

*Designing Vertical Model to Cope Urban Sprawl in Khartoum  
State Using GIS software*

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*Abstract: The main purpose of this paper is to seek and counter the accelerated horizontal urban sprawl that came as a result of steady population growth in Khartoum state. Using computer tools (GIS software) to design vertical model for (Khartoum central area) in accordance with the modern planning standards, in order to contribute in the process of population distribution and acquiring a large swath of land that can be exploited and reimagined, commensurating with the strategic plans of the State.*

*An Spatial Interpolation was made to identify the shallows of Earth as it is the fundamental basis in the urban planning process, and then manipulating the map and download metadata, linking it with Oracle database to absorb the maximum amount of digital and analytical data. Then after that using Arc Scene to build the new vertical model, through separating the study area (Khartoum central area) from the buildings layer and add a field named (height) to show the new vertical model with the possibility of responding to various queries that can illustrate the advantage of vertical construction.*

*The paper concluded that the area gained and calculated by the system after the proposed vertical design represent [1:2] of the status quo, which two thirds of the total area of the region.*

*Keywords: GIS, Khartoum State, Re-Planning, Urban Sprawl, Vertical Model.*

## I. INTRODUCTION

Mankind today are passing through a revolution sweeping technique, perhaps the most important features is the sheer amount of information accumulated, which flowed profusely from all sides and quarters, this vast vocabulary or rather its numbers, data and statistics of natural and human assets on the ground and the generated interaction of products that are of multidimensional civilization. [1]

Because of the intensity of this information, it has become more difficult to deal with this information, absorbed and utilized, even by planners, strategists, policy makers and others, unless it is classified, indexed, stripped and digitally reduced in an image of databases. In this way it can be handled automatically and utilized without upsetting this shorthand or brevity its accuracy and significance.

Due to the availability of information and its increasing capacity, serious attention is directed towards human frameworks which are capable of absorbing as much of the useful information, and coordinating, controlling and exploiting it with biggest payoff that is possible for development goals [2]. Thus, it has become certain that, the most dangerous and discerning of community development and its civilization, is the creation of entities and technical methods that would exploit possible informatics bigger payoff. Perhaps the most important information systems at all that has emerged in recent times and greatly contributed in developing a method of work in all fields of Earth is the Geographic Information System (GIS). [3]

## II. CURRENT SITUATION OF STSTE

Sudan is as other developing societies living and building social and economic changes which are clearly evident in Khartoum State, where the State's population soon after independence in 1956 from 504.923 to 8.6 million in the year 2017 [4], in an area of about 22, 000 square kilometers, equivalent to 4.7 m Leon acres. This large population demographic focus came as a result of being the center of political, economic and leadership center, job market and containing the capital of the state (Khartoum). All this has made it a state of formidable weight mandate and resources which are not utilized optimally.

Lack of optimal planning that can beastly suit its potential with double distribution of essential services and infrastructure that is parallel to the accelerated horizontal growth of the state in turn led to the loss of the area to its urban and rural aspects spread with a steady increase in crime, especially in the state terminals. This also led to the difficulty of providing basic services and AIDS necessary for human life in the region.

Residential areas also overlap with commercial and government. It was a discount on farmland, with 60% of the territory of Khartoum State agricultural land. In addition to environmental problems (weather change, water pollution, overflowing sewage, etc) and health disasters (prevalence , epidemiology of water kinds of diarrhea , fevers, the emergence of previously unknown diseases and the spread of cancer and so on) in addition to traffic jams and frequent congestion, which in turn affects directly in the human environment mandate of the state[5]- [7].

## III. METHODOLOGY AND TOOLS

This part explains the proposed automation of re-planning process as an alternative to the current applied system used in the re-planning. The advantages of automation of this process are to reduce time, cost and effort, preserve rights, and provide efficient documentation, storage, and retrieval. The steps of designing of the proposed model had been stated below.

### 3.1 Study area

The study area is Khartoum state, which is located in the heart of Sudan, at blue and white Nile confluence, forming together the river Nile. The area is sandwiched between longitude 31-34.5 degrees East and latitude 15-16 degrees North.

### 3.2 Sources of data

Aerial photograph had been used as a primary source of spatial data with the following specifications:

Produced by: Khartoum State Survey Department.

Year of Photography: 2012.

Resolution: 10cm

Datum: WGS84.

