CHAPTER FIVE

RESULTS

5.1 Urgent Solutions

The study area needs to be re-planning, new roads are opened, large expansions are being made on existing roads, a large number of bridges, a network of tunnels , tram and metro are being built. This will take a long time, in addition to that the current economic situation may not allow for significant changes in infrastructure. But there are some urgent solutions that can be taken to reduce the problem of the traffic congestion in less time and lower cost.

5.1.1 Expansion and Extension of some roads:

- Expansion of Al- TABIA Street 30 meters in the southern part, because there are no important buildings in this area as shown on the map see the Figure(5.1).

Figure(5.1) shows building affected by expansion of Al- TABIA street.

- Extend the street south of the Jackson bus station and connect it to Al-Gaba street, by adding a short road as shown below, to use by buses coming to Jackson Station or departing to Omdurman see Figure(5.1).

Figure(5.2) shows extending the street south Jackson bus station

This will help ease the pressure on Al- TABIA street and at the intersection of Al-Gaba St. With the railway making this entrance to only one direction to the south, cars coming from the south pass through the road to the east of the instrument used the additional road to enter Al-Gaba Street

- The Entrances and Exits: Adding a new crossing connecting Abdel Moneim to the study area by Street and Abd El Fadil El Maz Street by opening a corridor across the railway area, especially there are no important buildings in this area.

Figure(5.3.a) shows Abdel Moneim street.

Figure(5.3.b) shows adding new exit study area

5.1.2 Construction and modification of bridges and tunnels:

- Construction of a bridge or tunnel at the intersection of AL- BALADIYA Street with Al-TABIA (Imam Al-Mahdi Al-Sharqi)

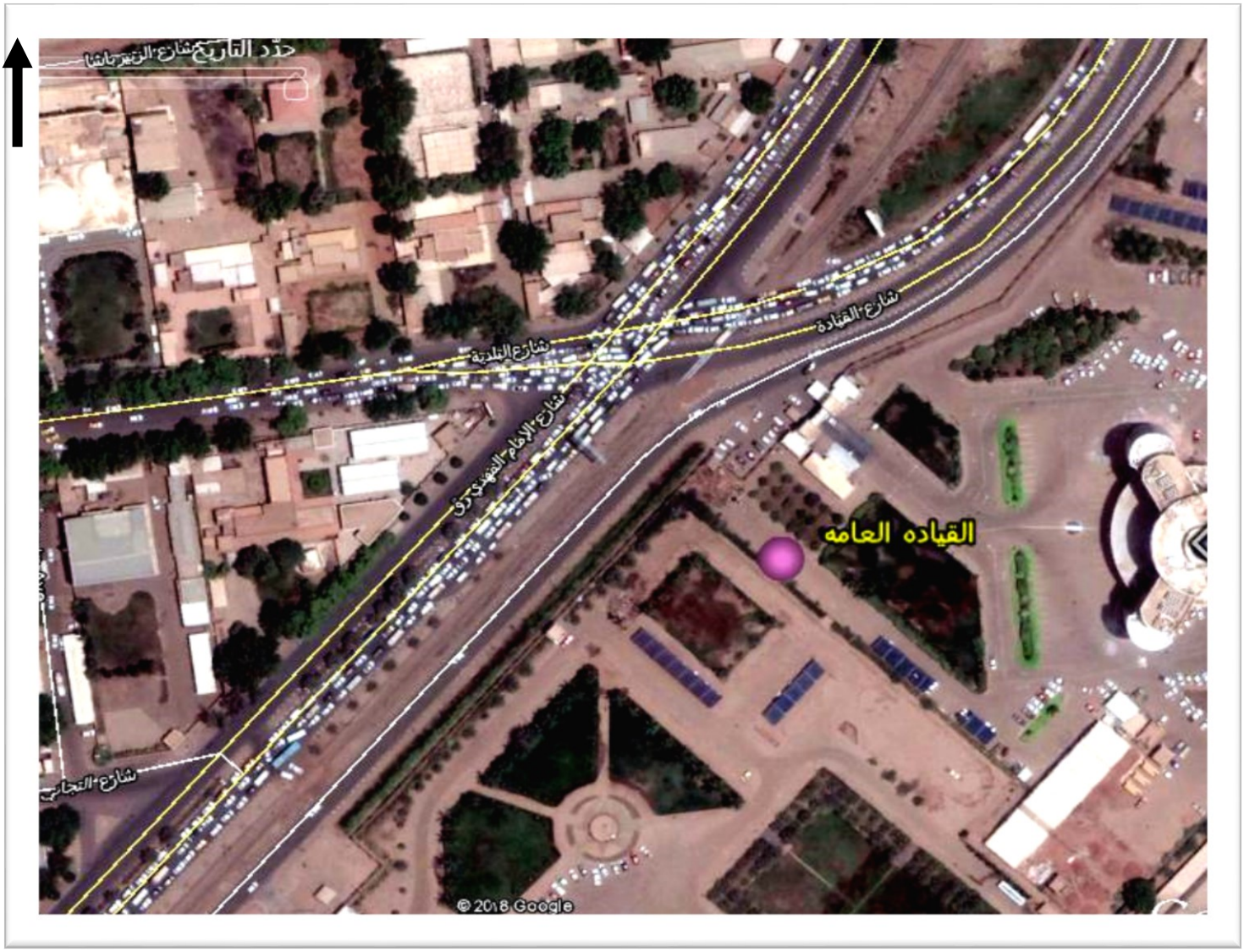
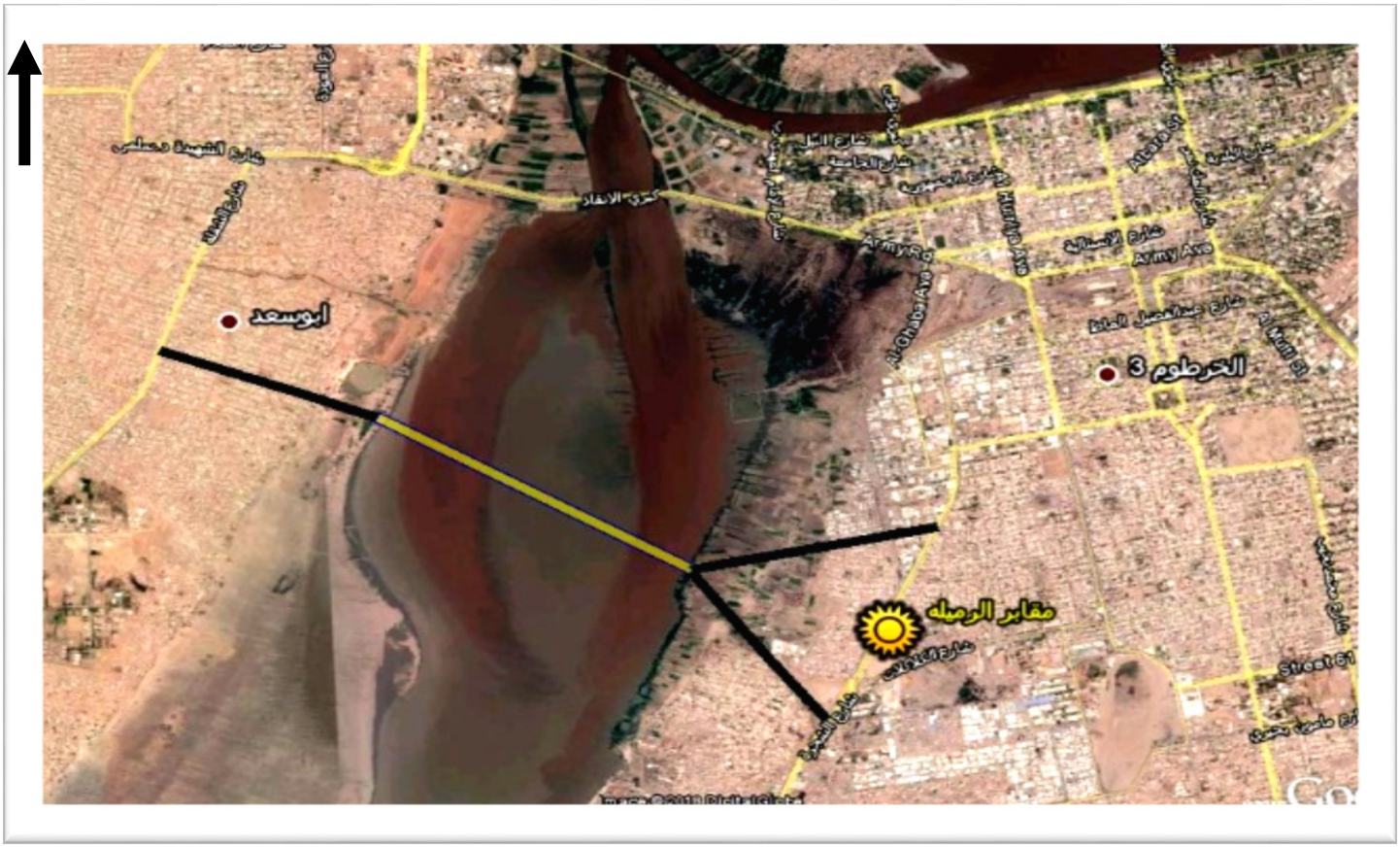


Figure (5.4) shows the intersection of AL- BALADIYA Street with Al- TABIA st.

