# GEOMATICS ENGINEERING DEPARTMENT

## SECOND YEAR GEOMATICS

### GEODESY 2 (GED209)

### LECTURE NO: 7

# HISTORY OF EGYPTIAN GEODETIC NETWORKS

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# Overview Of Previous Lecture

- Gravimetric Effect
- Geodetic Observations
- Reduction of Azimuth
- Reduction of Horizontal Angles
- Reduction of Vertical Angles
- Reduction of Distances
- Example from Real-World Scenario

# Overview Of Today's Lecture

- History of Egyptian Geodetic Networks
- Description Of Network (1)
- Description Of Network (2)
- Satellite Networks In Egypt
- Summary

# History of Egyptian Geodetic Networks

# Brief History

- Between 1853 and 1859 years, a complete survey of Egypt was made but did not depend on a triangulation scheme.
- In this, time a geodetic triangulation was constructed but it was low order, it was second order triangulation.
- The Egyptian first order triangulation network, which is one of the first true national networks in Africa, dates back to the first decade of twentieth century.

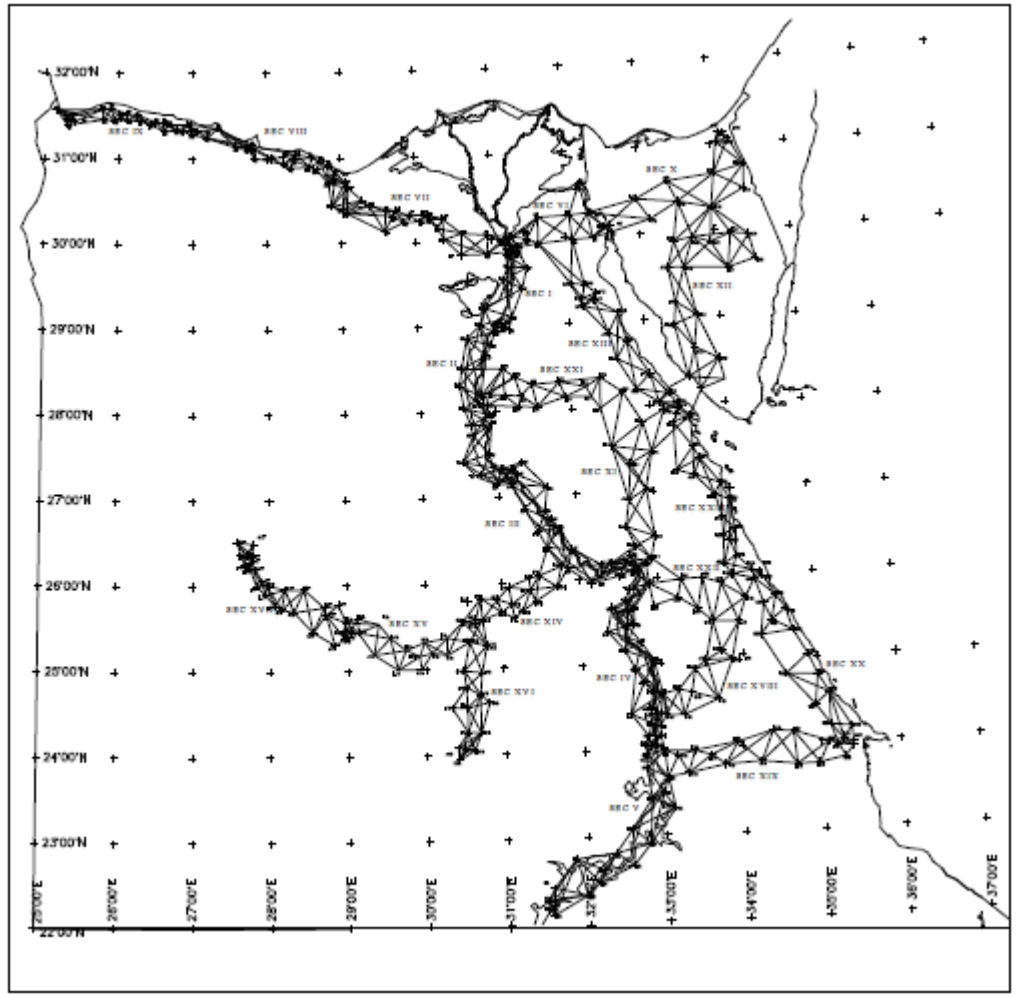
# Brief History

- In 1907, it became possible to begin a new work for establishing a geodetic triangulation frame for Egypt, which is the first national network to be established in Africa.
- The mean reason for carrying it out was to fix, with the greatest possible accuracy, basic control stations on which the cadastral survey and national mapping of the country was based.
- Egyptian network was used for constructing Sudanese geodetic network and most of the African geodetic networks.
- The first order geodetic control networks of Egypt is containing two main networks, Network (1) and (2).

