Chapter 1

INTRODUCTION

Overview

Housing is one of the most pressing issues because of the growing demand from the population, and housing is one of the biggest problems faced by citizens in developing countries, including Sudan. Housing is a growing problem that moves with the social and economic development of peoples not only to meet the needs of the community of residential units but to meet its changing living needs. The systems are constantly seeking to develop housing policies, that integrate the economic and social aspects; taking into account the technical, architectural, legal, manufacturing, organizational and administrative aspects. This leads to a breakdown in housing plans and programs [1].

1.1 Definition of Housing

We can define the home in general as a unit of construction inhabited by man, including all the necessities, facilities, equipment, services and services needed or desired by the individual to ensure the natural, mental and social health of him and his family. It is a place where the individuals enjoy comfort and privacy and feel safe [1].

1.2 Definition of Housing Plans

Housing plans are studies of housing units where people live and also study the wishes and requirements of people for their own housing, and the problems people face to get decent housing. A Housing plan can also be defined as a study that adopts the development of programs and plans that harmonize the provision of housing with the needs of the population by applying sociology, economics, architecture, politics, psychology and law to provide one of the most basic needs of the people housing [1].

1.3 The Importance of Housing

Housing as a basic human need must be provided by the concern of the regimes and governments, that develop housing policies and give them primary government spendings, has not come from a vacuum; many factors affect and are affected by the success or failure of housing policies. Many studies of psychology and sociology have focused on the fact that the housing issue fulfills the psychological, social and cultural demand for shelter. Recent theories of psychology suggest that the housing issue has a particular primacy in mental health; it has been included as one of the basic needs of man - food, security, health and housing [1].

This research deals with how to provide suitable land for living according to the criteria set by the Rural Development and Re-Planning Administration in Khartoum State. The overall goal is improving the agricultural land near the residential cities and public roads and then re-planning them to become housing plans to achieve stability for families with limited income, and at the same time achieving financial income for the State Treasury.

We found out that this requires the use of Geographic Information Systems technology (GIS), which will also assist to derive building models, that will analyze agricultural land layers with respect to residential lands and roads layers, and then produces layers that may explain the re-use of agricultural land to be turned to residential areas.

The GIS software of Esri ArcGIS 10.2 Desktop is one of those software's that contain Geographic Information Systems technologies helping in drawing maps, charts, and designing and maintaining geographic databases. We expect that we will derive the building plans as required to solve the overall goal.

1.4 Problem Statement

The problem of this research is the lack of residential land close to the residential areas, where all the necessary services to live a good life, such as hospitals, water and electricity and sanitation systems are necessary. Most of the current housing plans lack such services relative to the distance from the populated areas.

The problem is to analyze the processes of finding vacancy lands to be sold. Quite often, this requires long-lasting administrative procedures. For example, the Rural Development and Re-Planning Administration in Khartoum State has to report each case to the Executive Office of the General Director and the Department of sloughing and adjustments, as well as to local offices in order to provide them with vacancy lands. These departments have to search through customization books to see vacancies (land which has not registered as personal property), and then provide the Rural Development and Re-Planning Administration in Khartoum State with those vacancies information. This has to get in touch with the Survey

Department to see land sites in nature. Finally، maps are designed and charts are on display to be offered as housing plan.

Another way would be to establish a team of employees as committee to search over targeted area for vacancy lands and then do the same steps that are mentioned above. But this causes more cost of efforts and time that should be redirected on other activities.

1.5 Research Significance

The importance of this research is to reduce the time and efforts required to find suitable land to be close to cities and public roads, where basic services such as water, electricity and sanitation systems are available.

1.6 Hypotheses

Using Esri's ArcGIS 10.2 desktop will help on finding agricultural land that can be used for housing plans making processes fast and transparent.

1.7 Objectives

1. Using overlay toolset to do some measurements.
2. Using proximity toolset to eliminate land that does not satisfy the measurements.
3. Using ArcMap for layers editing.
4. Using Arc Catalog for building models.

1.8 Methodology

Theoretical and applied.

1.9 Scope

This research specializes at agricultural lands at west geriaf city blocks (84,79,90) and block (1) of ferdoos only at the study area.

1.10 Contents:

1. Introduction.
2. Related Work and Literature Review.
3. Methodology and Reserach Planning.
4. System Design.
5. Experiments and Results.
6. Conclusions and Outlook.

CHAPTER 2

RELATED WORK AND LITERATURE REVIEW

2.1 Literature Review

At the beginning we cite basic definitions of a Geographic Information System and its components, as given in the SUST GeoInformatics lectures by D. Fritsch (2016). Afterwards we will refer to references dealing with similar topics as reserached by this Master's Thesis.

2.1.1 What is a Geographical Information System (GIS)?

GIS has a history of about 60 years. It was C. Tomlinson, who made first experiments to use computers for mapping huge forest areas in Canada, end of the 1950s and beginning of the 1960s. At this point in time, computer graphics was just introduced, and computers were big mainframes driven by punch stripes and later by punch cards. This have been the pioneering times to use computers for economics and technical applications. In the 1970s, with the invention of desktop computers drawing and mapping became an important issue, also GIS applications. The Environmental and Research Institute (ESRI), Redlands, USA launched by Jack Dangermond, was one of the key drivers developing GIS software. In parallel, it was intergraph, Huntsville, making first maps for military applications. As Esri is still a market leader of GIS software, Intergraph was acquired by Hexagon, Heerbrugg, in 2009, but maintained as a brand till today for powerful GIS software [2].

There are various definitions for a GIS. In the following four are given, which are mostly cited in literature:

(1) Geographical Information System: is a computer based systems for the acquisition and update, storage and query, analyses and simulation as well as output and presentation of spatial data [2].

(2) GIS is used for the acquisition, management, analysis and presentation of all data that describe a part of the landscape and the technical, administrative, geoscientific, economic and ecological objects which are on the landscape [2].

(3) A widespread collection of tools for the acquisition, management, provision in case of need, transformation and presentation of spatial data of the real world within special applications [3].

(4) A system for the decision support that integrates spatial data in the problem solution environment [2].

2.1.2 GIS Components and Platforms [2]:

A GIS is simply composed of four components (see fig. 2.1)

- **Components:**

		Life cycle	Price
H	Hardware	~ 2 – 3 years	Cheap
S	Software	~ 5 – 10 years	Middle
D	Data	Up to 100 years	Expensive
A	Applications	~ 10 – 50 years	

Figure [2-1]:GIS Components

During the 60 years of history several platforms for running GIS applications are used, see below:

- **Platforms:**
  - Desktop viewing (at PC, tablets etc) passive.
  - PC GIS, Tablet GIS passive and active.
  - Client-Server-GIS passive and active

2.1.3 GIS Sections [2]:

- **Land Information Systems (LIS):** systems which are developed and operated by state surveying institutes.
  - land property maps
  - state surveying

- Communal surveying (city ground maps).

- **Network Information Systems (NIS):**

  Facility management of networks (for example from energy, water and gas supply companies) .

- **Space Information Systems (SIS):**

  systems for the decision support for planning and development .

  - development maps.
  - land use maps.
  - statistic maps.

- **Environmental Information Systems (EIS):**

  - environmental compatibility tests.
  - Radioactivity.
  - protection of species.
  - planning and simulation of agricultural fields.
  - Documentation or air, water and ground (contaminated sites, natural resources, etc.).

- **Domain Information Systems (DIS):**

  systems which have special applications:

  - navigation (street, water, air).
  - transport management.
  - military applications.

2.1.4 Description of Land Use Planning

Land use planning refers to the process by which a society, through its institutions, decides where, within its territory, different socio-economic activities such as agriculture, housing, industry, recreation, and commerce should take place. This includes protecting well-defined areas from development due to environmental, cultural, historical, or similar reasons, and establishing provisions that control the nature of development activities. These controls determine features such as plot areas, their land consumption or surface ratio, their intensity or floor-area ratio, their density or units of that activity (or people) per hectare, the technical standards of the infrastructure and buildings that will serve them, and related parking allowances. In relation to pollution prevention, land use provisions should include, where applicable, levels of gas emissions, light radiation, noise, water, solid waste discharges, and on-site or pre-disposal treatment of pollutants. All of these provisions should be included in the jurisdiction's land use or zoning code. This code becomes the legal guide for landowners, developers, citizens, and authorities. A good system of protected areas, together with strong land use provisions, should result in a less-polluted jurisdiction [4].

2.1.4 The Benefits of GIS to Land Use Planning

The development of information technologies has significantly changed the approach to land use and spatial planning, and the management of natural resources. GIS considerably simplifies territorial planning operating and analyzing necessary data concerning their spatial relationship that allows carrying out complex assessment of the situation and creates a basis for adoption of more exact and scientifically reasonable decisions in the course of land use. To assess the current land use situation and the possibility of modeling possible future changes associated with complex adopted measures, GIS allows for the integration of diverse spatial data, for example, data about soils, climate, vegetation, and others, and also to visualize available information in the form of maps, graphs or charts, and 3D models. For the purposes of land use GIS allows for using data of remote sensing, which allows to make monitoring of anthropogenic influence in a particular area and estimate scales and rates of degradation of green covers, flora and fauna. Assessment of land use can be made in complex or component-wise modes, indicating the test sites depending on the goals. GIS makes it easy to model spatial distribution of various types of pollution of stationary and mobile sources in soil, atmosphere and the hydrological network. Based on results of the analysis made by GIS we can choose the optimal solutions of land use that provides the minimum impact on the environment, make optimal decisions of conflict associated with land use and control of their using. One of the major advantages of using GIS is th possibility of the complex analysis in concrete existential aspect. Analytical opportunities of GIS define conditionality of spatial distribution of objects and interrelation communication between them. For a variety of land management objectives, analysis methods are chosen based on the parameters of the problem and parameters of use of its results [5].

2.1.5 Urban Planning Applications of GIS

GIS can be applied to many types of problems. Among these are representatives of both raster and vector data base structures, both simple and complex analytical models. Master planning applications are one of them. Especially for area monitoring (both on a sectoral and integral basis), regional potential and feasibility analyses and site selection studies. For studies in which plan alternatives are generated, much more flexible design, optimization and evaluation tools would be needed in order to give GIS a dominant position in the development process.

GIS can also be helpful for the documentation of spatial plans and in the approval process for the development, building and installation permits.

GIS is applied to a wide range of land management and land use planning issues including the interpretation and formulation of land use policy. Land-use policy can be interpreted within GIS using a modelling approach.

Output in the form of maps showing areas, in which land-use changes are more likely to occur, and statistics, graphs and tables summarizing this information according to a variety of specified spatial units. Such output allows land-use implications to be discussed.

The predicted land-use changes can also form input for GIS-based impact assessment.

GIS have become of increasing significance for environmental planning and assessment in recent years. One reason for this is the availability of a great number of spatial data with their attributes, to be involved in environmental planning. GIS represents a toolbox of highly efficient instruments for such planning tasks. GIS can be used to develop natural and cultural resource inventory to identify contamination sources, to assess environmental constraints, selection of sites for land application of sewage waste. Suitability for several treatment techniques can be considered using soil, topographic and land use factors, integrated with information about the biological, chemical and physical properties of waste [6] (see fig. 2-2).