- Construction of a bridge or tunnel at the intersection of Al-mak Nimer with AL- GAMA'A st.

Figure(5.5) show the intersection of Al-mak Nimer with AL- GAMA'A Street.

- Construction of a new bridge on the White Nile, west Al-Reimaila tombs to connect the area with the area of Al-futaihab, to reduce congestun on the bridge ofAl-ngaz.



Figure(5.6) show suggested bridge on the White Nile, west Al-Reimaila

- Modification of the uses of the Khartoum north Bridge. Through one of the following options:
  - To stop the movement of trains between the cities of Khartoum and the khartoum north city temporarily until the construction of new bridge.
  - Engineering treatment in the eastern wing to allow the passage of cars and trains together to be closed at night so that the passage of trains only

5.1.3 Construction of new, bus stations and parking

- Establishment of commercial parking's in parts of the Khartoum hospital and prevent cars to stopping in the street of AL- Isbitaia completely. The income of this parking use to support the

hospital. This will reduce the congestion on the street and contribute to the acceleration of the movement in AL- QASER Street.

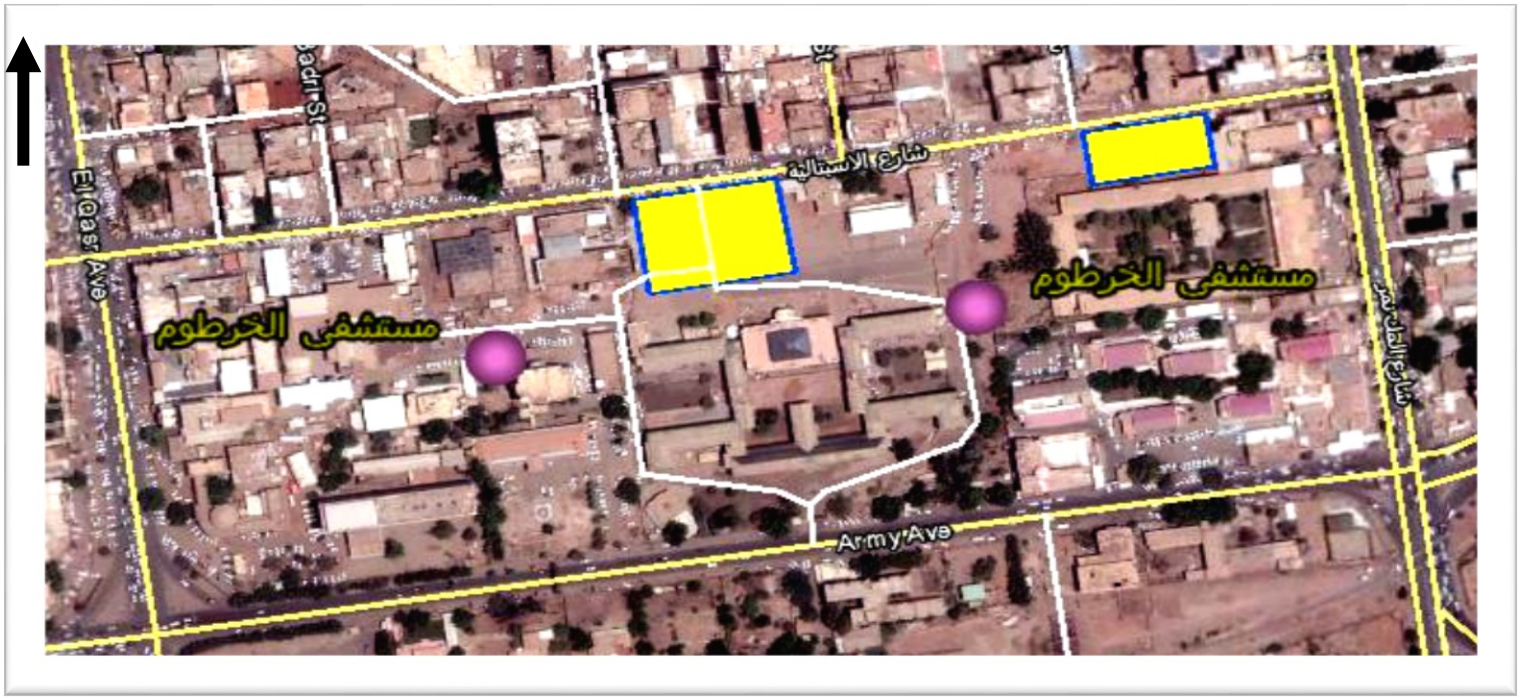


Figure (5.7) show suggested parking in khartoum hospital

➢ Establishment of a commercial car park in Mohira Bit Abboud street, due to the parking of many cars on both sides of this road and neighboring roads, by exploiting part of the adjacent garden while keeping the green face as it is, or rent the parcel appears on the image for new parking.