# Brief History

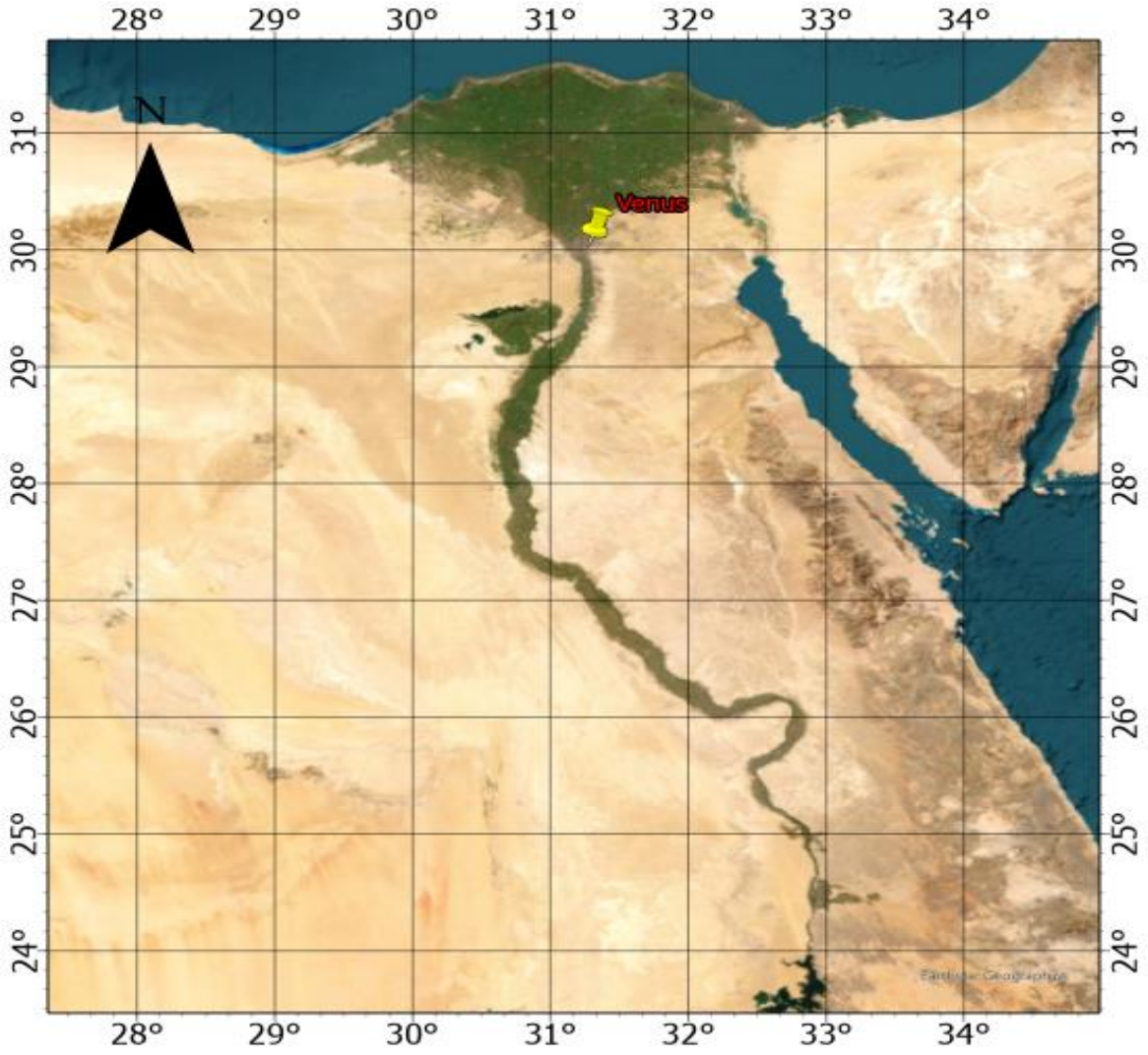
- For geodetic mapping, the accuracy of the coordinates of the network points is sufficient. However, this accuracy was not sufficient for precise geodetic applications.

| Parameter | Value |
|---|---|
| Shape | chain quadrilaterals with all angles observed |
| Side lengths | 40 to 50 km |
| computational surface | Helmert ellipsoid (1906) |
| Fundamental point (initial point) | Venus station (F1) on the Almokattam hills. |



The first order geodetic control networks of Egypt

# Brief History




| Parameter | Symbol | Value |
|---|---|---|
| Geodetic Latitude | ø | 30° 01′ 42.8519″ |
| Geodetic Longitude | λ | 31° 16′ 33.6000″ |
| Meridional component of the vertical | ξ | 3.93″ |
| Longitudional component of the vertical | η | 0.00″ |
| Geoid undulation | N | 0.00 m |

