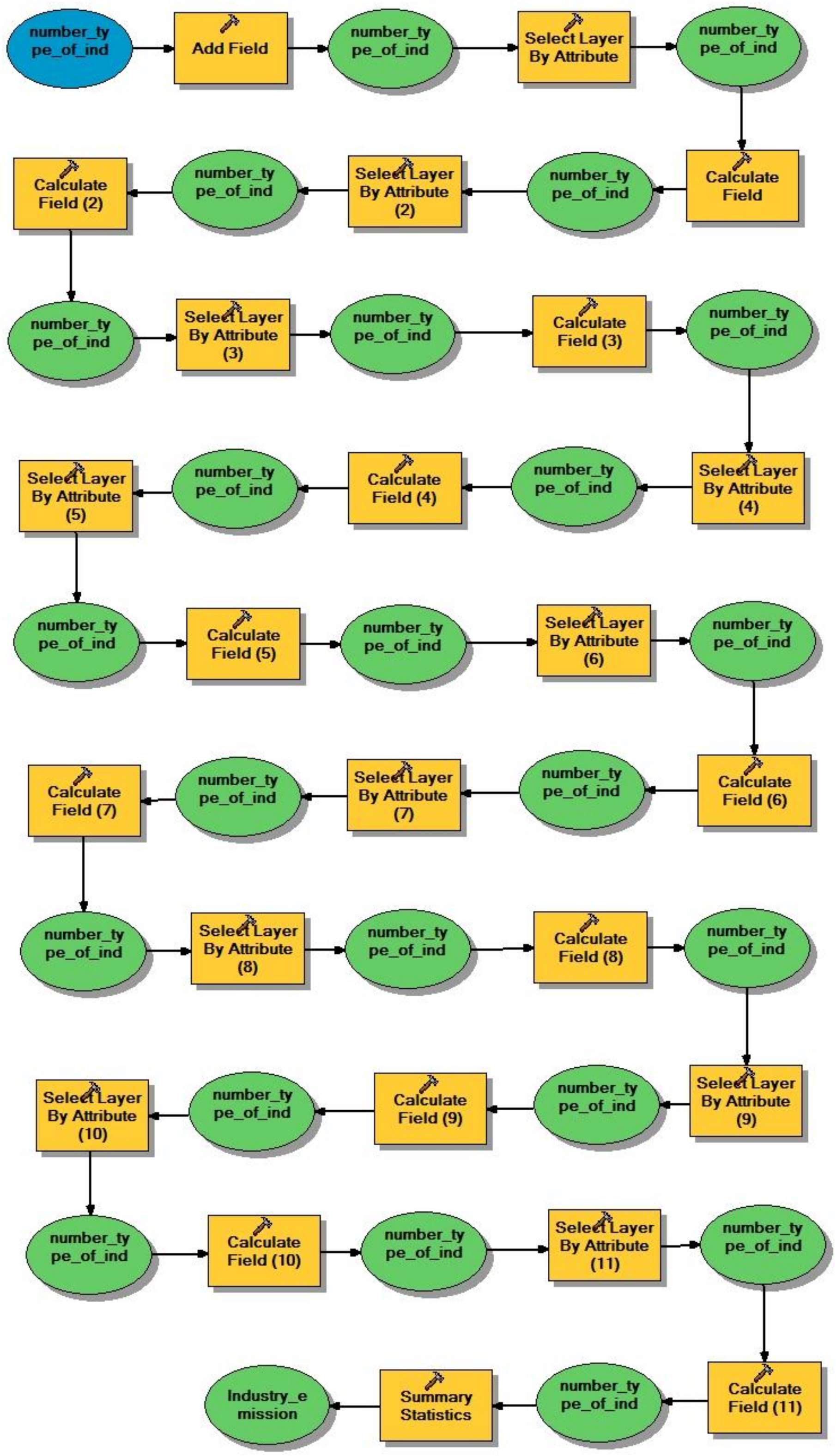


Figure 6-31 CO2 Industrial Zones Emission Model

(Source: Researcher)

The following steps are going to illustrate the previous model:

- Create a field (double) named CO2_emission_Industrial_zone in the feature class Industry_Type and then select by attribute Industry_Type = Agriculture and livestock products, then field calculator on the CO2_emission_Industrial_zone to write the following equation = (310.7 Ton per year * number of Factories in 10th of Ramadan).

- In the feature class Industry_Type and then select by attribute Industry_Type = Food processing, beverages and tobacco, then field calculator on the CO2_emission_Industrial_zone to write the following equation = (Ton per year * number of Factories in 10th of Ramadan).

- In the feature class Industry_Type and then select by attribute Industry_Type = Textiles, garments and leather, then field calculator on the CO2_emission_Industrial_zone to write the following equation = (Ton per year * number of Factories in 10th of Ramadan).

- In the feature class Industry_Type and then select by attribute Industry_Type = Wood and wooden products, then field calculator on the CO2_emission_Industrial_zone to write the following equation = (987.6 Ton per year * number of Factories in 10th of Ramadan).

- In the feature class Industry_Type and then select by attribute Industry_Type = Paper, printing and publishing, then field calculator on the CO2_emission_Industrial_zone to write the following equation = (949.9 Ton per year * number of Factories in 10th of Ramadan).

- In the feature class Industry_Type and then select by attribute Industry_Type = chemicals, then field calculator on the CO2_emission_Industrial_zone to write the following equation = (5977.8 Ton per year * number of Factories in 10th of Ramadan).

- In the feature class Industry_Type and then select by attribute Industry_Type = building materials, then field calculator on the CO2_emission_Industrial_zone to write the following equation = (2176.5 Ton per year * number of Factories in 10th of Ramadan).

- In the feature class Industry_Type and then select by attribute Industry_Type = Metals, then field calculator on the CO2_emission_Industrial_zone to write the following equation = (10578.2 Ton per year * number of Factories in 10th of Ramadan).

- In the feature class Industry_Type and then select by attribute Industry_Type = Engineering, electrical and electronics, then field calculator on the CO2_emission_Industrial_zone to write the following equation = (789.5 Ton per year * number of Factories in 10th of Ramadan).

- In the feature class Industry_Type and then select by attribute Industry_Type = Manufacturing, then field calculator on the CO2_emission_Industrial_zone to write the following equation = (1767.6 Ton per year * number of Factories in 10th of Ramadan).

- In the feature class Industry_Type and then select by attribute Industry_Type = Repair and maintenance centers, then field calculator on the CO2_emission_Industrial_zone to write the following equation = (473.8 Ton per year * number of Factories in 10th of Ramadan).

Finally by running this model the following table is generated:

Table 6-21 Industrial CO2 emission

(Source: Researcher)

Industrial Zone	CO2 Emission Gram/year
Agriculture and livestock products	310.7
Food processing, beverages and tobacco	47937.2
Textiles, garments and leather	79977.6
Wood and wooden products	37528.8
Paper, printing and publishing	77891.8
Chemicals	1906918.2
Building materials	252474
Metals	296189.6
Engineering, electrical and electronics	350538
Manufacturing	30049.2
Repair and maintenance centers	473.8
Total	3080288.9

The Total Co2 emitted from Industrial Use = 3.08 Million Ton / Year

D. The steps used to calculate CO2 emitted from Land parcels along the city:

Here is the model that has been created to be run in GIS to calculate the CO2 emission.