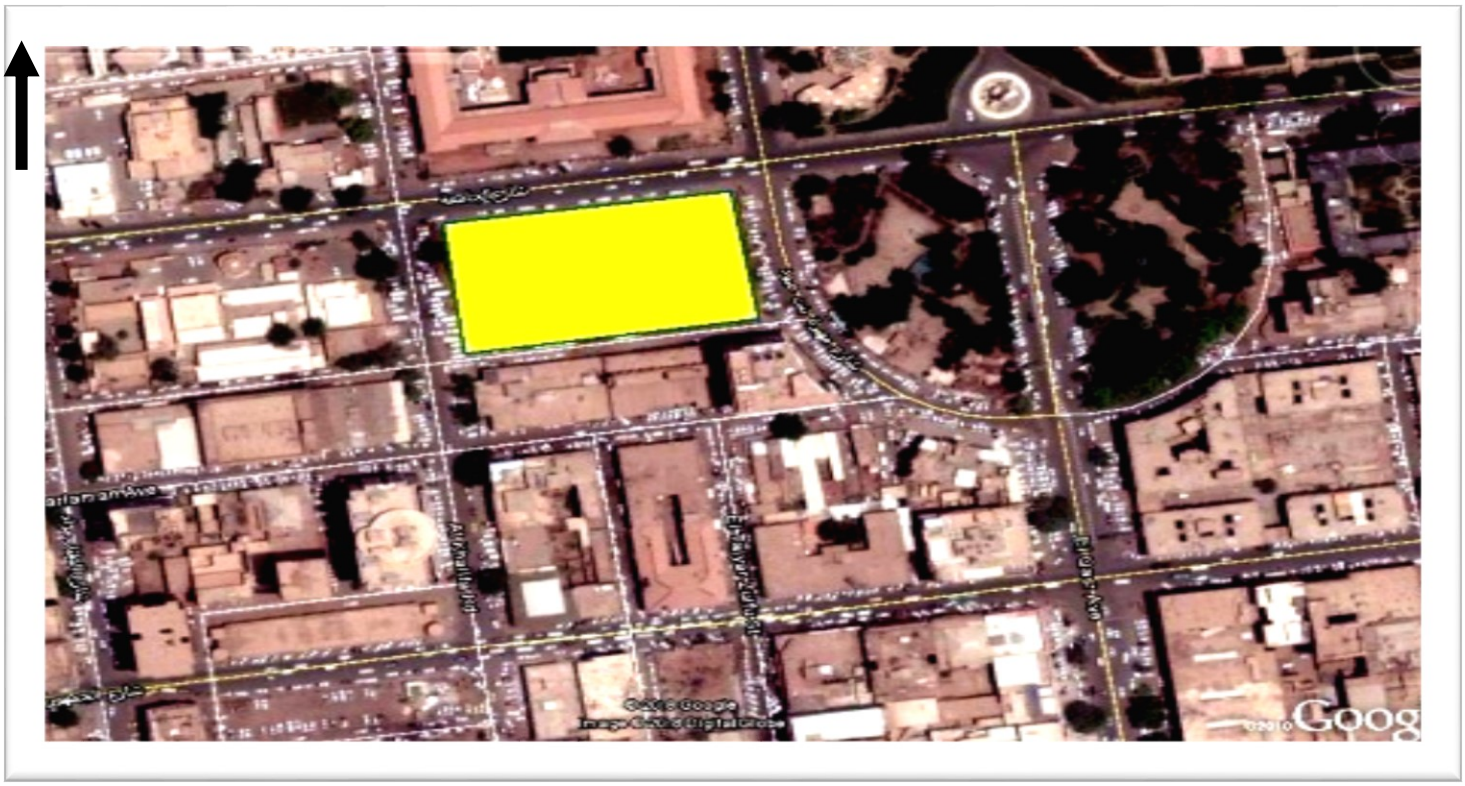


Figure (5.8.a) shows suggested parking beside Mohira Bit Abboud

Figure(5.8.b) shows suggested parking beside Mohira Bit Abboud

- Construction of a commercial parking, by exploiting of the south-west part of the Al-Waha Mall, due to the congestion of this area.

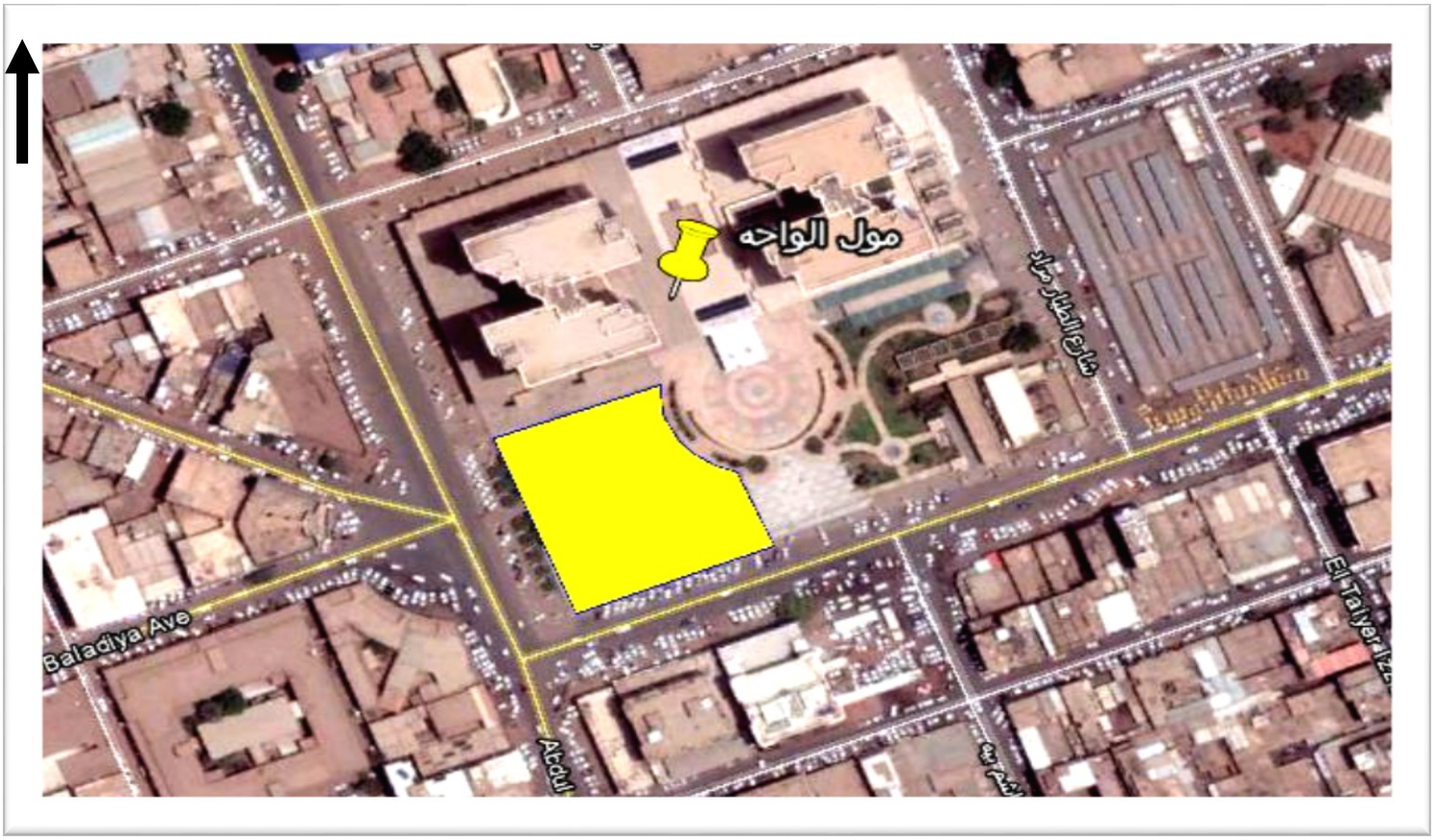
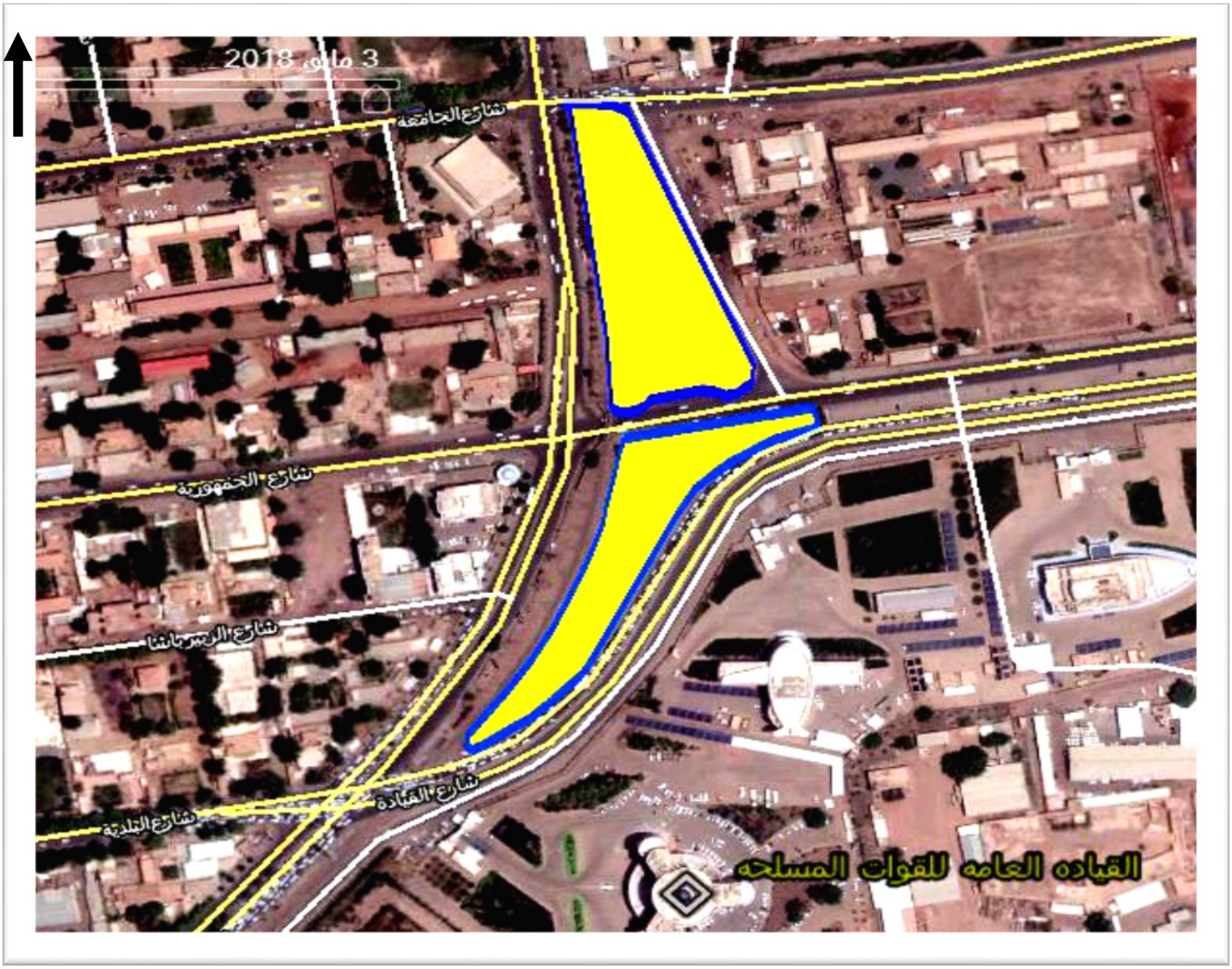