Projection: UTM, Zone 36N.

- ArcGIS 10 software had been used to automate the re-planning process and designing a model with full database for spatial data linked to attribute data (oracle database), which has the capability to be used for storage, analyses and editing by changing the data only.
- Kmler tool& Microsoft .net framework 2 service pack1 had been used to generate Spatial Interpolation.

### 3.3 Steps of the designing of the proposed model

Main steps for the creation of the proposed model:

**3.3.1 Data collection**

- Aerial photograph of the study area has been input to ArcGIS software, ArcMap interface, see Figure 1.

**3.3.2 Data processing**

Many steps have been followed to process the data.

**3.3.2.1 Spatial Interpolation**

Spatial Interpolation should be made with the aim to create contours for the state and contour interval coordinates, associated with the digital database that indicate the x- coordinates , and the x-coordinates processing (x\_utm) and (y) coordinates processing (y\_utm)and the height z processing (z\_utm).

**3.3.2.2 Creation of the layers**

Using Arc Catalog interface, the required layers have been created as follows:

- File Geodatabase named vertical model: It contains all the feature classes of layers used in the model.
- Building layer of polygon feature class with the fields: Building No (integer), Name(text field), Area (Double), location(text), Block No(integer), Street No (integer), Land uses(text), Year(integer).
- Contour lines layer with the fields: x(float), x\_utm(Double), y(float), y\_utm(Double), z(float), z\_utm(Double),
- Street layer of polyline feature class with the fields: Name (text), Width (integer), Class (text).
- Agricultural areas layer of polygon feature class with the fields: Name(text field), Area (Double), location(text), Block No(integer), Street No (integer), Year(integer).
- Study Area layer of polygon feature class: representing the total area of study.
- New\_ Area layer of polygon feature class: representing the vertical model (new model).

**3.3.2.3 Digitizing and Construction layers**

After initializing the layers and preparing the attribute data. The digitizing and construction process should take place and make the map become digital, addressed and including all layers along with the attribute data, then attaching oracle database parameters to fast readers of all inquiries.

**IV. DATA ANALYSIS**

1. Work of (Spatial Interpolation) for Khartoum state should be started through contour layer to create contour values (xyz\_ project) and coordinating the points of shape file [fig 2] , which can be done through the following code:

Dim output As Double,

Dim pPoint As point,

Set pPoint = [shape],

Output = pPointX.

2. In conjunction to the new proposed system (model), re-planning the study area had been started by surveying of existing buildings (main layer), building layer had been created (Figure 3), the building had been numbered to be used in the new model, and the building number must be a unique number (identifier) to link the building map with the attribute table (oracle database).

3. Incorporate Building layers & Agricultural standardized descriptive database to see how agricultural areas on the predominance of residential buildings in the State.
4. The Khartoum Central region should be separated from the buildings layer and rename it (new\_area) to build the new vertical form.
5. Using Arc Scene interface to process layer (new\_area) and download the database, with the addition of a field naming it (hight).
6. Calculating the area of a layer (new\_area) of the total area and to be separated by height.
7. Show the amount of space gained by the new model.
8. View the new vertical form outline.

## V. MODEL DESIGN

The power of GIS Software lies in its capability to assemble a set of tools and processes in one model to perform a particular task.

All the previous procedures has been built in one model which is called a vertical model (Figure 5-9) which has been added to the toolbox to be used as a model to repeat the process( re- planning) in each location in Sudan.

## VI. RESULTS AND DISCUSSIONS

Applying the analysis steps as shown in the vertical model, (Figure 5-9) results have been drawn and obtained as follow:

1. The significant increase in the population of Khartoum state is one of the factors causing the horizontal stretch.
2. It is seen through the new vertical form design that two thirds of the total area of study area, derived space (vacant) utilized, it can be reimagined and distributed in proportion to the strategic plans of the State. Figure [5-9].
3. Predominance of the newcomers on agricultural areas, converting them to population areas that have left negative repercussions on the mandate of the state, which is due to extend mandate in response to population growth. Figure [4].
4. Weaker expansion accelerated horizontal mandate implementation plans and visions of the future, diagrams, routers Centre for difficult access control migrations which requires new layout with variable population density.
5. Automation of the process reduces cost and time which enables the elimination of problem complexity.
6. The digital spatial database can be used for different purposes, such as managing services, census, economic and social planning...etc.