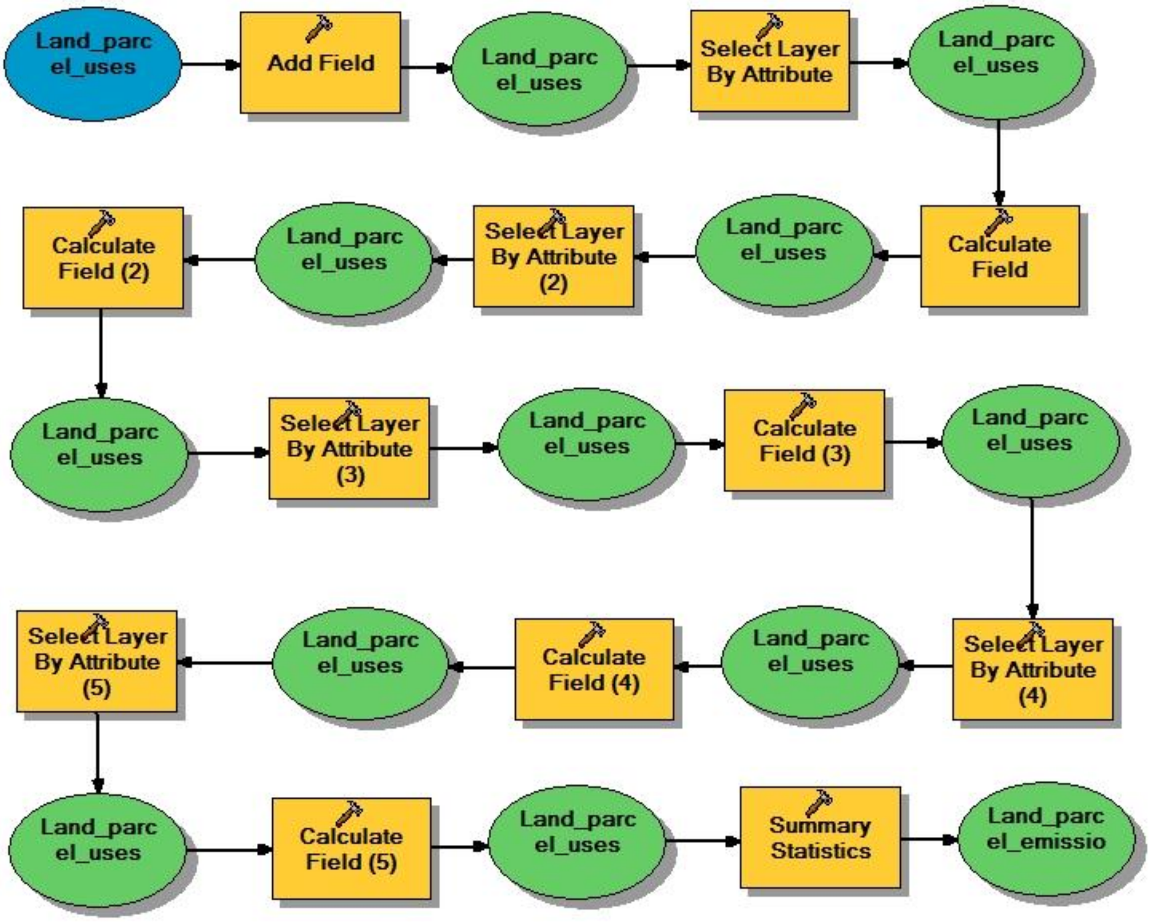


Figure 6-32 GIS Land Parcel Model

(Source: Researcher)

The following steps are going to illustrate the previous model:

- Create a field (double) named CO2_emission_Land_parcels_uses in the feature class Land_parcles_uses and then select by attribute CO2_emission_Land_parcels_uses = Agriculture Land, then field calculator on the CO2_emission_Land_parcels_uses to write the following equation = (Shape area * 1.2 / 1000). it will give CO2 in ton

- In the feature class Land_parcles_uses and then select by attribute CO2_emission_Land_parcels_uses = Crushers, then field calculator on the CO2_emission_Land_parcels_uses to write the following = 0.5 ton. it will give CO2 in ton

- In the feature class Land_parcles_uses and then select by attribute CO2_emission_Land_parcels_uses = Forests Land, then field calculator on the CO2_emission_Land_parcels_uses to write the following equation = (Shape area * 52 / 1000000). It will give CO2 in ton.

- In the feature class Land_parcles_uses and then select by attribute CO2_emission_Land_parcels_uses = Oxidation Lakes, then field calculator on the CO2_emission_Land_parcels_uses to write the following equation = (Shape area * 1300 * 5.5 / 1000000). It will give CO2 in ton.

- In the feature class Land_parcles_uses and then select by attribute CO2_emission_Land_parcels_uses = Public mold, then field calculator on the CO2_emission_Land_parcels_uses to write the following equation = (Shape area * 220 * 15 / 1000000). It will give CO2 in ton.

Finally by running this model the following table is generated:

Table 6-22 Land Parcels uses

(Source: Researcher)

Land Parcels Uses	CO2 Emission Ton/year
Agriculture Land	20835.2032
Crushers	0.5
Forest Land	586.6599
Oxidation Lakes	48771.5369
public mold	27208.4287
Total	97402.3287

The Total Co2 emitted from land parcel = 97.4 Thousand Ton / Year

The previous model will generate the following pollution emission map

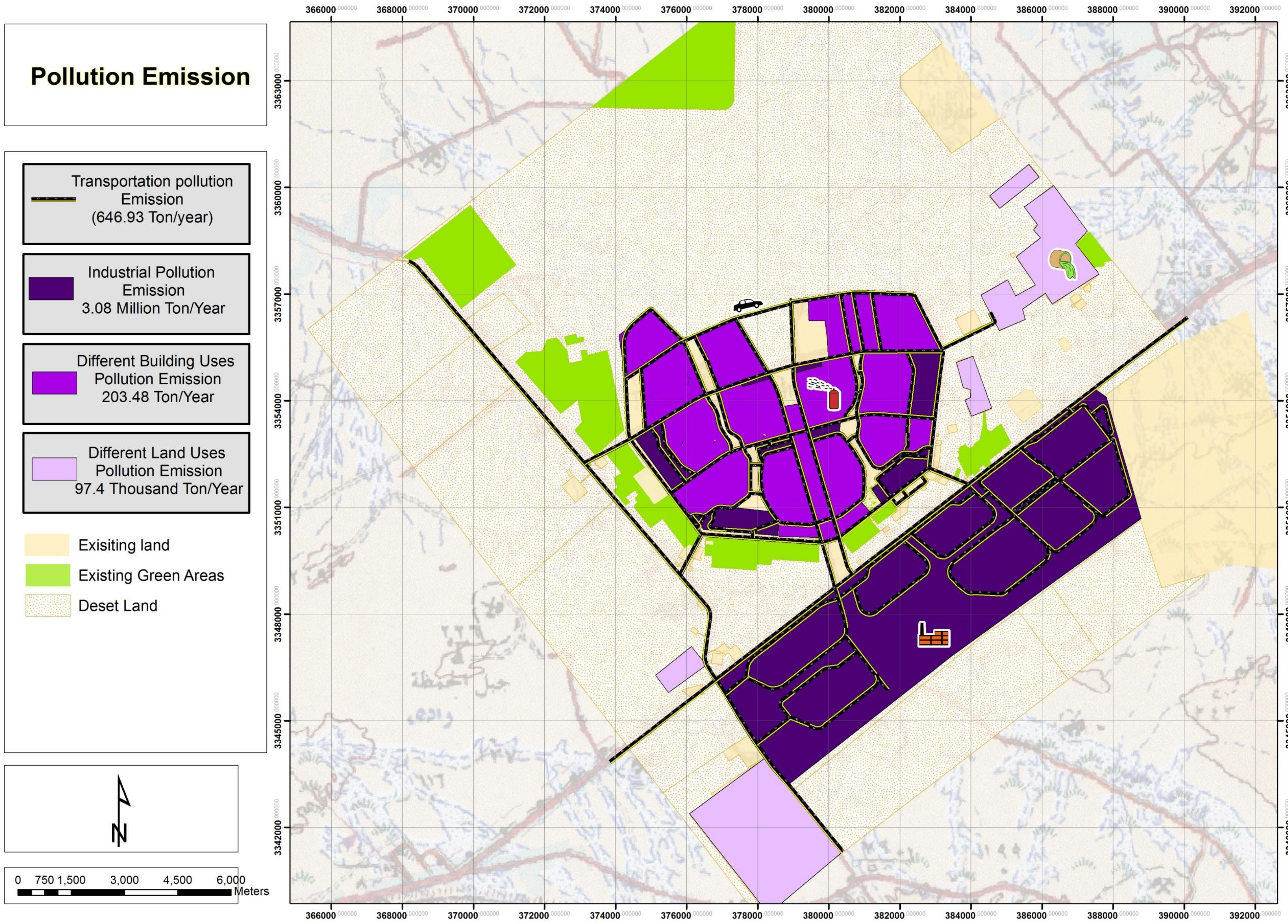


Figure Error! No text of specified style in document.**-3 Pollution Emission map**

(Source: Researcher)

E. The Total CO2 Emitted from The whole City:

The Total Co2 emitted from transportation + the Total Co2 emitted from building use + the Total Co2 emitted from Industrial Use + The Total Co2 emitted from land parcel=

0.00064693 Million Ton / Year + 0.00020348 Million Ton / Year + 3.08 Million Ton / Year + 0.0974 Million Ton / Year = 3.17825041 Million Ton / year

Consumption of O2 = Carbon dioxide emission * 0.6 / 0.9

2.11 Million Ton / year = 3.17 * 0.6 /0.9

The annual per hectare O2 production = 170 ton

The area needed for green areas = 2.11 * 1000000 /170 = 12411.7 Hectare = 124.11 Km2

6.5.4. The Landscape Ecology Principles:

The landscape ecology principle is going to organize green areas along three scales within the city, green structure along the region scale, green structure along the city scale, and the green structure along the neighborhood scale.