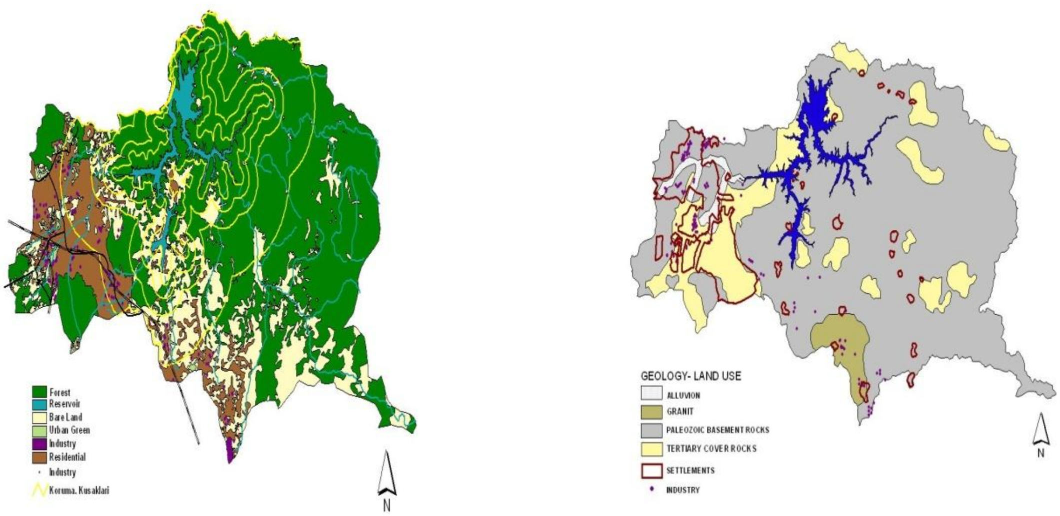


FIGURE [2-2]: GIS IN LAND USE PLANNING

2.2 THEORETICAL FRAMEWORK

2.2.1 What is ArcGIS?

Esri’s ArcGIS Is a geographic information system for working with maps and geographic information. It is used for creating and using maps compiling geographic data, analyzing mapped information, sharing and discovering geographic information, using maps and geographic information in a range of applications, and managing geographic information in a database. It provides an infrastructure for making maps and geographic information available throughout an organization, across a community, and openly on the Web. And it includes the following Windows desktop software [7]:

- **ArcReader:** which allows one to view and query maps created with the other ArcGIS products.
- **ArcGIS for Desktop:** which is licensed under three functionality levels:
  - ArcGIS for Desktop Basic (formerly known as Arc View), which allows one to view spatial data, create layered maps, and perform basic spatial analysis.
  - ArcGIS for Desktop Standard (formerly known as Arc Editor), which in addition to the functionality of Arc View, includes more advanced tools for manipulation of shape files and geodatabases.
  - ArcGIS for Desktop Advanced (formerly known as Arc Info), which includes capabilities for data manipulation, editing, and analysis.

2.2.2ArcGIS for Desktop Components

ArcGIS for Desktop consists of several integrated applications, including Arc Map, Arc Catalog, Arc Toolbox, Arc Scene, Arc Globe, and ArcGIS Pro.

2.2.2.1 ArcMap

ArcMap is the main component of Esri's ArcGIS suite of geospatial processing programs, and is used primarily to view, edit, create, and analyze geospatial data. ArcMap allows the user to explore data within a data set, symbolize features accordingly, and create maps. This is done through two distinct sections of the program, the table of contents and the data frame [8].

Functionality:

Users can create and manipulate data sets to include a variety of information. For example, the maps produced in ArcMap generally include features such as north arrows, scale bars, titles, legends, neat lines, etc. The software package includes a style-set of these features. As well as the ability to upload numerous other reference styles to apply to any mapping function [8].

2.2.2.2 ArcCatalog

ArcCatalog is an application that provides a catalog window that is used to organize and manage various types of geographic information for ArcGIS for Desktop. The kinds of information that can be organized and managed in ArcCatalog include [8]:

- Geodatabases.
- Raster files.
- Map documents, globe documents, 3D scene documents, and layer files.
- Geoprocessing toolboxes, models, and Python scripts.
- GIS services published using ArcGIS for Server.
- Standards-based metadata for these GIS information items.

ArcCatalog organizes these contents into a tree view that it can be work with to organize GIS datasets and ArcGIS documents, search and find information items, and to manage them.

Functionality:

Arc Catalog is used to:

- Organize GIS contents.
- Manage geodatabase schemas.
- Search for and add content to ArcGIS applications.
- Document project contents.
- Manage GIS servers.
- Manage standards-based metadata.

2.2.3 Geo Database

A geodatabase is an alternate way to store GIS information in one large file, which can contain multiple point, polygon, and/or polyline layers [8].

2.2.4 Planning Decisions

Are decisions to plan, re-plan and distribute a certain area of the land to make plots of different sizes for public health or the well-being of the population or for the development of any city or one of its regions or any village. The planning department prepares a draft outline for the new planning of the area, which may also include a change in the degree of land. The draft general map is then presented to the Planning Committee for approval.

Types of planning decisions:

- **A planning decision for the purpose of annexation:** Combine two adjacent pieces.
- **A planning decision for the purpose of Secretion**: Divide one piece into more than one share according to the number of owners in condition that in the case of residential plots less area is 200 meters.
- **Planning decisions to change the purpose of regions.**
- **Planning decisions in order to increase or decrease areas.**

2.2.5 List of Areas

After the Planning Committee authorizes the draft of the general map and the issuance of the planning decision, a request is made to raise the survey area from the Directorate General of Survey. Which in turn make sure that there are no obstacles on the ground, then sign the outline on the nature, the work of the detection of spaces and send it to the specialist registers office to open the register record of new pieces resulting from the planning decision.

2.2.6 RESIDENTIAL Lands Customization Books

The Department of Survey sends the list of areas of lands to the land department, which in turn give the land to the citizens, either through the housing plan or grant them as compensation to citizens affected by other planning decisions, or sold it at a public auction or direct selling. The list of spaces is recorded in books called customization books, which include land number and the area and the name of the person who has been granted to do so in accordance with the procedures mentioned above. The lands that have not been granted shall be nominated for sale according to the specified features.

2.2.7 Land Location and Purposes Using Types:

- **Normal:** open in one dirt road or asphalt with a width of less than 15 meters.
- **Corner:** Open in more than one dirt road or asphalt with a width of less than 15 meters.
- **Featured:**Open in one or more than one asphalt with a width of larger than 15 meters.

Lands use purposes:

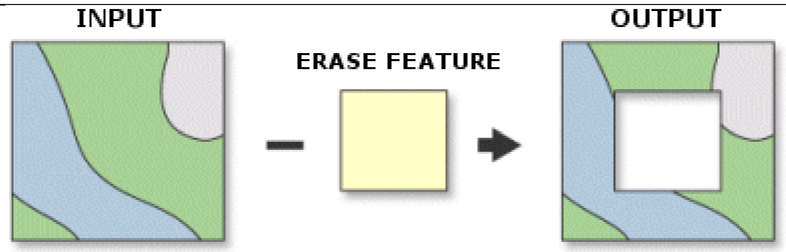
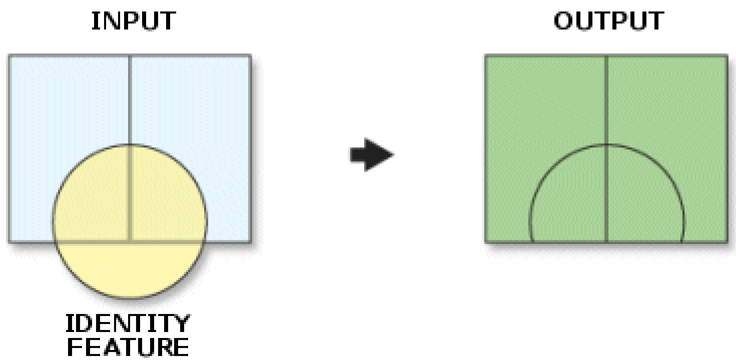
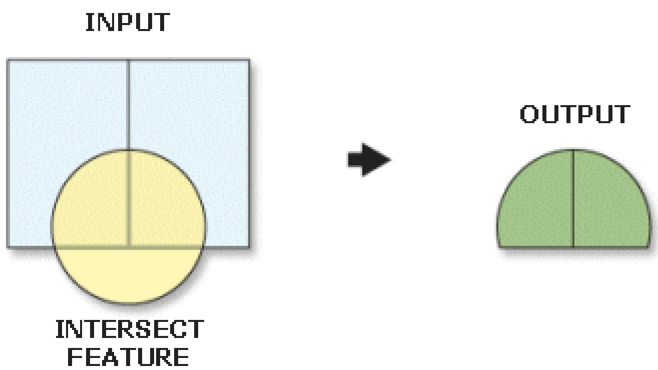
- **Agricultural:** for agricultural purposes only.
- **Residential:** for families only.
- **Commercial:** used financial purposes as shops and super markets.
- **Investment:** to be rented for organizations or institutes etc….

2.2.8 Overlay Toolset

Contains tools to overlay multiple feature classes to combine, erase, modify, or update spatial features, resulting in a new feature class. New information is created when overlaying one set of features with another. There are six types of overlay operations; all involve joining two existing sets of features into a single set of features to identify spatial relationships between the input features [9].

Tools in Overlay Toolset:

TOOL	DISCRIPTION
Erase	Creates a feature class by overlaying the input features with the polygons of the erase features. Only those portions of the input features falling outside the erase features outside boundaries are copied to the output feature class.

	
Identity	Computes a geometric intersection of the input features and identity features. The input features or portions thereof that overlap identity features will get the attributes of those identity features. 
Intersect	Computes a geometric intersection of the input features. Features or portions of features which overlap in all layers and/or feature classes will be written to the output feature class. 
Spatial Join	Joins attributes from one feature to another based on the spatial relationship. The target features and the joined attributes from the join features are written to the output feature class.
Symmetrical Difference	Features or portions of features in the input and update features that do not overlap will be written to the output feature class.

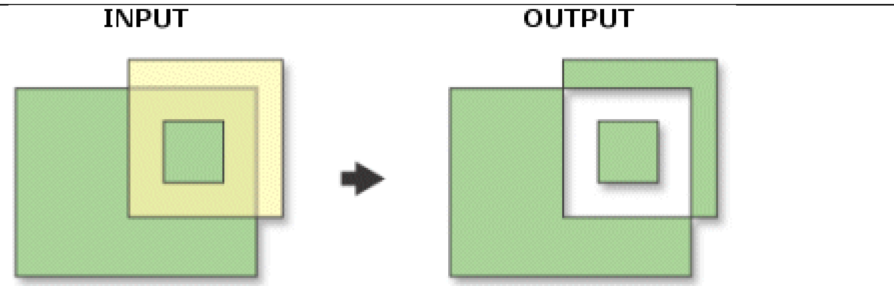
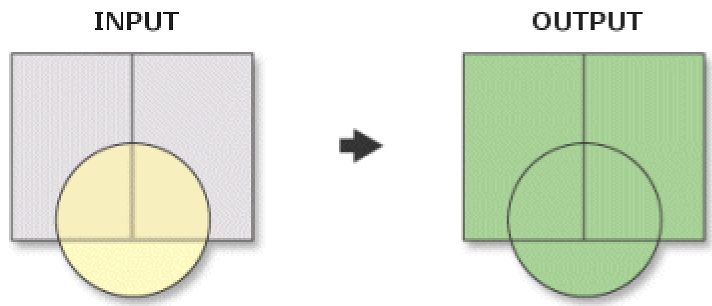
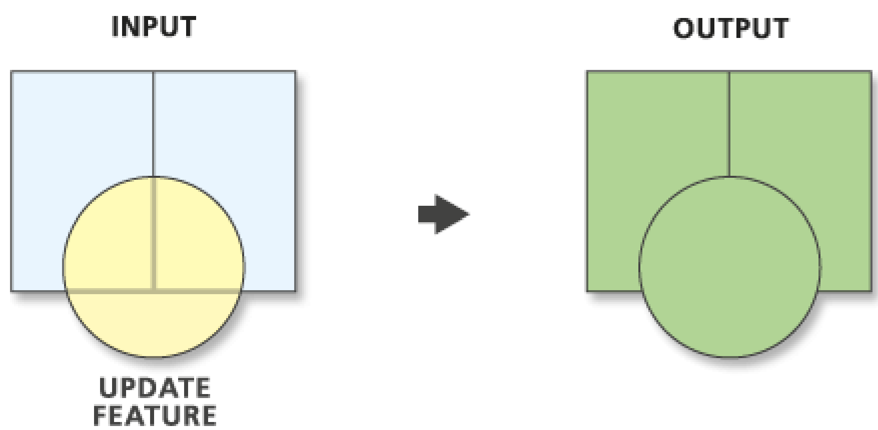
<table>
<tr><td></td><td>
</td></tr>
<tr><td>Union</td><td>Computes a geometric union of the input features. All features and their attributes will be written to the output feature class.

</td></tr>
<tr><td>Update</td><td>Computes the geometric intersection of the Input Features and Update Features. The attributes and geometry of the input features are updated by the update features in the output feature class.

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Table [2-1]:Tools in the Overly Toolset

2.2.8 Proximity Toolset

Contains tools that are used to determine the proximity of features within one or more feature classes or between two feature classes. These tools can identify features that are closest to one another or calculate the distances between or around them [10].