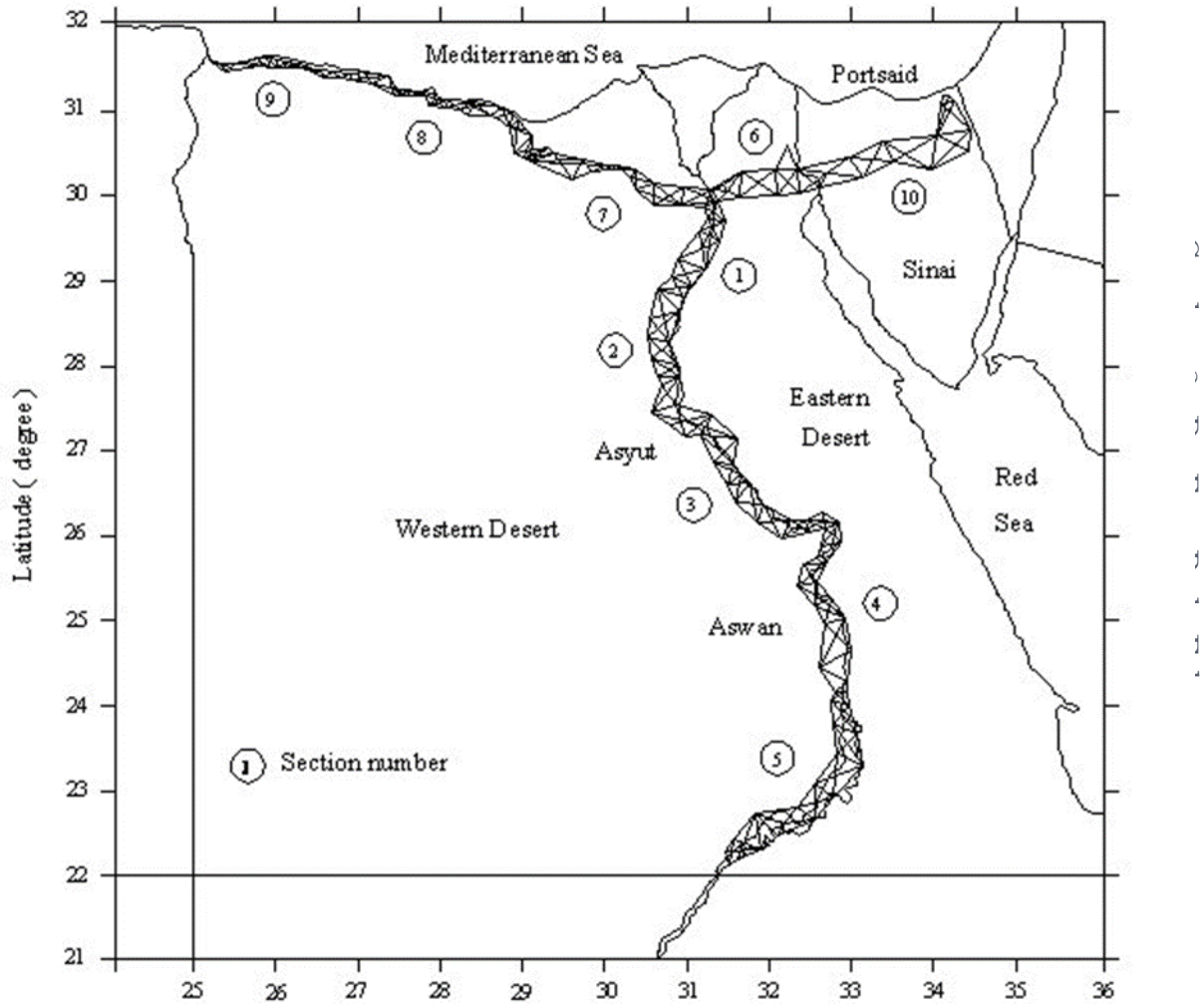
Topocentric Positional Parameters At The Initial Point.

# Description Of Network (1)

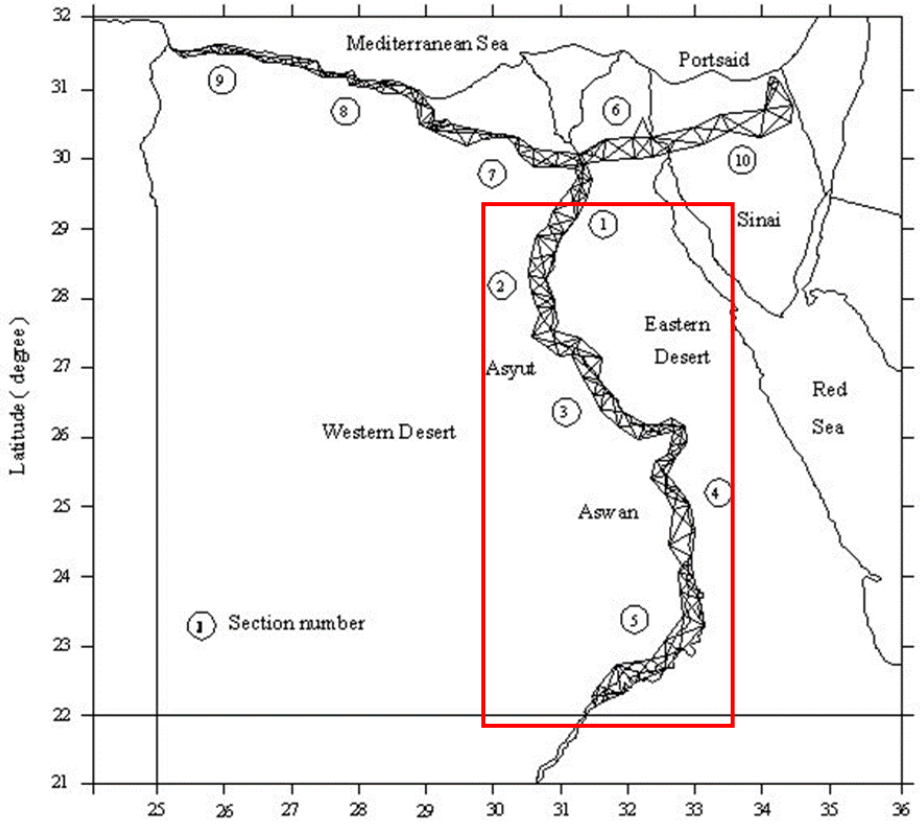
- Network (1) was started in a year 1907 and was finished in 1945.
- It consists of ten sections contain 195 stations and the general form as (T) shape, with initial point on the Almokattam hills to the east of Cairo.
- The nearly horizontal part from (T) shape contains 5 sections cover the north area from Alarish in the east to Alsalom in the west and passing through Cairo region.
- The nearly vertical part from (T) shape contains the other 5 sections cover the cultivated area of the Nile valley from Cairo southwards till Adindan near Sudanese borders.
- Most of triangulation points are located on both sides of the valley on mountain tops forming braced quadrilaterals.
- Each section starts from a base line and ends on the next base lines.
- Station $Z_5$ (Adindan) in the south is the origin of the Sudanese geodetic network and most of the African geodetic networks.