A. A review of Green Structure in 10th of Ramadan:

The base layers of data maps are overlaid to analyze the overall ecological structure and function of the city, natural and built patches including open and green spaces, due to their fundamental role in the ecological structure of the city are recognized. Main access of roads, highways and streets as main structural elements and ecological corridors in urban context, especially in the densely built up urban fabric, as connecting elements of the ecological patches and as structural elements of the ecological systems. The three mentioned layers have been analyzed to locate the main and most effective ecological patches and corridors in the city matrix. The overall ecological structure of the city is then obtained by merging the layers of natural or manmade ecological patches and corridors into one single map which contains all the effective features in the structure of the city.

Area of existing green areas is 34 km2 and the required green areas is 124km2 to reach the carbon oxygen balance, so the remaining required area to be distributed within the city is 90km2.

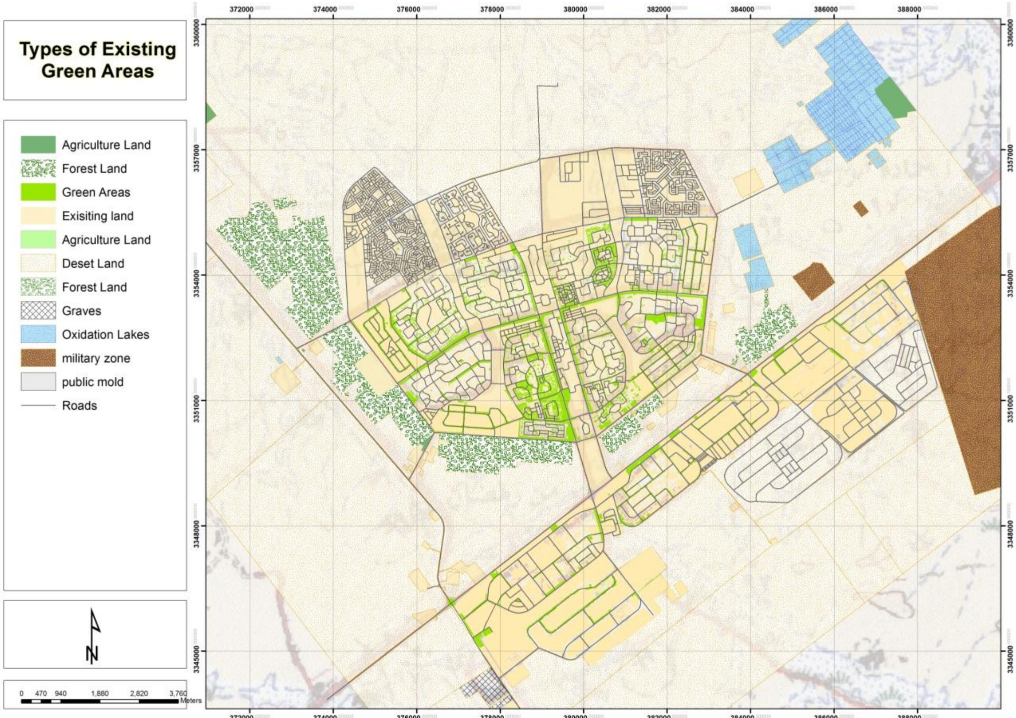


Figure 6-34 Existing green areas along the city

(Source: Researcher)

B. Green Structure at the Region Scale:

Green structure at the region scale may be called green wedges or patches. The green wedges or patches are composed of parks, gardens, farmlands, rivers and wetlands.

The development of green wedges is based on open space and agricultural land.

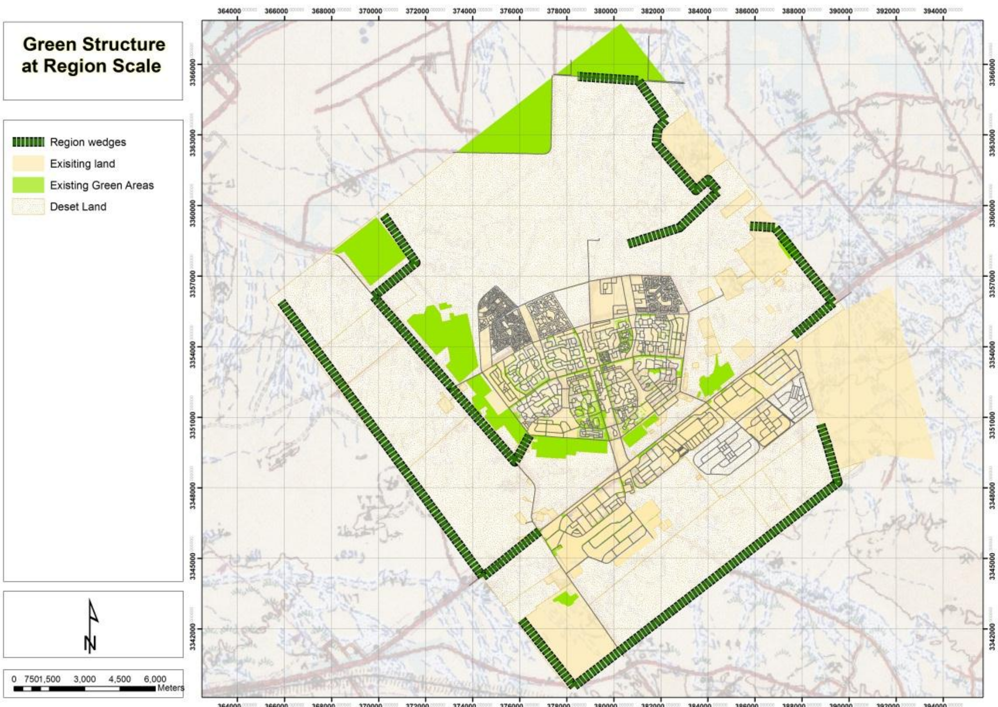


Figure 6-35 Green structure at region scale

(Source: Researcher)

Based on the landform data, landscape ecology principles, and an assessment of the planned green spaces, five green wedges (28.3 Km2) were proposed to connect outer green spaces and inner green spaces. This is regarded as an offensive strategy of green structure planning, and brings nature into the city.

C. Green Structure at the City Scale:

Green structure at the city scale may be called greenbelts. Greenbelts can be understood to be narrow strips of parkland more or less encircling part of a built-up metropolitan area or large urban area. Green belts is used to resist urbanization, so it is difficult to use one green belt to resist urbanization because it is easily encroached on by the urban sprawl process and easily breached by urban leapfrog growth. From this perspective, the green structure of 10th of Ramadan should be augmented by an inner greenbelt at the present peri-urban areas because the development and augmentation of other green spaces such as road greenways, green cores and green links of green cores in the inner greenbelt might be difficult due to land budgeting and pressure of urban development.