Tools in Proximity Toolset:

Tool	Description
Buffer	Creates buffer polygons around input features to a specified distance.
Create Thiessen Polygons	Creates Thiessen polygons from point features. Each Thiessen polygon contains only a single point input feature. Any location within a Thiessen polygon is closer to its associated point than to any other point input feature.
Generate Near Table	Calculates distances and other proximity information between features in one or more feature class or layer. Unlike the Near tool, which modifies the input, Generate Near Table writes results to a new stand-alone table and supports finding more than one near feature.
Graphic Buffer	Creates buffer polygons around input features to a specified distance. A number of cartographic shapes are available for buffer ends (caps) and corners (joins) when the buffer is generated around the feature.
Multiple Ring Buffer	Creates multiple buffers at specified distances around the input features. These buffers can optionally be merged and dissolved using the buffer distance values to create non-overlapping buffers.
Near	Calculates distance and additional proximity information between the input features and the closest feature in another layer or feature class.
Polygon Neighbors	Creates a table with statistics based on polygon contiguity (overlaps, coincident edges, or nodes).

Table [2-2]:Tools in the Proximity Toolset

2.3 Related Work

In the following we study related work for the research of this Master's Thesis. All are cited in the References Section.

2.3.1 A Spatial Optimization Model for Sustainable Land Use at Regional Level in China: A Case Study for Poyang Lake Region:

This study was carried out in 2015, and dealt with the problem of the rapid deterioration of the environment and a sharp decline in arable land area in China because of population growth, which in turn led to a lack of spatial distribution of both sustainable agricultural land or residential at the regional level. A model was built to help the planning process to achieve a balance between urbanization and arable land and natural resources protection.

The technique that has been used was general landform map and a raster DEM (digital elevation model) system. The model that was built is not a static approach to balance all the different areas, because of the different characteristics of the regions [11].

2.3.2 State of the Art of Land Use Planning Using Remote Sensing and GIS:

This study was conducted in 2014, where it discussed the use of remote sensing data with geographic information systems in the optimal planning of land use to solve agricultural problems to meet the needs of the people by providing food resources in the future.

The technique that has been used was remote sensing and GIS software (ArcInfo and ArcView). Here the display technologies rely totally on satellite images taken in order to be analyzed. There is no geographic data involved or referenced to establish a link between remote sensing data and the existing maps [12].

2.3.3 Land use suitability using GIS technique in Erzurum watershed, Turkey:

This study was conducted in 2015. It discussed the process of planning the use of land water catchment areas of Erzurum, Turkey, in order to convert them to residential areas according to the proportion of the increasing population growth, which in turn requires the preparation of land-use plans to provide residential land to accommodate the next generation of the population, by knowing their suitability for that type of use.

A Geographic Information Systems was used to analyze and evaluate the extent of land for the purpose of residential use, through the analysis carried out to identify potentially hazardous areas, depending on proximity to the catchment area of Erzurum, Turkey, to the affected territories, moisture, and take advantage of it in the planning of facilities in the future. Building models are extracted and maps showing high-risk areas - these together can be considered as exploited areas.

ArcGIS software is used to create maps, but it was also possible to add other factors to the process of classifying areas by soil type, such as the vulnerability of the soil by nature factors such as rain [13].

2.3.4 GIS in land use and land development in a city:

This study was conducted in 2013, and focused on how Geographic Information Systems can be used in the creation, maintenance and analysis of urban information, land use and the development of educational institutions, industry, housing, water supply facilities and services, and sewage systems. The study includes the current situation of Boduppal suburbs and Pirzadiguda in the city of Hyderabad in Andhra Pradesh, India.

ArcGIS software used to create maps, and to carry out analysis processes. Furthermore, three-dimensional editing tools can be used to increase the accuracy of the maps, including the creation and storage of vertical lines in the geographic database [14].

2.3.5 GIS in archeology:

This study was made in November 2013, and deals with the production of maps of archaeological sites. This has been done for several time periods for each site. Afterwards, the sites have been flooded virtually by the waters of kagpar dam, and the results are interpreted.

The ArcGIS 9.3 desktop software is used to create maps, and to create a geographical database. But the weaknesses in the application lies in the process of updating the maps and then reverse the updates to the geographic database. As a novel approach it was possible to use a server (gis server) and develop the application on the Web, so that new archaeological sites can be added and reflect data on the rules of geographic data directly to the server.

2.4 System Description

The aim of this thesis is to develop a system, that uses the agricultural and residential land layers and the public roads layer for the western region of Al-Gharif to analyze the selection of agricultural land near the residential areas by creating a model, that produces a layer showing the land suitable for improvement and changing its purpose for residential settlements.

CHAPTER 3
Methodology and Research Planning

3.1 Research Community:

West Al-Grief is a western Sudanese neighborhood located in the state of Khartoum, in particular in the city of Khartoum, one of the oldest and oldest neighborhoods of Khartoum. Moreover, it is an important area in Khartoum, whose inhabitants played key roles in economic, political and social activities in Sudan. Geographically it is located at longitude 32.86667 and latitude 15.96667 degrees (see fig. 3.1).

Some reports differ in the location and geography of the city, due to the confusion of the great geographical transformation in the capital Khartoum and the expansion of the residential neighborhoods, located east of Khartoum adjacent to the Blue Nile.

In the past, the west of Al-Grief included large areas such as Al Mamoura, Manshiyah, Al-Firdous, Riyadh, Taif, Salameh and Jibra. But in the past it shrunked, thanks to the plans of population, urbanization and expansion of the city.

In the past the Al-Grief neighborhood was called Al-Sawaqi and starts from Al-Sakia (1) and ends at Al-Sakiya (7) north of Soba and south of Al-Grief west, because it is an agricultural area. These streams were gradually changed to residential areas.

The neighborhoods located in Al-Gharif west are the citadel of Al-Qalaa, and Al-Haj neighborhood.It was called Al-znarikha and other neighborhoods are alqrareeg, sheeta, thaqulat, hugairaat …etc.

The inhabitants of this region were all farmers and they knew the ancient agriculture since the time of the Fung to the present time. From the beginning, all kinds of vegetables and fruits are cultivated.

The old Al-Gharif had rich gardens and was famous for the quality of cultivated vegetables and fruits such as guava and lemon, a land with fertile clay soil. In addition, these large farms of large size and agriculture are irrigated with barber or oysters in space around that area.

These features have been changed for many reasons, including the increase in the number of the population with an engineering transition. The size of the agricultural land has not met the size of the population. The city has expanded and the housing plans have led to the temptation of the people to sell the agricultural and residential lands. Not only the land has been transformed gradually, but also the agriculture has disappeared and also old landmarks.

In addition, many people quit work in agriculture and other occupations, to start new careers in administrations, business, economics, engineering, consultations and many more.

This induced the government of the region to try to benefit from the conversion of agricultural land to residential areas, by intended land selling, with distinctive specifications through auctions or direct sales. The overall aim was to achieve a high proportion of revenues for the state treasury and in order to provide more residential land for citizens.

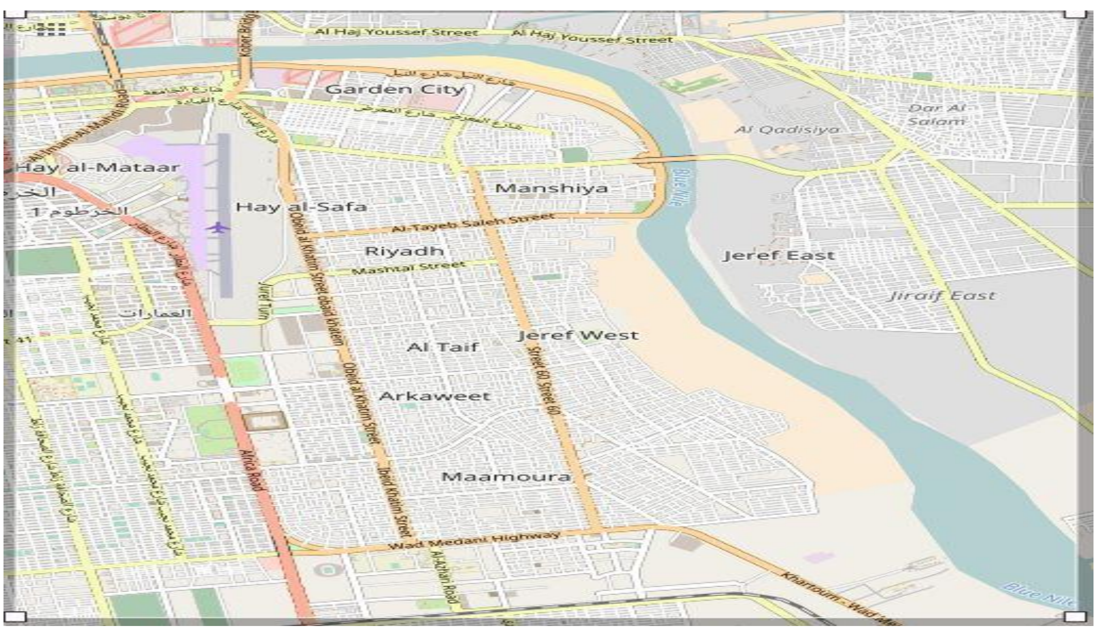


Figure [3-1]: Study Area

3.2 Methodology

3.2.1 Data Collection and Preprocessing

The data was collected from the General Directorate of Survey of Khartoum State, which are the layers of agricultural land and residential lands in addition to the public roads layer. The agricultural land layer was then treated by dividing it into small squares to help in the analysis process more clearly and easily.

3.2.2 Model Building

The model was built by using ArcGIS desktop(10.2) software in creating a toolbox at Arc Catalog and then build the model with it. Layers (agricultural land, residential land, public roads) were added to the model ,in the analysis toolbox using the proximity toolset. In particular were applied the Predefined measurements by using the buffers tools to determining the target distances as a criterion for measuring the extent of the agricultural land distance from residential land. Furthermore, the erase tools, which are included in the overlay toolset, are used as well to eliminate all agricultural lands, that does not satisfy the determined target distance in the buffer.

3.2.3 Execution and Results Evaluation

After the model was built and implemented, a layer was created that showed the farmland, that is maximum 7km away from the residential lands and therefore can be transformed to residential areas.

3.3 Research Planning

		Time period per week								
NO	**task**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	background									
2	Previous studies									
3	Data collection									
4	design									
5	Analysis and result assessments									
6	Research writing									

Figure [3-2]: Research Planning

CHAPTER 4
System Design

4.1 System Requirements

For a good performance it is recommended to use the Esri Business Analyst 10.2 with Windows 7 64-bit Operating System. So the minimum system requirements are written in the table 4.1 below.

CPU Speed	2.2 GHz minimum; Hyper-threading (HHT) or Multi-core recommended
Processor	Intel® Core™ Duo, Intel Pentium® 4, or Intel Xeon® processors; SSE3 minimum. Run this Microsoft utility from Windows command prompt to check processor.
Operating System	▪ Windows 8.1 Basic, Professional and Enterprise (32-64 bit [EM64T]) ▪ Windows 8 Basic, Professional and Enterprise (32-64-bit (EM64T)) ▪ Windows 7 Ultimate, Enterprise, Professional, Home Premium (32-64-bit (EM64T)) ▪ Windows Vista Ultimate, Enterprise, Business, Home Premium (32-64-bit (EM64T)) Version: min SP1 max SP2 ▪ Windows Server 2012 R2 Standard, and Datacenter (32-64 bit [EM64T])** ▪ Windows Server 2012 Standard, and Datacenter (32-64-bit [EM64T]) ▪ Windows 2008 Server Standard, Enterprise & Datacenter (32-64-bit (EM64T)) Version: max SP2 ▪ Windows 2008 R2 Server Standard, Enterprise & Datacenter (32-64-bit (EM64T)) ▪ Windows Server 2008 R2 with Citrix XenApp 6 and XenApp 6.5* ▪ Windows 2003 Server Terminal Services Version: min SP2 max SP2 ▪ Windows 2003 Server Standard, Enterprise & Datacenter (64-bit (EM64T)) Version: min SP2 max

	SP2 **Note**: Microsoft Windows Server 2003, 2003 R2, Vista and XP are no longer supported starting at ArcGIS 10.2.2.
Display	Greater than 256 color depth
RAM	2 GB minimum, 6 GB or higher recommended
Swap Space	Determined by the operating system; 500 MB minimum
Disk Space	43 GB NTFS for complete software and data
Screen Resolution	**:**1024x768 recommend or higher at Normal size (96dpi)
Video/Graphics Adapter	NVIDIA, ATI, and Intel chipsets supported, 24-bit capable graphics accelerator, OpenGL version 2.0 runtime minimum is required, and Shader Model 3.0 or higher is recommended.
Networking Hardware	Simple TCP/IP, Network Card or Microsoft Loopback Adapter is required for the License Manger.
Media Player	USB drive is required to install the application
.NET Framework	Microsoft .NET Framework 4.0 Requirement
Internet Explorer Requirement	ArcGIS for Desktop requires a minimum installation of Microsoft Internet Explorer Version 7.0 or 8.0. If you do not have an installation of Microsoft Internet Explorer Version 7.0/8.0, you must obtain and install it prior to installing ArcGIS for Desktop. Internet Explorer Versions 9 and 10 are also supported.
Python Requirement for Geoprocessing	ArcGIS for Desktop geoprocessing tools require that Python 2.7.x and Numerical Python 1.6.x are installed. If the ArcGIS for Desktop setup does not find either Python 2.7.x or Numerical Python (NumPy) 1.6.x installed on the target computer, Python 2.7.2 and Numerical Python 1.6.1 will be installed during a complete installation. You can choose a Custom installation to unselect the Python feature and avoid installing it. Additionally, if the Python setup is executed during the ArcGIS for Desktop installation, you will be provided with the opportunity to choose its installation location. The Python installation location should not include spaces.