# Description Of Network (1)

- The fundamental point is station F1 on the Almokattam hills. From this point, the net extends forming three main parts divided into 10 sections.
- Several second order triangulation networks are linked to the first five sections (vertical part).
- One chain of triangulation network extends from Cairo going south covering Alwasta and Alfayoum.
- Another network starts from Naga Hamadi westwards to cover the governorate of Elwadi Elgaded.
- Another network extends from Qena eastwards to cover portions of the Eastern Desert reaching the Red Sea coast.



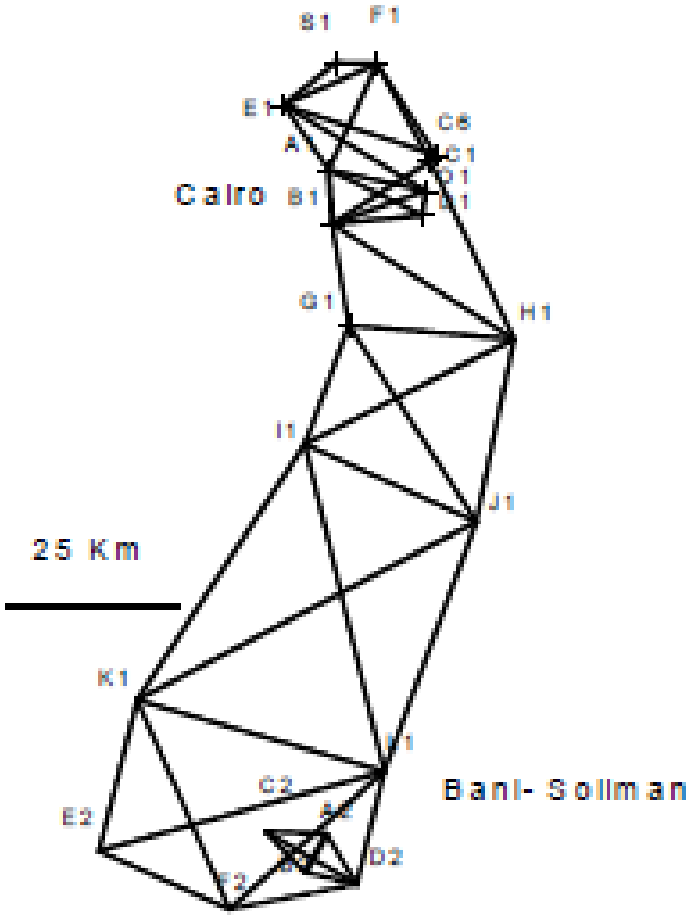
# Description Of Network (1)




- Network (1)
  - First Part (Cairo until Halfa on the southern border of Egypt )
    - Section I
    - Section II
    - Section III
    - Section IV
    - Section V

# Description Of Network (1) – Section I

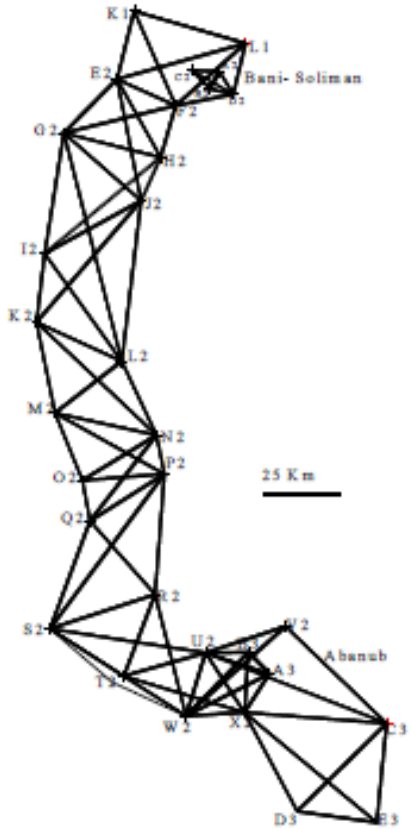
- The length of this section is approximately 100 Km.
- It consists of 14 Stations, Starts from Cairo at Saqqara base line in Badrashine (A1B1 = 7.9 Km approximately) and ends at Bani-Soliman base line (A2B2 = 6.4 Km approximately), near Benisuef.
- The fundamental azimuth for the geodetic triangulation net was determined across the Nile valley from base terminal Saqqara to Helwan observatory station and vice versa.
- The astronomical latitudes have been determined at eight stations.
- Astronomical longitudes were observed at two stations O1 and F1 which are Laplace stations.