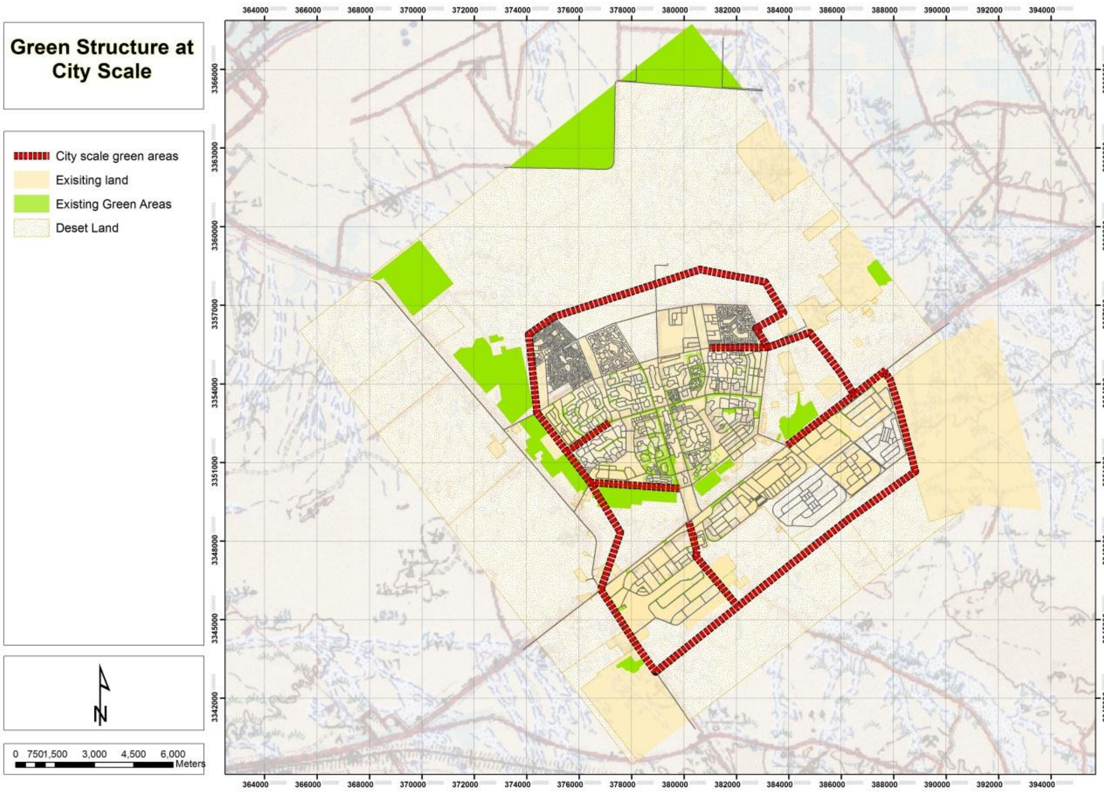


Figure 6-36 Green structure at city scale

(Source: Researcher)

This greenbelt (26 Km2) is representing not only a zone for conservation but also a transitional zone with the function of resisting the urban sprawl, constraining the urban development, maintaining biodiversity, and enhancing recreation.

Moreover, almost all industrial zones in 10th of Ramadan are mainly concentrated in this belt area. These industrial zones are embedded in 10th of Ramadan as a belt and make air pollution more serious. Therefore, maintaining this proposed greenbelt is necessary not only for the above benefits but also for improving the urban environment. Planning parks and other public green spaces at the city scales reflects a defensive strategy for planning green structure. Such parks and public green spaces can be connected by corridors such as road greenways.

D. Green Structure at the Neighborhood Scale:

Attached green spaces. Each part in the 10th of Ramadan is a mixture of residential, industrial, business and organization-owned areas where each of them is allocated a plot of land with scant space for developing green space. These green spaces are distributed unevenly and are somewhat isolated. Attached green spaces are composed of organization-owned green spaces, residential green spaces, etc., which play an important role in providing opportunities for residents to get in contact with nature. Besides this, their function is to enhance local beauty, and to act as ecological stepping stones.

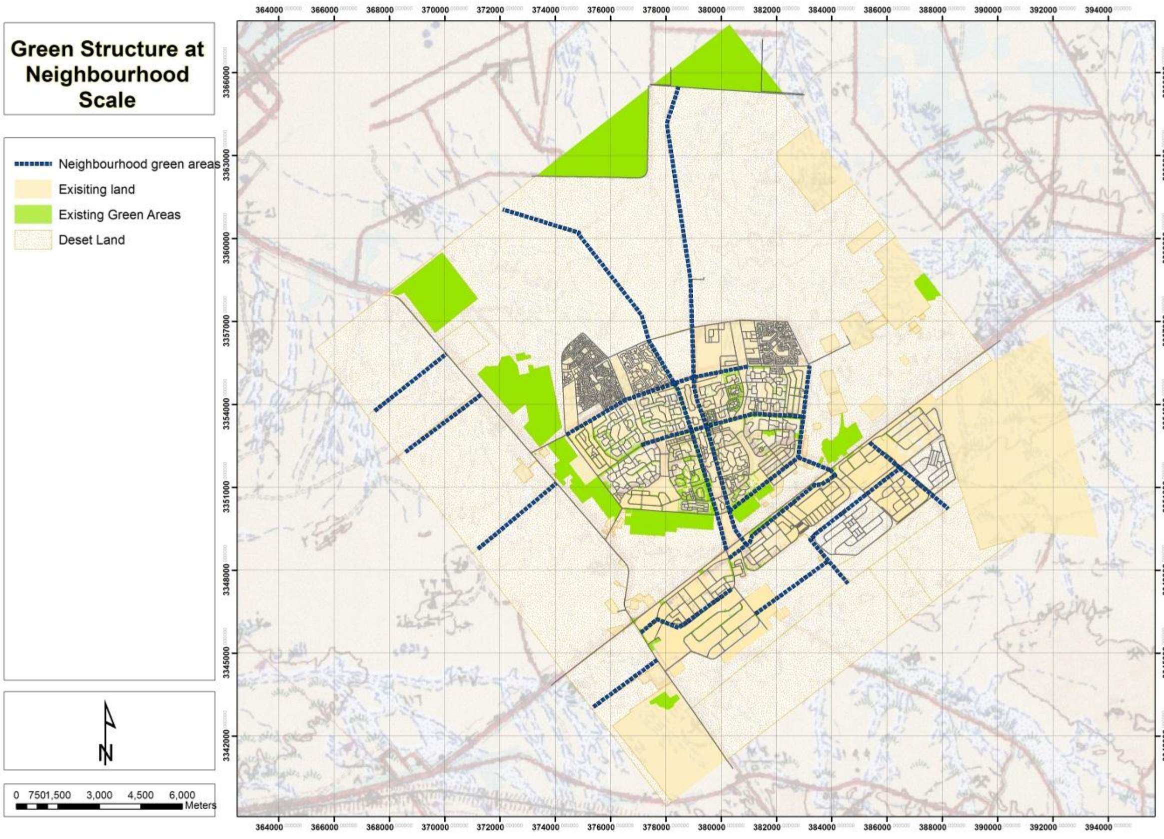


Figure 6-37 Green structure at the neighbourhood scale

(Source: Researcher)

Road greenways (36 Km2) are an important component of greenway networks in urban areas.

E. Green Structure Planning at the Regional Scale, City Scale, and Neighbourhood Scale:

The following figure will shows the green structure of the city at the regional scale, city scale, and neighbourhood scale, with area respectively for each scale 28, 26, 36 Km2.