Figure (5.9) shows suggested parking in the south-west part of the Al-Waha Mall

- Turn some of the bus stations coming from north of khartoum North city to the location between Al-Qayada and railway, in the east of the study area to relieve the congestion on Al-Gomhouria st., AL- Gamaa st. and Al- TABIA streets, as well as reducing congestion around the Khartoum Stadium area.
- Use of large buses to connect the proposed station to the sharwani and Jackson bus stations



Figure(5.10) shows suggested parking for north of Bahri buses

5.1.4 Modification of buildings:

- Remove the southern part of the building that places North Jackson bus Station to expand the intersection of Al-horia st. and Al- Tabia st.

Figure (5.11) shows the boundary modification

- Owners of new buildings must be forced to create parking spaces in the basement

5.1.5 Use river buses: Construction of the line, near the AL-dpaseen Bridge until its completion, or the construction of an alternative bridge, to link south Khartoum, with South Omdurman. This line will reduce the congestion indirectly by reducing the number of buses heading to the study area

5.1.6 Reduce the impact of the rainy season: There are many roads that are flooded by in autumn season and contain pools of water, which hinders traffic, so it must:

- Sewage treatment to avoid water accumulation on roads
- Elevation the level of asphalt in low-level roads.

- Cleaning the roads from the soils, some of the main roads lose about half the width of asphalt in some parts because of the soil.

5.1.7 Taking fees in certain roads:

Charges are levied on any parked car on Parliament Street, Al-Gomhouria Street, Ali Abdul Latif, Al-Huraiya area, and the northern part of AL- QASER Street, especially in the parts close to the Presidential Palace.

Figure (5.11) show Ali Abdul Latif and Al-Huraiya streets

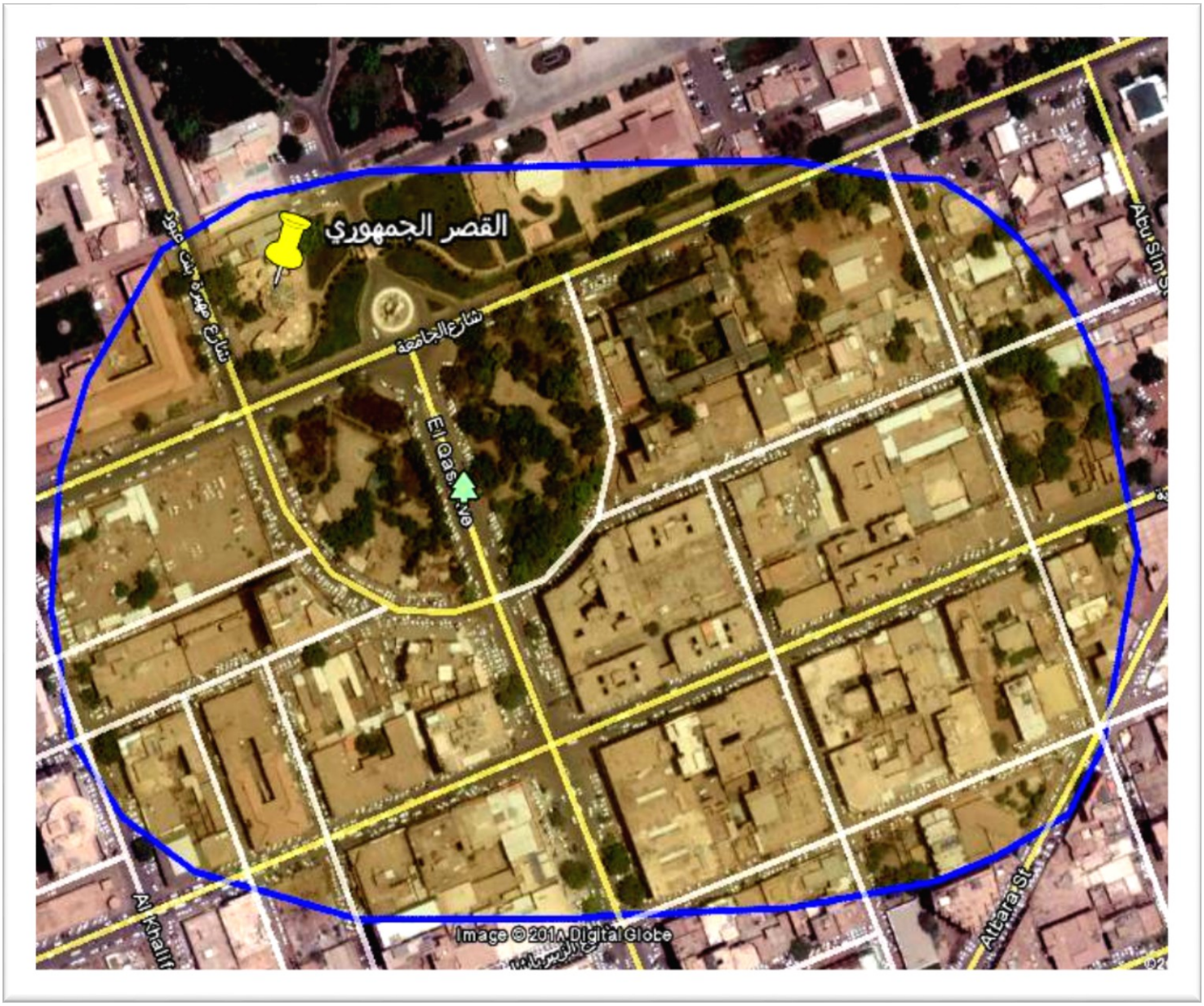


Figure (5.12) shows the northern part of AL- Qaser street

5.1.8 Synchronization and priority, for traffic signal time

Give time priority to all roads going from east to west and vice versa, except for the Al-mak Nimer Streets and Al-Huria Streets.

- Synchronization: Often we pass the traffic signal and when we get to the next signal we find that the following mark is red. These signals can be synchronized by knowing the lengths of the road parts between the signals and the speed of the road design, to calculate the time interval of the following signals, and this helps to avoid repeated downtime.

5.2 Addressing the Most Congested Roads:

In the analysis phase, congested roads were identified. After investigating the causes of congestion for each road separately, solutions have been developed that can be applied in the near future to eliminate these causes

5.2.1 Al- TABIA Street and its extension

The most important road, and expected to be the main solution key to the problem of traffic congestion in this area, due to its distinctive geographical location, where it is used by most cars coming or passing through the study area.