Section I

# DESCRIPTION OF NETWORK (1) – SECTION II

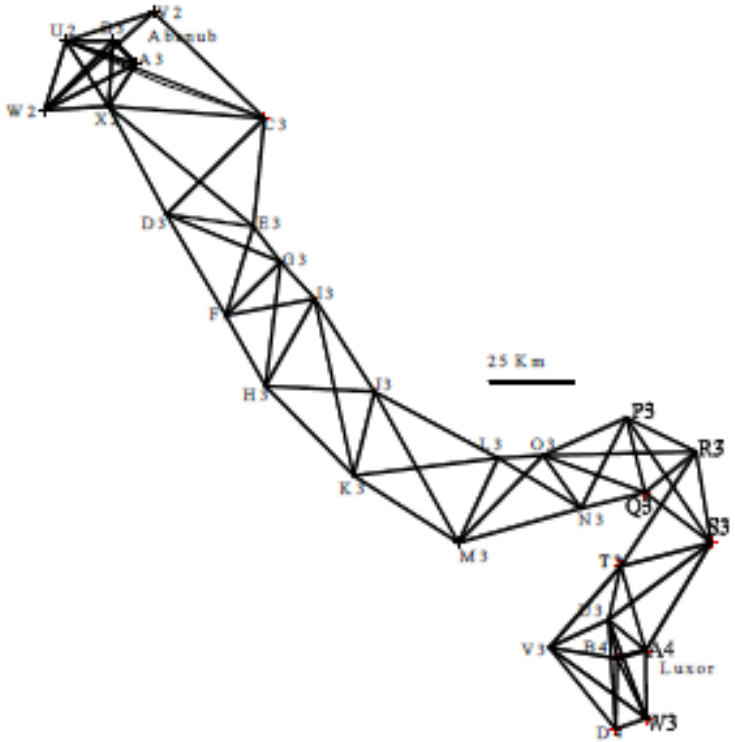
- Starts from Bani-Soliman base line and ends at Abanub base line near Asyuit (A3B3 = 9.7 Km approximately).
- The length of this section is more than 200 Km.
- It consists of 24 stations, the astronomical latitudes have been determined at seven stations.
- Four reciprocal astronomical azimuths where observed (AE2-F2, AF2-E2 , AO2-P2, AP2-O2 ). In addition, no longitude observations were taken.




Section II

# DESCRIPTION OF NETWORK (1) – SECTION III

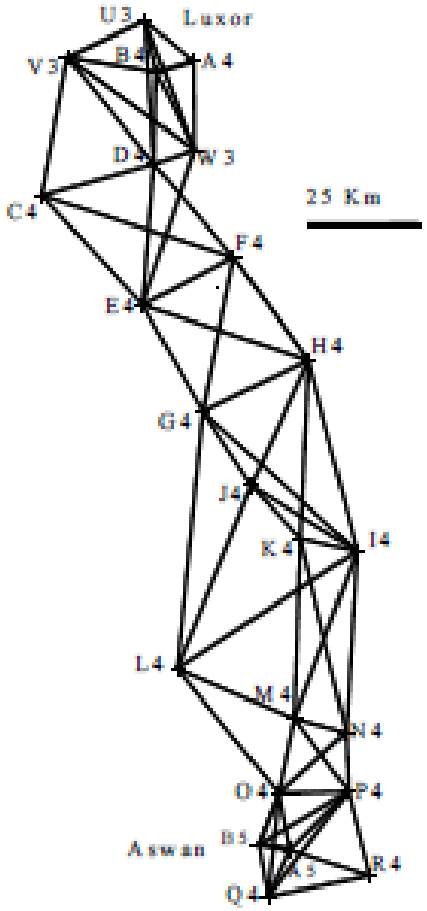
- Starts from Abanub base line and ends at Luxor base line (A4B4 = 8.7 Km approximately), the length of this section is approximately 300 Km.
- It consists of 23 Stations, the astronomical latitudes have been determined at 18 stations.
- Neither astronomical azimuth nor astronomical longitude was observed, another base line was measured at this section.




Section III

# DESCRIPTION OF NETWORK (1) – SECTION IV

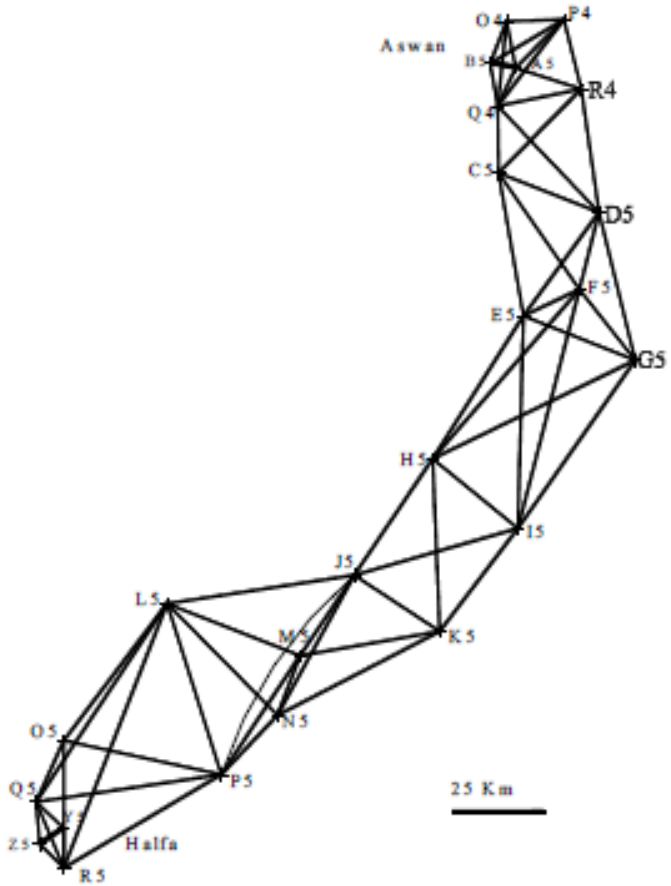
- Starts from Luxor base line and ends at Aswan base line (A5B5 = 7.0 Km approximately), the length of the section is approximately 200 Km.
- It consists of 18 Stations, the astronomical latitudes have been determined at 15 stations.
- Two astronomical azimuths (AA4-B4, AA4-U3) were observed.
- In addition, no astronomic longitude observations were done, another base line was measured at this section.