Table [4-1]: System Requirements

4.2 System Analysis

As an outcome, residential lands of different types, for commercial, residential and investment purposes, will be derived. Furthermore, sports spaces and schools for the 84 block west and parts of the blocks (79, 90)and block (1)of alferdoos neighborhood. Moreover, the public road layer representing the urban scale and the remaining agricultural land will be tested, according to the required standards. Agricultural lands, that are within the urban range of cities and governorates and close to the public streets, will be taken under the hypothesis to be transformed. That means, the agricultural land layers will be tested for proximity to the urban scale have. The agricultural lands beyond the urban range will be excluded. For agricultural land located at a maximum distance of 7 km of the urban scale of cities, can be improved and will be changed to be residential. This process is done by building a model to do all the analysis steps and explore results..Figure 4.1 shows the steps in the analysis process to build the model.

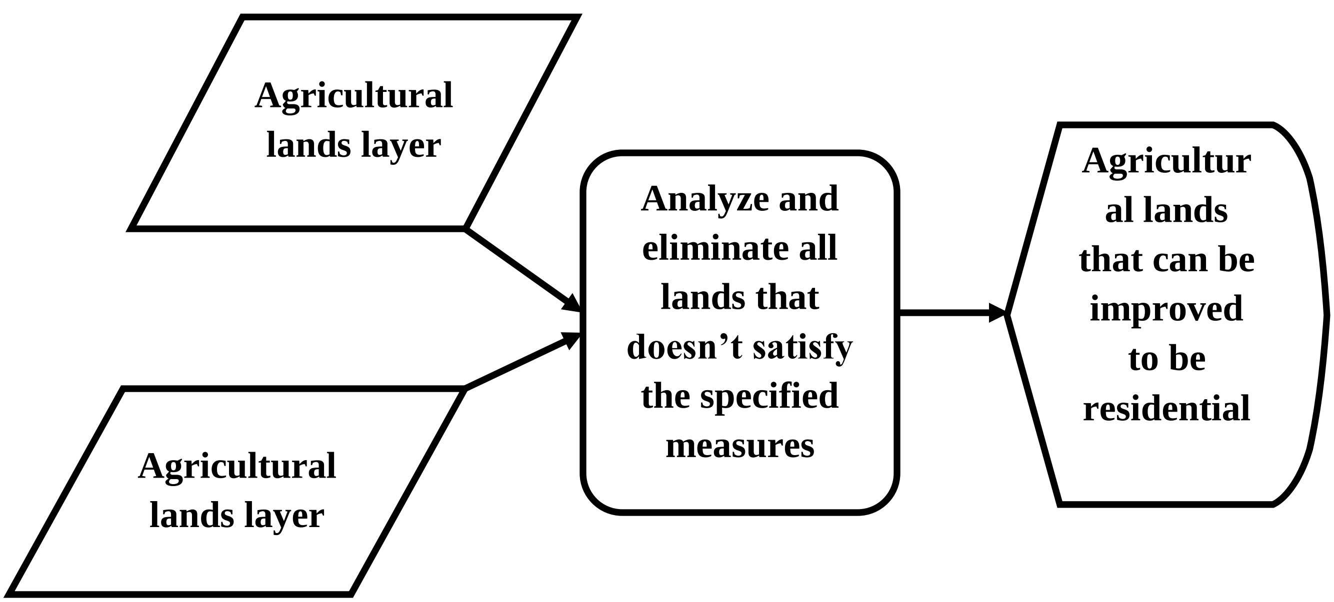


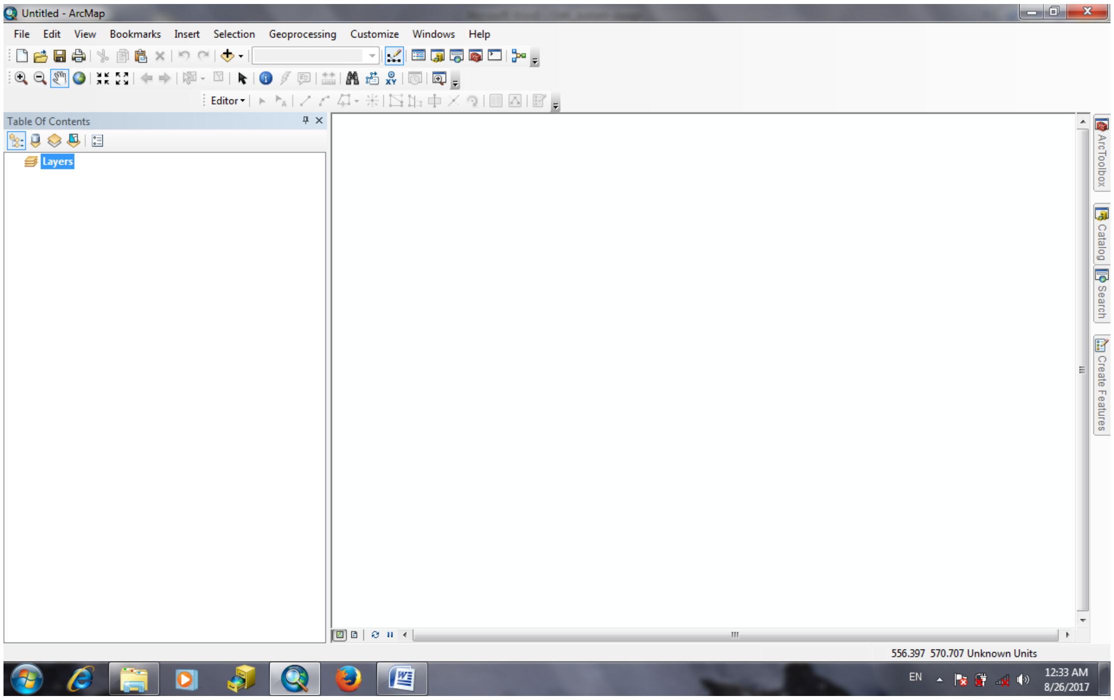
Figure [4-1]: System Work Flow

4.2.1 Model Building

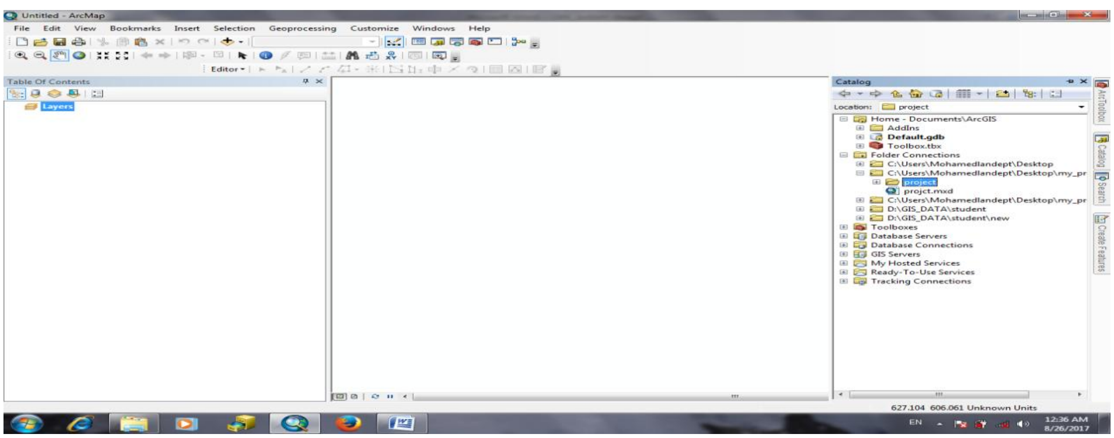
In the following the steps about model building using several land layers to do the analysis are described.

- **Create a toolbox to build a model in ArcMap and in ArcCatalog:**

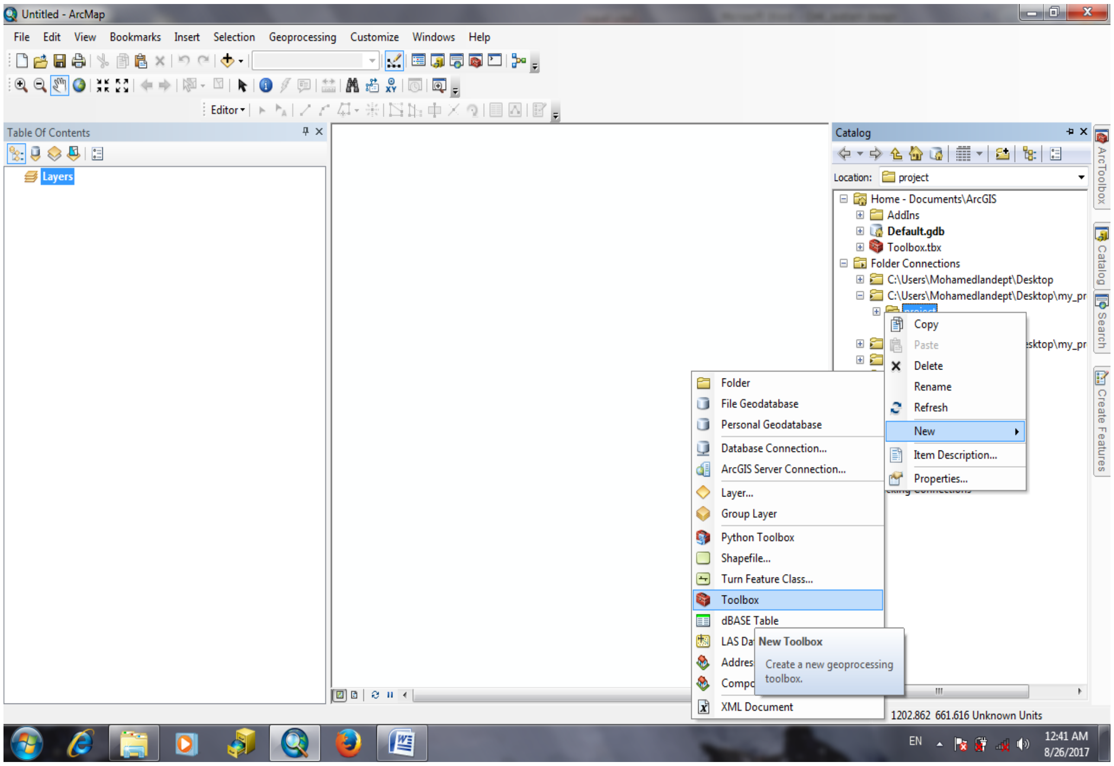
1. Open ArcMap:



2.Choosing project folder in the ArcCatalog tab:

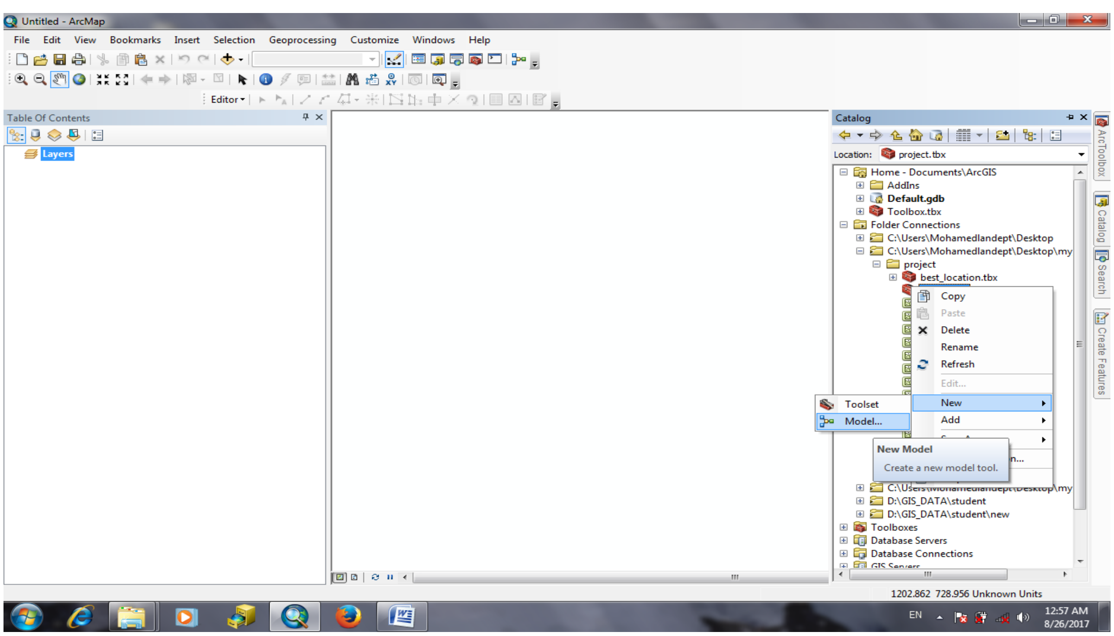


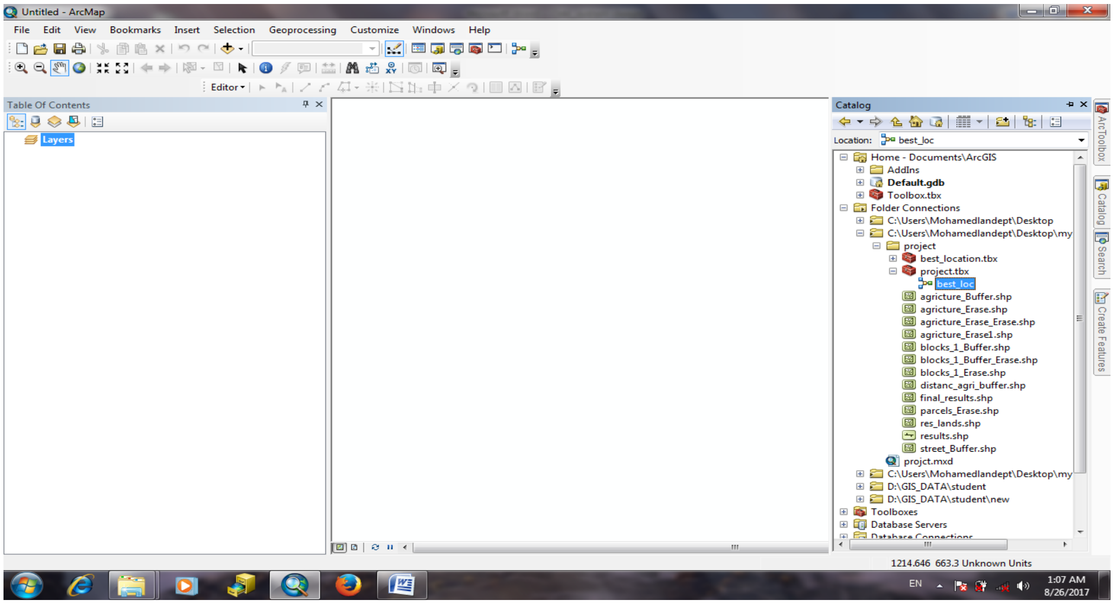
3.Create tool box and name it (project):



- **Build model in the toolbox (created above) and re-name it (best_loc):**

1. Create model:

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Bookmarks
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Selection
Geoprocessing
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Windows
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Editor
Table Of Contents
Layers
Catalog
Location: best_loc
Home - Documents\ArcGIS
AddIns
Default.gdb
Toolbox.tbx
Folder Connections
C:\Users\Mohamedlandept\Desktop
C:\Users\Mohamedlandept\Desktop\my
project
best_location.tbx
project.tbx
best_loc
agricture_Buffer.shp
agricture_Erase.shp
agricture_Erase_Erase.shp
agricture_Erase1.shp
blocks_1_Buffer.shp
blocks_1_Buffer_Erase.shp
blocks_1_Erase.shp
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res_lands.shp
results.shp
street_Buffer.shp
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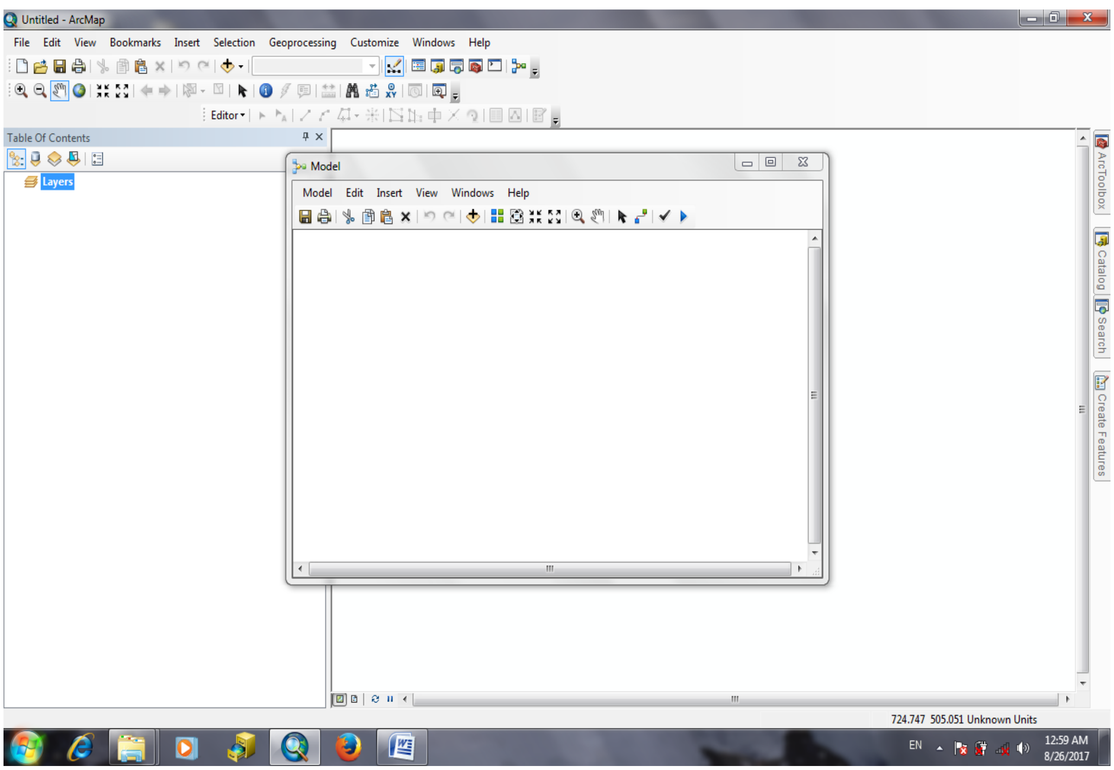
Untitled - ArcMap
File
Edit
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Customize
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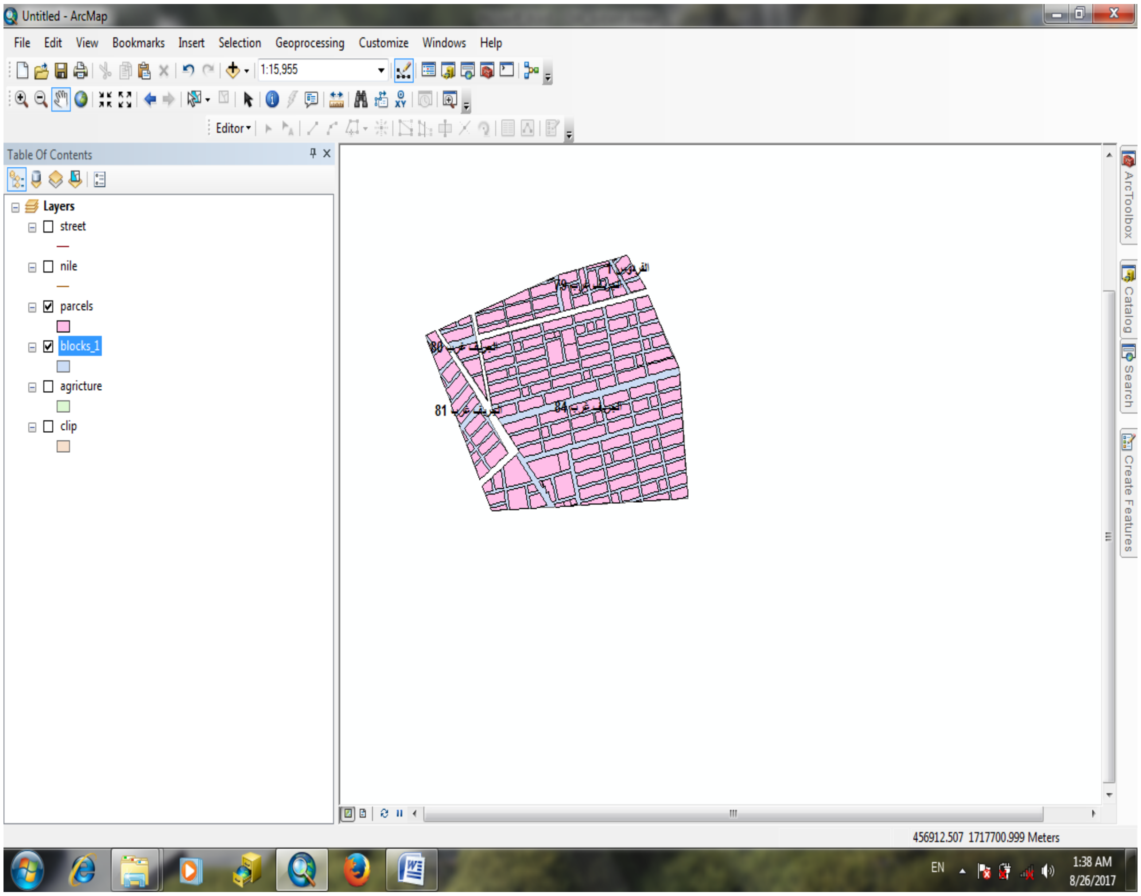
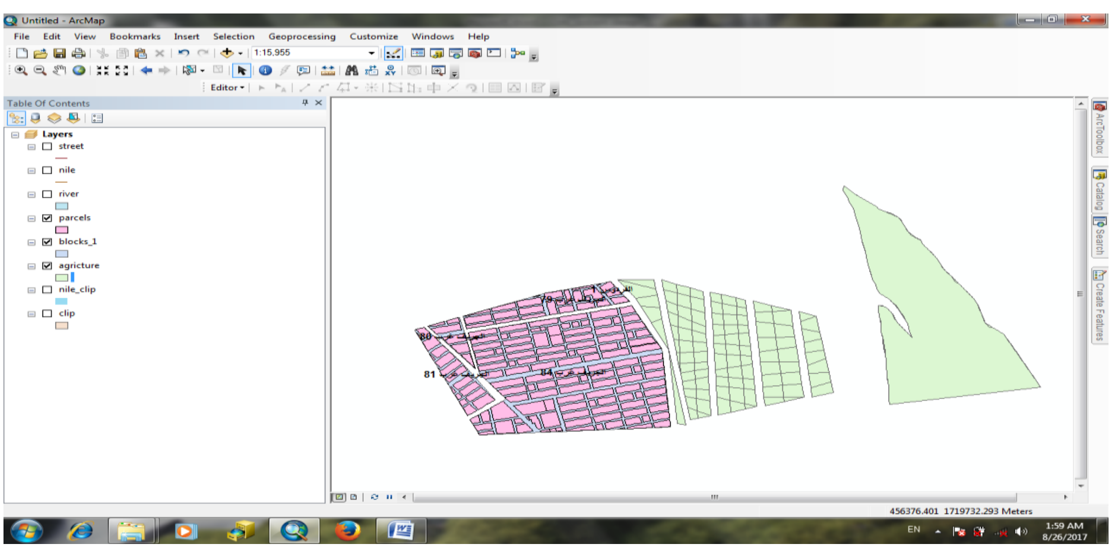
Editor
Table Of Contents
Layers
Model
Model
Edit
Insert
View
Windows
Help
ArcToolbox
Catalog
Search
Create Features
724.747 505.051 Unknown Units
EN
12:59 AM
8/26/2017

