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Valuation Of Lands by Geographic Information System

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Submitted to the College of Engineering
in partial fulfillment of the requirements for the
Bachelor's degree in surveying and geomatics Engineering

Hebron - Palestine

2022 - 1444

جامعه بوليتكنك فلسطين

كلية الهندسة

دائرة الهندسة المدنية

تخصص هندسة المساحة والجيوماتكس

مشروع التخرج

Valuation Of Lands By Geographic Information System

فريق العمل

جنى الرجبي   **زياد عيناش**

المشرف

د. غادي زكارنة

Thanks

I extend my thanks and gratitude to my university "Palestine Polytechnic University"

I also extend my thanks to the College of Engineering and the Department of Civil Engineering ... for the administration and teaching staff ...

Finally, I express my sincere thanks and gratitude to everyone who contributed to the completion of this work

I ask Allah Almighty to accept this work from us.

الاهداء

أمام عظمة الإيمان والإباء المتفجرة في ميادين التحرير لا يسعني إلا أن أقدم عملي هذا ليكون قطرة في رافد المعرفة الذي يتوجب أن يثور هو الآخر ليثمر ربيعنا العربي..

اهدي هذا العمل لأغلى وأحب انسانان على قلبي، صاحبا الفضل الأكبر علي من بعد الله عز وجل أبي وأمي..

كما أقدم هذا العمل بخالص امتناني وعرفاني وتقديري لصبرهم ودعمهم الدائم لي اخوتي..

ولكل من ساعدني وأضاء لي دروبا بدعمه أصدقائي..

Abstract

The project aims to build a model that works on estimating parcels using one of the GIS tools to reduce the field detection process that takes time from the evaluator in traditional methods

This project will be passed in three stages, starting with collecting data, such as a recent aerial photograph of the study area, and the urban plan to clarify the classifications of parcels "land use", and Oslo classifications. After collecting this data, will be digitizing everything in the area (lands, streets, buildings...), and based on this data, will be made a model builder for estimating and pricing parcels by (model builder).

The expected results of this project will be a map of the land and its prices, and many maps that show the specifications of the lands located in the study area.

تلخيص

يهدف المشروع لبناء نموذج يعمل على تخمين قطع الأراضي باستخدام احدى أدوات او برامج نظم المعلومات الجغرافية للتقليل من عملية الكشف الميداني التي تستغرق وقت من المخمن في الطرق التقليدية.

وسيتم عمل هذا المشروع على عده مراحل، أولها هي جمع البيانات اللازمة مثل الصورة الجوية الحديثة لمنطقه الدراسة، والمخطط الهيكلي لتوضيح تصنيفات قطع الأراضي حسب نوع الاستخدام وتصنيفات أوسلو، بالإضافة الى ذلك يجب الحصول على متوسط سعر قطع الأراضي في هذا الحوض، وأسماء مالكي قطع الاراضي، وبعد جمع هذه البيانات سيتم رفع وترسيم كل ما هو في المنطقة (من أراضي، شوارع، بناء قائم...) وبالاعتماد على هذه البيانات سيتم بناء نموذج خاص في تخمين وتسعير قطع الاراضي باستخدام خاصيه (model builder).

ونتائج هذا المشروع المتوقعة ستكون خريطة بقطع الأراضي واسعارها والعديد من الخرائط التي توضح طبيعة ومواصفات قطع الأراضي الواقعة ضمن منطقه الدراسة ونموذج لتحديث البيانات والاسعار.

Abbreviation

GIS: Geographic Information System

DBMS: Database Management System

GUI: Geographical User Interface

GEOMOLG: geospatial ministry of local governorate

GCS: Geographic Coordinate System

PCS: Projected Coordinate System

UTM: Universal Transverse Mercator

WGS84: World Geodetic System

RPPI: Residential Property Price Index

PMA: Palestine Monetary Authority

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Chapter1

1. Introduction

1.1.Background

Both the human population and the urban population are growing. The need to accommodate an ever-increasing population is causing urbanization to spread globally, making knowledge of land valuation valuable

Land valuation is the process of determining a property's value using technical knowledge and considering its features in light of the current economic climate. Taxation, expropriation, privatization, assurance, land register and cadaster fees, land readjustment, and urban development all depend on knowing the worth of the land. More accurate assessments are becoming more and more crucial as nations' economies develop and evaluations get more and more complex. A common misconception about land valuation appraisal is that it is an unorganized, ungoverned procedure that lacks any kind of legal structure and is far from being scientific or objective. This is likely because this process is dependent on personal opinions that are not subject to checks or controls to ensure uniformity and equality.

as a result of the need to determine the cost of land objectively and impartially. and to accurately estimate the value of the land, it is possible to objectively evaluate and analyze the data used. This project will use a model builder to determine land valuation. this helps to provide more consistent information about the land accurately and fairly by using its environmental conditions, physical characteristics, and relations with social-cultural centers. and to do all of this through a geographic information system. Geographic Information Systems (GIS) is an important information technology that enables this process management to be performed most appropriately.

1.2. Problem statement

In many cases, it is difficult to access land to estimate its price so the owners of land offer their land at imaginary prices that exceed the real price, or the opposite is to reduce the price of the parcels to sell it as soon as possible, and there may be an agreement between the estimator and the buyer to reduce the price of the parcel. These problems are the result of the lack of clear rules and equations for estimation in Palestine

1.3. Aims

The project aims to Make a model builder to estimate the prices of the lands by gis

1.4. Objectives

Some objectives must be achieved to reach the aims of this project, which are as follows

1. Land classification according to the use and the Oslo Agreement.
2. Classification of streets according to type (primary, secondary) and condition (paved, unpaved, not open) and width (wide, middle, narrow).
3. Calculate the shape index and classify the land according SI (regular, semiregular, irregular).
4. Calculate the slope for each parcel of land.
5. Calculate the distance between each land and major road
6. Collecting the market value according to the last lands parcel sold in the zone to determine the adjustment factor value
7. Calculate the standard of value "median of the market value"

All these factors must be achieved because they affect the price of the parcels of land, and based on these objectives, the model builder is made to calculate the market value to the lands

1.5. Methodology

The following stages provide a summary of this project's methodology:

1. collecting data such as the aerial image of the study area and structural plan that clears the classification of land use and the classification of Oslo
2. digitizing the roads and making classification roads into (primary and secondary) ,(paved, unpaved and unopened), (width)
3. digitizing the buildings and classify it to number of floors, contained on store or no and contained on parking or no
4. make a Classification of lands according to use and Oslo Agreement (A, B, C)
5. make a Classification of lands according to shape (regular, irregular, semi-regular)
6. calculated distance between lands and major road
7. calculate the slope for each parcel
8. using least square to determine the values of adjustment factor and detected the irrational prices
9. calculate the standard of value
10. After preparing the data, will be made a model builder to calculate the market value of land
11. prepared many maps that show the specification of the area study

1.6. Scope of work

The project is divided into several chapters that give information about the project

A description for each chapter is given:

 Chapter 1(**Introduction**): In this chapter, the general aim and objective of the project were clarified ,why it was chosen, and what problem it will solve in the future. Also, the procedure for this project was clarified.

Chapter 2(Geographic Information System): In this chapter, the definition of geographic information systems, their components, functions, applications, spatial analysis, and coordinate systems were clarified.

Chapter 3(Land Valuation)

In this chapter, the definition of land valuation was clarified, what are the factors on which the valuation process depends, and the methods used in valuation worldwide in general. Finally, it was clarified how the land valuation process is done in Palestine and how the price of land is calculated.

Chapter 4(Analysis and Results) In this chapter, it was shown how the operation of collecting and processing and analysis of data was done

Chapter 5(valuation of land model) In this chapter, it was explained how the standard value was determined, how the values of the factor were determined using the least square method, and how a model builder was created in the ArcGIS Pro to price the parcels of lands.

Chapter 6(Conclusion and recommendation) In this chapter, the results of the research and some recommendations were clarified

1.7.Schedule of work

	W1	W2	W3	W4	W5	W6	W7	W8
Selection of problem	■	■	■					
Literature review		■	■	■	■			
Primary data collection					■			
Data preparation					■	■	■	■
Gis training							■	■
Least square to determine the factors values								
Model builder to valuation of lands								
Writing text					■	■	■	■

Presentation								

	W9	W10	W11	W12	W13	W14	W15	W16
Selection of problem								
Literature review								
Primary data collection								
Data preparation	■	■						
Gis training	■	■						
Least square to determine the factors values	■	■						
Model builder to valuation of lands			■	■				
Writing text	■	■	■	■	■	■	■	
Presentation								■

1.8. Study area

The study area in this project represented zone (5) in dura city

Dura is a Palestinian city located eleven kilometers southwest of Hebron, in the southern West Bank, in the Hebron Governorate of the State of Palestine, and its astronomical location is 31°30′25″N 35°01′40″E

The first parcel that was chosen is "5", "khallit manna, Where this zone consists of 2 neighborhood an eastern and western neighborhood

This zone overlooks the main road, its width is 17 m. The zone contains commercial, agricultural, and residential lands and many specifications that will be clarified later. This zone was chosen to clarify the differences in the prices of parcels of land for more than one classification.

Figure a.1 Hebron Governorate

Figure a.2 dura zone 5

Figure 1. 1 study area [1]

Chapter 2

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Chapter 2

2. Geographic Information System

2.1. Gis definition

A geographic Information System (GIS) is a computer-based system that provides the following four sets of capabilities to handle georeferenced data. This includes support for various kinds of coordinate systems and transformations between them, options for data analysis, and a large degree of freedom in how this information is presented. [2]

2.2. Gis components

GIS has mainly 5 components: Hardware, Software, Data, People, and Methods. [2]

Figure 2. 1 geographic information system components [3]

1. Hardware: GIS software runs on a wide. range of hardware types, from centralized computer servers to desktop computers. Data storage and manipulation are done using a range of processors. The choice of hardware system ranges from 300MHz Personal Computers to Super Computers having capability in teraflops.

2. Software: GIS software provides the functions and tools needed to store, analyze and display geographic information. A database management system (DBMS) and a geographical user interface (GUI) are key software

components. The most commonly used GIS software in use is ArcGIS, MapInfo, Global mapper, AutoCAD Map, etc.

3. Data: A GIS will integrate spatial data with other data resources and can even use a DBMS, used by most organizations to organize and maintain their data. Data is one of the most important, and often most expensive, components of a GIS. It can be collected in-house or purchased from a commercial data provider. Geographic data is entered into a GIS using a technique called digitizing. This process involves encoding geographic features such as buildings, roads, or county boundaries.

   GIS uses Relational Databases to store and manipulate attribute data. A GIS will integrate spatial data with other data resources.

4. People: GIS technology is of limited value without the people who manage and plan for using it. The GIS users range from technical specialists to those who use it to help them perform their everyday jobs. One classification scheme classifies users into three groups: System users, End Users, and Data Generators.

5. Methods: A successful GIS operates according to a well-designed plan and business rules, which are the models and operating practices unique to each organization. It establishes a one-to-one correspondence between the spatial and non-spatial data. The map creation can either be automated raster to vector creator or it can be manually vectorized using the, scanned images The source of these digital maps can be either map prepared by any survey or satellite imagery

2.3. Gis Functions

The processes of integration and interrogation can be broken down into several general categories. [2]

1. Automated Mapping: Replicating paper maps on computers.
2. Thematic Mapping: For instance, using customer information and demographic data.
3. Map Overlay or Composite Mapping: Producing a map from several layers of data.

4. Spatial Querying: Obtaining information from a database in response to the identification of particular conditions.

5. Spatial Browsing: Exploring the contents of a database in response to the identification of particular conditions.

6. Spatial Problem Solving: For example, deducing inclusions of points in polygons, or for spatial decision-making incorporating both spatial and logical deductive reasoning.

7. Analysis of Spatial Data: Tasks deal with entities' attributes, like the average size of sales territories or the degree to which product sales are related to weather conditions.

8. Creating Spatial Statistics: Tasks that require measurements of spatial properties of phenomena, like the total distance traveled by a vehicle on a road network.

9. Analysis of Spatial Statistics: Tasks that treat spatial properties as attributes, for example, the correlation between highway network connectivity and levels of economic development.

10. Spatial Analysis: Encompassing tasks, including simulation, which uses a variety of tools of spatial statistics and location-based problem-solving.

2.4. Gis Application

The GIS (Geospatial information system) is a powerful tool that allows users to map and model complex networks, such as those supplying water, power, and telecommunications. Such a system may operate at a variety of scales, modeling service Connections to consumers, service districts, and detailed facilities inventories and layouts. [2]

Many Applications of the GIS:

❖ Navigation (Routing and Scheduling.