Section IV

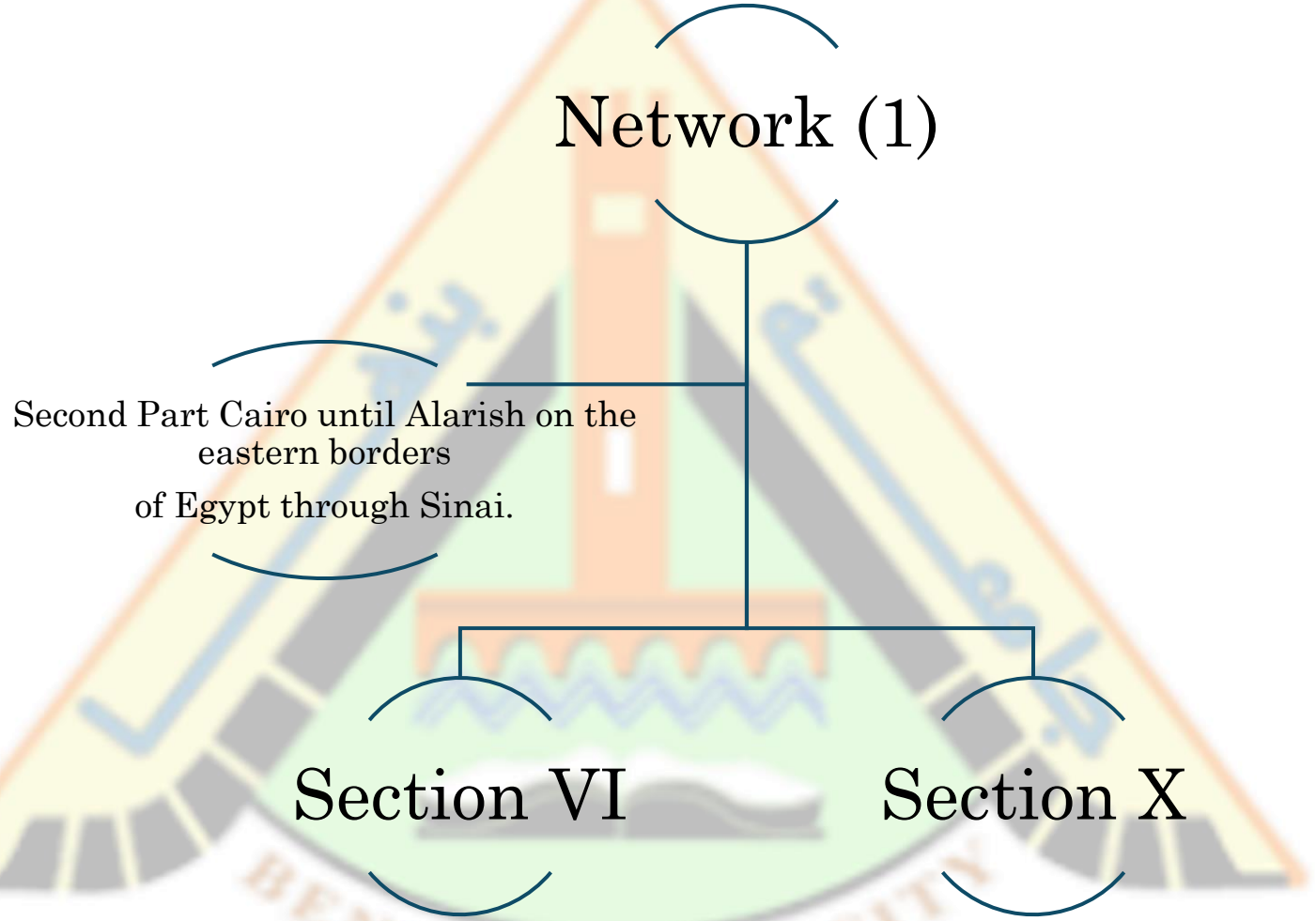
# DESCRIPTION OF NETWORK (1) – SECTION V

- The length of this section is approximately 280 Km.
- Starts from Aswan base line and ends at Adindan base line (Y5Z5 = 7.9 Km approximately), On the southern territory of Egypt.
- It consists of 20 Stations and the ends at Adindan base on the southern territory of Egypt.
- The astronomical latitudes have been determined at all stations.
- Astronomical longitude and azimuths were carried out at the terminals of the Adendan base, also at station A5 (Laplace points)