## VII. CONCLUSION

This paper explained the importance of GIS in urban planning by providing digital vertical model contributing in the field of planning. The model is dependent and supported on the generation of spatial and geographic information system integration capabilities with oracle database from which to extrapolate all the results of queries.

The paper concluded by vertical form designer that vacant space (acquired), calculated by the system as a result of vertical expansion represents two thirds of the total area.

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Figure 1: Shows the preparation of the image using ArcMap

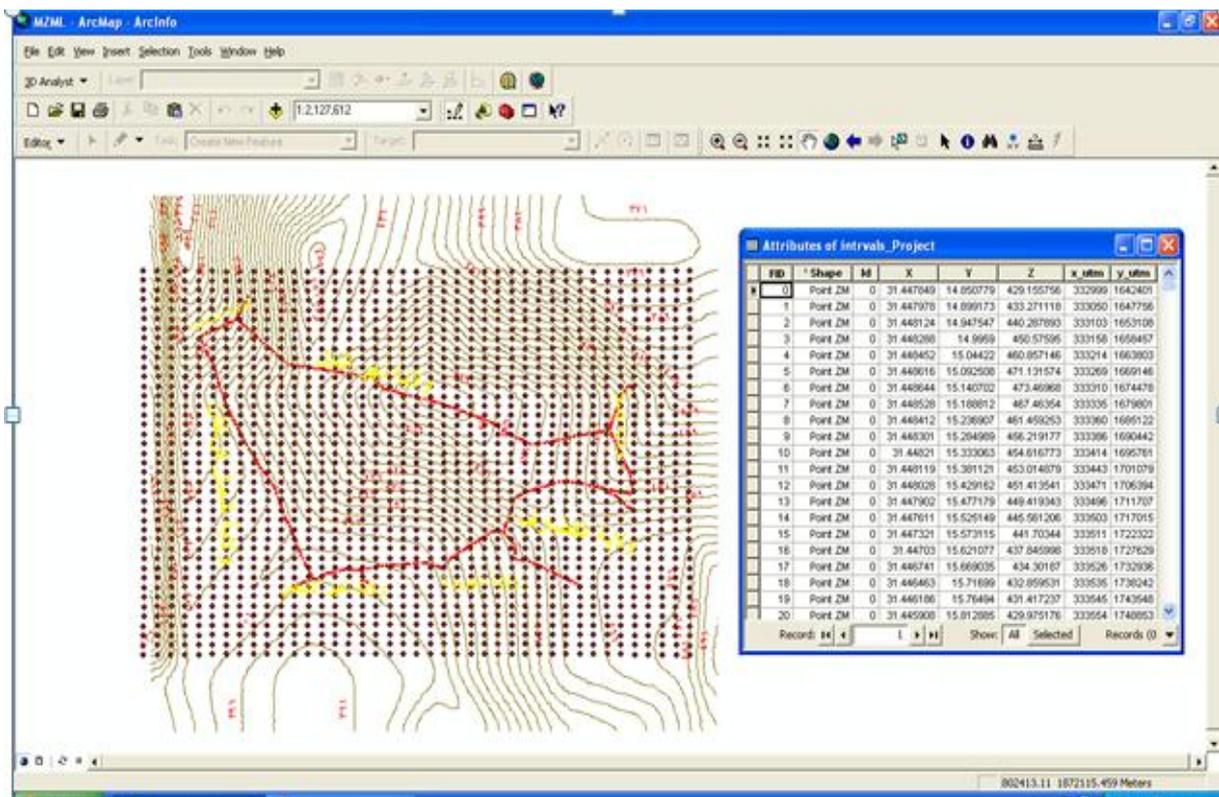


Figure 2: Shows the contour interval layer coordinates and metadata.