❖ Surveying

❖ GIS Applications in Geology, as shown in figure 2.2

Figure 2.2 gis application in geology [18]

❖ GIS for Planning and Community Development

❖ Tourism Information System

❖ Worldwide Earthquake Information System

❖ Energy Use Tracking and Planning

❖ Municipal Infrastructure

❖ Regional Planning

❖ Tax Management

❖ Emergency Services

❖ Forestry Management

Figure 2.3 gis application for urban planning [17]

❖ Urban Development Planning, as shown in figure 2.3

❖ Business purposes

❖ Agricultural purposes

❖ Environmental uses

2.5. spatial analysis in gis

Even though most of the real world can be examined with the naked eye, it is frequently challenging to analyze and organize what is seen. When the representation of that reality is kept in digital form as spatial data and attribute tables, it becomes much more challenging. In GIS, many different spatial analysis techniques may be used to transform these data into information that is relevant and simple to access and utilize. GIS offers a variety of tools and features for data analysis. To achieve the project's goals, GIS users can manage, retrieve, integrate, and analyze both spatial and non-spatial data. [4]

2.5.1. Basic spatial analysis techniques

2.5.1.1.   gis data manipulation

Spatial data manipulation: spatial data can be manipulated by various techniques [4]:

- Reclassify: reclassifies polygon based on attributes
- Dissolve: merges equal category polygons
- Generalize: generalizes data according to the level of detail as per the scale
- Append: joins two-layer side by side like mosaicking.
- Rubber sheeting: to adjust the layer with the reference layer, here shape and size will be distorted.
- Will be distorted.

reclassification

generalize

dissolve
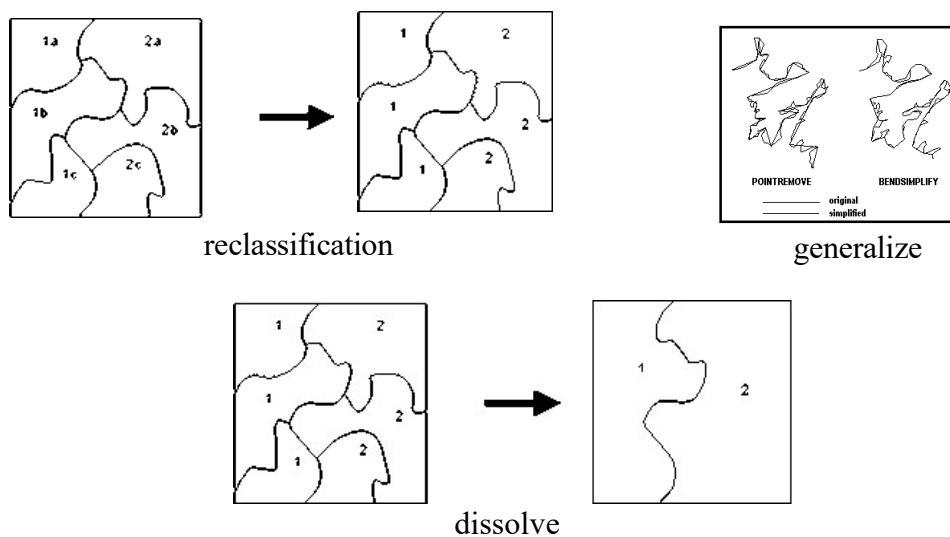
Figure 2. 4 spatial data manipulation [4]

Gis has a wide range of additional features and tools that can be used to edit spatial databases.

Data modification that isn't geographical different methods, such as reselecting, reclassifying, creating new indices, relating and joining two tables, etc., can be used to change non-spatial data.

Simple browsing (display) and database queries can be used to retrieve gis databases. [4]

1. Spatial query: the practice of choosing a portion of a study area based on spatial attributes is known as a spatial query. A particular feature can be chosen or a visual form can be drawn around a group of features to implement this question. For instance, the user can create a box or other strange shapes, click, and choose the features spatially. By just clicking on the feature, users can also point and ask a question regarding the feature's characteristics. Additionally, information on strata that are not visible but share the same frame of reference and research area can be obtained.

2. Attribute query: the method of locating a subset of features based on the categories of the attributes is known as attribute querying. Typically, attribute inquiries are carried out based on logical requirements. Depending on the value of an attribute, users can request the position of a feature. Apply logical conditions and show the regions that meet certain requirements.

3. Statistics: it is possible to calculate the area for each category within the theme, as well as the minimum, maximum, standard deviation, and mean.

2.5.2. integrated analysis

Through the geometric intersection of the features, these operations are carried out on two layers (maps) at once in vector-based gis. According to the arc/info user's manual, the infuser is the layer on which manipulation is done, and the analysis layer is the layer in charge of the operational space. [4]

Overlay analysis:

Vector overlay: integrate more than one layer (union, identity, intersect)

1. The union process is only utilized on maps with polygon features. It carries forth the geometric fusion of the two themes' aspects. All of the territories are covered by the union operation. New polygons are produced in the output layer by splitting the arcs of the input layers at their intersections. As a result, there are more polygons in the output

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layer than there are in any of the input layers. When the application requires the combined region and eight combined characteristics of the two input thematic layers for querying or additional analysis, this specific procedure is carried out.

2. Identity operation is carried out to combine the features of the overlapping regions of the input and analysis layers to create an output layer. It is mostly used to precisely maintain the thematic map's borders. Including the district boundaries on the state map without any discrepancies between the district boundaries and the state boundary is one example. To overlay points, lines, or polygons on polygons while maintaining all input coverage properties, use this technique.

3. Intersect operation is carried out to overlay points, lines, or polygons on polygons, but only the parts of the input coverage feature that fall within the overlay coverage features are kept. The analysis layer must have polygon topology, although the input layer can contain points, lines, or polygons. This particular operation is typically carried out to determine the number of tube wells, dug wells, highways through human settlements, the distribution of land use within a specified administrative boundary, etc.
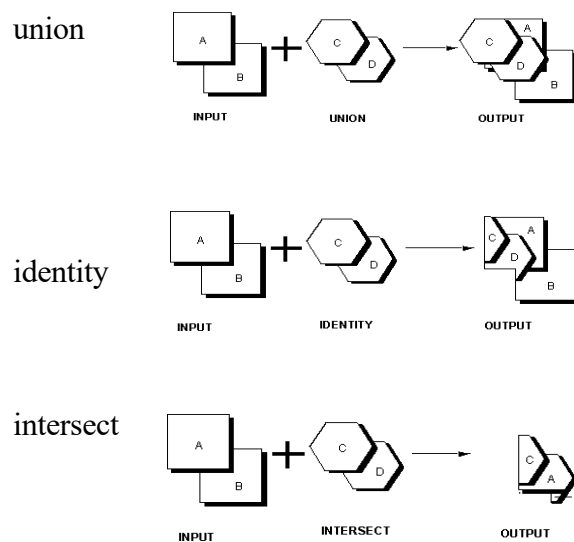
Figure 2.5 vector overlay (union, identity, and intersect) [4]

Raster overlay operation: (add, subtract, multiply, division, difference) [4]

1. Add the arithmetic operation of adding the cell values of two levels. The relevant cell value of another layer is increased by the information from the input layer. This data is later saved for later analysis, if necessary.

2. Subtracting is the process of taking the values of one layer and subtracting them from the other layer. The typical procedure is used to track changes over time.

3. Multiplication process: the multiplication process involves multiplying the input layers' cell values, and the outcome is recorded in the output layer. To extract a small portion of the bigger data set layer, this kind of action is required.

4. Division operation: dividing the cell values of one set by the corresponding values of another data set. When calculating densities, one uses this operation.

5. Difference: is accomplished by figuring out the absolute values of differences between two layers.

0	2	1
2	3	4
2	2	5

+

1	1	3
1	2	2
3	2	0

=

1	3	4
3	5	6
5	4	5

Addition

0	2	1
2	3	4
2	2	5

-

1	1	3
1	2	2
3	2	0

=

-1	1	-2
1	1	2
-1	0	5

Subtraction

Subset and masking (Clip, Erase):

In this operation, two input layers are overlaid similar to feature combination analysis. However, the depth of the analysis layer determines whether or not to keep the area of interest. In a CLIP operation, the resultant layer only contains the attributes of the input layer, retaining the features that are within the analysis layer's border. The input layer for this operation can be made up of points, lines, or polygons, but the analysis layer must be made up of polygons. A smaller data set is extracted from a bigger data set using this function. When

using the reverse of CLIP, called ERASE, the features of the input layer that are inside the analysis layer's boundary are removed while the characteristics outside the boundary are kept. [4]
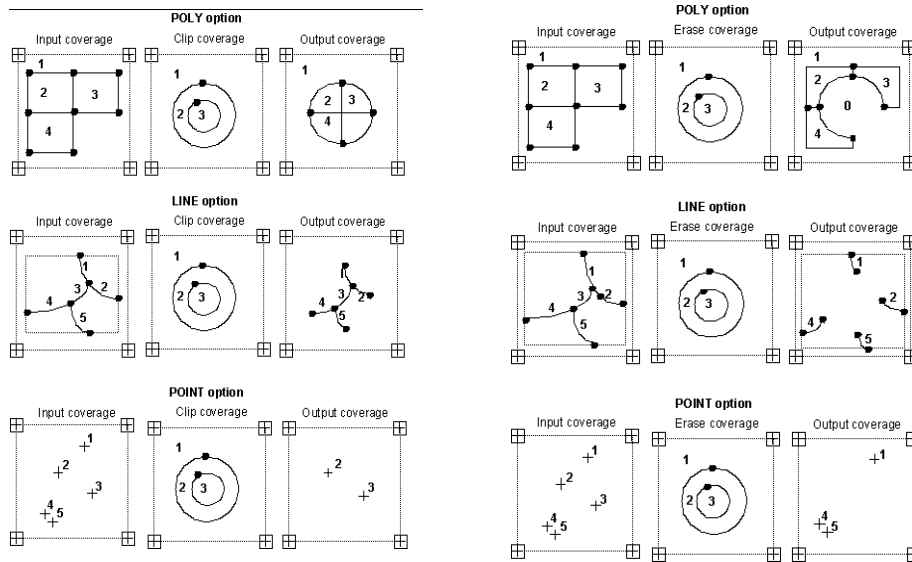
Figure 2.6 Clip and Erase operation
[4]

1. SPLIT operation: the improvement of CLIP functionality. This procedure is typically used to generate an output layer of different CLIP operations based on predetermined criteria. Advanced users can utilize this technique to do many CLIP operations with just one command. [4]

2. UPDATE operation: used to perform cut and paste analysis. Similar to earlier operations, the analysis layer defines the area of control of the input layer that needs to be updated. [4]

Thus, the output layer will have features from the input layer in the non-overlapping area and the features from the analysis layer will be in the overlapping area. It is used to generate a time series map showing the changes in thematic information through time. [4]

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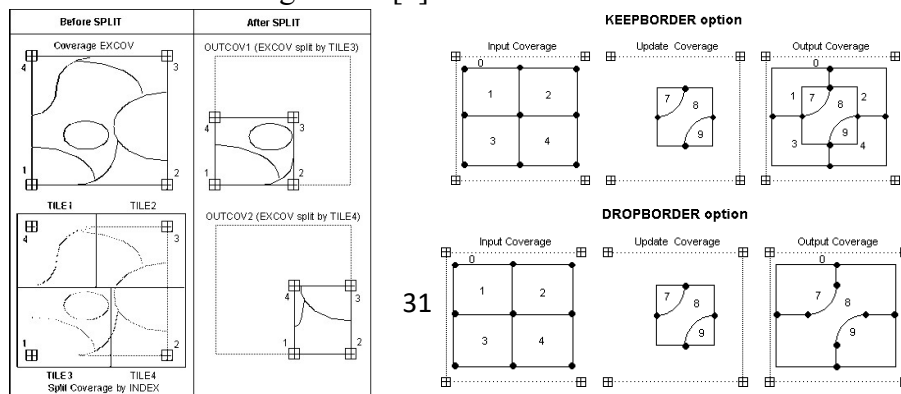
Figure 2.7 Split and Update operation [4]

Distance analysis the construction of proximity boundaries for polygons at a user-specified distance is another interesting application of GIS. Proximity polygons or buffer zones are the resulting polygons. The operation's distance input is referred to as the "search radius" or "buffer distance". On features such as points, lines, and polygons (both within and outside of polygons), buffers may be produced. This procedure is used to determine how close or far apart the features are from one another. Ownership information about mining areas, water bodies, flood zones, etc. [4]

Finding the separation between a road and a community using the nearness function is helpful.
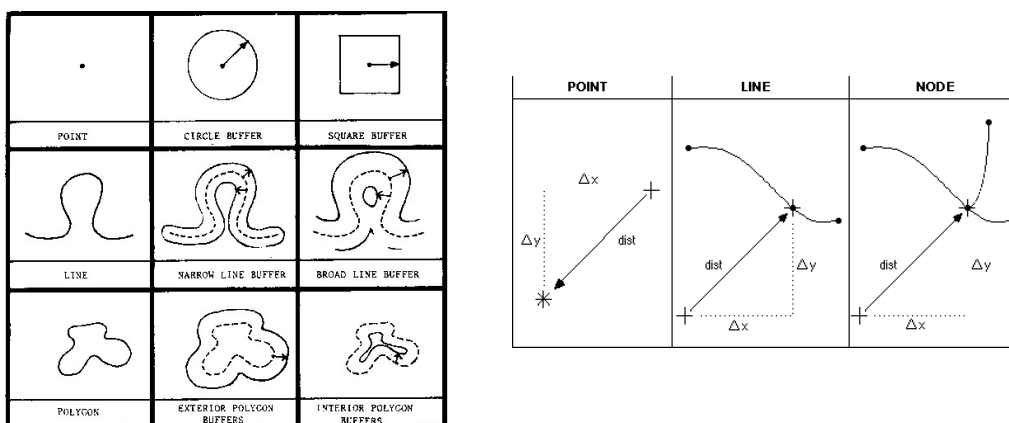
Figure 2.8 Buffer and Near operation [4]

2.6. Model Builder

A visual programming tool for creating geoprocessing workflows is called Model Builder in ArcGIS. It can be used to automate repeated tasks using any combination of Arc Toolbox products or for a complicated workflow with multiple intermediary steps. In Model Builder, you may construct and change geoprocessing models. A model is a diagram that connects a series of processes and geoprocessing tools, utilizing the output of one process as the input to

another. A model can be created using any tool in the Arc Toolbox and then executed directly from the Model Builder window or as a custom tool within Arc Toolbox. ArcGIS may also be integrated with other programs via Model Builder. Other people can access and use the models. [5]

establishing a fundamental process for interpolating point data and contouring the resulting grid A point dataset (point shape file or event file) is used in this model, which interpolates it using a mask polygon before contouring it. For a single file, the procedure is straightforward, but for more than a few files, it becomes laborious. Model builder can probably be used to automate this repetitious task. Even better, we can repeat this procedure for every point file in an mxd. [5]
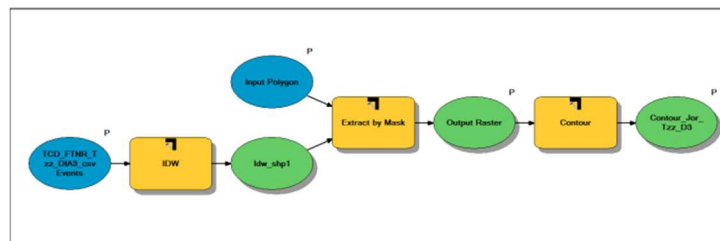
Figure 2. 9 . Model for creating a contoured grid file [5]

The model begins with an input point data file (Blue oval), then applies an interpolation tool to it to create an intermediate grid file (Yellow rectangle) (Green oval). It then uses an Extract by Mask tool with an input mask polygon and an intermediate grid file to produce a final output raster. The contour tool uses this output raster as input and outputs the contours. The parameters that can be entered when the model is used as a tool from a toolbox are denoted by the letter "P" in the inputs or tools [5].