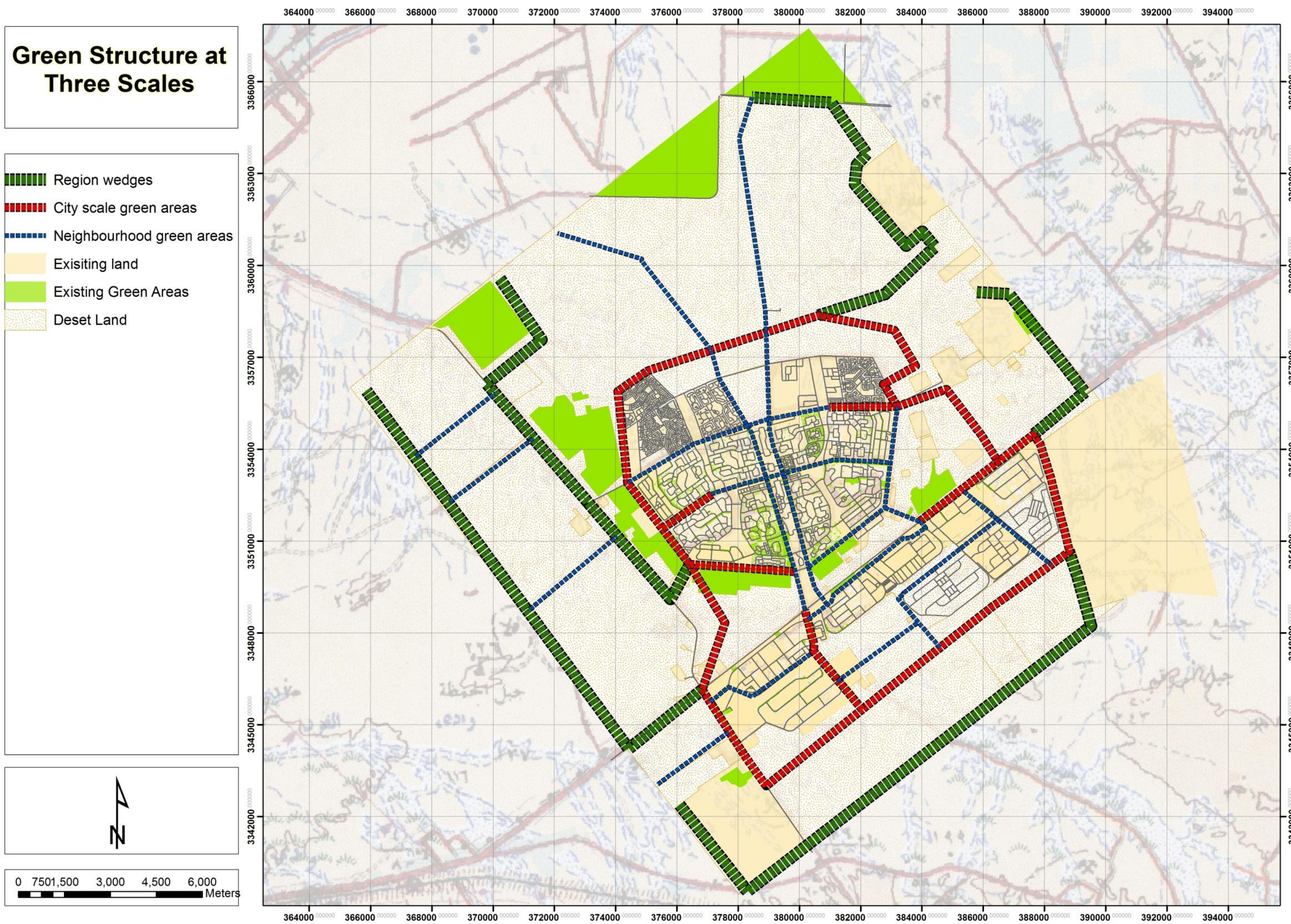


Figure Error! No text of specified style in document.**-4 Proposed green structure at 10th of Ramadan**

(Source: Researcher)

6.6. Discussion:

The methodology that was developed and applied in this study has been divided into four main steps in supporting a land suitability problem, these steps are compromised in the following points first developing a conceptual framework, second selecting the most suitable sites for green areas, third calculating CO2 emitted from the new desert cities to analyze the carbon oxygen balance according to the ecological threshold method, and finally distributing the green spaces along the cities according to landscape ecology principle.

A. The first step: (Developing a conceptual framework)

The theoretical part first defined the conceptual framework structure for the design of suitable sites of green areas through identifying the main objectives of the green spaces. According to (Di Fidio et al., 2001; Mauri, 2000; Provincia di Milano, 2002), the protection and improvement of the environmental quality of the territory appeared to be the main goal of developing green spaces, this goal could be met through the following objectives: (i) protection of valuable areas and (ii) restoration of degraded situations. The degree of satisfaction of the first objective “protection of valuable areas’’ was measured through the following criteria: protection of agricultural areas, enhancement of rural historical and architectural assets, and finally protection of assets of high natural value. The degree of satisfaction of the second objective “restoration of degraded situations’’ was measured through the following criteria: restoration of degraded urban areas, and mitigation of environmental compensation for impacts of new infrastructures.

By applying the theoretical part on the practical, the following criteria are used in the case study for the following reasons. “Protection of agricultural areas” is assigned due to presence of agricultural areas in 10^{th} of Ramadan, “enhancement of rural historical and architectural assets” is assigned despite of absences of rural and architectural assets in 10^{th} of Ramadan yet it may found in any of the new cities, “protection of assets of high natural value” is assigned due to presence of forests with high natural value in 10^{th} of Ramadan, “restoration of degraded urban areas” is assigned due to presences of handicrafts areas in 10^{th} of Ramadan needed to be restored, and finally “mitigation of environmental compensation for impacts of new infrastructures” is assigned because it is considered as one of the main targets of the research.

B. The second step: (Selecting the most suitable sites for green areas)

In the last decades a variety of applications of spatial analysis to site selection have been made. Many of them concerned the search of the most suitable location where to build things, such as waste disposal sites (Sharifi and Retsios, 2004; Keeney and von Winterfeld, 1994). Some applications regarded habitat suitability modeling (Store and Kangas, 2001) and other environmental management issues (Giupponi et al., 1999; Phua and Minora, 2004). Few applications concerned green spaces planning problem. Some instances mainly concerned the establishment (Keisler and Sundell, 1997) or the boundary relocation (Sharifi et al., 2002) of green spaces. Land suitability analysis is one of the strongest and most effective spatial analyses in planning (Malczewshi, 2004; Shearer and Xiang, 2009). It aims at identifying the most appropriate spatial pattern for future land uses according to specific requirements, preferences, or predictors of some activity (Collins et al., 2001; Malczewshi, 2004). The GIS – based land suitability analysis has been implemented in a wide variety of situations, including suitability of land for agricultural activities (Kalogirou, 2002), landscape evaluation and planning (Miller et al., 1998), locating of forest uses (Store, 2009) and site selection of local parks (Zucca et al., 2008). Over the last three decades, GIS-based land suitability techniques has increasingly become essential components of urban, regional, and environmental planning activities (Brail and Klosterman, 2001; Collins et al., Malczewshi, 2004).

The theoretical part indicated two different ways of determining the lands suitable for green areas, the first way has been stated in Hanoi, Vietnam according to (Uy and Nakagoshi, 2008). They applied land suitability analysis based on GIS as a very useful and effective tool in identifying suitable sites for developing green spaces. To reduce the subjectiveness in analyzing green space suitability, the AHP and pairwise comparison process were used with the support of MATLAB software in solving the eigenmatrix. The results show that almost all planned green spaces in the 2020 Hanoi master plan were compatible with the land suitability analysis. The second way has been stated in Bergamo Province according to (Antonella Zuccaa, Ali M. Sharifib, Andrea G. Fabbria, 2008). They investigated a site selection process for setting up green spaces. It was reinforced by a value focused approach and spatial multi-criteria evaluation methods. A first set of spatial criteria was used to design a number of potential sites. Later, a new set of spatial and non-spatial criteria was employed. The criteria included the social functions and the financial costs, together with the degree of suitability for the green spaces to evaluate the possible sites and to recommend the most acceptable one. The entire process was assisted by a software tool that supports Spatial Multi Criteria Evaluation (SMCE). The application of this tool, integrated with a constant feedback by the public administration, has provided an effective method to solve the complicated decision making on land use and urban planning. (Giordano and Riedel 2008) used SMEC method in a GIS environment for demarcation of river greenways in Sao Paulo, Brazil. They elaborated a suitability map for the allocation of the greenway and identifying areas for leisure activities, and ecologically important areas.

By applying the theoretical part on the practical, land suitability analysis is applied on 10th of Ramadan to provide a methodology for developing green areas in new cities in Egypt using GIS technique that has been applied on Hanoi, Vietnam, spatial multi criteria evaluation that has been applied on Bergamo Province, and applying the idea of multi criteria on 10th of Ramadan with a new GIS technique the research used called “weighted sum”. The GIS–based land suitability analysis has been implemented on 10th of Ramadan through raster analysis and weighted sum techniques using the following maps, these maps are: land use, Lithology, pollution, climate properties, ground water extraction, and water network system. According to the potentials and constrains of 10th of Ramadan, Lithology map plays a main role in the suitability of green areas therefore it takes the highest raster score 28% to influence the final weighted sum, then the current land use map takes the second priority as the suitability of green areas are applicable in desert and vacant lands so it takes a score of 23% to influence the final weighted sum, then water network system map takes the third priority in determining the lands that is suitable for green areas as 10th of Ramadan depend mainly on Ismailia Canal as a main feeding source of water, so it takes a score of 17% to influence the final weighted sum, then Source of pollution map takes the same influence as water network system, then Climate properties takes the fourth priority in determining lands suitable for green areas so it takes a score of 12% to influence the final weighted sum, and finally comes the ground water extraction map in the last priority as the quantity of water that can be extracted from the soil is too small so it takes a score of 3% to influence the weighted sum. This method can be applied in any of the new cities but the influences can be changed according to the potential and constrains of the city.