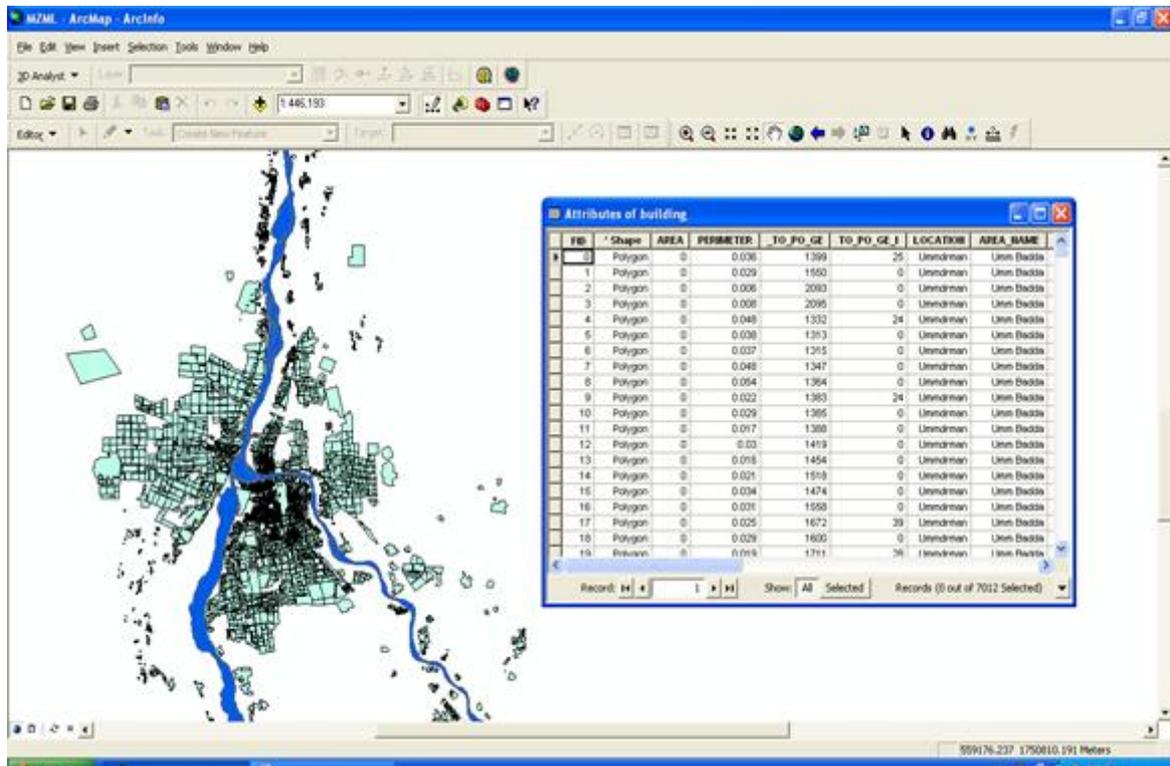


Figure 3: Shows the layer buildings and metadata

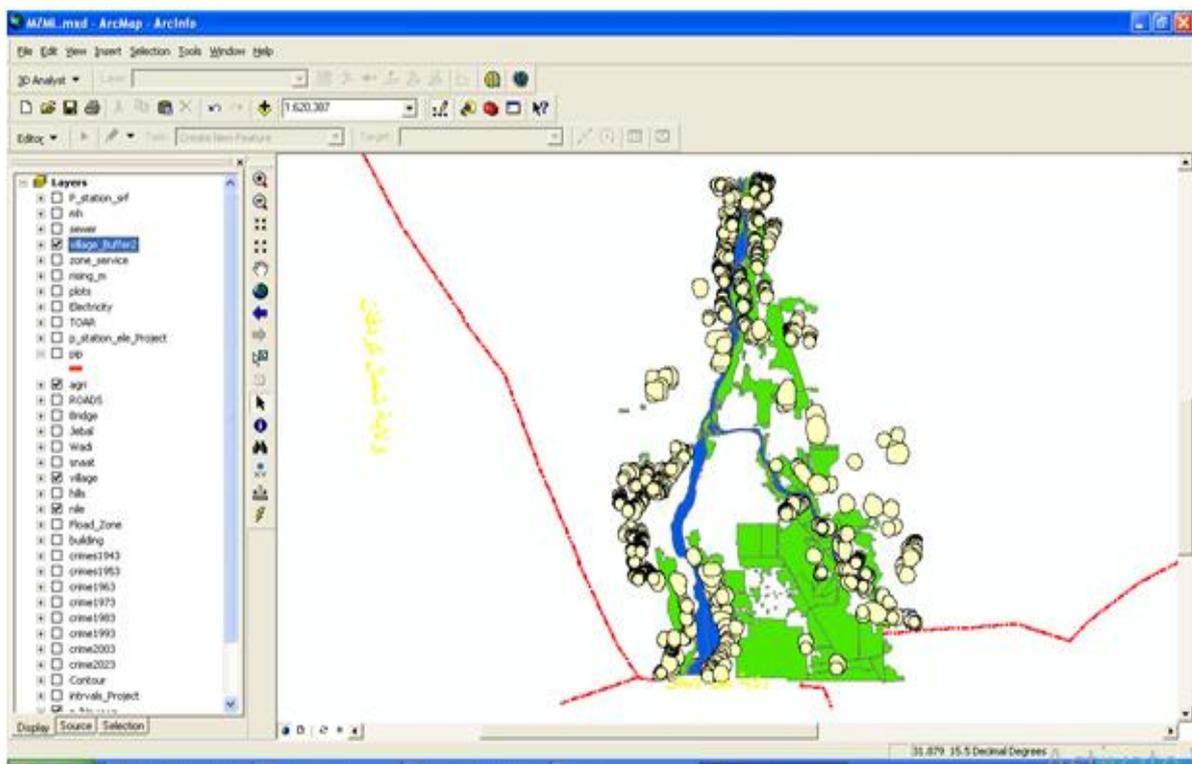


Figure 4 : Shows the predominance of residential