2.7. Coordinate system

Different kinds of coordinate systems are used to position data in space. We will discuss the geographic coordinate system in coordinate systems 2D and 3D space. The geocentric coordinate system, also known as the 3D Cartesian coordinate system is used to locate data on the Earth's surface. [6]

2.7.1. 2D Geographic coordinates (φ, λ)

Lines of geographic latitude (phi or φ or ϕ) and longitude (lambda or λ) make up the most popular type of global coordinate system. Parallels are lines that have the same latitude. They create rings on the ellipsoid's surface. Equal-length lines Meridians are the names for latitude and longitude, and they form ellipses (meridian ellipses) on the ellipsoid, as shown in figure 2.10.

. [6]
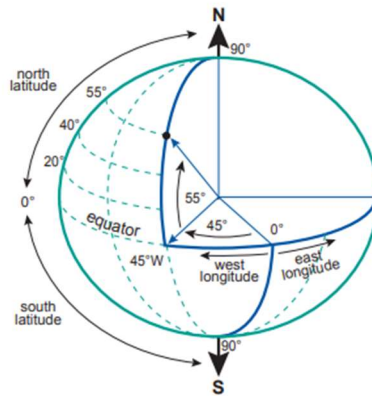
Figure 2. 10 The latitude (φ) and longitude (λ) angles represent the 2D geographic coordinate system. [6]

2.7.2. 3D Geographic coordinates (φ, λ, h)

The ellipsoidal height h is added to the system to provide the 3D geographic coordinates (φ, λ, h). The vertical distance of a point above the ellipsoid is known as the point's ellipsoidal height (h). From the point to the ellipsoid surface, it is measured in distance units along the ellipsoidal normal. An Earth's surface position can be determined using 3D geographic coordinates as shown in figure 2.11. [6]
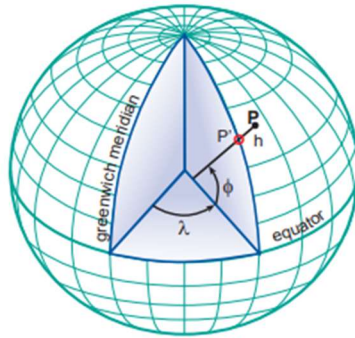
Figure 2. 11 The latitude (φ) and longitude (λ) angles and the ellipsoidal height (h) represent the 3D geographic coordinate system [6]

2.7.3. 3D Geocentric coordinates (X, Y, Z)

Geocentric coordinates (X, Y, Z) can be used to define a 3D position on the surface of the Earth. The three axis are mutually orthogonal and form a right-handed system. It should be noted that the rotational axis of the earth changes its position over time (referred to as polar motion), as shown in figure 2.12. [6]
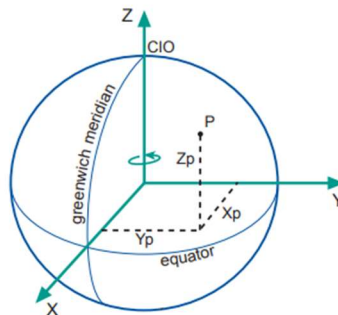
Figure 2. 12 An illustration of the 3D geocentric coordinate system [6]

2.7.4. 2D Cartesian coordinates (X, Y)

The only two dimensions of a flat map are width (from left to right) and length (from bottom to top). Map projections and coordinate transformations are used to turn the three-dimensional Earth into a two-dimensional map. Two-dimensional Cartesian coordinates (x, y), commonly referred to as planar rectangular coordinates, are utilized to precisely pinpoint any point's location in

this application, as well as in many other cartographic ones. The X- and Y-axes are the two major axes of the 2D Cartesian coordinate system, which is composed of intersecting perpendicular lines. Typically, the vertical axis is referred to as the Y axis and the horizontal axis as the X axis (Note that the X axis is also sometimes X axis Easting and the Y -axis the Northing), as shown in figure 2.13 [6]
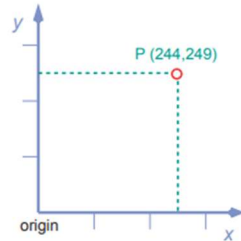
Figure 2. 13 An illustration of the 2D Cartesian coordinate system [6]

2.7.5. 2D Polar coordinates (α, d)

Another possibility for defining a point in a plane is by polar coordinates. This is the distance d from the origin to the point concerned and the angle α between a fixed (or zero) direction and the direction to the point. The angle α is called Bearing or azimuth or bearing and is measured in a clockwise direction. It is given in angular units while the distance d is expressed in length units. Bearings are always related to a fixed direction (initial bearing) or a datum line. In principle, this reference line can be chosen freely. However, in practice, three different directions are widely used: True North, Grid North, and Magnetic North. [6]

The corresponding bearings are called: true (or geodetic) bearings, grid bearings, and magnetic (or compass) bearings. Polar coordinates are often used in land surveying. For some types of surveying instruments, it is advantageous to make use of this coordinate system. [6]

2.8. Geographic coordinate system

A reference system for locating locations on the wavy surface of the planet is a geographic coordinate system. Locations on the surface of the earth are measured in angular units from its center about two planes: the equator-defined plane and the prime meridian-defined plane (which crosses Greenwich England). Latitude and longitude are the two values that make up the definition of a location. [6]

Latitude is a measurement of the angle between a location on the earth's surface and the equatorial plane. The angle between the prime meridian plane and the north-south plane that intersects the area of interest is measured by a longitude. [6]

A GCS is defined by an **ellipsoid**, **geoid**, and **datum**

2.8.1. ellipsoid

For small-scale maps, the assumption that the earth is perfectly spherical substantially simplifies mathematical calculations (maps that show a large area of the earth). However, if precise measurements are required when working at greater sizes, an ellipsoid model of the earth can be preferred. The semi-major axis (also known as the equatorial radius) and the semi-minor axis are the two radii that make up an ellipsoid (the polar radius), as shown in figure 2.14. [6]
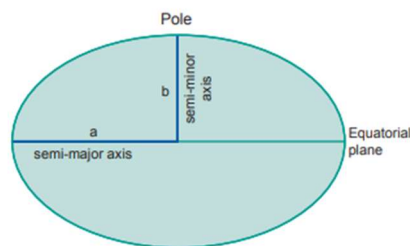
Figure 2. 14 An oblate ellipse, defined by its semimajor axis an a and semi-minor axis b [6]

2.8.2. Geoid

For a GIS environment, it is essential to mathematically model the geoid, which is the actual form of the world. The earth's surface is not completely smooth, though. Due to variations in the pull of gravity on its surface, it features undulations. Although these undulations might not be visible to the

unaided eye, they can affect locational measures and are detectable. Note that we are not discussing mountains and ocean bottoms, but only the gravitational potential of the earth, which is best understood by picturing the entire surface of the earth submerged in water and calculating the distance from the center of the earth to the surface of the water over the entire surface, as shown in figure 2.15. [6]
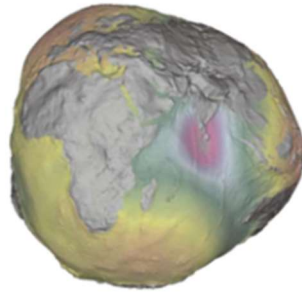
Figure 2. 15 The Geoid, exaggerated to illustrate the complexity of its surface [6]

2.8.3. Datum

the ellipsoid (or sphere) representation of the earth and the geoid, and to map the surface features of the world onto this ellipsoid/sphere. The alignment can be geocentric, where the ellipsoid is aligned with the center of the earth, or local, where the ellipsoid surface is tightly fitted to the geoid at a specific region on the earth's surface (such as the state of Kansas). A datum is determined by the method used to align the ellipsoid to the geoid. [6]

2.9. Projected Coordinate Systems

Maps are flat, yet the earth's surface is curved. A reference system for locating and measuring features on a flat (map) surface is known as a projected coordinate system (PCS). It is made up of lines that cross one other at right angles to create a grid. The x, y, and linear units of measure are all included in projected coordinate systems, which are based on Cartesian coordinates. Mathematical changes are required to convert from a GCS to a PCS. Planar,

cylindrical, and conical projection types can be combined into one of three groupings. [7]

2.9.1. Planar Projections

The earth's surface features are represented on a flat surface by a planar projection, also known as an azimuthal projection, which meets the earth's surface at a single point (tangent case) or along a line of tangency (a secant case). [7]

This projection is widely used in mapping polar regions but can be used for any point on the earth's surface (in which case they are called oblique planar projections). [7]
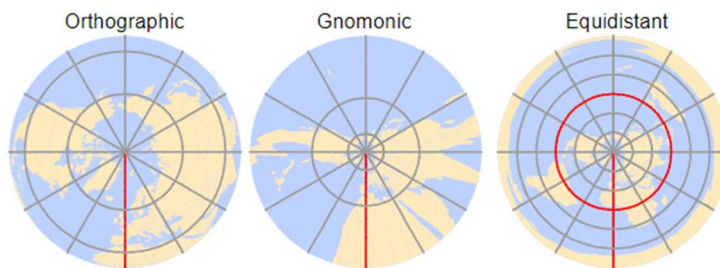
Figure 2. 16 Examples of three planar projections: orthographic (left), gnomonic (center), and equidistant (right). Each covers a different spatial range (with the latter covering both the northern and southern hemispheres) and each preserves a unique set of spatial [7]

2.9.2. Cylindrical Projection

Using a cylindrical map projection, the earth's surface is depicted on a map that has been rolled up (which can then be flattened into a plane). The cylinder can make contact with the earth's surface along just one line of tangency (a tangent instance) or two lines of tangency (a secant case). [7]

The cylinder may be perpendicular or tangent to the equator. The Transverse Aspect, which is tangent to lines of longitude, is an exception. The State Plane and Universal Transverse Mercator (UTM) coordinate systems are defined using this common projection. The UTM PCS is a well-liked coordinate system in the US and it covers the entire world. It's crucial to remember that the UTM PCS is divided into zones and hence restricts its application to these zones,

each of which is 6° broad. In the US, NAD27 and NAD83 are two common datums associated with the UTM coordinate system. A WGS84-based UTM coordinate system is also available. [7]

Distortion is minimized along the tangent or secant lines and increases as the distance from these lines increases.
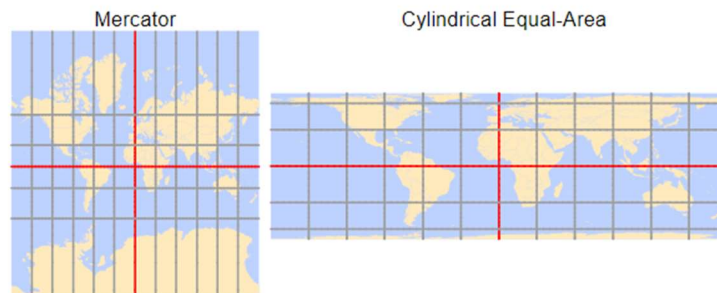
Figure 2. 17 Examples of two cylindrical projections: Mercator (preserves shape but distorted area and distance) and equal-area (preserves area but distorts shape) [7]

2.9.3. Conical Projection

The surface of the world is represented on a map with a conical map projection. The cone can touch the earth's surface along a single line of tangency (a tangent case) or along two lines of tangency, similar to the cylindrical projection (a secant case). [7]

As you move further away from tangent or secant lines, distortion gets worse and becomes more pronounced. Use one of the conical projections, such as the Equidistant Conic (distance preserving) or Albers Equal Area Conic, when distance or area measurements are required for the contiguous 48 states (area-preserving). [7]

Conical projections, such as the Europe Albers Equal Area Conic and the Europe Lambert Conformal Conic, are also common PCS in European maps. [7]
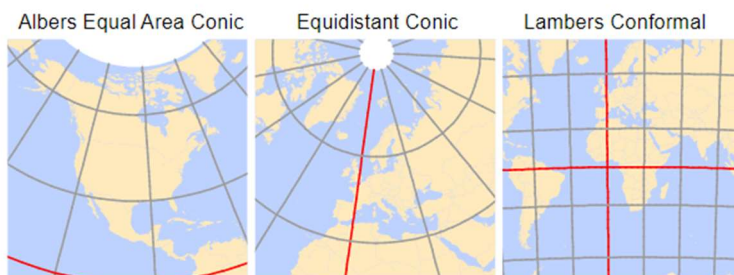
Figure 2. 18 Examples of three conical projections: Albers equal area (preserves area), equidistant (preserves distance), and conformal (preserves shape). [7]

2.10. The geographic coordinate system in Palestine

The geographic coordinate system enables any place in the world to be located using its latitude and longitude. The latitude is the position relative to the equator, specifying the north-south position. The longitude specifies the east-west position measured from a reference meridian (usually the Greenwich Prime Meridian). The latitude and longitude of the Palestinian Territory have been calculated based on the geodetic datum WGS84. [8]

WGS84 coordinate reference system is the latest revision of the World Geodetic System.