- **Adding layers to ArcMap:**

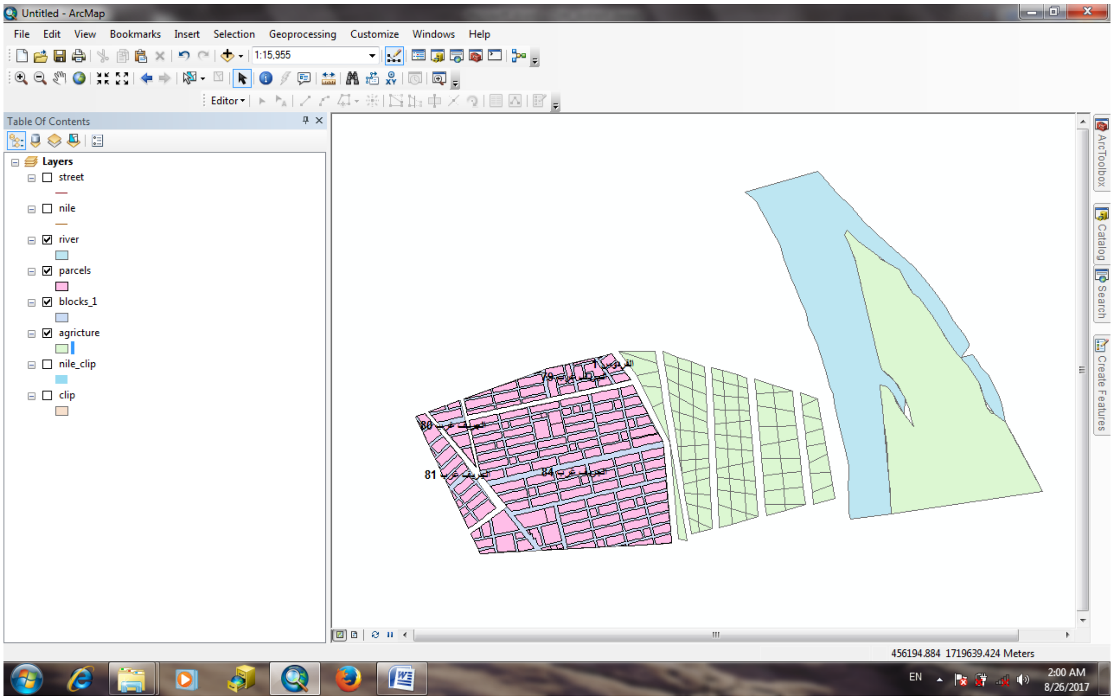
1. Adding residential lands layer:



2. Adding agriculture lands layer:

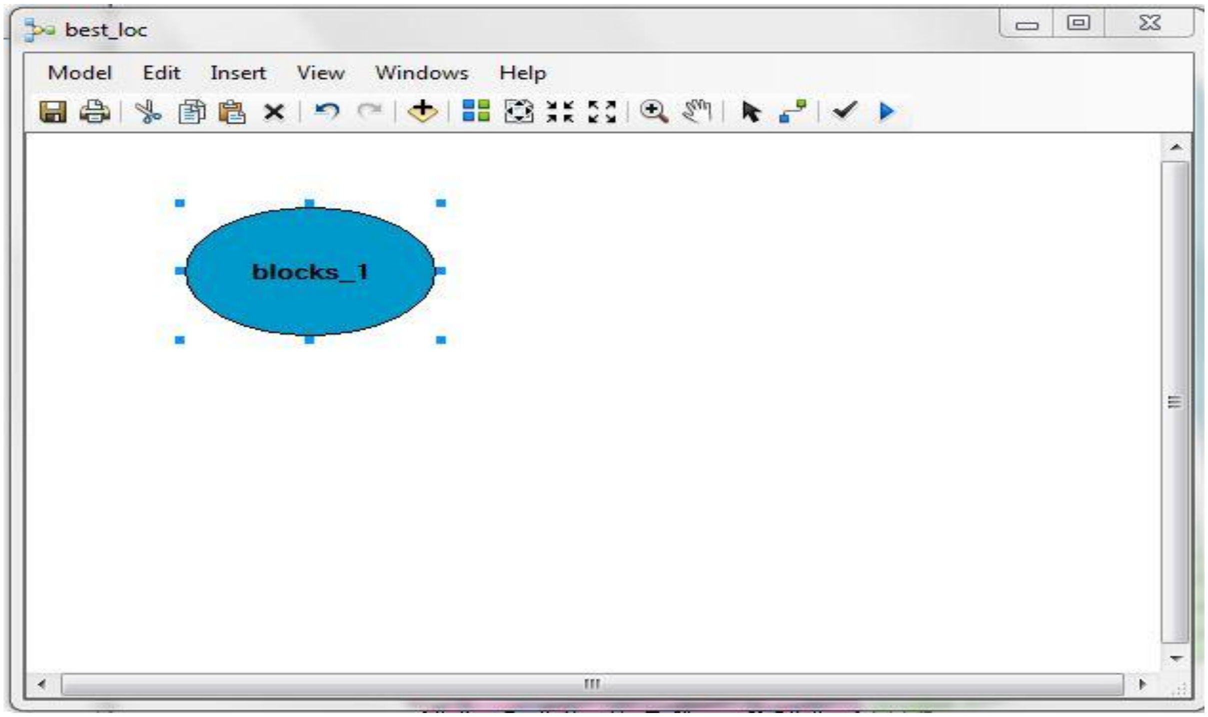


3. Adding the river layer:

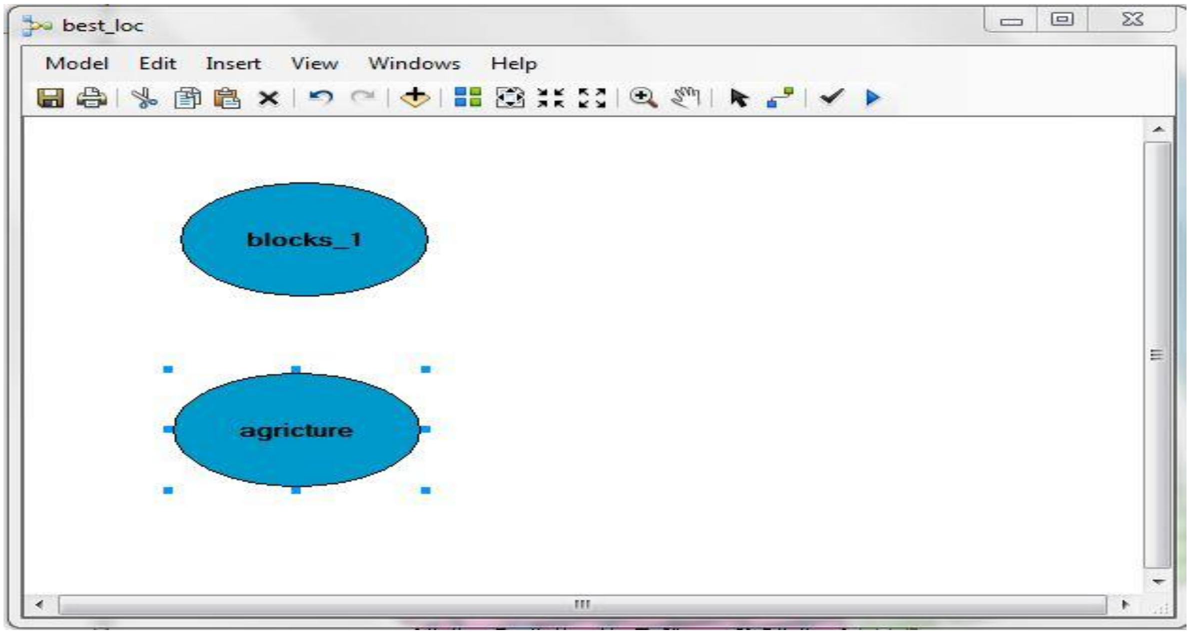


- **Dragging and dropping layers to the model that has been created:**

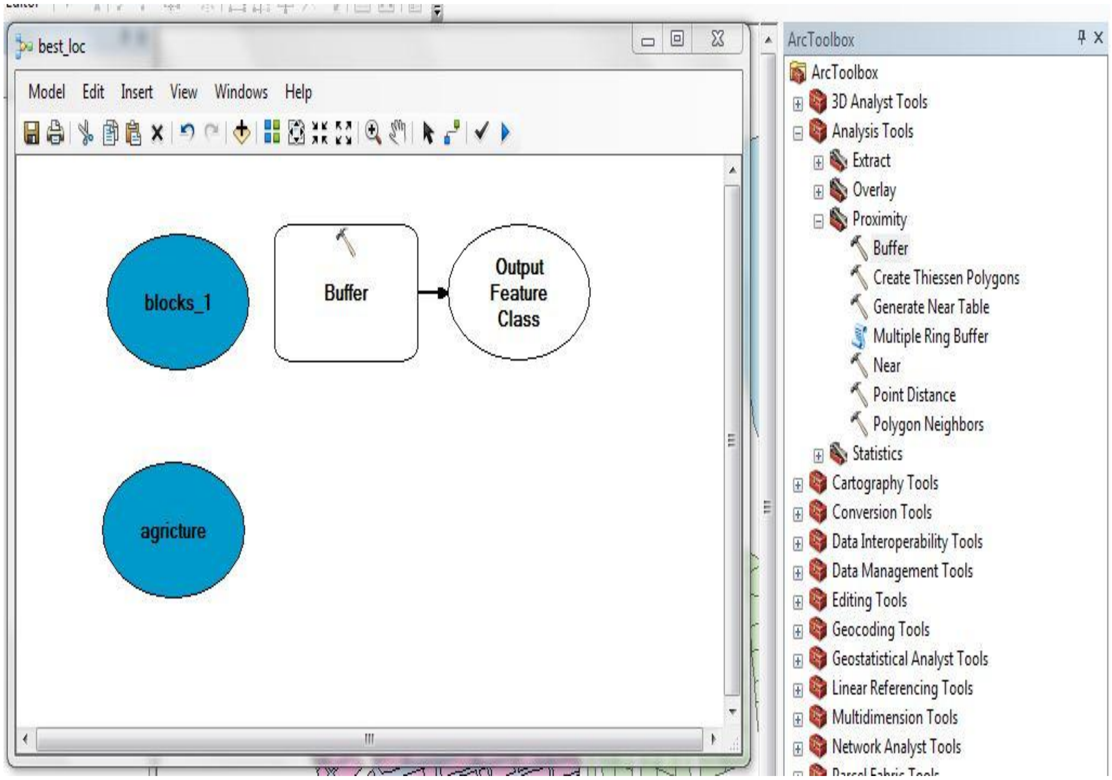
1. Adding blocks layer:

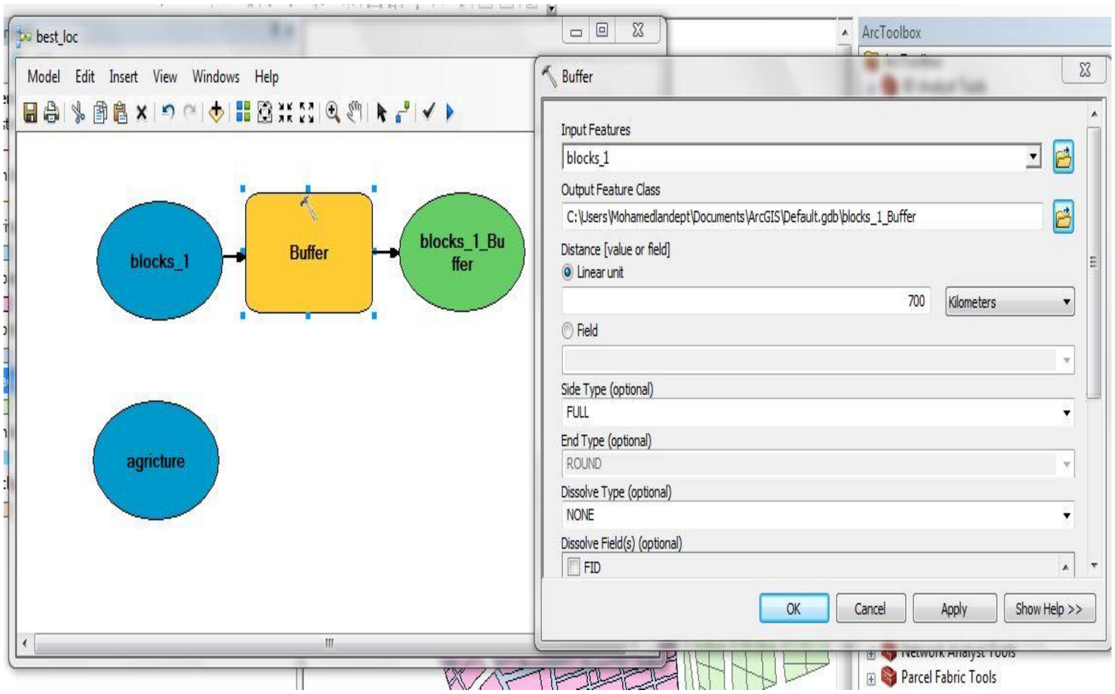


2. Adding agricultural lands layer:

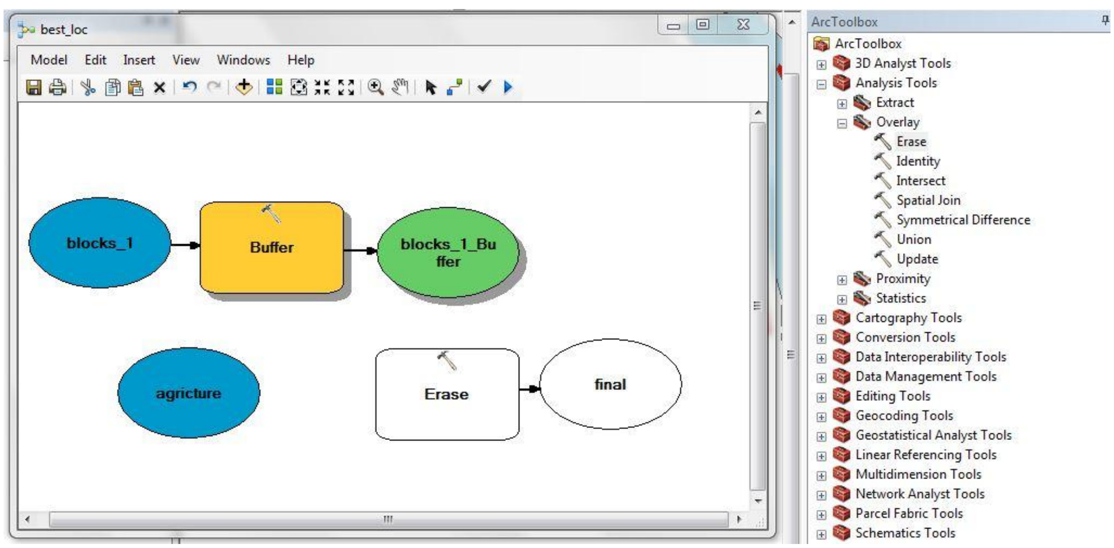


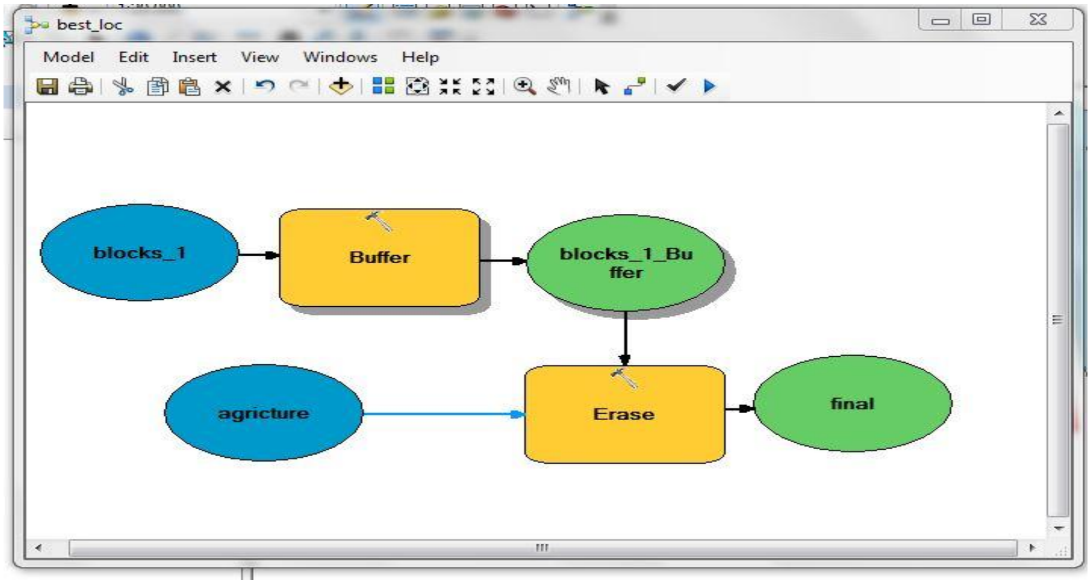
3. Creatingbuffer for blocks layer to set the elimination measurement which is 1 kilometer.





4. Erase all agriculture lands that exceeds the specific measurement:





After this step the model is completed and ready to be executed and tested to see the results which would generate the layers accepting agricultural land to be residential.

CHAPTER 5
Experiments and Results

5.1 Test bed Description:

In this chapter, the model that has been build will be tested through the layers that will be generated by the model to determine whether it contains the specific agricultural land according to the conditions that were developed during the analysis process.

5.2 Method used on system testing:

Active Testing is used for testing consisting in introducing test data and analyzing the execution results. Also **Functional Testing is used** for testing system for the functional requirements. This checks whether the application is behaving according to the specification.

5.3 Algorithms implemented:

5.3.1 Buffer:

Creates buffer polygons around input features to a specified distance.

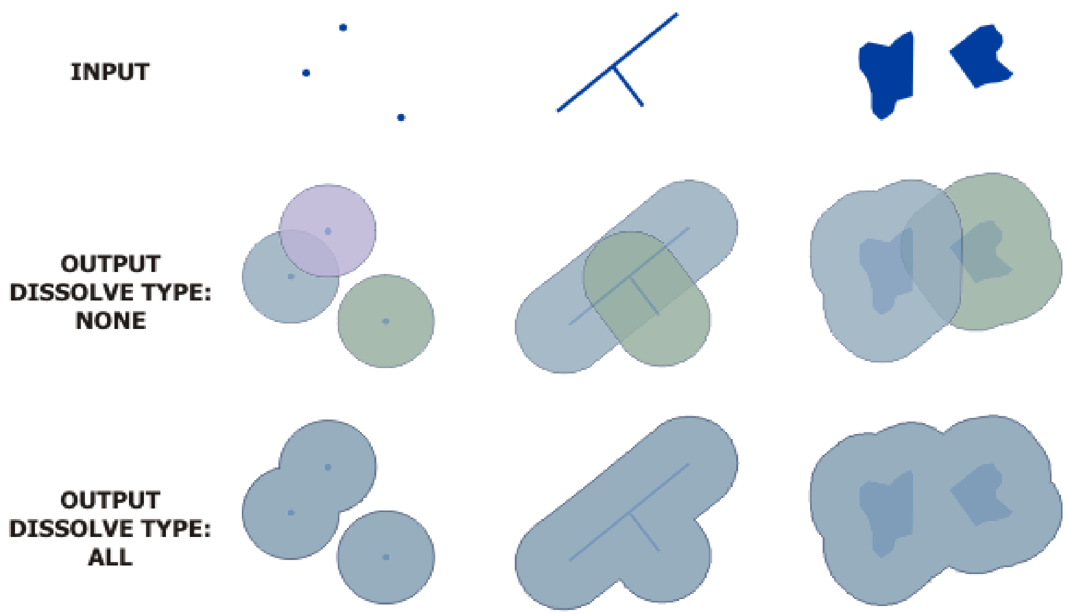


Figure [5-1] illustration of Buffer Tool

Usage

- As described in How Buffer works, an important feature of the Buffer tool is the Method parameter which determines how buffers are constructed. There are two basic methods for constructing buffers:
    - Euclidean buffers measure distance in a two-dimensional Cartesian plane, where straight-line or Euclidean distances are calculated between two points on a flat surface (the Cartesian plane). Euclidean buffers are the more common type of buffer and work well when analyzing distances around features in a projected coordinate system, which are concentrated in a relatively small area (such as one UTM zone).
    - Geodesic buffers are those that account for the actual shape of the earth (an ellipsoid, or more properly, a geoid). Distances are calculated between two points on a curved surface (the geoid) as opposed to two points on a flat surface (the Cartesian plane). geodesic buffers should be used when:
        - The input features are dispersed (cover multiple UTM zones, large regions, or even the whole globe).
        - The spatial reference (map projection) of input features distorts distances in order to preserve other properties such as area.
- The Method parameter determines how buffers are created.
    - Planar (method = "PLANAR" in Python) is the default option. This option will automatically determine which method to use based on the coordinate system of the Input Features.
        - If the input features have a projected coordinate system, Euclidean buffers will be created.
        - If the input features have a geographic coordinate system and a Buffer Distance is specified in linear units (meters, feet, and so forth, as opposed to angular units such as degrees), geodesic buffers will be created.
    - Geodesic (method = "GEODESIC" in Python) which is used in this research creates a shape-preserving geodesic buffer regardless of the input coordinate system. The shape-preserving geodesic buffer densifies the input features prior to creating the output geodesic buffers in order to create buffers that more closely represent the input features shape. If you are concerned about the shape of your buffers and how closely their shape matches the original input features, it is recommended you investigate using this option, particularly when your input data is in a geographic coordinate system. In some cases this may

take more time than the geodesic buffer created using the planar option, but the result is a buffer that more accurately matches the shape of the input feature.

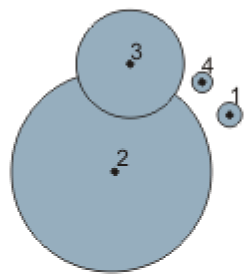
- When using the Planar method, it can improve the accuracy of buffers created with projected inputs by using a projection that minimizes distance distortion, such as an Equidistant Conicor an Azimuthal Equidistant projection and is geographically appropriate for the input.
- When buffering features in a projected coordinate system with output to a geodatabase feature class, the geometries created may contain circular arc segments (when buffering points, the output will always be circular arcs). If buffers containing circular arcs are reprojected to a different coordinate system, the location and size of the original buffers will be transformed, but the shape of the buffers will not change, causing the reprojected buffers to no longer accurately represent the area covered by the original buffer. If you reproject buffers containing circular arcs, first use the Densify tool to convert circular arc segments to straight lines, and then reproject the densified buffers.

- The output feature class will have a BUFF_DIST field that contains the buffer distance used to buffer each feature in the linear unit of the input features' coordinate system. When using the Geodesic method for buffer creation, the buffer distance entered will be converted to Meters in all cases. If a field named BUFF_DIST exists in the input, its values will be overwritten in the output. If a Dissolve Type of All or List (ALL or LIST in Python) is used, the output will not have this field.

  - The output feature class will have a ORIG_FID field that contains the feature ID of the input feature for which the buffer was created. If a field named ORIG_FID exists in the input, its values will be overwritten in the output. If a Dissolve Type of All or List is used, the output will not have this field.
  - When buffering polygon features, negative buffer distances can be used to create buffers inside the polygon features. Using a negative buffer distance will reduce the polygons' boundaries by the distance specified.

- If a field from the Input Features is used to obtain buffer distances, the field's values can be either a number (5) or a number with a valid linear unit (5 Kilometers). If a field value is a number, it is assumed that the distance is in the linear unit of the Input Features' spatial reference (unless the Input Features are in a geographic coordinate system, in which case, the value is assumed to be in meters). If the linear unit specified in the field values is invalid or not recognized, the linear unit of the input features' spatial reference will be used by default.