buildings on the agricultural land in the State

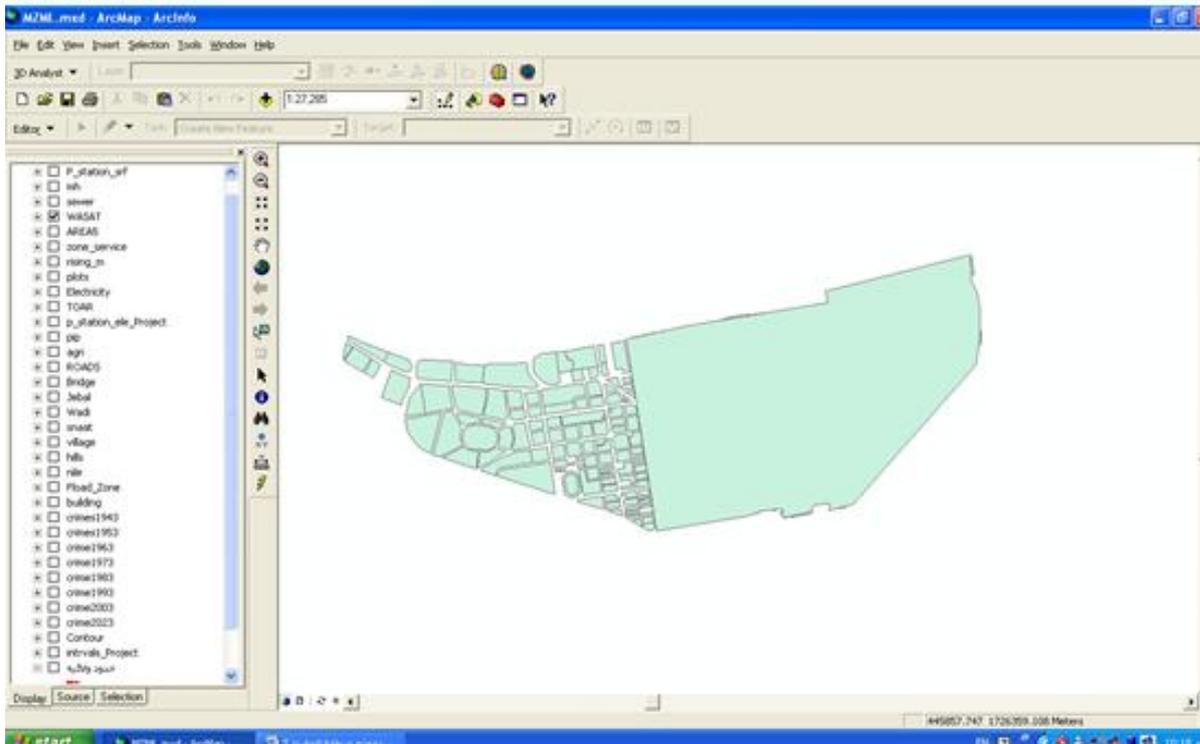


Figure 5: Shows the disconnection of the central Khartoum from demonstrates layer buildings