THE GEOGRAPHIC COORDINATE SYSTEM IN PALESTINE	
UNIT	Meter
GEODETIC CRS	Palestine 1923
DATUM	Palestine 1923
ELLIPSOID	Clarke 1880 (Benoit)
PRIME MERIDIAN	Greenwich
DATA SOURCE	EPSG
COORDINATE SYSTEM	North

CENTER COORDINATES	143345.04 85938.41
PROJECTED BOUNDS	69099.9 -126393.26 216561.8 298746.25
WGS84 BOUNDS	34.17 29.45 35.69 33.28

table 2.1 geographic coordinate system in Palestine [8]

Chapter 3

3.Valuation of land

3.1.Land valuation definition

3.2.Factors considered during the land valuation

3.3.Methods of Valuation of Land

3.3.1.Comparative method

3.3.2.Income Method

3.3.3.Cost Method

3.4.Valuation in Palestine

3.4.1.Key Principles of Valuation

3.4.2.A Valuation of Land

Chapter 3

3. Valuation of land

3.1. Land valuation definition

The process of assessing and calculating the fair price or value of a land parcel is known as land valuation. Depending on the quantity of information available, any or all of the key land valuation techniques may be used to value a plot of land. [9]

In both urban and rural locations, land can be divided into agricultural and non-agricultural categories. In general, urban land, whether used for agriculture or not, is worth more than rural property. In general, more fertile agricultural land is worth more than bare land. Residential, commercial, or industrial are the three categories of non-agricultural property, and the value of these types of lands is essentially determined by the potential for building an acceptable structure over them. [9]

3.2. Factors considered during the land valuation

A. Location of the land

We can all agree that the location of a piece of property is crucial for its value. As a result, property in a city is worth more than a similar property in a rural location or a city suburb.

In addition, a property on a tarmac, an industry, a school, or a significant development will be worth more than one in an area with few developments. [9]

B. Type of land

Residential, commercial, and agricultural land use are the three basic types. In contrast to agricultural land, commercial land typically has a higher value because it may provide more income. [9]

Therefore, it is advised to classify the land before performing a value.

C. The size

The value of land varies depending on its size. However, depending on the type of land, location, and intended use, an eighth-acre plot may occasionally be worth more than an acre or more. [9]

Therefore, resist the temptation to assume that a larger piece of land can be valued higher than a smaller one. The land itself and the developments on it have a significant impact on the value of the land. [9]

D. Amenities on the land

The valuation is directly impacted by the amenities that are present on the property. A developing neighborhood with access to markets, hospitals, schools, water, and electricity would be valued higher. [9]

E. Accessibility

The accessibility of a piece of land affects its value as well. A parcel of land will be worth less than one that is more accessible if it is difficult to access it or if the access road is narrow. [9]

F. Floor Space Index (FSI)

This is the total amount of floor space that can be added to a building while the land is being developed. The total floor area of the structure that can be constructed on the plot, or FSI, determines the value of the property. [9]

G. Soil type

Another consideration in valuation is the type of soil; this is also known as soil-bearing capability. This directly affects how much it costs to create a foundation because rich soil is relatively inexpensive to produce while poor soil costs more. Land with good soil-bearing capacity will therefore cost more. [9]

H. Environmental factors

When determining the value of the land, adverse environmental phenomena including erosion, flooding, landslides, and others are taken into account. [9]

I. Special advantages on the land

When valuing land, specific advantages that the property may have due to its location or other factors are also taken into account. [9]

3.3. Methods of Valuation of Land

There are various methods of conducting the valuation of land and we are going to discuss them one by one

3.3.1. Comparative method

This approach assumes the assumption that the market value is equivalent to the cost previously paid for a comparable piece of real estate or plot of land. The challenge for the valuer is to ascertain what the market regards as recent and comparable. To order to account for discrepancies between the properties used in the comparison and changes that have since occurred in the market or are structural in nature, adjustments may need to be made. A significantly different judgment might be anticipated if a nearly comparable house that was previously sold next door for a known price lacked a certain amenity, such as a garage or central heating. The method is frequently the simplest and most effective way to estimate market value, especially for single-family homes in a competitive market. [10]

3.3.2. Income Method

The market value of a land interest is equal to the present value of the net income that is expected to come from the land in the future, according to this method, which is also a comparison method. The net profit is the gross profit less the cost of overheads, which includes the depreciation of the building stock and the cost of upkeep and maintenance. It must be discounted at a suitable rate because it is comparable to national rent. The valuer's challenge is to compare the land's expected net benefits to those of comparable properties, and then to

calculate the market discount rate by looking at recent transactions of comparable assets. [10]

3.3.3. Cost Method

The quantity survey strategy or the contractor's method are other names for this. It is predicted that the value is equal to the expenses of replacement less reasonable depreciation. The challenge is to compile appropriate cost information, including the site's cost, and calculate depreciation rates. The technique is especially helpful for assessing new projects and for insurance purposes, where the cost of site clearance may be increased to account for the probability of a building being destroyed by fire. [10]

3.4. Valuation in Palestine

The Residential Property Price Index in Palestine (RPPI) findings for the first quarter of 2022 have been made public by the PMA, and they show that the overall index has climbed significantly by around 5% to reach 113 points. Although to differing degrees, the two subindices (apartments and homes) have both increased. In comparison to the prior quarter, the home price index climbed by about 5.8%, while the average increase for apartments throughout the majority of Palestinian cities was about 3.4%. [11]

3.4.1. Key Principles of Valuation
a. Target of Valuation

Under these Valuation Standards, property, which is made up of both land and buildings, is subject to a value appraisal.

This Valuation Standard identifies parcel as the basic unit of valuation for land and flat as the basic unit of valuation for buildings for determining the value. [12]

b. Bases of property valuation

Market value serves as the foundation for valuing land while rental value serves as the foundation for valuing buildings. [12]

c. Important Valuation Methods

This Value Standard uses an Area-based Approach as its fundamental property valuation technique. The approaches frequently employed through the Sales Comparison Approach are also incorporated into this Valuation Standards to ensure its fairness, simplicity, and neutrality.

d. Categorizing municipalities and calculating Standard Land Reference

The quantity survey strategy or the contractor's method are other names for this. It is predicted is equal to the expenses of replacement with less reasonable depreciation. The challenge is to compile appropriate cost information, including the site's cost, and calculate depreciation rates. The technique is especially helpful for assessing new projects and for insurance purposes, where the cost of site clearance may be increased to account for the probability of a building being destroyed by fire. [12]

e. Calculating the standard value of quarter/the block by usage category

Calculate the standard value of the target quarter/block for each of the following four (4) usage categories. [12]

1) Residential area

2) Commercial area

3) Industrial area

4) Tourism area

For each of the four (4) consumption categories every quarter/block, the standard value is essentially predetermined. When all of a property's characteristics are taken into account, the value of the land or building is what is left. The standard value of each property's quarter or block will be used to

determine the final appraised value for each property. The market value of the land serves as the basis for the standard value of the land, and the value of a flat serves as the basis for the standard value of the building. The usage category of a piece of land is established using the Physical Master Plan's usage category as of the base date of valuation, while the usage category of a building is established using a field examination. [12]

Applying Value Adjustment Matrix based on property's value influence factors A value Adjustment Matrix is created based on the degree of discrepancies between the standard value of a quarter/block and the value of each property within the same quarter/block. It is a tabulated set of data that indicates adjustment weight per each valuation influence factor by the category of the municipality as well as the usage category of the property. Adjustment weights on value-influencing elements are used as the instrument to assess each property's value about a benchmark value. [12]

3.4.2. A Valuation of Land [12]

a. Identifying parcel number: Determine the target land's parcel number by consulting block maps, the Physical Master Plan, and other available sources.

b. Identifying parcel area size: By using the available information, determine the size of the lot.

c. Identifying the usage category of land: Decide whether the land is being used for residential, commercial, industrial, or tourism purposes.

d. Collecting required data referring to the value influence factors: To get the necessary information regarding the elements that affect value, conduct a survey.

e. Applying Value Adjustment Matrix Based on the result of the survey, determine the adjustment weight of each value influence factor by referring to the relevant Value Adjustment Matrix. Multiply all the adjustment weights to compute the Net Adjustment Weight.

For land properties, in principle, the Value Adjustment Matrix with the following factors shall be applied It should be noted that there are slight differences in Value Adjustment Matrix among different usage

and municipality categories. (Factors in Value Adjustment Matrix for land valuation)

☐ Road width

☐ Road linkage

☐ Pavement

☐ Parcel shape

☐ Parcel area size

☐ Topography

By multiplying all adjustment weights of these factors, a ratio (Net Adjustment Weight: a composite of all adjustment ratios for valuated property based on designating 1.00 to all factors of standard land value) which indicates the difference of values between standard land value and the value of the evaluated property will be worked out.

f. Calculating parcel market value Multiply the Standard Land Market Value (B) with the parcel area size (D) and with the Net Adjustment Weight (E) to obtain the parcel market value (F).

$$F = B * D * E \qquad (1)$$

Chapter 4

4.analysis and results

4.1.The analysis and result

Chapter 4

4. analysis and results

4.1. The analysis and result

Initially, the lands and aerial image of the area study (Khillit Manna) were obtained from the Land Authority.
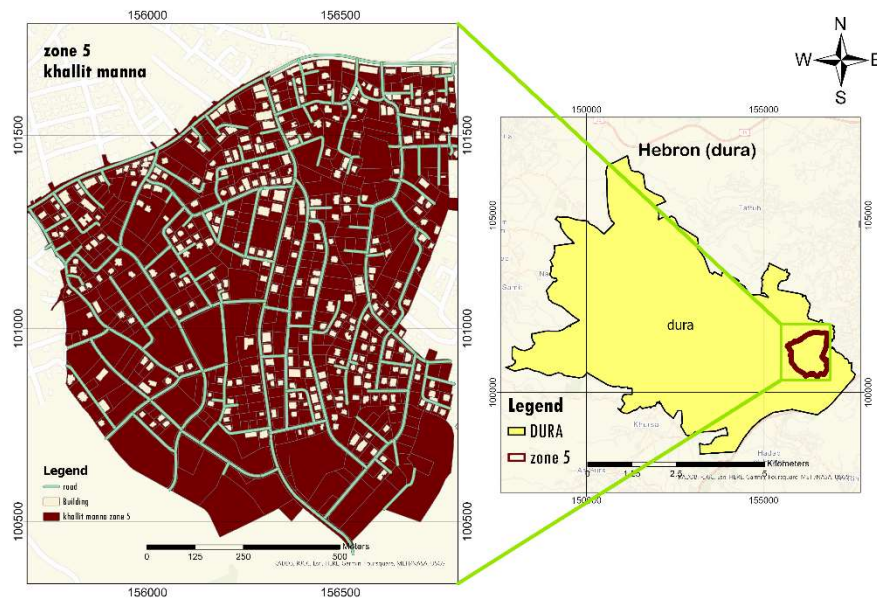
Figure 4. 1 study area

Areal image properties

Figure 4. 2 areal image [1]

columns	24578
Rows	21434
number of bands	4
cell size x	0.100001233
cell size y	0.099998591
uncompressed size	1.96 GB
Format	JP2
source type	Generic
pixel type	unsigned char
pixel depth	8 Bit
color map	Absent
pyramids	level: 8, resampling: Nearest Neighbor
compression	JPEG2000
mensuration capabilities	Basic

table 4. 1 raster information [1]

projected coordinate system	Palestine 1923 Palestine Grid
projection	Cassini
Wkid	28191
Authority	EPSG
linear unit	Meters (1.0)
false easting	170251.555
false northing	126867.909
central meridian	35.21208056
scale factor	1
latitude of origin	31.73409694

geographic coordinate system	Palestine 1923
Wkid	4281
Authority	EPSG
angular unit	Degree (0.0174532925199433)
prime meridian	Greenwich (0.0)
Datum	D Palestine 1923
Spheroid	Clarke 1880 Benoit
semimajor axis	6378300.789
semi-Mainor axis	6356566.435
inverse flattening	293.4663155

table 4. 2 spatial references [1]