C. The third step: (Calculating CO2 emitted from the new desert cities to analyze the carbon oxygen balance according to the ecological threshold method)

The theoretical part indicated the basic amount of green spaces required in planning can be obtained by the principles of ecological balance (Jim and Chen, 2003; Li et al., 2005). According to Zang et al. (2007), there are three methods for controlling the amount of green spaces, namely the recreation space ration method, the ecological plat method, and the ecological element threshold method. The recreation space ration method pursues the function of recreation and came from Soviet Union. It did not take the limit of land resources into account in most developing countries. The ecological factor plat method is widely employed in landscape planning or landscape ecological planning in western developed countries. By contrast, the ecological factor plat method is applicable merely for the environment areas of biodiversity where habitats are less distributed by human activities. This is not the case in all developing countries. Egypt belongs to hot and arid climatic zone, hence, the ecological element threshold method is, in practice, one of the best methods to control the quantity of green space. The ecological factor threshold method quantifies how much green area is needed for a city in terms of maintaining ecological balance. The method is adapted from (Zang et al.2007) who applied it for planning urban green space systems based on analyzing the key ecological elements. The method includes population carrying capacity, and carbon – oxygen balance. The carbon oxygen balance relates to the total of carbon emission by human as well as natural activities, and to absorbing carbon dioxide and releasing oxygen in photosynthesis of green plants (Jo, 2002; Mchale et al., 2007). In green space planning, the carbon – oxygen balance is established on a constant adjustment of green plants of green spaces and various kinds of oxygen consuming activities (Mchale et al., 2007). Achieving balance has a potential impact on regional sustainable development. Research on the relationship and the distributing characteristics in carbon dioxide and oxygen consumption and supply will contribute to the cycle of oxygen production and oxygen consumption in the atmosphere closed to the ground through systematically planned green space eco systems. The oxygen consumption is mainly for the burning of fuel and natural gas, respiration and oxygen consumption of biological materials such as excrement decomposition. The theoretical part stated several ways for calculation of the CO_2 emitted from living territories, transport system and finally industrial uses.

According to (Frederick Turner 2010; Anqing Shi 2001; Colorado Department of Public Health and Environment 2002; Anna Pagès Ramon, Albert Cuchí Burgos 2008; Chang, T.C., Leo, Y.C., Yang, S.S. 2000), three ways are stated for calculating living territory and land use carbon emission, the first way depend on calculating CO_2 according to the energy consumption of the living territories and land uses, the second way depend on calculating CO_2 according to the construction of the buildings, and finally the third way depend on calculating CO_2 according to the area and different uses of the Buildings.

According to (AASHTO 2006; I.J. Lu, S.J. Lin, and C. Lewis 2007; Helen Lindblom & Christian Stenqvist 2007; M.J. Bradley 2007; Alsema EA 2000; Colorado Department of Public Health and Environment 2002; Guidelines to Defra’s GHG Conversion Factors 2008),

five ways are stated for calculating transportation system carbon emission, the first way depend on calculating CO_2 according to the fuel consumed, the second way depend on calculating CO_2 according to the vehicle type, the third way depend on calculating CO_2 according to the total annual fuel used by each mode of transportation, the forth way depend on calculating CO_2 according to the forecasts obtained from the department of energy, and finally the fifth way depend on calculating CO_2 according to the transportation impact per km (or passenger-km, tone-km)
According to (Ruben van der Helm, Rutger Hoekstra and Jan Pieter Smits 2008; Colorado Department of Public Health and Environment 2002; International Energy Agency IEA 2002; Mark Schipper 2006), six ways are stated for calculating industrial zones carbon emission, the first way identify the carbon emission of the Industrial zones in U.S., the second way identify the carbon emission of the Industrial zones in in Netherland, the third way depend on calculating CO_2 according to the forecasts obtained from the department of energy, the forth way depend on calculating CO_2 according to non-combustion, on-site fossil fuel combustion, and purchased electricity, the fifth way depend on calculating CO_2 according to the quantity and type of industrial product, and finally the sixth way depend on calculating CO_2 according to the number of factories & type of industrial product.

By applying the theoretical part on the practical, a new model is contributed through GIS building modular technique to calculate the CO_2 emitted from different land uses along the new city depending on the different theories that has been stated in the theoretical part. This module gives the availability for the urban planner to calculate the CO_2 emitted from any of the new cities by dividing the city into three sectors living territory sector, transportation sector, and finally the industrial sector. In 10th of Ramadan this module stated that this city emitted CO_2 equal to 3.17825041 Million Ton / year, which in return needs 124.11 Km^2 green areas to reach the carbon oxygen balance.

D. The forth step: (Distributing the green spaces along the cities according to landscape ecology principle)

The theoretical part indicated that the landscape ecology is the study of interactions among landscape elements. It deals with the effects of the spatial configuration of “mosaics” on a wide variety of ecological phenomena (Forman and Gordan, 1986). It has provided a foundation for planning landscape in general and green networks in particular (Aspinall and Person, 2000; McHarg, 1995; Mortberg et al., 2007). Landscape enables the users to achieve an integral understanding of the development of landscape, since it deals with their structure, functioning and changes occurring in them. This insight is considered as a framework that assists to distinguish key ecosystems for maintaining biodiversity in landscape (Pirnat, 2000). Ecological suitability analysis of land use is a comprehensive application of ecology, earth science, system science, environmental science, and computer science to analyze land development and utilization suitability for seeking the best pattern and planning of land use (Jie et al., 2010). The ecological principles used in planning land use and landscape planning are lot size, number and location; edge parameters (i.e., the boundary with edge structure and shape); corridors and connectivity and network mosaics (Hersperger, 2006). Previous studies have indicated how green space planning established on ecological principles can be implemented. (Forman and Gordon 1986) suggested the model of patch, corridor and matrix. The patches are relatively homogeneous non-linear areas while the corridor and the matrix are a continuous link between patches that construct a prominent connectivity network of green areas. (Wu ad Hobbs 2002) supported Forman and Gordon’s proposal and added that a network of patches and corridors can provide connectivity of natural elements and aid to preserve the linkage between different ecosystems. The patches, the matrix, the corridors, are considered basic components of any landscape, and state that landscape ecology deals with the effects of spatial configuration of mosaics on a wide variety of ecological phenomena (Li et al., 2005). According to (Flores et al. 1998) the green space system for New York City region indicate that ecological content, context, dynamics, heterogeneity and hierarchies are ecological principles for the development of green spaces. Landscape ecology conceptions and applied metrics are useful in addressing the spatial dimension of sustainable planning, (Frey, 2000; Jim and Chen, 2003) provided a theoretical basis for landscape and urban planning. (Pirnat 2000) suggested a model for patch and corridor connectivity using GIS. His study suggested that new corridors of trees can be established along motorways to connect the fragmented remains of ecological infrastructure. The proposed network of green patches and corridors would represent a higher connectivity of natural vegetation. (Jim and Chen 2003) applied comprehensive green space planning to compact Nanjing city, China. They reported that theories of landscape ecology (Forman and Gordon, 1986; McHarg, 1995) provide fundamental strategies for green space system design. Their study comprised a network of green ways, green wedges, and green extensions, which linked isolated green patches within and outside the city at three scales: metropolis, city and neighborhood scales. (Ong 2003) proposed the “green plot ratio” (GPR) as an ecological indicator. It refers to a single-side leaf area per unit ground area. He suggested this indicator as a suitable measure for the greening of architecture and urban planning. This indicator can be applied as an urban tool, for master planning, as well as architectural design tool, for individual buildings, yet it has been applied on regional and city planning scale.

(Li et al. 2005) developed an ecological concept planning of urban greening in Beijing, China. They proposed three spatial scales for "green space" planning, including: regional scale (i.e., the entire area of province); the city scale (i.e., the urban area with its suburbs and the surrounding peri-urban zone) and the neighborhood scale (i.e., typical areas within urban area). Additionally, (Li et al. 2005) showed that according to the principles of landscape ecology, green wedges and green corridors may comprise a suitable green network system planning urban greening. Additionally, (Yokohari, Amati 2005) proposed that urban parks need to be regarded as core areas in the city, that an outer green belt is to surround the city; and that green corridors along rivers and streets will connect the cores and the outer areas. Thus, an organization of urban green spaces based on landscape ecology principles, in respect to using linear (e.g., green ways) and nonlinear elements (e.g., parks), encompasses the connectivity and networking of green spaces in urban areas better than considering them separately.