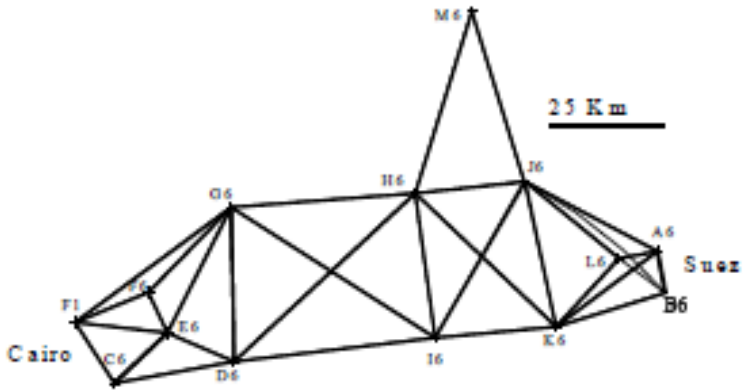

Section V

# DESCRIPTION OF NETWORK (1)



# Description Of Network (1) – Section VI (Cairo – Suez)

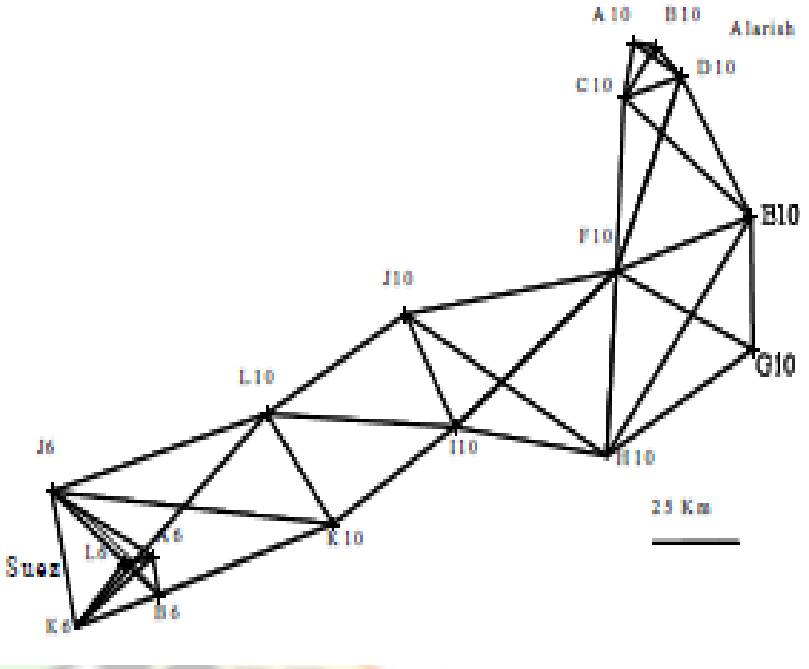
- This section starts from Saqqara base line in Badrashine and ends at Suez.
- The baseline (A6B6 = 9.2 Km approximately). Length of this section is approximately 130 Km.
- It consists of 13 stations.
- The astronomical latitudes were observed at 11 stations.
- Two Laplace Stations were observed at the terminals of the Suez base line at stations A6 and B6.
- Astronomical latitude, longitude and azimuth were observed at these stations




Section VI

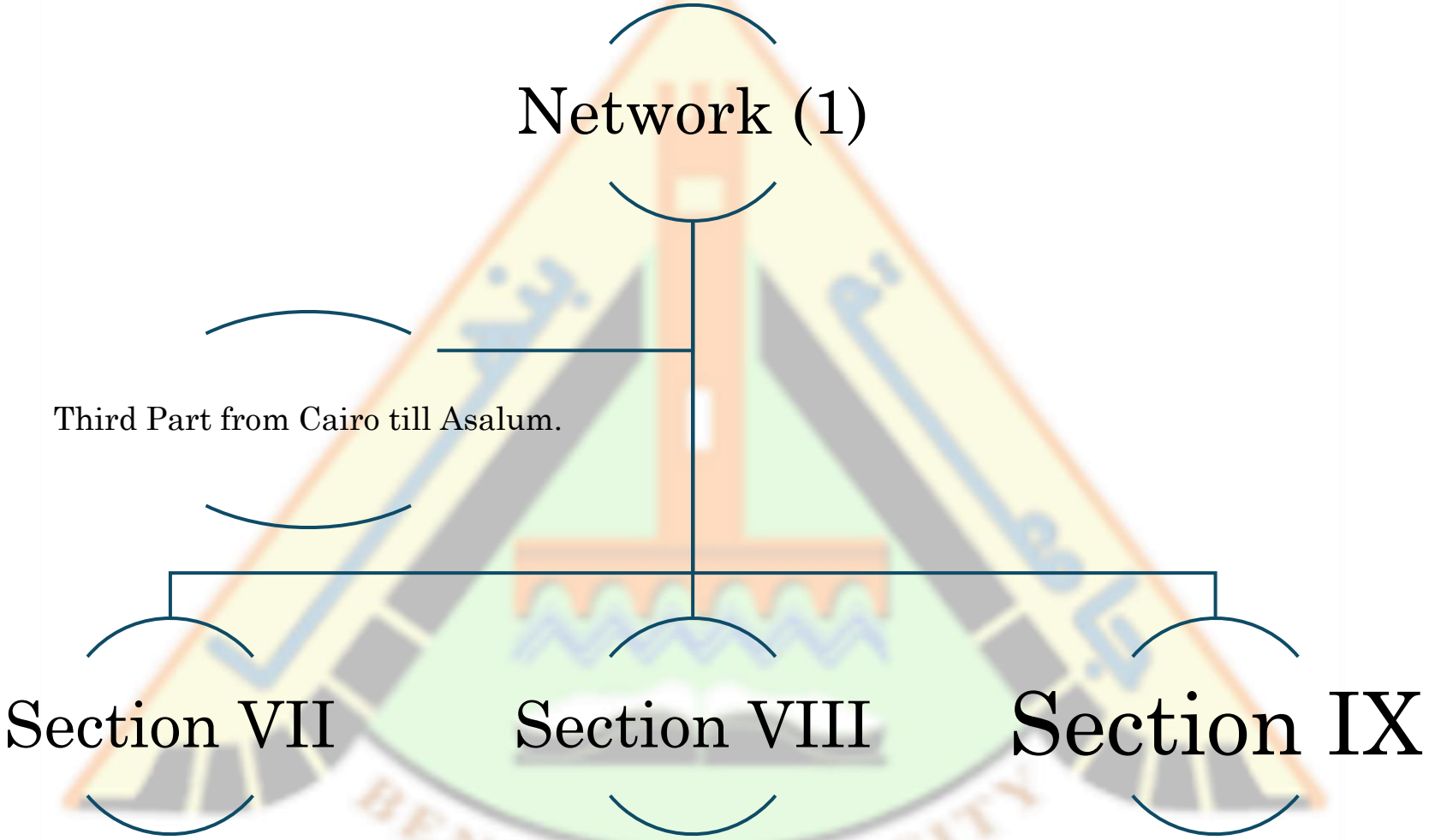
# Description Of Network (1) – Section X (Suez – Alarish)