1. **The roads were digitized manually and classified into primary and secondary ,as shown in figure 4.3**
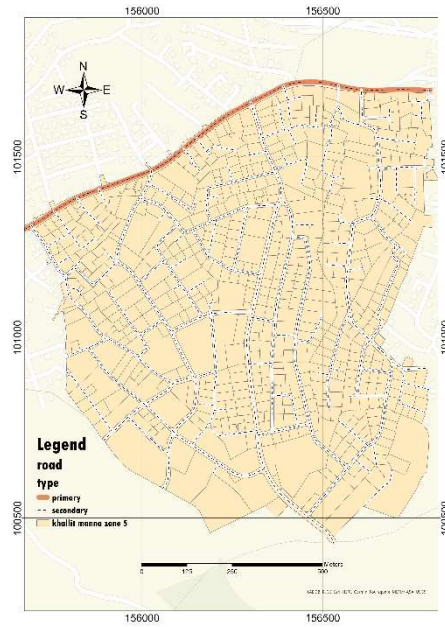
Figure 4. 3 type of road

2. **The roads were classified according to condition (paved, unpaved, unopened, base course), as shown in figure 4.4**
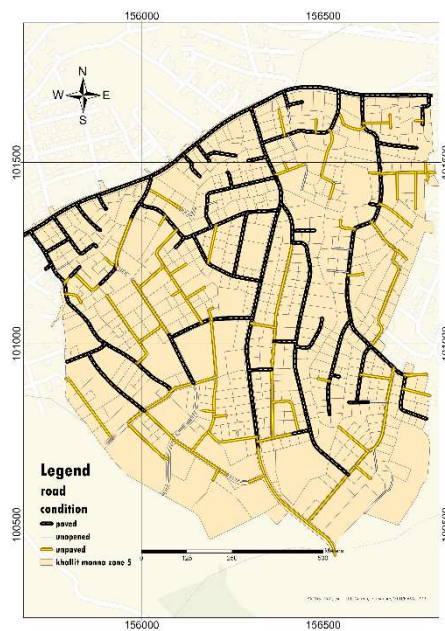
Figure 4. 4 conditions of the road

3. **The roads were classified based on their width, as shown in figure 4.5**
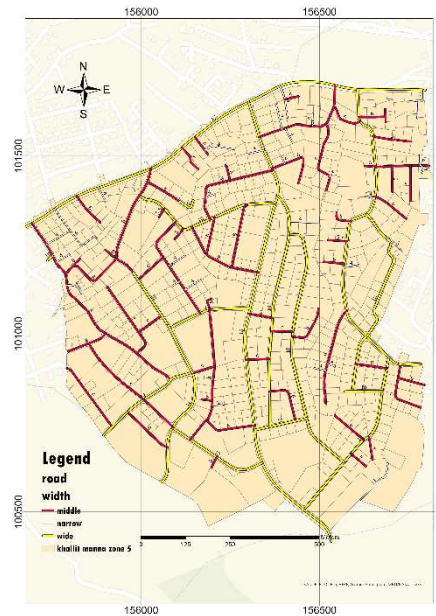
Figure 4. 5 width of the road

4. **The lands were classified according to land use based on the structural plan (residential A, residential B, residential C, residential D, an agricultural area, a commercial area, etc.), as shown in figure 4.6**

   master plan an area's future development and land use patterns, open space areas, the layout and type of infrastructure (including transportation links), and other significant features and constraints that affect how the effects of development are to be managed are all defined by a structure plan, which serves as a framework for guiding new development or redevelopment of an area.

   One or more maps, plans, or diagrammatic representations of the projected character, characteristics, and links for developed or redeveloped areas make up a structure plan. Usually, the maps or plans in structural plans don't go into enough detail to specify the lot lines or the precise shapes of buildings and structures.
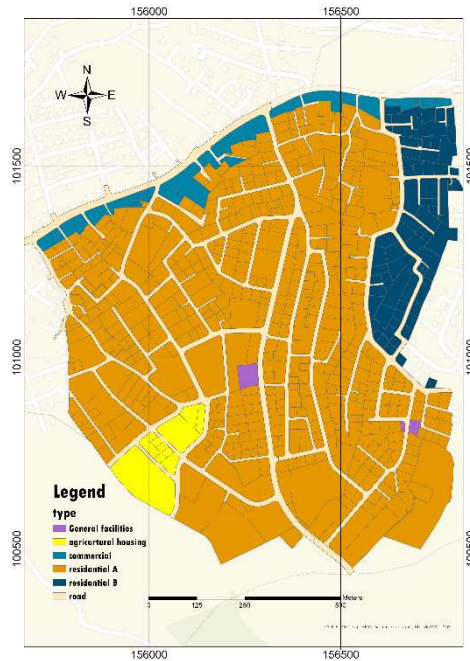
Figure 4. 6 land use according to structural plan

5. **The lands were classified according to the Oslo agreement,** as shown in figure 4.7, The Oslo Process aimed at achieving a comprehensive peace treaty between Israel and the PLO. It was unveiled with the signing of the Declaration of Principles on September 13, 1993. The agreement did not directly address the key "permanent status" issues of water, refugees, Jerusalem, settlements, and borders

In order to provide a temporary solution while waiting for a final status agreement, the 1995 Oslo II Accord established the administrative partition of the Palestinian West Bank into areas A, B, and C. The divisions still exist, with Area A being governed by the Palestinian Authority, Area C being governed by Israel, and Area B is governed jointly.

Area A

Area A is governed by Palestinian authorities in terms of administration and law enforcement.

Area B

Area B is under the administrative administration of the Palestinian Authority, although Israeli authorities also have security control over it.

56

Areas A or B in the West Bank are home to the vast majority of Palestinians.

Area C

Over 60% of the West Bank is administered by Area C, which Israel controls. Along with about 400,000 Israeli settlers living in over 230 settlements, an estimated 300,000 Palestinians reside in 532 residential communities that are either entirely or partially located in Area C.
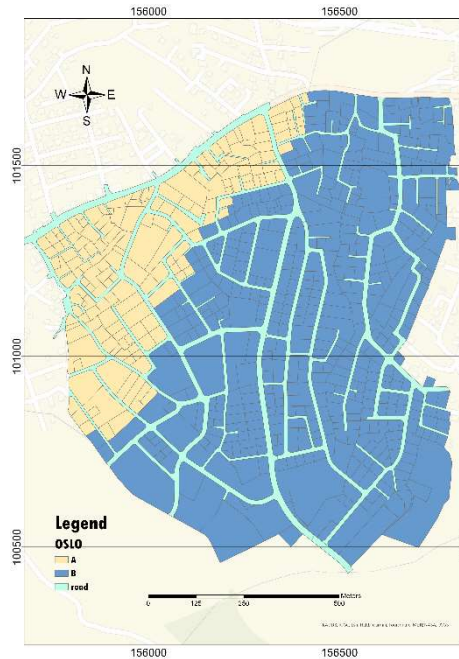
Figure 4. 7 land classification according to Oslo agreement

6. **The lands were classified according to shape (regular, semi regular, irregular), as shown in figure 4.8,** by comparing parcel shapes, the shape index (SI) is used to calculate the land valuation for certain case study locations. As seen,

regular range: 1.020 to 1.291

Semiregular range: 1.292 to 1.541

irregular range: 1.542 to 39.730

However, it is easy to demonstrate that parcels with irregular forms may also have equal values for these indices, hence this assumption may be false.

The indices, which utilize the parcel perimeter and area, are given the following definitions:

$$SI = \frac{P}{2\sqrt{\pi a}} \qquad (2)$$
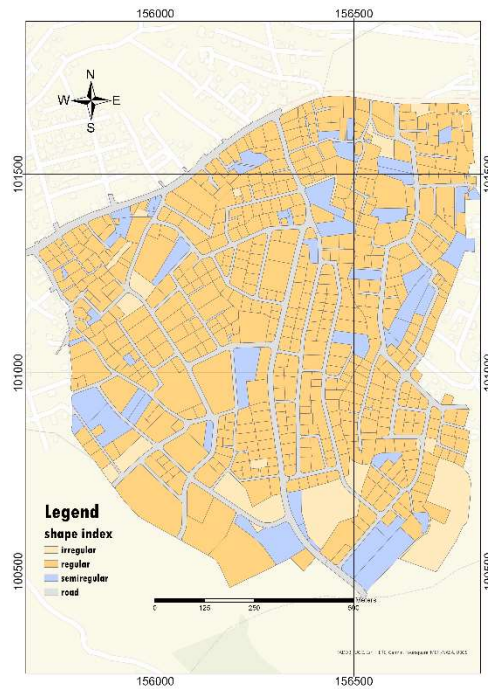
Figure 4. 8 shape index of the land

7. The distance between each parcel of land and the main street was calculated by a near tool, as shown in figure 4. 9
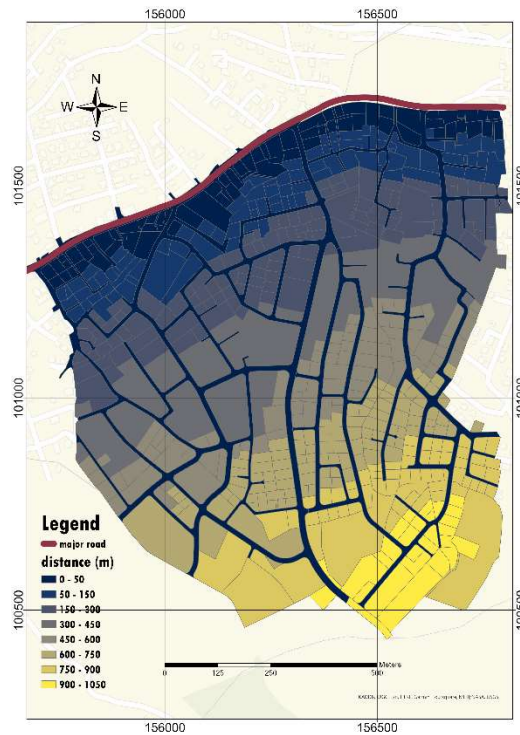
Figure 4. 9 the distance between lands and major road

8. The Slope and topography

The shape and relief of the land are described by the slope and topography.

The slope is the percentage change in elevation over a given distance in topography, which is a measurement of elevation.

Lines connecting places with the same height can be used to measure topography; these are known as topographic contours.

The slope is calculated as the elevation difference between two points divided by the lateral distance between those sites, as shown in figure 4.10
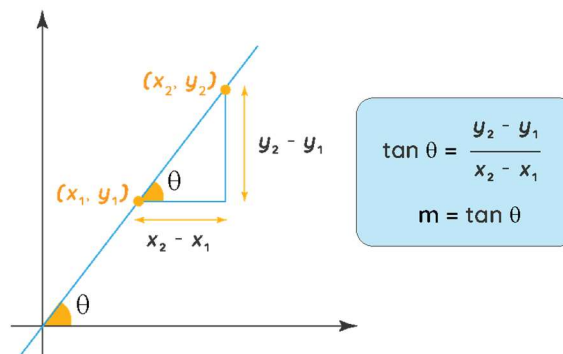
Figure 4. 10 slope formula

In ArcGIS Two methods are available for slope computation: Planar and Geodesic. Planar involves measuring the maximum rate of change in value from a cell to its immediate neighbors, while geodesic involves calculating the angle between topographic surface and the referenced datum. Both methods require at least seven cells neighboring the processing cell to have valid values. If there are fewer than seven valid cells, the calculation will not be performed, and the output at that processing cell will be No Data. as shown in figure 4.11
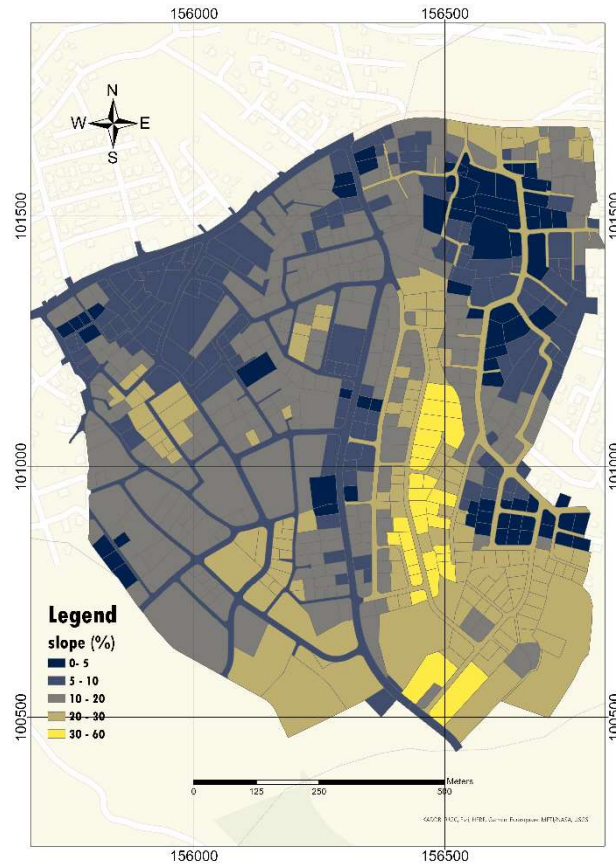
Figure 4. 11 The slope map

To make sure the program functioned properly, seven parcel were calculated the slope manually to contour 10 m, and the result was as follows:

# of parcel	y2-y1	x2-x1	slope
677	0.5	92.58	0.540073
29	3	30.85	9.724473
161	9	57.38	15.68491
630	12	40.22	29.8359
578	12	32.14	37.33665
572	11	25.05	43.91218
700	20	39.16	51.07252