A "green wedge" (Forman and Gordon, 1986; Li et al., 2005) is primarily composed of parks, gardens, farmlands and where applicable rivers and wetlands. Green wedges and green corridors would create an integrated ecological network through connecting the urban center, Forests Park, mountains and the surrounding regional spaces (Li et al., 2005). (Jim and Chen 2003) have shown that limiting or preventing the development activities inside and near "green wedges" are essential. Green wedges are more efficient than traditional "green belts". Greenbelts are narrow strips of park land more or less encircling part of a built up metropolitan area or large urban area (Kuhn, 2003). (Taylor et al., 1995) have presented the influence of greenbelts near urban areas, in cases which have been ineffective in controlling urban growth outside of the greenbelt. Additionally, (Li et al. 2005) reported the limitations of greenbelt planning in their study of greenscape planning of Beijing, China.

By applying the theoretical part on the practical, in 10^{th} of Ramadan green wedges is suggested as a proper tool to enhance the urban green areas at the region scale. These green wedges are proposed to respect the "high suitability" and "moderate suitability" areas that have been generated in the land suitability analysis. Based on 10^{th} of Ramadan master plan, landform data, landscape ecology principles (Jim and Chen, 2003; Li et al., 2005), and an assessment of the planned green spaces scheme based on land suitability analysis, five green wedges (28.3 Km2) were proposed to connect outer green spaces and inner green spaces. This is regarded as an offensive strategy of green structure planning, and brings nature into the city. In order to maintain ecological balance on the city scale, green belts are proposed, 10th of Ramadan planning intended to develop greenbelts with area 26 Km2. According to (Taylor et al. 1995), green belts are criticized as a primary way to establish green structure surrounding the city to control the urban sprawl. Based on the recommendations of (Li et al., 2005), it is not feasible to employ one green belt to resist urbanization because it is easily affected by urban sprawl process and readily damaged by urban growth. From this perspective, the green structure of 10th of Ramadan should be augmented by an additional inner greenbelt at the present urban areas. At the neighborhood scale, most parts of 10th of Ramadan centers are currently combination owned areas. Each of these areas is allocated a plot of land with space for developing a green space. These green spaces are unevenly distributed and are, to some extent, isolated. Applying the ecological principles of (Wu and Hobbs, 2002 and Uy and Nakagoshi 2008) on 10th of Ramadan, a network of road greenways and green patches are patches with area 36 km2 are proposed. The existing roads in 10th of Ramadan are wide; accordingly, they provide a good opportunity to successfully develop green ways.

Chapter 7

Conclusion and Recommendation.

7.1. Conclusion

7.2. Recommendation

7.3. Findings

7.1.Conclusion:

A. Applying land suitability analysis based on GIS is a very useful and effective tool in identifying suitable sites for developing green spaces. The results show that almost all planned green spaces in 10th of Ramadan were compatible with land suitability analysis. As shown in Miller et al. (1998), "*land suitability analysis is dependent on many criteria and many data and it is an extremely difficult task which should take into account natural, social, and economic factors"*. This approach reflects green space suitability more accurately, adequately, and comprehensively. Regarding ecological and environmental significances, six principal components (Current land Use map, Lithology map, Water network map, Pollution map Climate map, and Ground Water Extraction Map) were selected for this analysis. More importantly, the research case study has introduced a useful, effective and efficient method for identifying suitable sites for developing green spaces in urban areas. This method based on GIS new technique (weighted sum), which give the urban planner the availability to reach land suitability map through determining the influence of each map of six principle component.

B. Quantifying green areas is necessary for urban planning and there are diverse ways to quantify such green areas, the research case study has introduced a new model to quantify area of green spaces based on calculating the CO2 emitted from the different land uses along the city. It was found that the ecological factor threshold method is especially suitable for quantifying green areas in the context of developing countries. The results of this study show that existing green areas in 10th of Ramadan are not enough to maintain the ecological balance, thus 10th of Ramadan need an extra 90 Km2 to reach the carbon oxygen balance. The CO2 calculating model is considered an important contribution in the research as this model can be applied on any new city master plan to calculate its CO2 emission.

C. Based on landscape-ecology principles, a network of green structure was suggested in 10th of Ramadan to guarantee the preservation of ecological functions. This is a conceptual approach for organizing green infrastructure and building an ecological city. Continuity and connectivity of green patches, green cores which are upheld by the creation of corridors, road greenways are important because Hobbs and Saunders (1990) "*show that preserving green areas is only a temporary solution, and without* *connections between them, isolation and loss of genetic diversity is imminent".* An analysis of green spaces organization in 10th of Ramadan master plan showed that green spaces would be somewhat fragmented and isolated. This would lead a reduction not only in green space area but also in the quality of ecosystem services, taking away the local inhabitants' rights to access these green spaces, and making urban environmental issues more serious.

D. A further point is that 10th of Ramadan master plan seems to lack a theoretical basis or a holistic framework for organizing green structure at different scales. These shortcomings will be compensated for by applying landscape-ecology principles, and the proposed comprehensive green space framework aims at fulfilling a number of fundamental landscape-ecology requirements. (Jim and Chen, 2003) *The combination of various green spaces to make a green network is very important in planning green structure because it is very difficult to use only one, or few different, kinds of green spaces to maintain all the benefits of greening in urbanized areas.*

E. In the proposed 10th of Ramadan green structure at the region scale, five green wedges (28.3 Km2) play a pivotal role in bringing nature into the city and maintaining biodiversity. At the city scale, an inner greenbelt (26 Km2) is proposed which offered the best potential for supporting an ecological network. Moreover, it can be combined with the planned outer greenbelt to control the urban sprawl process more effectively and efficiently. Planning green wedges and greenbelts represents offensive and defensive strategies in green structure planning, respectively. At the neighborhood scale, a network of road greenways (36 Km2) was proposed. The greenways play a role as corridors in wildlife movement, and in bringing nature to move deeply into the city. This reflects a defensive and opportunistic strategy of green structure planning. The development of green wedges is based on open space and agricultural land, however the development and augmentation of other green spaces such as road greenways, green cores and green links of green cores in the inner greenbelt might be difficult due to land budgeting and pressure of urban development.

F. In the other words, this green space system is facing with some obstacles such as rapid urbanization, weakness in controlling and managing urban development, land use change, and economic growth. However, such pressures can be managed if planners and decision-makers, in Egyptian government, understand the roles and importance of these green spaces in developing a sustainable urban area. (Li et al. 2005) *show that measures regarding legal, economic, institutional, and social technology aspects to protect green spaces require particular attention.*

G. Finally, it is concluded that this proposed green network helps green patches enhance the connectivity and reduce fragmentation and isolation through the linked and integrated greenway system. This improves different attributes of fragmentation of green patches such as density, isolation, size, shape, aggregation, and boundary characteristics, and can act as a catalyst to preserve existing green spaces and generate new ones.

H. This green network will be a basis for planning, designing and organizing green infrastructure whilst ensuring the sustainable development of 10th of Ramadan as the first industrial ecological city in the future.

7.2. Recommendation:

The thesis recommendations is going to describe number of actions to be taken by urban planner to reduce emissions of CO_2 within the master plan of the new cities. Various innovations, such as well insulated buildings, city structures where people can live within walking distance, and the development and spread of energy-saving devices will enable energy demand to be reduced while satisfying the service demands. It is shown that CO_2 emissions can be reduced from the emission level of the master plan by implementing low-carbon measures by energy suppliers, such as increasing the share of solar, wind power and other renewable and appropriate use of nuclear power and carbon capture and storage.

To achieve the goal of reducing CO_2 emissions, the Egyptian government should take strong initiatives in sharing the goals of a low-carbon society, establishing comprehensive measures and long-term plans, reforming industrial structures, and funding infrastructures to encourage private investment in energy-saving technologies.

7.2.1. Actions in homes and offices:

Many energy-consuming devices are used in homes and offices to make life and work more comfortable and efficient. Such devices are a major source of CO_2 emissions. To reduce energy load sharply, houses and buildings need to be designed to prevent heat from escaping and penetrating inside; solar heat and natural wind should be used for temperature control of buildings, and solar power should support lighting. To encourage the construction and penetration of such houses and buildings, policies should be implemented for reducing the economic burden on their owners and systems should be introduced for assessing and labeling the environmental performance of buildings. Well insulated houses minimize temperature differences among rooms; enable the provision of high-quality heat with low carbon emissions, such as radiant heat. These measures are appropriate for an aged society.