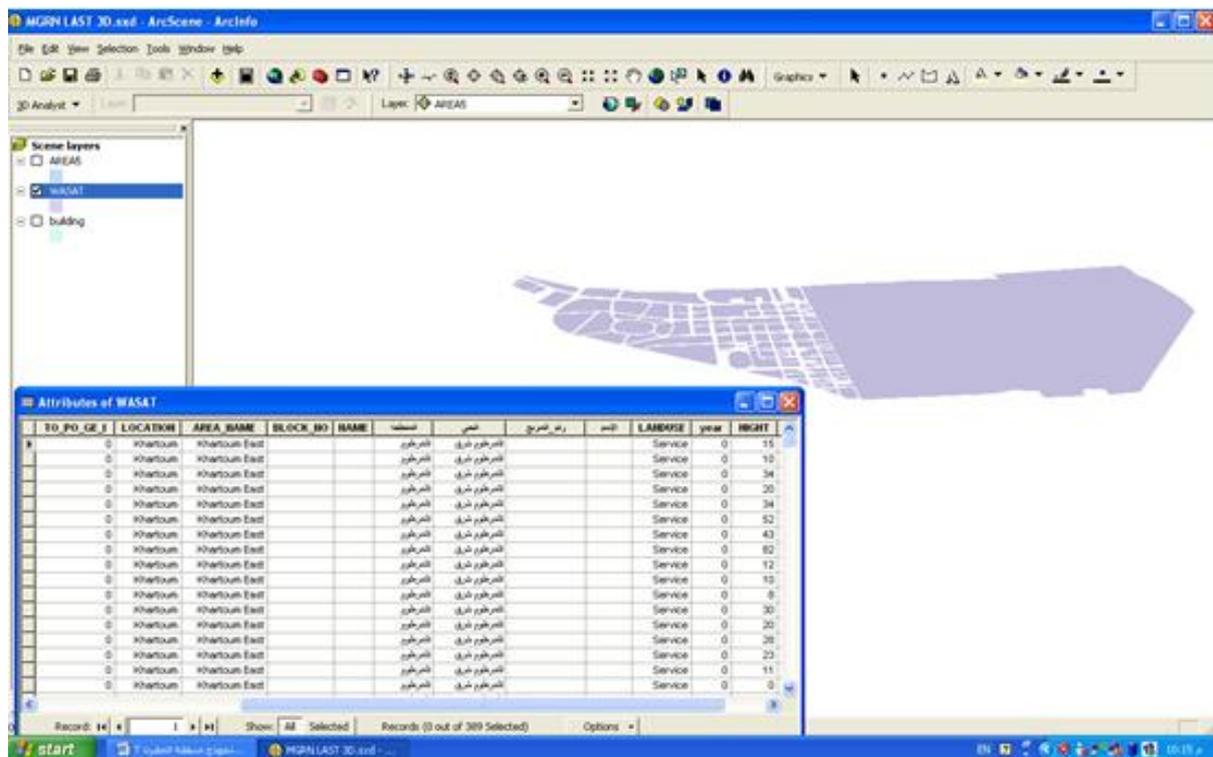


Figure 6: Shows the Khartoum Central area and its database in Arc scene including the total area