9. **The buildings were digitized manually and were classified according to the number of floors, as shown in figure 4.12**
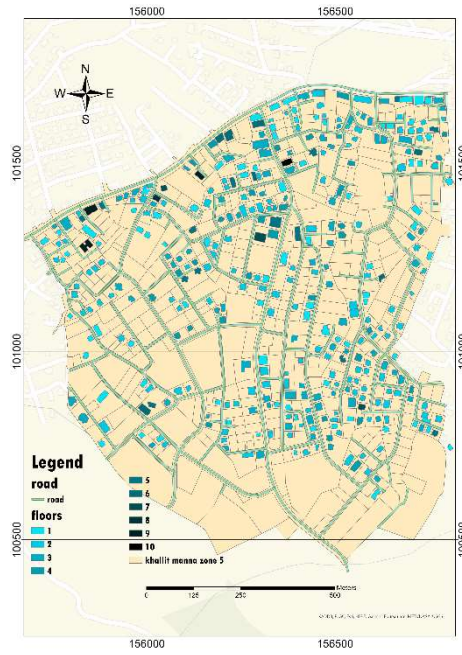
Figure 4. 12 the number of the floor in each building

10. The buildings were classified if containing parking or not as shown in figure 4.13

parking	yes	no
Number of buildings	**32**	**415**
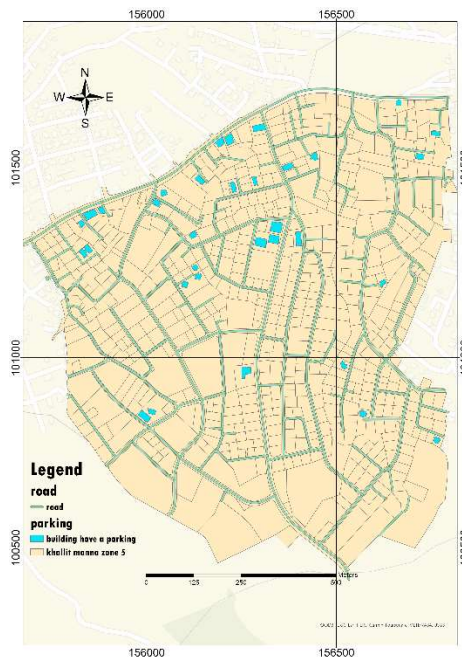
Figure 4. 13 the building contains parking

11. The buildings were classified if contain stores or not, as shown in figure 4.14

store	yes	no
Number of buildings	83	364
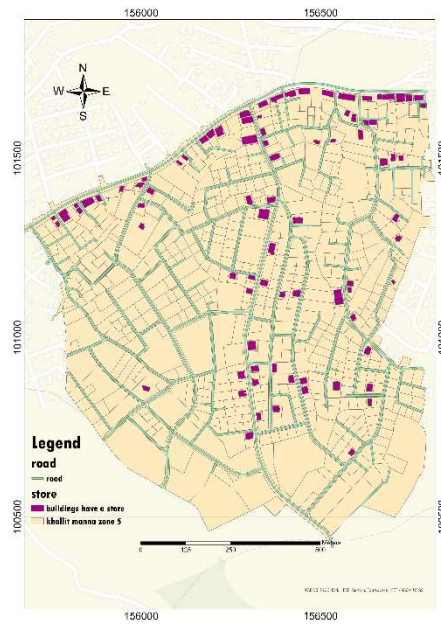
Figure 4. 14 the building contains parking

Chapter 5

5. Land valuation model

5.1. flowchart for land valuation

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5.5.1. Percentage Change

Chapter 5

5. Land valuation model

5.1. flowchart for land valuation

A flowchart is a diagram that shows how a system, computer algorithm, or process works. They are frequently used in many different fields to examine, organize, enhance, and convey frequently complex processes in simple, understandable diagrams. Rectangles, ovals, diamonds, and possibly many other shapes are used in flowcharts, also known as flow charts, to indicate the type of step, and connecting arrows to indicate flow and sequence. [13]

A flowchart was created to demonstrate how this land estimating procedure was carried out.

```
                          ┌─────────────┐
                          │    start    │
                          └─────────────┘
                                 │
                                 ▼
                    ╱─────────────────────────╲
                   ╱ Calculate the slope of parcels ╲
                  ╱───────────────────────────╲
                                 │
                                 ▼
                    ┌─────────────────────────┐
                    │   Classification the slope   │
                    └─────────────────────────┘
                                 │
                                 ▼
                ┌─────────────────────────────────┐
                │ classification of land according to Oslo (A, B, C) │
                └─────────────────────────────────┘
                                 │
                                 ▼
        ┌─────────────────────────────────────────────┐
        │ Classification of land according to land use (residential, industrial │
        │          , tourism, commercial              │
        └─────────────────────────────────────────────┘
                                 │
                                 ▼
                    ┌─────────────────────────┐
                    │ Road type (primary, secondary) │
                    └─────────────────────────┘
                                 │
                                 ▼
            ┌─────────────────────────────────────────┐
            │ road condition (paved, unpaved, unopened, base coarse) │
            └─────────────────────────────────────────┘
                                 │
                                 ▼
                    ┌─────────────────────────┐
                    │ Road width (wide, meddle, narrow) │
                    └─────────────────────────┘
                                 │
                                 ▼
                    ╱─────────────────────────╲
                   ╱    Calculate the distance between    ╲
                  ╱      each parcel and the main road      ╲
                 ╱───────────────────────────────╲
                                 │
                                 ▼
                    ┌─────────────────────────┐
                    │   Classification this distance   │
                    └─────────────────────────┘
                                 │
                                 ▼
                    ╱─────────────────────────╲
                   ╱       Calculate SI          ╲
                  ╱───────────────────────────╲
                                 │
                                 ▼
        ┌─────────────────────────────────────────────┐
        │ Classification of land according to SI (regular, semiregular, │
        └─────────────────────────────────────────────┘
                                 │
                                 ▼
            ┌─────────────────────────────────────────┐
            │ Analysis building (# OF FLOOR, STORE, PARKING) │
            └─────────────────────────────────────────┘
                                 │
                                 ▼
                ╱─────────────────────────────────╲
               ╱   Calculate the factor by least square   ╲
              ╱───────────────────────────────────╲
                                 │
                                 ▼
                ╱─────────────────────────────────╲
               ╱     Determine the standard value     ╲
              ╱───────────────────────────────────╲
                                 │
                                 ▼
                ╱─────────────────────────────────╲
               ╱     Calculate the net adjustment factor  ╲
              ╱───────────────────────────────────╲
                                 │
                                 ▼
                ╱─────────────────────────────────╲
               ╱      Calculate the market value      ╲
              ╱───────────────────────────────────╲
                                 │
                                 ▼
                          ┌─────────────┐
                          │     end     │
                          └─────────────┘
```

5.2.Determined Adjustment Factor

To determine the adjustment weight of each value influence factor by referring to the relevant Value Adjustment Matrix. Multiply all the adjustment weights to compute the Net Adjustment Weight [12]

5.2.1. Least Square

The coefficient value was calculated using the least square approach following the preparation and gathering of the required data.

A fundamental statistical technique used to find a regression line or the best-fit line for the given pattern is the least-squares method. an equation with particular parameters can be used to explain this procedure. in assessment and regression, the least squares method is frequently employed. this method is a standard approach in regression analysis for approximating sets of equations where the number of equations exceeds the number of unknowns. [14]

The minimizing of the sum of squared deviations, or the mistakes in each equation's outcome, is what the least-squares approach truly specifies as the solution. discover the sum of squares of errors formula, which aids in identifying variations in observed data. [14]

The least-squares method is often utilized in data fitting. the sum of squared errors or residuals, which are defined as the discrepancies between the observed or experimental value and the matching fitted value provided in the model, are thought to be reduced by the best-fit result. [14]

The two fundamental types of least-squares issues are:

linear or conventional least squares

least squares with nonlinearity, they depend on whether the residuals are linear or nonlinear. regression analysis is a common application of linear issues in statistics. on the other hand, non-linear problems are frequently used in the iterative method of refinement in which the model is approximated to the linear one with each iteration. [14]

5.2.2. Least square formula

According to the least-squares method, the curve with the lowest sum of the squared residuals (or deviations or errors) from the provided data points is the one that best fits a given set of observations. Assume the data points are (x1, y1), (x2, y2), (x3, y3),… (xn, yn), where x is an independent variable and y is a dependent variable. Assume as well that d stands for error or departure from each provided point and f(x) is the fitting curve. [14]

$$dn = yn - f(xn) \qquad\qquad (3)$$

Suppose when have to determine the equation of the line of best fit for the given data, then we first use the following formula.

The equation of a least square line is given by $y = a + bX$

The normal equation for 'a':

$$\sum y = na + b\sum X \qquad\qquad (4)$$

The normal equation for 'b':

$$\sum XY = a\sum X + b\sum X2 \qquad\qquad (5)$$

Solving these two normal equations can get the required trend line equation.

Thus, can get the line of best fit with the formula $y = ax + b$

In this case, the least-squares solution is

$$X = (AT * A))^{-1} * AT * L \qquad\qquad (6)$$

5.2.3. The General Equation That Was Written

For the purpose of calculating factor values and determining irrational prices (blunder value) by the least square method, several market prices were gathered for a variety of randomly selected land parcels

Depending on the main equation of least square, 13 equations were written, and the adjustment factor values were determined in these equations. each parcel of land has a unique equation.

$$EQNn = aX + bY + cZ + dQ + eW + fE + gR + hT + iU + jI + kO + lP$$

(7)

Were is

X: slope classification factor

Y: Oslo classification factor

Z: land use classification factor

Q: road type classification factor

W: road condition classification factor

E: area factor

R: road width classification factor

T: near from main road factor

U: SI classification factor

I: number of floor classification factor

O: store factor

P: parking factor

the equations for land valuation were as follows:

$$EQN1 = 0.85X + 1Y + 1.08Z + .92Q + 1.09W + 1013E + 1R + .75T + 1.1U$$

(8)

$$EQN2 = 1.05X + 1Y + 1Z + .92Q + 1.09W + 1415E + 1R + .85T + 1.1U + 1.1I + 1.05P$$

(9)

$$EQN3 = 1.05X + 1Y + 1Z + .92Q + 1.09W + 2692E + .92R + .85T + 1.1U + 1.1I$$

(10)

$$EQN4 = 0.85X + 1Y + 1Z + .92Q + 1.09W + 437E + 1R + .75T + 1.1U + 1.05I$$

$$(11)$$

$$EQN5 = 0.95X + 1.1Y + 1.08Z + .92Q + 1.09W + 1560E + 1R + .85T + 1.1U$$

$$(12)$$

$$EQN6 = 1.05X + 1Y + 1.08Z + .92Q + .85W + 5987E + .92R + .9T + 1.1U$$

$$(13)$$

$$EQN7 = 0.95X + 1.1Y + 1.08Z + .92Q + .92W + 1003E + .92R + .95T + 1U + 1.1I$$

$$(14)$$

$$EQN8 = 0.95X + 1Y + 1.08Z + .92Q + 1.09W + 1082E + 1.05R + .85T + 1.1U$$

$$(15)$$

$$EQN9 = 0.9X + 1Y + 1.08Z + .92Q + 1.09W + 2102E + 1.05R + .8T + 1.1U$$

$$(16)$$

$$EQN10 = 1.05X + 1Y + 1Z + .92Q + 1.09W + 1183E + 1.05R + .95T + 1.1U + 1.1I$$

$$(17)$$

$$EQN11 = 0.85X + 1Y + 1.08Z + .92Q + 1.09W + 615E + 1R + .75T + 1.1U$$

$$(18)$$

$$EQN12 = 0.95X + 1.1Y + 1.08Z + .92Q + .92W + 533E + 1R + .85T + 1.1U + 1.05I$$

$$(19)$$

$$EQN13 = 0.95X + 1.1Y + 1.14Z + 1Q + 1.09W + 822E + 1.05R + 1T + 1.1U + 1.1I + 1.05O$$

$$(20)$$

5.2.4. least square solution

1. A matrix was filled in the values of the factors that were determined in these equations as shown in table 5.1

	X	Y	Z	Q	W	E	R	T	U	I	O	P
1	0.85	1	1.08	0.92	1.09	1013	1	0.75	1.1	0	0	0
2	1.05	1	1	0.92	1.09	1415	1	0.85	1.1	1.1	0	1.05
3	1.05	1	1	0.92	1.09	2692	0.92	0.85	1.1	1.1	0	0
4	0.85	1	1	0.92	1.09	437	1	0.75	1.1	1.05	0	0
5	0.95	1.1	1.08	0.92	1.09	1560	1	0.85	1.1	0	0	0
6	1.05	1	1.08	0.92	0.85	5987	0.92	0.9	1.1	0	0	0
7	0.95	1.1	1.14	0.92	1.09	1003	0.92	0.95	1	1.1	0	0
8	0.95	1	1.08	0.92	1.09	1082	1.05	0.85	1.1	0	0	0

9	0.9	1	1.08	0.92	1.09	2102	1.05	0.8	1.1	0	0	0
10	1.05	1	1	0.92	1.09	1183	1.05	0.95	1.1	1.1	0	0
11	0.85	1	1.08	0.92	1.09	615	1	0.75	1.1	0	0	0
12	0.95	1.1	1.08	0.92	0.92	533	1	0.85	1.1	1.05	0	0
13	0.95	1.1	1.14	1	1.09	822	1.05	1	1.1	1.1	1.05	0

table 5. 1 A matrix

2. the L matrix was filled in with the prices of the random land parcels that were Obtaining it, as shown in table 5.2