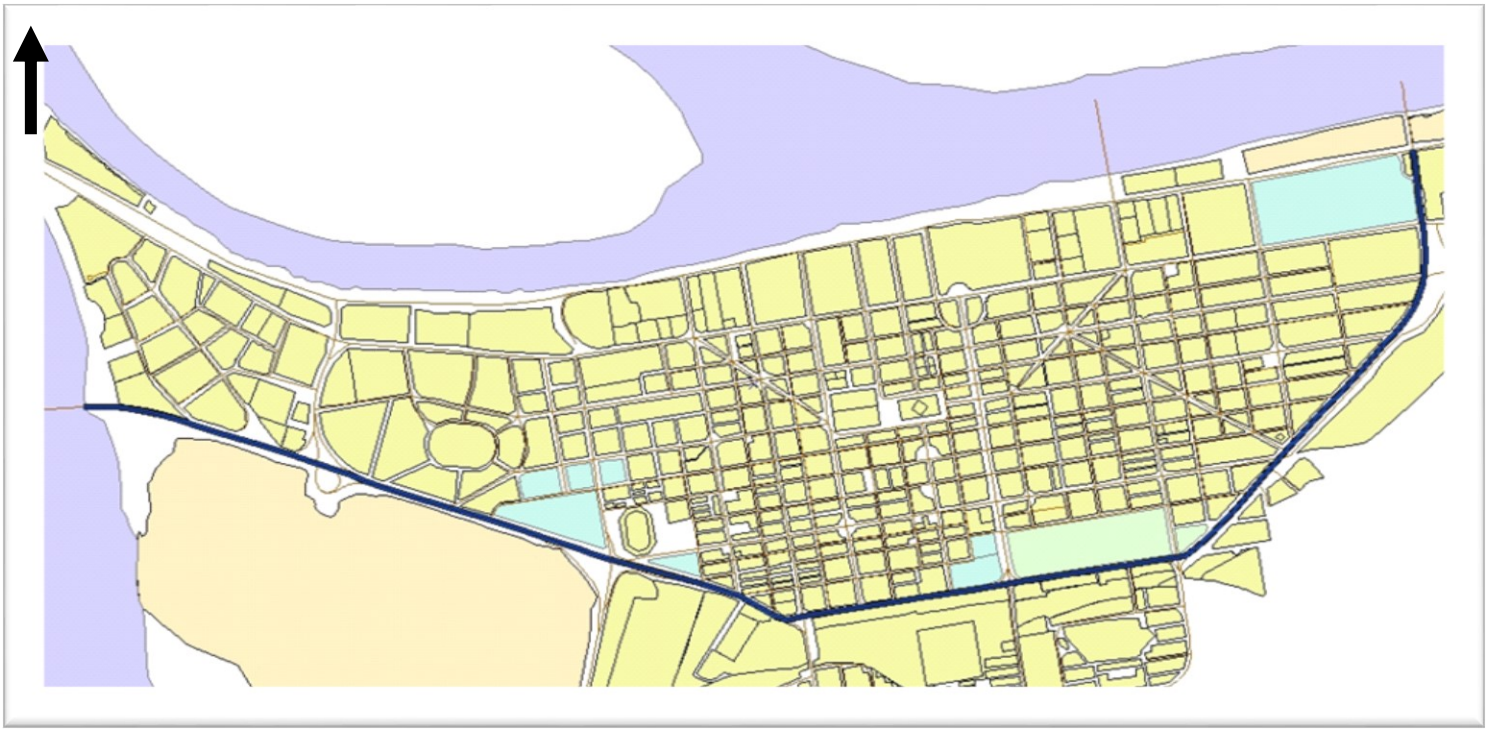


Figure (5.13): shows Al- Tabia Street and its extension

Table (5.1): shows Al- Tabia Street characteristic.

Road characteristics	Values
Road length	6800m
Average width	25 - 50 meter
Directions	two ways
The speed allowed	50 Km/h

The most congested part is the intersection of this road with Al-mak Nimer

- **Causes of congestion in Al- TABIA st**
  - **Narrow of road**: This road is narrow compared to the large number of cars used by, especially in the part that lies between its intersection, with Al-mak Nimer and and AL-huria streets
  - **Nearby buildings**: Next to this road number of institutions such as Khartoum Hospital , faculty of medicine main bus station Jackson
  - **Geographical location**: Cars coming from the southern and eastern areas that target or cross the study area must cross this road.
  - **Bus Lines**: This road is used by a number of bus routes, AL-haj Yousif , Al-sahafa east,Al-soug Al-shaabi and khartoum a brading port Al-bary towards Jackson bus stations and Khartoum Stadium.

Suggested solutions:

This road can be the key to solve the problem of traffic congestion in the study area that as follows:

i. Extends road width at least 30 meters from the southern end, discount from the railway campus, General Command of the Armed Forces and the Karker bus station.

ii. Increase the design speed to at least 80 km.

iii. Make the road from the red roads where stopping is completely prohibited

iv. Tunnels Construction:

- Construction of one-way tunnels for the pass the cars coming from Berri through AL-GAMA'A and Al-Gomhouria Street
- Building three tunnels (two-way) for cars coming from Al-mak Nimer st.,AL- qaser st and AL- huria st

5.2.2 AL- Gama'a Street

It is one of the most important roads in study area. It is one of the main accesses the area, where used by many private cars and public transport buses, coming from Bahri and Buri area

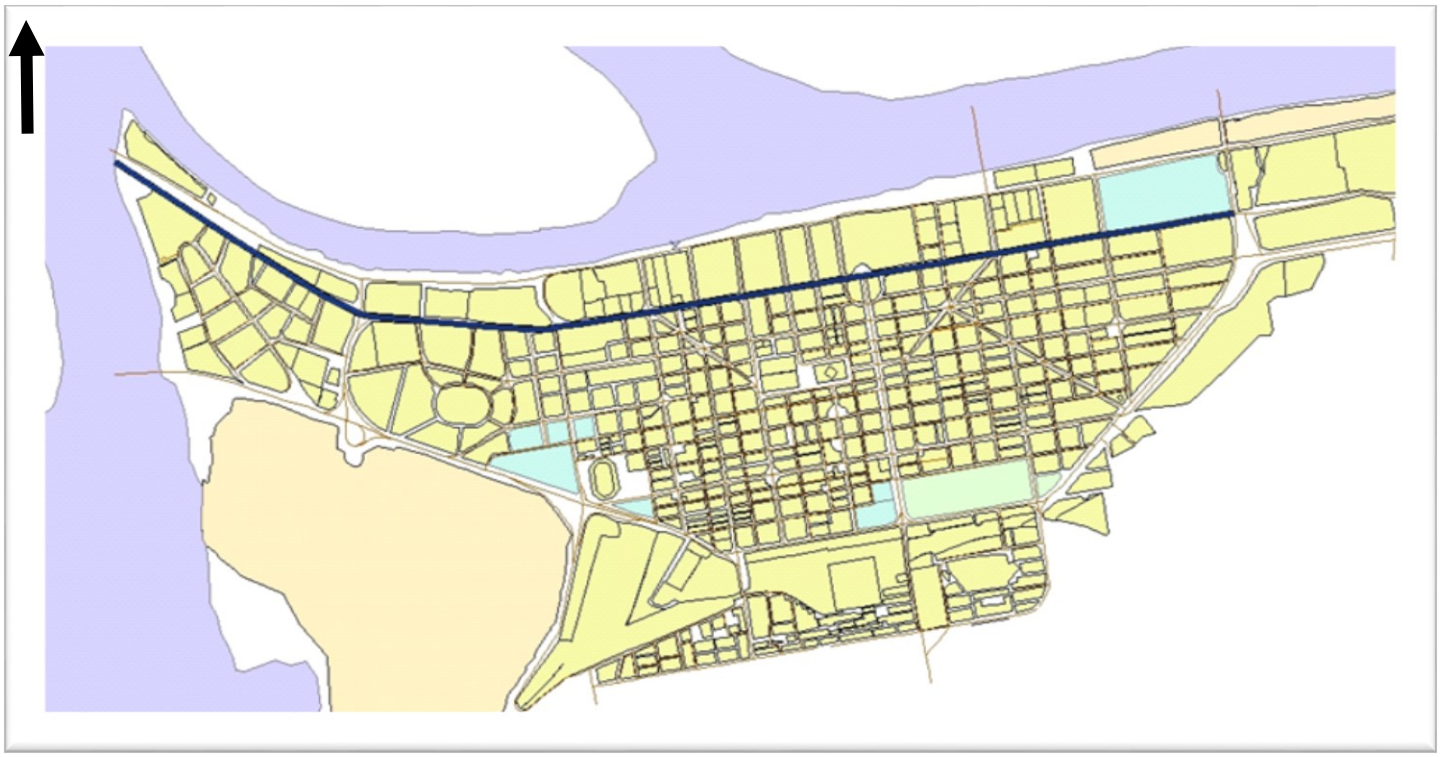


Figure (5.14): shows AL- GAMA'A Street

Table (5.2) Table (5.1): shows Al_GAmmaa Street characteristic.