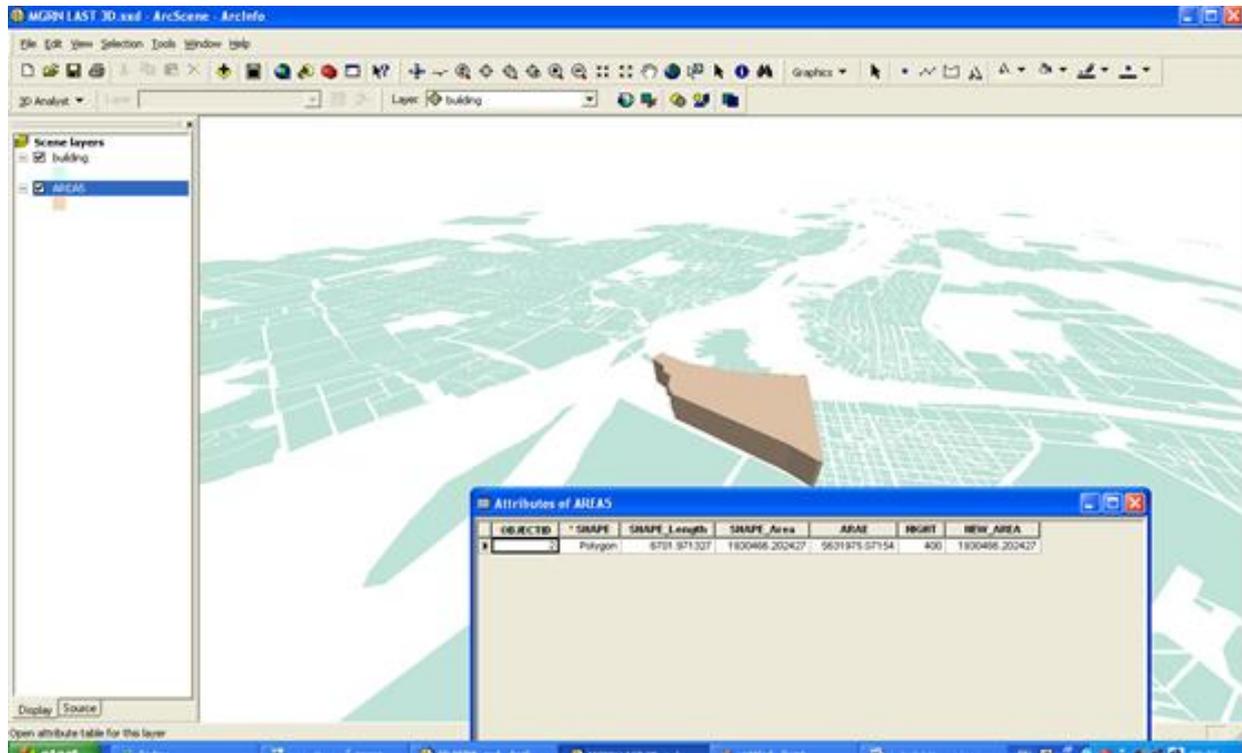


Figure 7: Shows the vertical sample demonstrating the total area of central Khartoum from database