L(M2)
354550
636750
1265240
152950
546000
3592200
481440
270500
504480
526435
212175
201474
419220

table 5. 2 L matrix

3. The N (13*13) Matrix IS "AT*A":

1.19E+11	1.28E+11	1.32E+11	1.1484E+11	1.31E+11	2.0238E+14	1.23E+11	1.06E+11	1.3545E+11	7445000000	99750000	1.1E+10
1.278E+11	1.38E+11	1.43E+11	1.2416E+11	1.42E+11	2.0836E+14	1.34E+11	1.15E+11	1.463E+11	7925000000	1155000000	1.05E+10
1.3186E+11	1.43E+11	1.48E+11	1.2824E+11	1.46E+11	2.1731E+14	1.38E+11	1.18E+11	1.511E+11	7992000000	1197000000	1.05E+10
1.1484E+11	1.24E+11	1.28E+11	1.11568E+11	1.27E+11	1.8874E+14	1.2E+11	1.03E+11	1.3152E+11	7080000000	1050000000	9.66E+09
1.31025E+11	1.42E+11	1.46E+11	1.27464E+11	1.46E+11	2.0756E+14	1.37E+11	1.17E+11	1.5027E+11	8105500000	1144500000	1.14E+10

2.02379E+14	2.08E+14	2.17E+14	1.88742E+14	2.08E+14	5.8077E+17	1.99E+14	1.77E+14	2.23881E+14	8.845E+13	8.631E+12	1.49E+13
1.23485E+11	1.34E+11	1.38E+11	1.20072E+11	1.37E+11	1.9929E+14	1.29E+11	1.11E+11	1.4164E+11	753400000000	110250000000	1.05E+10
1.0635E+11	1.15E+11	1.18E+11	1.0292E+11	1.17E+11	1.7707E+14	1.11E+11	9.56E+10	1.2115E+11	674000000000	105000000000	8.93E+09
1.3545E+11	1.46E+11	1.51E+11	1.3152E+11	1.5E+11	2.2388E+14	1.42E+11	1.21E+11	1.552E+11	825000000000	115500000000	1.16E+10
744500000000	7.93E+10	7.99E+10	708000000000	8.11E+10	8.845E+13	7.53E+10	6.74E+10	825000000000	825500000000	115500000000	1.16E+10
997500000000	1.16E+10	1.2E+10	105000000000	1.14E+10	8.631E+12	1.1E+10	1.05E+10	1155000000000	1155000000000	1102500000000	0
110250000000	1.05E+10	1.05E+10	9660000000	1.14E+10	1.4858E+13	1.05E+10	8.93E+09	115500000000	115500000000	0	1.1E+10

table 5. 3 N matrix

4. N⁻¹ (13*13) Matrix Is:

4.72993E-07	1.33E-07	-5.5E-07	2.21507E-06	-2.1E-07	7.7343E-12	2.87E-07	-5.3E-07	-1.49382E-06	-4.08885E-08	-3.82825E-08	-3.2E-08
1.32774E-07	5.45E-08	-1.8E-07	6.63746E-07	-6E-08	1.8904E-12	8.94E-08	-1.5E-07	-4.48996E-07	-1.24407E-08	-1.18594E-08	-9.1E-09
-5.47658E-07	-1.8E-07	7.72E-07	-2.9347E-06	2.72E-07	1.0171E-11	-3.4E-07	6.13E-07	1.8955E-06	5.61402E-08	5.74418E-08	3.77E-08
2.21507E-06	6.64E-07	-2.9E-06	1.14536E-05	-1.1E-06	-3.999E-11	1.36E-06	-2.5E-06	-7.4773E-06	-2.15607E-07	-2.18456E-07	-1.5E-07
-2.06768E-07	-6E-08	2.72E-07	-1.0675E-06	1.02E-07	3.8666E-12	-1.3E-07	2.3E-07	6.94338E-07	2.01442E-08	2.046E-08	1.41E-08

-7.73429E-12	-1.9E-12	1.02E-11	-3.999E-11	3.87E-12	1.7695E-16	-4E-12	8.18E-12	2.52654E-11	7.96394E-13	7.7674E-13	5.2E-13
2.87414E-07	8.94E-08	-3.4E-07	1.35622E-06	-1.3E-07	-3.9975E-12	1.96E-07	-3.3E-07	-9.33309E-07	-2.40938E-08	-2.36575E-08	-2E-08
-5.27801E-07	-1.5E-07	6.13E-07	-2.4784E-06	2.3E-07	8.1759E-12	-3.3E-07	5.98E-07	1.68055E-06	4.50175E-08	4.2646E-08	3.61E-08
-1.49382E-06	-4.5E-07	1.9E-06	-7.4773E-06	6.94E-07	2.5265E-11	-9.3E-07	1.68E-06	4.95743E-06	1.3891E-07	1.38397E-07	1.02E-07
-4.08885E-08	-1.2E-08	5.61E-08	-2.1561E-07	2.01E-08	7.9639E-13	-2.4E-08	4.5E-08	1.3891E-07	4.20116E-09	4.17433E-09	2.78E-09
-3.82825E-08	-1.2E-08	5.74E-08	-2.1846E-07	2.05E-08	7.7674E-13	-2.4E-08	4.26E-08	1.38397E-07	4.17433E-09	4.67319E-09	2.64E-09
-3.22841E-08	-9.1E-09	3.77E-08	-1.5173E-07	1.41E-08	5.2026E-13	-2E-08	3.61E-08	1.02305E-07	2.77581E-09	2.64071E-09	2.33E-09

table 5. 4 N inverse matrix

5. n Matrix is (N⁻¹*AT)

n
8.25935E+11
8.42114E+11
8.76475E+11
7.62945E+11
8.31944E+11
2.47491E+15
7.9875E+11
7.21853E+11
9.03471E+11
4.0251E+11

43155000000
66858750000

table 5. 5 n matrix

6. X MATRIX IS (n*L)

The X matrix represents the values of the factors (slope, oslo, land use......etc).

	x
X	-41.242721
Y	-21.7090275
Z	2.58747672
Q	-50.719374
W	0.709327623
E	0.003417648
R	-66.1259263
T	63.70093172
U	107.5122823
I	0.17602987
O	-1.30300975
P	3.2091279

table 5.6 x matrix that represent factor value

7. V matrix that represents the error or residual in each price as shown in table 5.7

v
-2966.23577
-2.85953E-05
-7.410865073
-439.4192491
20.92471156
14.8216506
7.36071E-06
-1381.990917
947.0181543
446.8300325
3386.386776
-20.92473622

-1.87612E-05

table 5. 7 v matrix

It's important to note that the prices' inaccuracy rate is less than 5%.

5.2.5. Root Mean Square Error (RMSE)

One of the methods most frequently used to assess the accuracy of forecasts is root mean square error, also known as root mean square deviation. It illustrates the Euclidean distance between measured true values and forecasts. [15]

Root mean square error can be expressed as

$$\sqrt{\frac{\sum_{I=1}^{N}(Vi-\widehat{Vl})2}{N}} \qquad (21)$$

Root Main Square Error was calculated to the market value and the result was as shown

RSME	1343.55467

5.3. Defined Standard Value

The standard of value aids in giving lands a consistent value and enabling measurement of their value's growth or decline through adjustment factors, so the standard value was calculated by dividing the median market value of the chosen land parcels over theirs ,as shown in table 5.8

LANDS PRICES FOR 1M²
500
480
470
450
450
445
378
350

350
350
345
250
240

table 5. 8 standard value

5.4. Land valuation model

the model builder tool in ArcGIS has been used to construct a value land model and the major goal of this model is to establish a land's market value using several land valuation elements that have been conceptualized and spatially explored.

i. Firstly, To calculate the slope, a TIN must be generated in order to extract DEM from it, after that was calculated the slope

Figure 5. 1 Model builder to calculate slope

The average slope for each parcel of land was discovered, transformed to points, and linked to the zone by the Spatial Joint Tool

Figure 5. 2 Model builder to link the slope with khallit manna layer

The slope was divided into different categories, and each category had a unique factor value,as shown in table 5.9

(0-5) flat

(5-10) near flat

(10-20) middle slope

(20-30) high slope

(>30) extreme slope

slope				
flat	near flat	middle slope	High slope	extreme slope
1.1	1.05	0.95	0.90	0.85

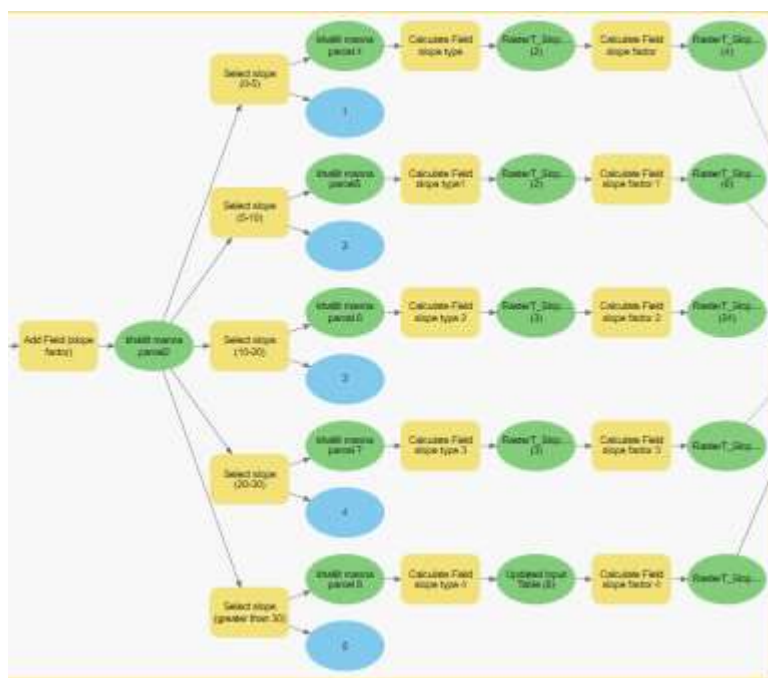*table 5.9 factor value to slope category*

Figure 5. 3 model builder to classify the slope and calculate the factor for each category

ii.   Secondly, the Spatial Joint Tool was used to join the previously prepared land property with the Khalit Manna Zone.
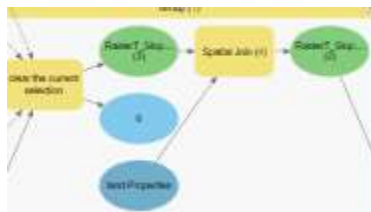

Figure 5. 4 Model builder to link land feature layer with khallit manna layer

The land was classified according to Oslo (Oslo A, Oslo B), and each categories give a unique factor value, as shown in table 5.10

Oslo	
A	B
1.1	1

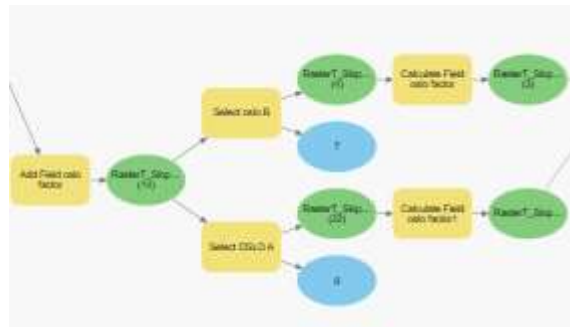*table 5. 10 factor value to Oslo category*

Figure 5. 5 model builder to calculate factor for each oslo classification

The land was classified according to land use ,and each categories give a unique factor value, as shown in table 5.11

land use				
residential A	residential B	residential agricultural		General facilities
1.08	1	0.9	commercial	
			1.14	0.88

table 5.11 factor value to land use category

Figure 5. 6 model builder to calculate factor for each land use classification

The land was classified according to type of road, and each categories give a unique factor value, as shown in table 5.12

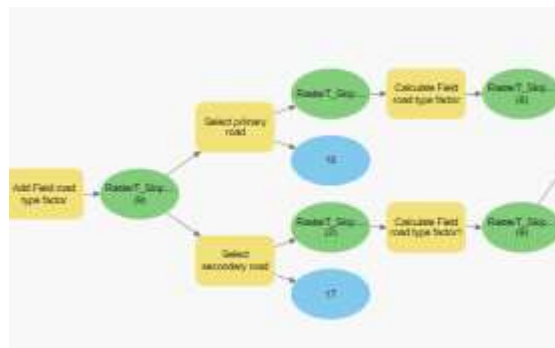| Road type	
primary	secondary
1	0.92

table 5.12 factor value to road type

Figure 5. 7 model builder to calculate factor for each road type

The land was classified according to condition of road, and each categories give a unique factor value, as shown in table 5.13

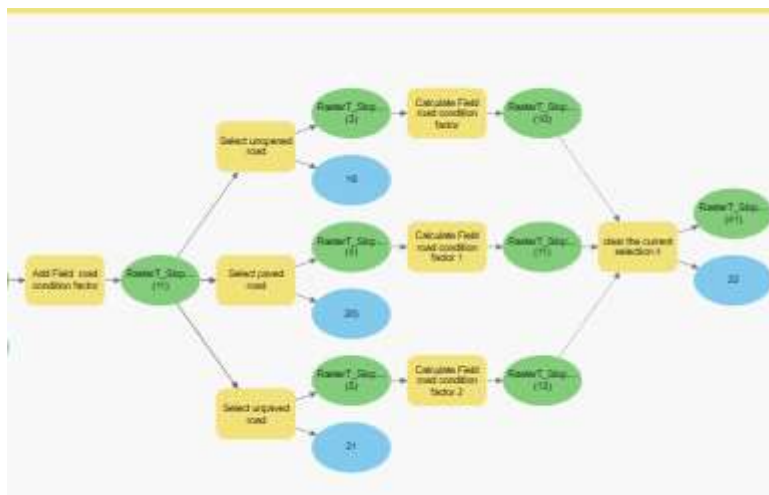| Road condition		
paved	unpaved	unopened
1.09	0.92	0.85

table 5.13 factor value to road condition

Figure 5. 8 model builder to calculate factor for each road condition

The land was classified according to width of road, and each categories give a unique factor value, as shown in table 5.14