Energy-efficient appliances and devices also contribute to the CO_2 reduction in homes and offices. In order to accelerate the improvement of energy efficiency, the coverage of the conventional top-runner system should be extended to include all energy devices, and the improvement targets should be revised every few years. Rewarding systems for entities that develop excellent technologies should also be adopted for strengthening market penetration of energy-efficient technologies.

However, these newly-developed efficient devices will not be widely used unless users actively adopt them. To support such low-carbon consumption, advertising systems and infrastructures should be constructed to enable consumers to obtain correct information about greenhouse gas emissions from their consumption behavior. Through these activities, CO_2 emission from production of goods and services could be cut indirectly.

Not eating vegetables, fruits and other food that are not seasonal reduces the energy required to produce farm products.

Active use of wood instead of steel and cement for constructing houses and buildings will reduce the consumption of materials whose production processes need high energy

There are also measures for sharply reducing energy, such as active use of solar, wind and biomass energies available locally and purchase of low-carbon electricity

7.2.2. Actions for transport:

Greenhouse gases in the transportation sector are mainly emitted when people travel by car or public transportation, and when goods are transported by truck and ship.

Concentrating houses, offices and commercial facilities at the center of cities will reduce the distances traveled by people and hence reduce greenhouse gas emissions. To achieve this goal, people should fully understand the advantages of living in cities where they do not need cars but can walk for living. Municipal governments, together with citizens, should draw up land use plans that consider such low carbon designs. Realizing such cities will raise market competitiveness of public transportation systems, such as bus, railways and Light Railway Transit (LRT), and thus these systems should be actively constructed. On the other hand, in regions where people live far away, they will need cars to move. The efficiency of cars should be greatly improved by switching engines to electric motors and reducing vehicle weight, resulting in the drastic reduction of CO_2 emissions from transportation.

To achieve low-carbon logistics, infrastructures for mass transportation systems such as railways and ships need to be constructed. Diverse forms of support should be given to increase the transportation capacities of these systems, such as by improving and expanding harbors and the railway network and developing high efficiency transportation devices. Systems and infrastructures should also be constructed to enable smooth transshipment at distribution centers.

Active use of solar and wind energy available locally for cars will contribute to sharp reduction of CO_2 emissions. Purchasing low-carbon electricity is also effective. It is also necessary to encourage the use of hydrogen fuel cell cars and bioenergy fuels.

To support low-carbon mobility, systems are needed to enable all entities involved in transport to acquire, at any time and place, information both on transportation system, such as timetable and transportation fare and on greenhouse gas emissions from transport.

7.2.3. Actions for industry:

Companies should minimize carbon production in the lifecycle of their products (production, transport, sales, consumption, and disposal). The entire business process should also be optimized using advanced information technologies so as to synchronize supply and demand and to construct efficient production-transportation systems.

With government providing economic support to low-carbon businesses, such as strengthening public investment and giving tax benefits, companies can continue to develop leading technologies with high energy-efficiency and low carbon intensity. Conventionally, energy devices are sold to users, but to shift to the low-carbon business model, industries and/or commerce should shift to leasing of devices and appliances. This business style also supplements the pathways towards sustainable and/or recycling society. Under this style, companies will be responsible for keeping the devices operating at maximum efficiency.

For farm products, farmers should intend to produce in-season foods, and information on production should be actively publicized to consumers to enable them to select low-carbon products. In forestry, the timber market should be expanded to replace steel and cement, which consume high energy in manufacture, and competitiveness should be enhanced by rationalization.

The energy industry should aim to supply zero-carbon power by combining renewable energies, nuclear power, and fossil-fired power. Introduction of hydrogen- and biomass-based fuels are also indispensable for achieving low-carbonization of industries.

Fosterage of low-carbon experts through school education curricula and establishment of qualification system, such as a low-carbon advisory system, will grow human capital and resources for practice of activities towards low-carbonizing industries.

7.2.4. Recommendations for Technologies Contributing to Short- to Medium-Term Greenhouse Gas Emissions Reduction:

Since Industrial process is considered as a major source of CO_2 emission so the following table is going to illustrate some recommendations concerning each type of industry to reduce CO_2 emission.

Table 0-1 Recommendations Technology

(Source: Researcher)

Sector	Technologies
Steel industry	Large-size equipment (coke oven, blast furnace, basic oxygen furnace etc.), equipment for coke dry quenching, continuous casting machine, top pressure recovery turbine. Continuous rolling machine, equipment of coke oven gas, open hearth gas and blast furnace gas recovery, direct-current electric arc furnace
Chemical industry	Large-size equipment for chemical production, waste heat recover system, ion membrane technology; existing technology is improving
Paper-making	Co-generation system, facilities of residue heat utilization, black liquor recovery system, continuous distillation system
Textile	Co-generation system, shuttle less loom, high-speed printing and dyeing
Non-ferrous metal	Reverberate furnace, waste-heat recovery system, continuous smelting process for lead and zinc production
Building materials	Dry-process rotary kiln with pre-calciner, electric power generator with residue heat, Colburn process, Hoffman kiln, tunnel kiln

Machinery	High-speed cutting, electric-hydraulic hammer, heat preservation furnace
Residential	Cooking by gas, centralized space heating system, energy-saving electric appliances, high-efficiency lighting, solar thermal for hot water, insulation of building and energy-efficient windows
Service	Centralized space heating system, centralized cooling heating system, co-generation system, energy saving electric appliances, high-efficiency lighting
Transport	Hybrid vehicle, advanced diesel truck, low energy-use car, electric car, fuel cell vehicle, natural gas car, electric railway locomotive, public transport development
Common-use technology	High-efficiency boiler, fluidized bed combustion technology, high-efficiency electric motor, speed adjustable motor, centrifugal electric fan, energy-saving lighting
Power generation	Super-critical unit, natural gas combined cycle, pressurized fluidized bed combustion boiler, wind turbine, integrated gasification combined cycle, smaller-scale hydropower, biomass-based power generation

7.3. Findings:

A. Cities are considered as places where people can live healthier and economically productive lives while reducing their impact on the environment.

B. Planning is the science responsible for designing an efficient city system.

C. Natural and manmade environment are considered as a component of any city structure. Whole structure of a city is related to the general planning, and the physical structure of a city is related to detail planning where it can work efficiently by harmonization between the different elements of the city.

D. Cities can acquire a variety of forms, according to either the natural conditions surrounding the city, or the planning form of it.

E. Climate change is caused by the emission of greenhouse gases. There are six greenhouse gases recognized under the Kyoto Protocol, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydro fluorocarbons (HFC), per fluorocarbons (PFC), and sulphur hexafluoride (SF6), that are released through various activities that take place inside the city. The most wide spreading and effective gas is the carbon dioxide gas.

F. There is a strong link between urbanization, economic growth, and greenhouse gas emissions, as it has been concluded the most important sector that is responsible for emitting GHG is the industrial activity, followed by utilities and transportation, then finally the living territories activities, and if the industrial activity is not one of the main activities in the city, then Utilities and transportation ranked as one of the main activities that is responsible for GHG emissions.

G. To provide a model for urban ecological systems based on landscape ecology approach, urban planners should take all natural and built structural elements into consideration.

H. Geographic Information Systems based on spatial databases is considered with as a necessary condition for the realization of statutory obligations of urban green spaces.

I. Green areas are considered as urbanized environment which provide people with a feeling of place and identity. Green areas play an important part of urban ecosystems; play a pivotal role in preserving biodiversity in urban areas. Moreover, green spaces sequester CO_2 and produce O_2, they reduce air pollution and noise, regulate microclimates, and reduce the heat island effect in cities affect house prices maintain diversity; have recreational and social values and produce a vitamin ‘‘G’’ for health, well-being and social safety.

J. The most accurate way to apply land Suitability Analysis is using a new technique in the GIS called weighted sum; that is used for applying a common scale of values to diverse and dissimilar input to create an integrated analysis.

K. Geographic problems often require the analysis of many different factors. For instance, choosing the site suitable for green areas development means assessing such things as Current land use map, Type of existing green areas, Water network system, Source of pollution, Climate maps (Mean monthly maximum temperatures, Mean monthly minimum temperature, Wind speed, Wind direction, Average annual rain fall, and Humidity), Lithology, and Ground water extraction.

L. The best way to apply the principle of the landscape ecology is dividing the city among three scales represented in green structure at the region scale, green structure at the city scale, and finally green structure at the neighborhood scale.

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