Road characteristics	Values
Road length	5500 m
Average width	25-30 meter
Directions	One way
The speed allowed	50 Km/h

The most congested part is the intersection of this road with Al-mak Nimer

- **Causes of congestion in AL- GAMA'A street:**
  - **Number of passing cars**: The large number of cars coming from the city of the Khartoum North and east of Khartoum, about 1389 cars pass through this road in the morning until the eighth o'clock
  - **Institutions**: This road is the face of many ministries and government institutions, including the Ministry of Justice - Ministry of Social Affairs - Presidential Palace - General Directorate of Traffic - University of Khartoum. With reference to the most influential institutions in traffic, we find that these institutions are one of the causes of congestion.
  - **Random Parking:** There are a large number of cars that stop on both sides of this road, causing other cars to be obstructed
  - **Bus lines:** where the buses move slowly and stop constantly and throughout the day, also there are no specific stops.

Suggested solutions:

i. To obligate the neighboring institutions of this road to establish internal parking,for customers and workers.
ii. Oblige some of these institutions to change the direction of their gates to roads running from north-south, if possible.
iii. Establishment of temporary bus stops in the road. By increasing the part of the edge of the roads asphalt, every 500 meters
iv. Build a cheap commercial car station to encourage those coming to the area to use. Because there is no open space next to this road, local authorities can buy or rent parcels for this purpose.
v. Change the time of traffic lights to give priority to this street, and add delay time for longitudinal roads.

5.2.3 AL- SAYED ABD AL- RAHMAN Street

It is also one of the most important roads in the study area; it is witnessing a lot of congestion especially in the western part. It passes through a complex of health centers, hotels, hospitals and banks. In addition, it leads to the Khartoum Stadium, the main bus station and shops.

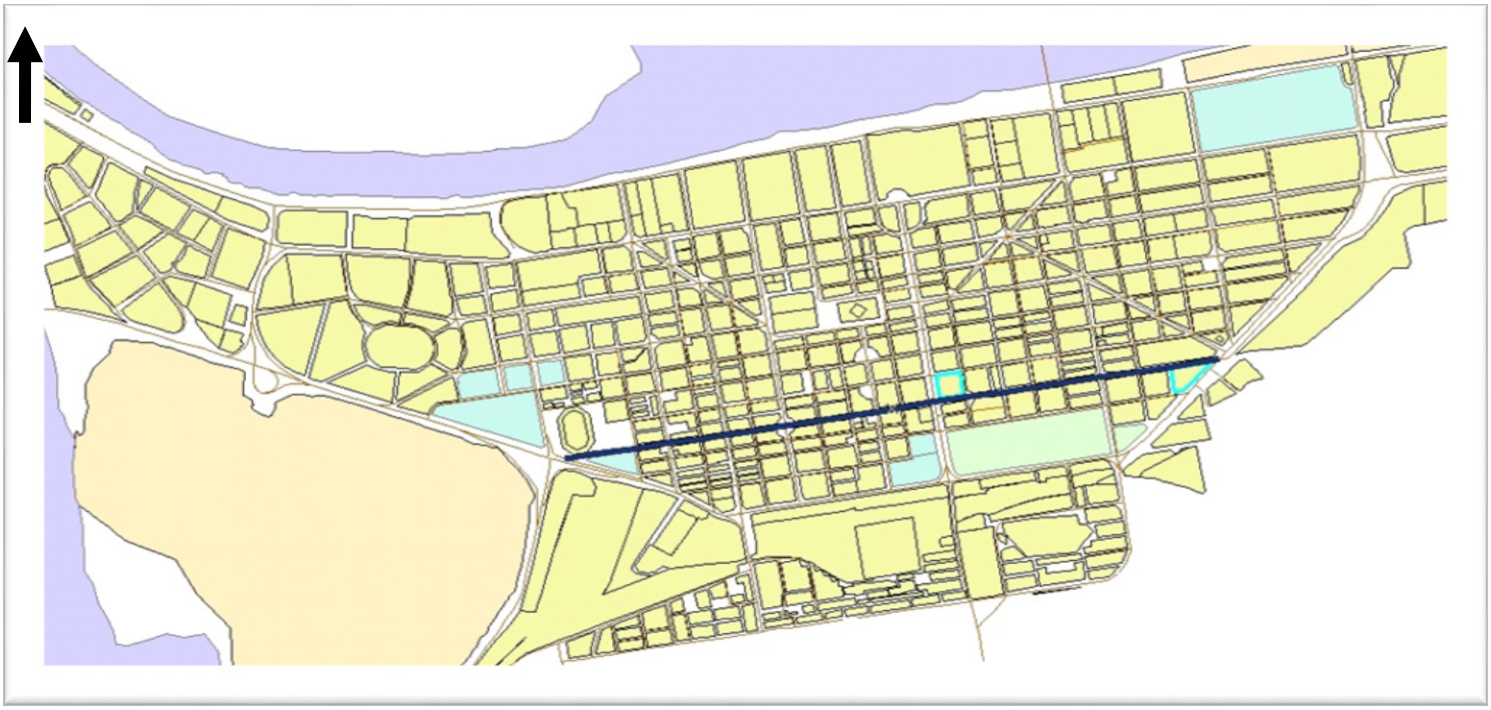


Figure (5.15):show AL- Sayed Abd AL- Rahman street.

Table (5.1): shows AL- Sayed Abd AL- Rahman street characteristic.

Roads characteristics	**Values**
Road length	2600 m
Average width	20 – 25 meter
Directions	One way
The speed allowed	50 Km/h

The most congested part is the intersection of this road with Al-mak imer st ,and AL- HURIA st

➢ **Causes of congestion in AL- Sayed Abd AL- Rahman street .**

- **Bus lines**: The biggest problem facing this road is the majority of bus coming

  From the east of the study area, which comes from Bahri city, uses this road to the main bus station in Khartoum.

- **Commercial and service centers**: This road is crowded with commercial and service sites that attract many citizens in their cars, in addition to pedestrians who pass this road constantly, the western part of road passes through the market, which is filled with random parking of cars beside the roads, bus stations, sellers, residues of commercial shops (Cardboard boxes and plastic bags)

Suggested solutions:

i. This road is difficult to increase its width due to the presence of many important buildings but can reduce the congestion using 21 October Street after its expansion and the transfer of some bus lines to it.

Figure (5.16): shows 21 October Street.

ii- Compelling the following institutions to build internal parking or rent a piece of land to be used as a parking lot and some of them need to change the direction of the gates such as:

ii. Omdurman National Bank, Investment Bank, Islamic North Bank, Bank of Workers, Arak Group, Badr Hotel and Rosa, Al- Bahrain Hotel

iii. Build of commercial car station to encourage those coming to the area to use. Because there is no open space next to this road, local authorities can buy or rent parcels for this purpose.

iv. Give places to vendors hikers, not just to drive them out, so they do not come back to put their goods on the road

5.2.4 AL- QASER Street:

This road passing in the center of the study area, and passes through the AL-soug Al-afranji market, commercial, centers in addition to health centers and services, such as Khartoum Hospital, Stack laboratories, and Faculty of medicine

Figure(5.17) Map shows AL- QASER Street

Table (5.3): shows ALqaser street characteristics.

Road characteristics	Values
Road length	1200 m
Average width	40 – 50 meter
Directions	Two ways
The speed allowed	50 Km/h

The most congested part is the intersection of this road with Al- TABIA st, AL GAMHURIYA st and AL- GAMA'A st.

- **Causes of congestion in AL- Qaser street:**
  - This road adjacent to each of the Khartoum Hospital, Faculty of Medicine and Al-sog Al-aranji where dozens of people cross this road to these sites, causing congestion.
  - The Random parking: There are a large number of cars that stop randomly on either side of this road. Although its width has helped to accommodate a large number of these vehicles, however, informal parking continues to be a nuisance to traffic on this road.