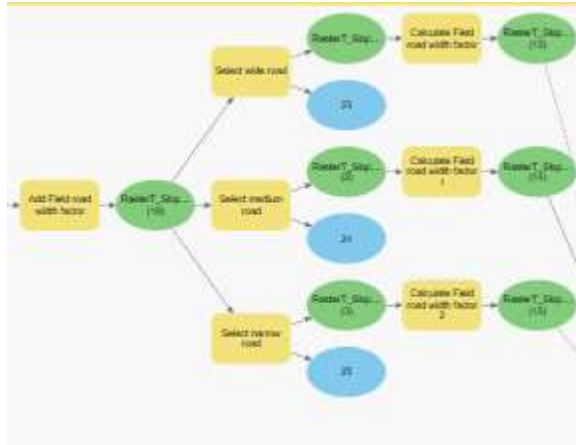| Road width		
wide	medium	narrow
1.05	1	0.92

table 5.14 factor value to road width

Figure 5. 9 model builder to calculate factor for each road width

iii. Thirdly Using the Near tool, the distance between each parcel of land and the main road was computed, and determined factor value ,as shown in table 5.15

distance							
0-50	50-150	150-300	300-450	450-600	600-750	750-900	900-1050
1	0.95	0.9	0.85	0.8	0.75	0.7	0.68

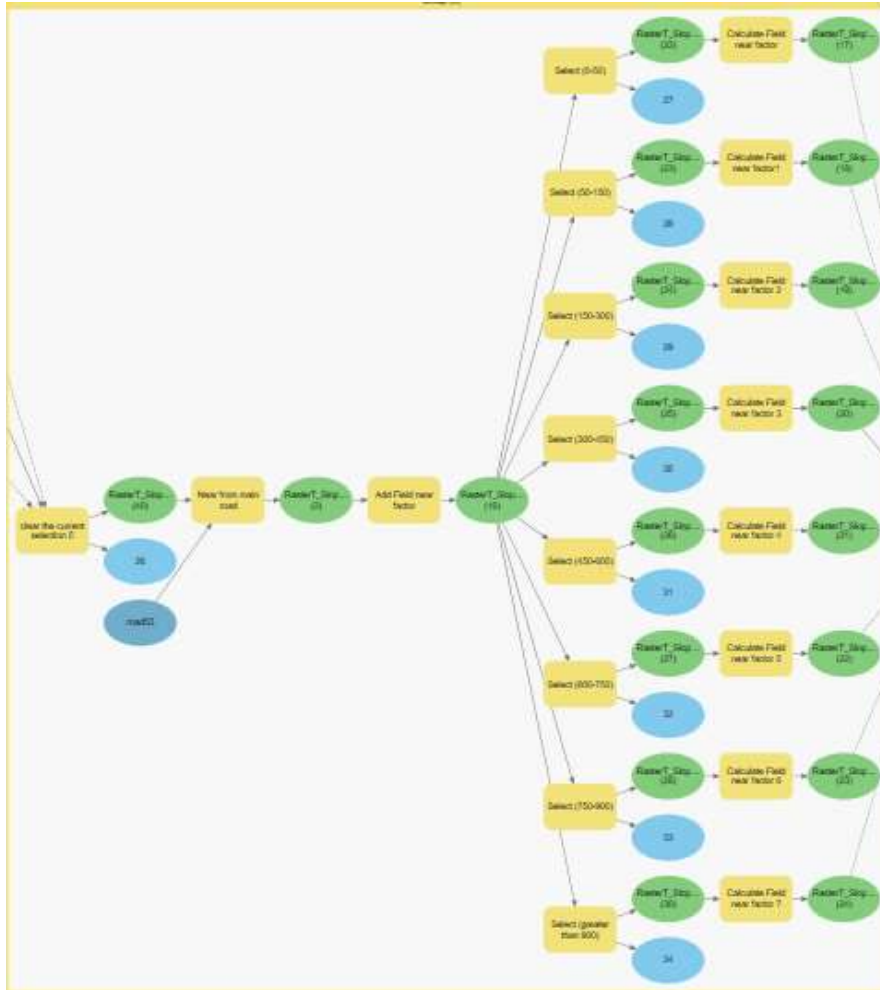*table 5. 15 factor values to distence btw lands and main road*

Figure 5. 10 model builder to calculate the distance between the lands and major road , and determine the factor for each lands depending on this distance

iv. Fourthly The land was divided into three categories (regular, semi-regular, and irregular), and the land valuation for several case study locations was determined by comparing the shapes of the parcels

$$SI = \frac{P}{2\sqrt{\pi a}} \qquad\qquad (22)$$

regular range: 1.020 to 1.291

Semiregular range: 1.292 to 1.541

irregular range: 1.542 to 39.730

Figure 5. 11 model builder to calculate shape index

After calculated the SI and classified it, was determined for each category, as shown in table 5.16

Shape index		
regular	semiregular	irregular
1.1	1	0.9

table 5.16 factor value to shape index category

Figure 5. 12 model builder to classify lands depending on the shape index and calculate the factor to this category

   v.   Fifthly, the Spatial Joint Tool was used to join the previously prepared building with the Khallit Manna Zone.

Figure 5. 13 Model builder to link Each building with its parcel of land

Determined the building that contain the store and give that factor value as shown in table 5.17

store	
0	1
1	1.05

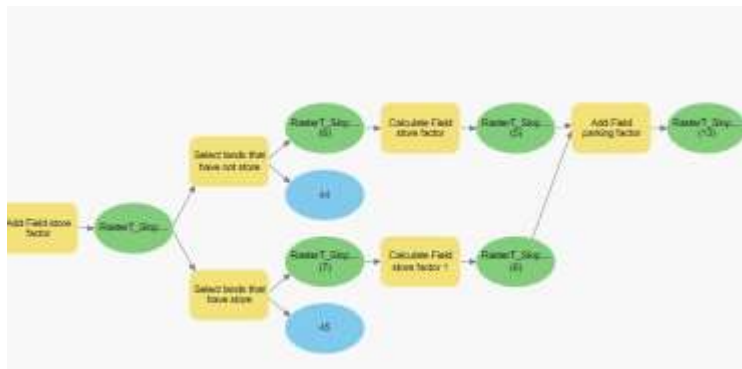*table 5.17 factor value if land have store or no*

Figure 5. 14 model builder to calculate the factor to lands that have a store

Determined the building that contain the parking and give that factor value as shown in table 5.17

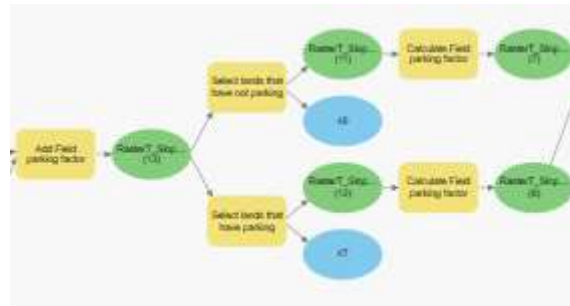| parking	
0	1
1	1.05

table 5 .18 factor value if land have parking or no

Figure 5. 15 model builder to calculate the factor to lands that have a parking

Determined the number of floor for each building and give that factor value as shown in table 5.19

floor		
1-3	3-6	6-10
1.05	1.1	1.15

table 5.19 factor value depending number of floor

Figure 5. 16 model builder to calculate the factor of lands depending on number of floors

vi.   Sixthly, after determining all the values for each factor, all the weights are multiplied with each other to obtain the net adjustment factor

Figure 5. 17 model builder to calculate the net adjustment factor for each land

84

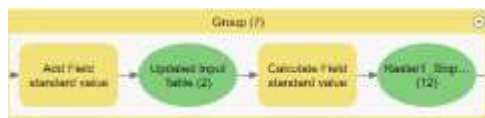vii.   Seventhly, Determined the standard value "one value for all lands"

Figure 5. 18 Model builder to calculate standard value

viii.   Eighthly, To calculate the market value for 1m2 for each land parcel multiply the net adjustment factor by standard value
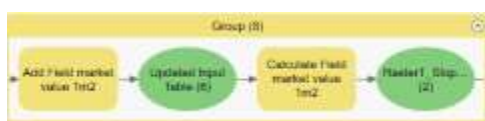

Figure 5. 19 model builder to calculate the market value for 1m2 for each land

ix.   Ninthly, To calculate the market value for each land parcel multiply the net adjustment factor by standard value by land area
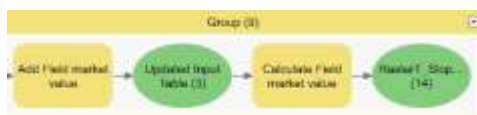

Figure 5. 20 model builder to calculate the market value for each land

5.5. Change land prices (2021-2022)

With the demand for land to construct affordable housing continuing to increase, price hikes are mostly caused by a higher price-per-m2 of land.

5.5.1. Percentage Change

In finance, the percentage change is frequently used to denote the percentage-based price change of a stock over time. Depending on whether the change is an increase or a decrease, a simple mathematical formula is employed to quantify this change as a percentage. [16]

Percent change is the relative difference between an old value and a new value. Positive values represent an increase over time, while negative numbers indicate a reduction. [16]

$$\text{Percent change} = \frac{\text{new value} - \text{old value}}{\text{old value}} * 100\% \qquad (23)$$

The parcel of land (40, 176, and 177) were priced in 2021 and 2022. The percentage change was determined in each parcel of land, and the average rate of change was taken between the three parcels of land, as shown in table 5.20

#of parcel	2021 y	2022 y	percent of change%
1	350	460	31.42857
2	350	450	28.57143
3	355	435	22.53521
avg percent of change is		27.51174	

table 5.20 percent of change in price (2021-2022)

Chapter 6

6.Conclusion and recommendation

6.1.Conclusion

6.2.Recommendations

6.3.Reference

Chapter 6

6. Conclusion and recommendation

6.1. Conclusion

GIS has been used to construct a value land model, which will boost the efficiency of the land valuation process. The major goal of this model is to establish a land's value using several land valuation factors that have been conceptualized and spatially explored *as shown in sec 4.1*. In large-scale spatial data applications, using GIS in a multi-criteria land valuation analysis also offers a value estimation mechanism. Some criteria for valuing land are chosen and developed to assign property values and determine numerical value to this factor by least square method *as shown in sec 5.2*. and determined the standard value to the study area (khallit manna zone) *as shown in sec 5.3*. GIS performed the appropriate value computations by model builder *as shown in sec 5.4*, to produce the land valuation maps *as shown in figure 6.1*. As a result, a visual land valuation model was developed that both appraisal experts and people who aren't familiar with technological techniques can easily understand. More crucially, GIS enhances the quantitative and qualitative capabilities of the process used by local authorities to analyze land valuation.
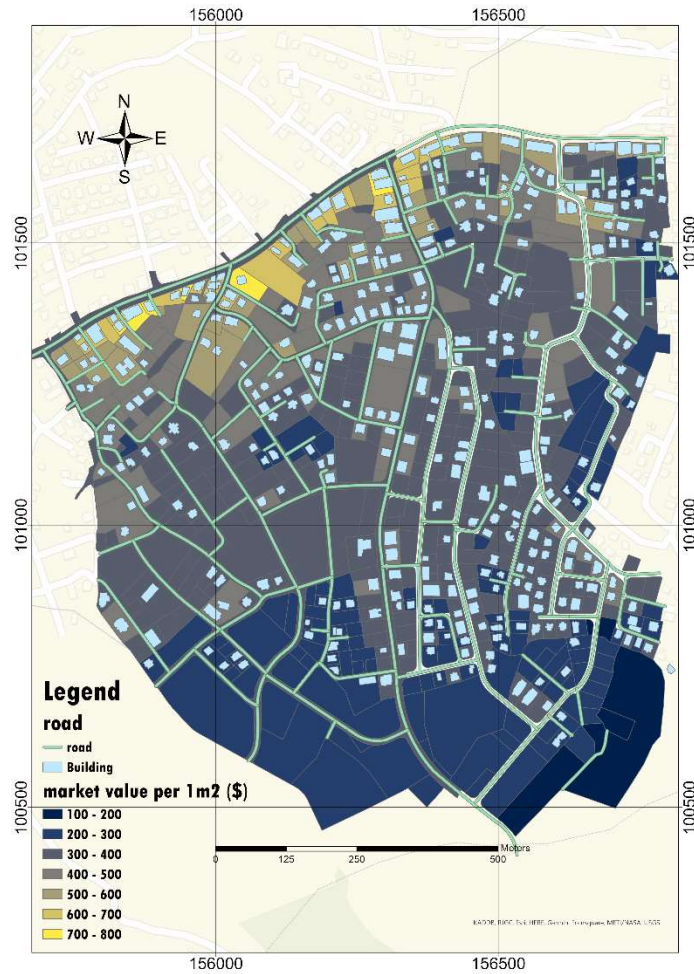
Figure 6. 1 prices map

6.2. Recommendations

- Using gis technology in the real estate appraisal process
- Carrying out for monitoring the real estate appraisal process, how is it handled in Palestine, and every violator punished
- Creating general maps for real estate appraisal, that contain of the standard value for each zone, with unifying factors that affect prices
- Finding real estate price indexes for Palestine in general and the governorates in specific to track the annual changes.

6.3. Reference

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