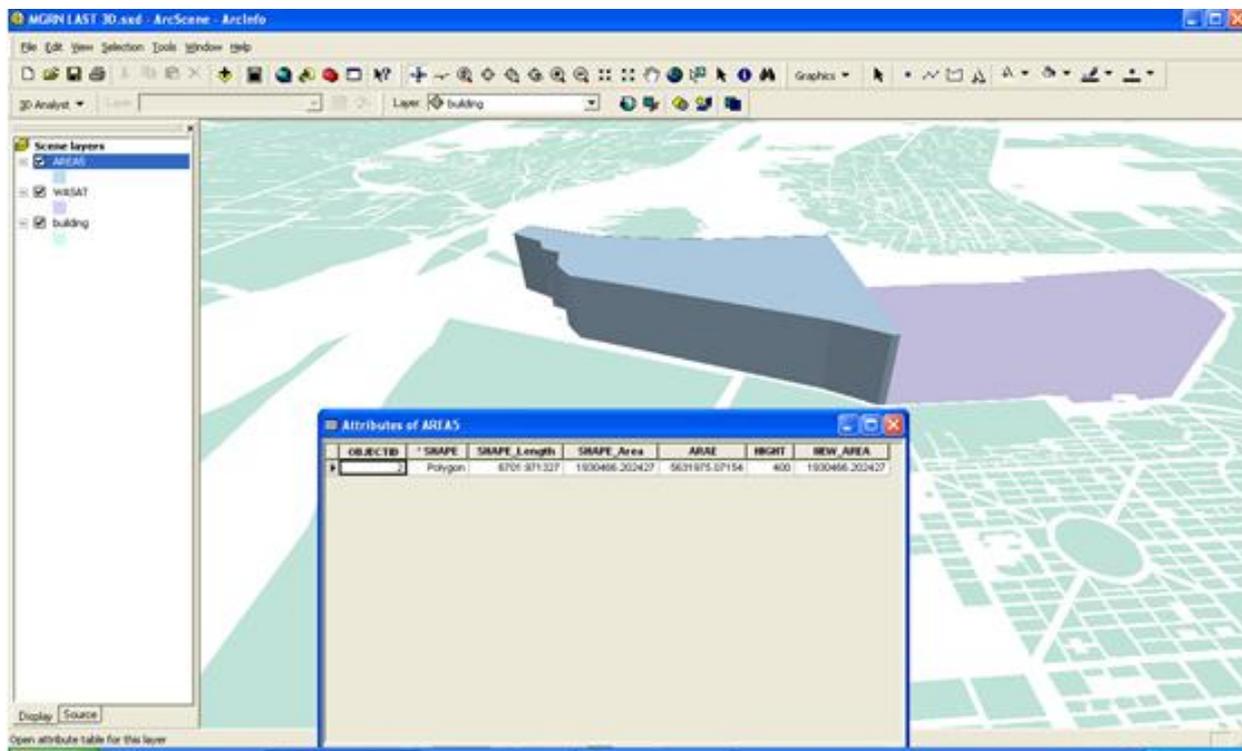


Figure 8: Shows the amount of space gained

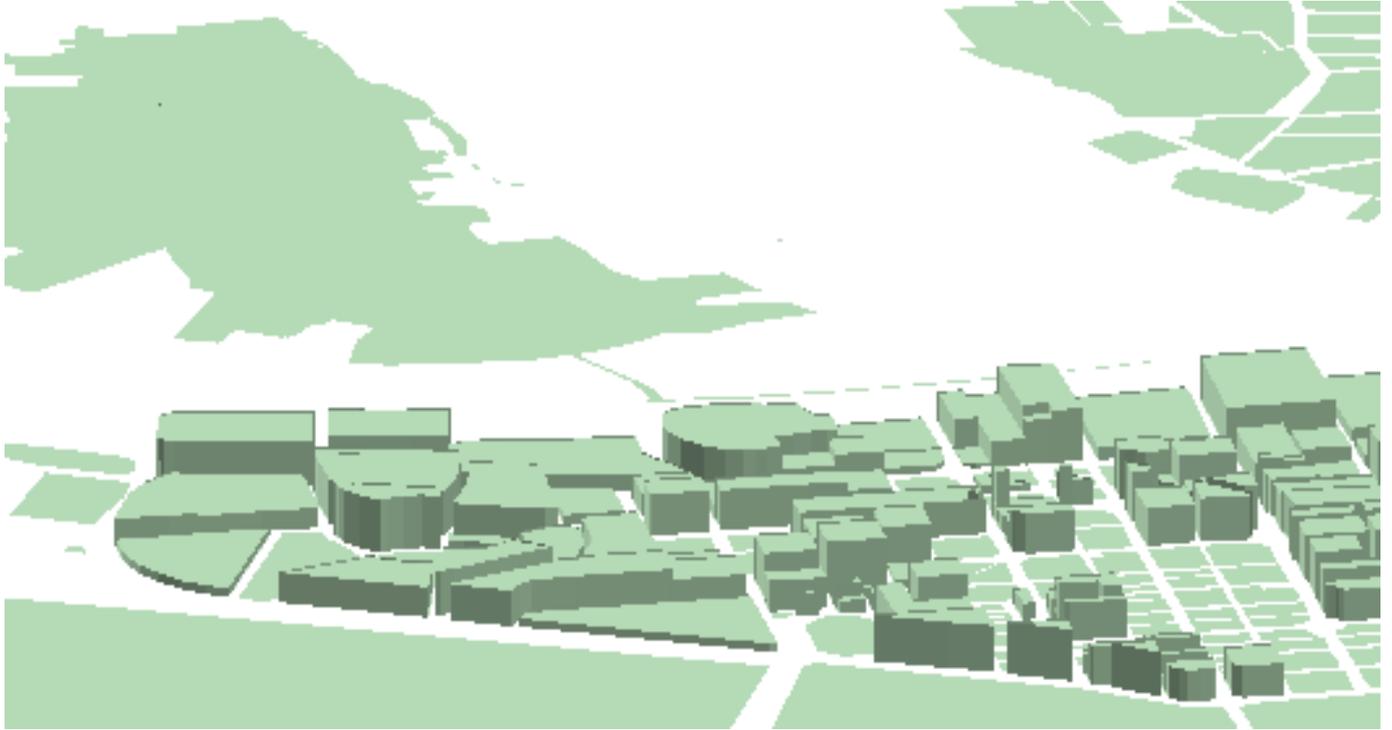


Figure 9 : shows The Detailed vertical outline to Khartoum downtown

#### AUTHOR(S) PROFILE



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