Suggested solutions:

Since the Palace Road is relatively wide and short and does not have bus lines, it needs to:

i. Organizing and planning random parking lots and setting the traffic signal to prevent standing near its intersection with other roads.
ii. the following institutions to build internal parking or rent a piece of land to be used as a parking lot and some of them need to change the direction of the gate.
iii. Setting traffic signs for pedestrians, in part of the road, pass through Afrangi market, and near Khartoum hospital.
iv. Rounding corners, at intersections of this road with other roads.

5.2.5 Al-Baladia Street:

It is one of the most important and longest roads in the region. The Al-Baladia street passes through the center of the study area and divides it horizontally. These roads suffer a traffic congestion frequently, especially the eastern part of it. It's closed by the buildings of the Grand Mosque and the Al-Waha Tower. Next to this road are many buildings that make the cost of expansion expensive.

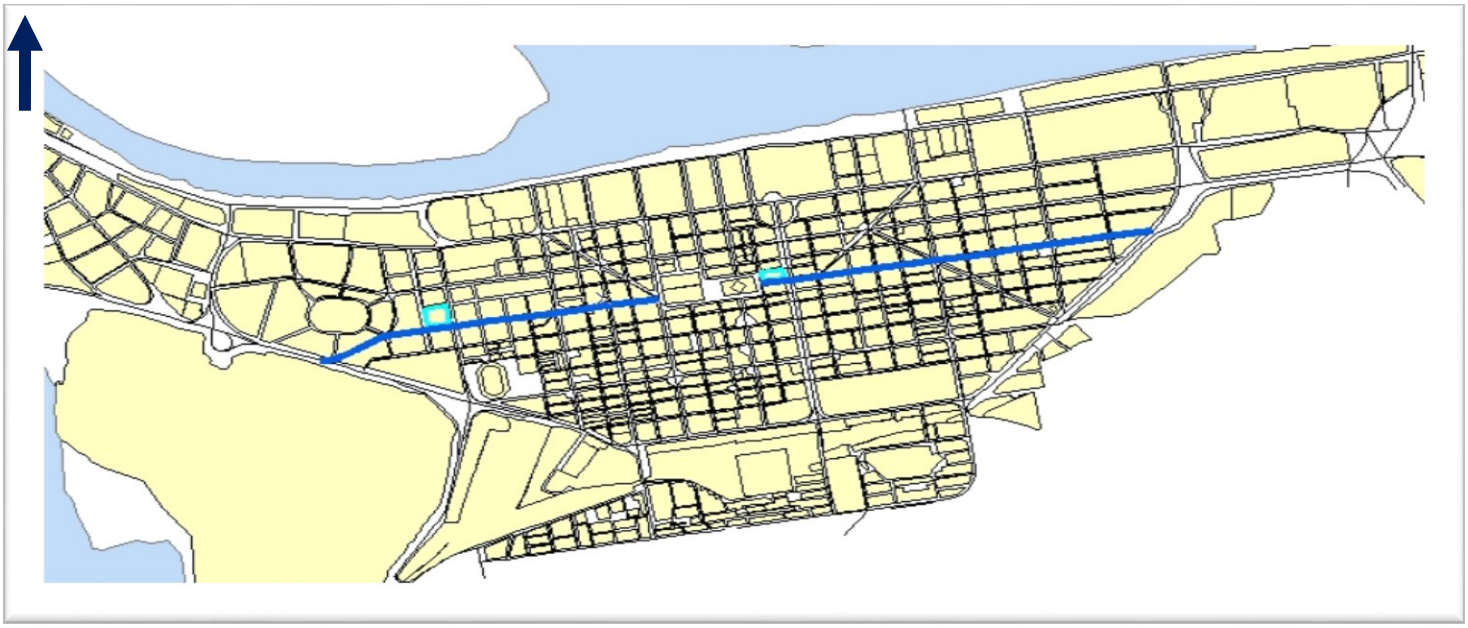


Figure (5.18) shows Al-Baladia Street

Table (5.4): shows Al-Baladia street.

Road characteristics	Values
Road length	3300m
Average width	20-30 m
Directions	Two ways
The speed allowed	50 Km/h

The most congested part is the intersection of this road with Al- TABIA street (Imam Al-Mahdi Al-Sharqi), Atbara,AL- QASER , Al-huria Street

- **Causes of congestion in AL-Baladia street:**

Number of passing cars: The large number of cars coming from east of Khartoum city

- **Commercial and service centers**: This road is crowded with commercial and service center that attract many citizens in their cars,
- **Random Parking:** There are a large number of cars that stop on both sides of this road, causing other cars to be obstructed.
- **Bus lines:** where the buses move slowly and stop constantly and throughout the day, also there are no specific stops .

Suggested solutions:

i. Construction of a bridge or tunnel at the intersection of AL- BALADIYA Street and Al- TABIA (Imam Al-Mahdi Al-Sharqi).

ii. Build a cheap commercial car station to encourage those coming to the area to use. Because there is no open space next to this road, local authorities can buy or rent parcels for this purpose.

iii. This road is difficult to increase its width due to the presence of many important buildings but can reduce the pressure using 21 October Street after its expansion and the transfer of some bus lines to it.

iv. This road is difficult to increase its width due to the presence of many important buildings but can reduce the pressure transfer some of bus lines to 21 October Street after its expansion .

5.3 Future Solutions:

The study area needs to fundamentally changes the infrastructure of highways, wide roads and manage them with smart technologies. This needs to re-plan the area and build many bridges, bridges and tunnels. The region also needs a different vision to develop the public transport sector, such as buses, trams and metro, as well as river transport. It also needs traffic plans and advanced road network analysis using simulations programs. Through the study of area maps, a scenario has been developed for what will be the case in the future such as:

5.3.1 Roads and Highway

i. Construction of highways for roads passing from north to south (Al-mak Nimer, AL-QASER St, and AL- HURIA Street), after expansion and construction of a bridge in its extension (except AL- QASER st because of Republican Palace buildings) to connect them to the roads of a khartoum North city.

ii. Construction of a upper road on Al- TABIA Street to connect it with the Al-ingaz bridge. This need to construct bridge on its intersection with roads passing from north to south (Al-mak Nimer, AL- QASER St, and AL- HURIA Street)

Figure (5.19) shows suggested highway Roads

Iii-Permanently remove the railway station and take advantage of its location to build a main metro station connecting the three cities (Khartoum - Omdurman - Khartoum North) and open some roads through the region.

Figure (5.20) shows extension of roads through railway station

Transfer the headquarters of the General Command of the armed forces and Khartoum Airport to outside the city and open roads across the Area.