OBJECTID *	SHAPE *	buffer_field
1	Point	200 Meters
2	Point	1 Miles
3	Point	1 Kilometers
4	Point	500 Feet



- The Dissolve Field(s) parameter Add Field button is used only in Model Builder. In Model Builder, where the preceding tool has not been run or its derived data does not exist, the Dissolve Field(s) parameter may not be populated with field names. The Add Field button allows expected fields to be added to the Dissolve Field(s) list in order to complete the Buffer tool dialog box [15].

5.3.2 Erase:

Creates a feature class by overlaying the input features with the polygons of the erase features. Only those portions of the input features falling outside the erase features outside boundaries are copied to the output feature class.

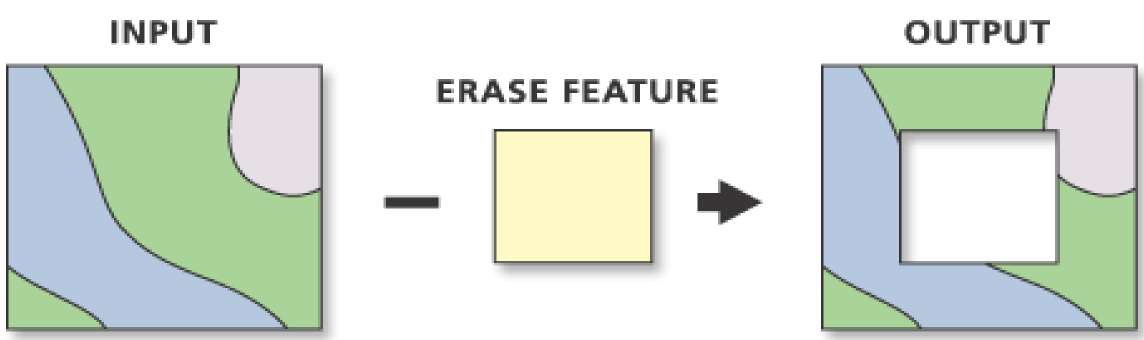


Figure [5-2] illustration of Erase Tool

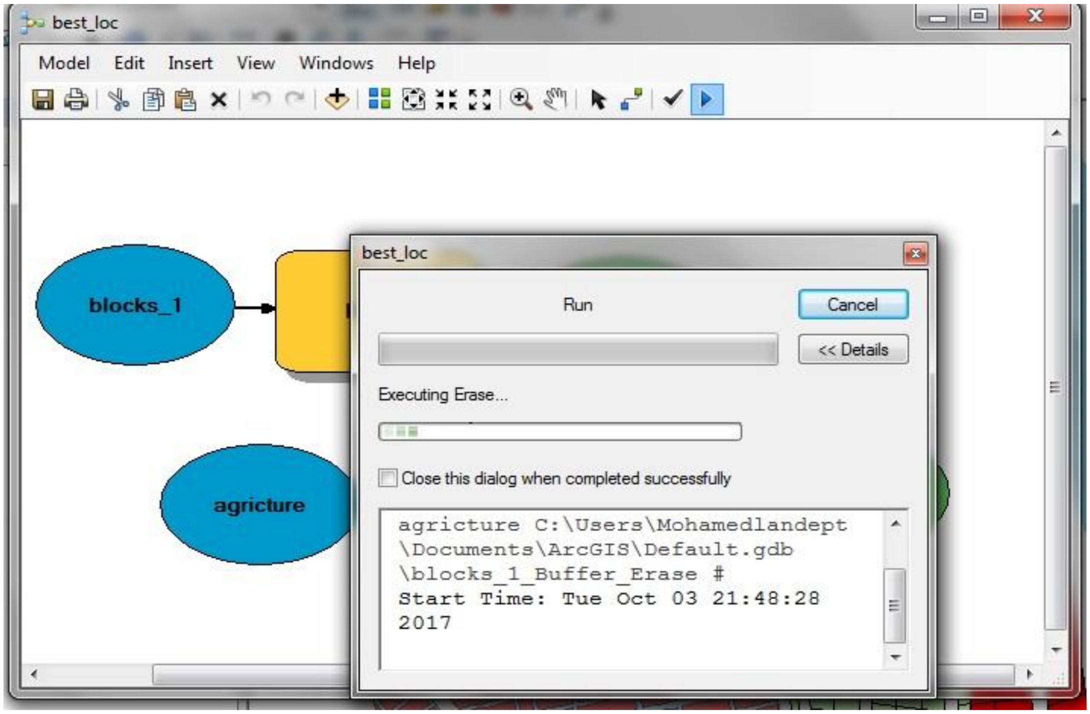
Usage:

- Input Feature geometries coincident with Erase Feature geometries will be removed.
- The Erase Features can be point, line, or polygon as long as the Input Feature is of the same or lesser order feature type. A polygon erase feature can be used to erase polygons, lines, or points from the input features; a line erase feature can be used to erase lines or points from the input features; a point erase feature can be used to erase points from the input features.
- Attribute values from the input feature classes will be copied to the output feature class. However, if the input is a layer or layers created by theMake Feature Layer tool and a field's Use Ratio Policy is checked, then a ratio of the input attribute value is calculated for the output attribute value. When Use Ratio Policy is enabled, whenever a feature in an overlay operation is split, the attributes of the resulting features are a ratio of the attribute value of the input feature. The output value is based on the ratio in which the input feature geometry was divided. For example, If the input geometry was divided equally, each new feature's attribute value is assigned one-half of the value of the input feature's attribute value. Use Ratio Policy only applies to numeric field types.
- This tool will use a tiling process to handle very large datasets for better performance and scalability. For more details, see Geoprocessing with large datasets.
- This tool may generate multipart features in the output even if all inputs were single part. If multipart features are not desired, use the Multipart to Singlepart tool on the output feature class.
- This tool honors the Parallel Processing Factor environment. If the environment is not set (the default) or is set to 0, parallel processing will be disabled. Setting the environment to 100 will cause parallel processing to be enabled [16].

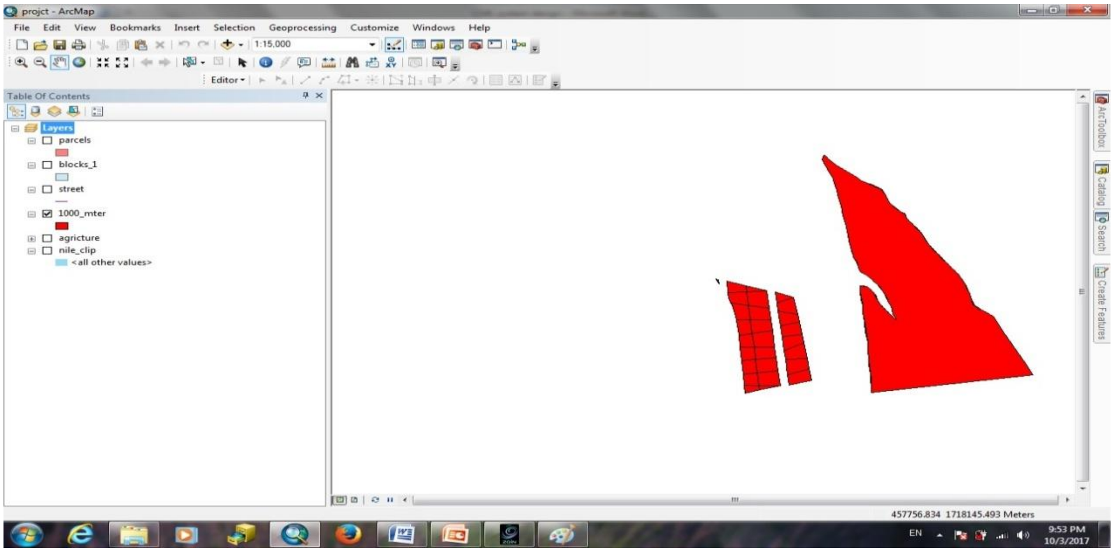
5.4 Results:

After model is build and all layers has been embedded on it using buffer and erase tools for the analysis part now it's time to run the model to get results.

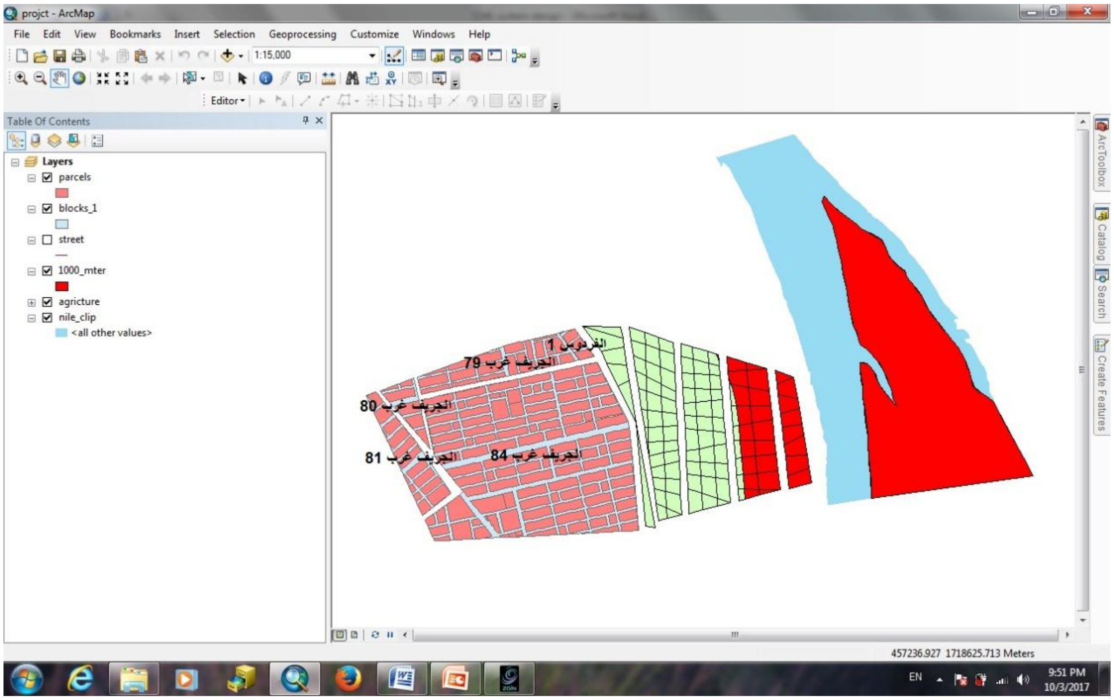
5.4.1 Executing the model:



5.4.2 Generated layer with eliminated lands:



5.4.3 Final results:



1. Red layer:

Represent eliminated agricultural lands according to specified measures which are 1000 meter 1 km far from the cities.

2. Green layer:

Represent agricultural lands that can be improved to be residential lands.

CHAPTER 6
Conclusions and Recommendations

6.1 Conclusions

This study provides a clear description of how GIS can be used to assist in the provision of suitable agricultural lands to be converted into residential units. Depending on certain criteria that were determined by this thesis, we provided a planning process to get a housing plan to be owned by the citizens, to provide stability to the families in the region. The model was built to process input layers of agricultural land and cities and then produced a layer showing the agricultural land suitable to be residential output.

6.2Recommendations

It is recommended to increase the criteria used in selecting agricultural land in addition to the criterion of distance from residential cities and public roads, by adding another criterion, which is the quality of the soil of agricultural land and suitability with buildings. Also we recommend to use programming language like Python that's help to get more accurate results.

6.3 Strength of this Thesis

The strength of this study represented on that it's the first one that talk about using geographic information systems in agricultural land use planning for housing plans purpose, to fulfills the psychological, social and cultural demand for shelter for families

6.4 Weakness of this Thesis

The weakness of this study lay on that many factors that can be useful are not included in the measurements of selecting agricultural lands to be used for residential purposes, examples of these factors are mentioned at the recommendations paragraph.

6.5 Opportunities of this Thesis

This study will be offered to the general directorate of land department so that he approve it to be used as one of the helping methods on finding lands for housing plans.

6.6 Threats of this Thesis

The threats of this study that at the future Sudanese government makes decision to stop agricultural land use for residential purpose. And also the version that has been used is cracked that’s mean the platform could be closed by the esri if they discovered its licensed by a fake key and well be available.

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