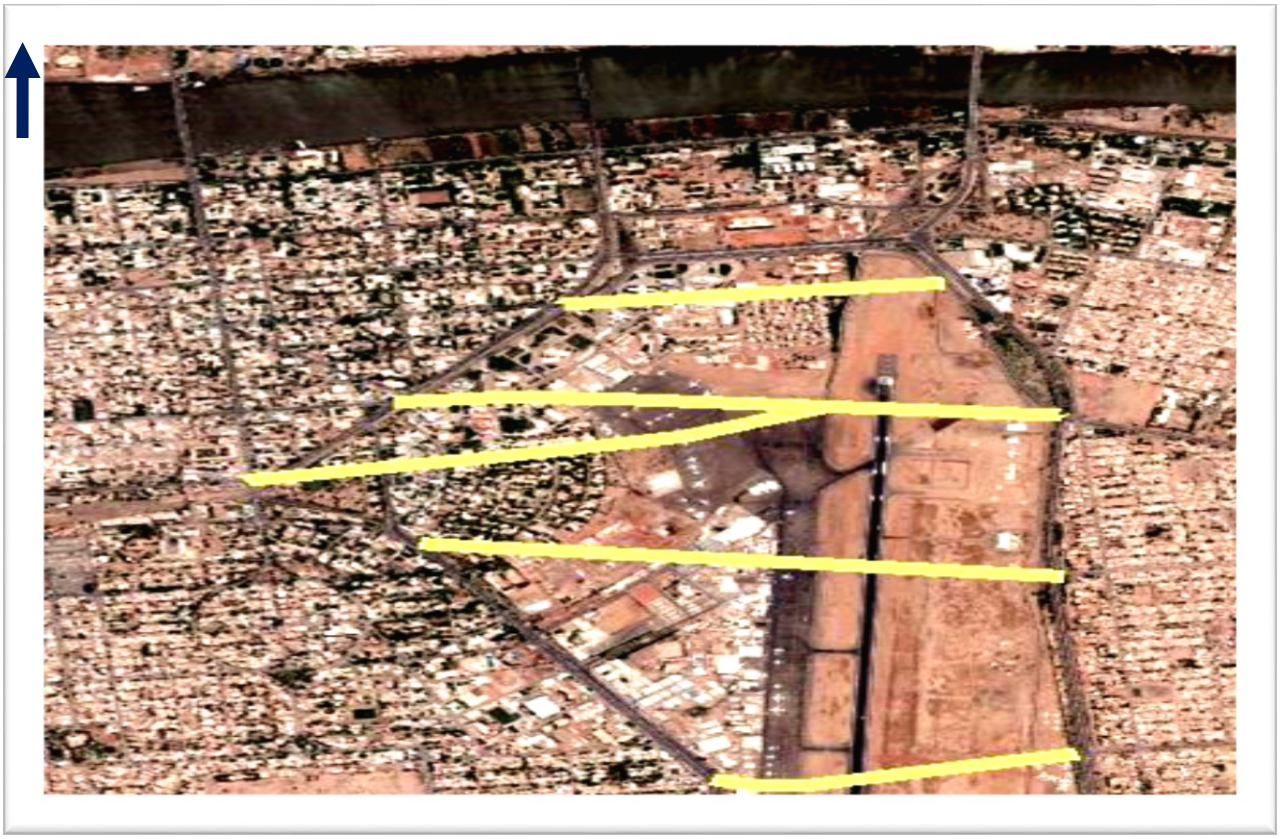


Figure (5.21) shows extension of roads through khartoum airport

5.3.2 River Transport:

Establishing a river buses lines network, to link Khartoum city, Omdurman and Bahri cities. as will as an internal lines network.

Figure (5,22) shows **river transport stations**

Figure (5, 23): shows river bus

There are also studies conducted by the Ministry of Infrastructure in the state of Khartoum to construction of river transport links to connect the three cities of capital as shown in the figure(5.21) .

The implementation of the river transport system linking the points shown on the map will help in the transfer of large numbers of citizens and thus reduce the traffic congestion, but it should taking into account the following aspects:

- Perform hydrographic studies using a comprehensive monitoring method rather than a point to point. To know the topography of the seabed without any confusion, and then the boats path selection to avoid accidents.
- Pave roads leading to these ports, as well as cheap buses to the port.
- Provide teams for rapid intervention of rescue operations when accidents occur.
- Provide awareness programs to assist citizens in cases of emergency.
- Provide programs to inform citizens of the advantages of this type of transport and reassuring them because most of the citizens are afraid to ride the sea.

5.3.3 Tram and Metro Systems:

- **Tram system:** There is a feasibility study for the tram network in Khartoum (Sudan). It agreement between the Republic of Sudan and the State of Khartoum. Ministry of Urban Planning and Schüßler-Plan co.(German) This study was prepared in between November 2007 until February 2009.

Figure (5, 24) shows tram image

The study included data collection for existing infrastructure, roads, bridges and congestion areas. Also the tramway network has been identified as described Figure(5.24).

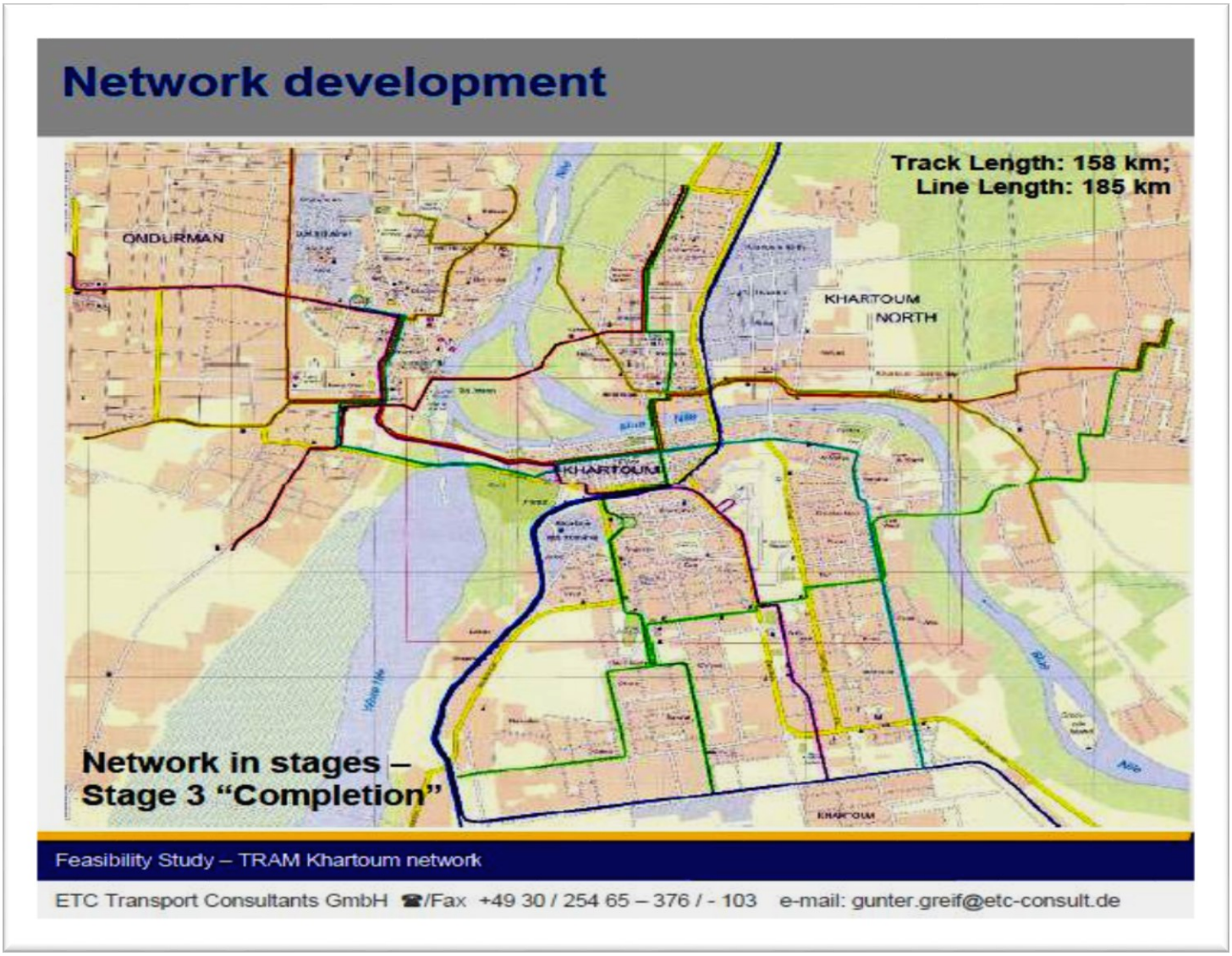


Figure (5,25) shows suggested tram network

No doubt it is a good study and will greatly contribute to reducing traffic congestion and will reflect the civilized face of the National capital. But there are some notes in the proposed tram network:

- Some tram lines pass through sites with frequent traffic congestion, such as Al- TABIA Street and Al-Maim Nimr Street.
- Some of its path goes in parallel and approaches together.

- Some long lines and this will increase the stations, the tram will be slow, which will lead to reluctance of citizens to use.
- Many paths intersect with each other
- The network is overlapping and relatively complex and its implementation requires a major change in the city map, leading to increased cost cost

- **Metro system:** The metro system is one of the urban transport systems that runs on iron bars in specific tracks with driver, and is designed to work within residential and commercial areas with high density and longer distances from the tram.The use of this system in the National Capital, which covers vast areas will help many in solving the problem of traffic jams and facilitate the mobility of citizens and their lives. I have seen the experience Metro Cairo, which link central Cairo with Helwan, Embaba, Cairo Airport, and Shobra which carries about 3.6 million people daily.

This system can be applied in Khartoum city as the capital of sudan and will certainly contribute to solving the problem of traffic congestion. This system requires extensive study of the urban planning, existing infrastructure, population density and environmental factors. It is certainly a big issue that cannot be addressed in this research.