- This section starts from Suez base line and ends at Alarish.
- The base line (A10B10 = 9.2 Km approximately).
- The length of this section is approximately 250 Km.
- It consists of 12 stations.
- The astronomical latitudes were observed at all stations.
- At the terminals of Alarish base line A10B10 the astronomic longitudes were observed,



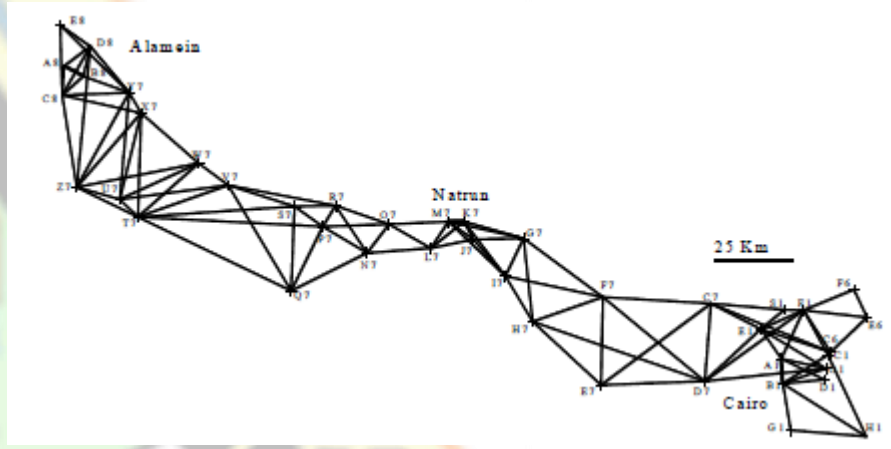

Section X

# Description Of Network (1)



# Description Of Network (1) – Section VII (Cairo – Alamein)

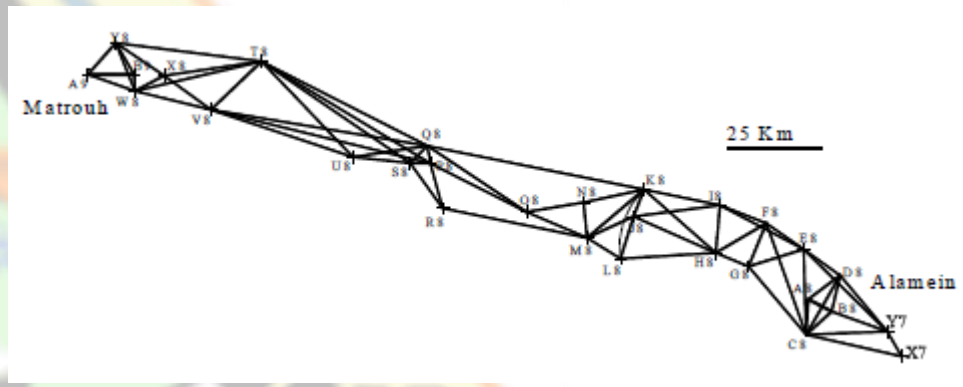
- This section starts from Saqqara base line in Badrashine and ends at Alamein.
- The baseline (A8B8 ≈ 9.2 Km).
- The length of this section is approximately 300 Km.
- Because of the comparatively long extent of this section, a second base line (Natrun base, K7M7 = 4.9 Km approximately) was measured at the middle of this section.
- This section consists of 24 stations.
- The astronomical latitudes were observed at 21 stations.
- Neither, in this section, astronomic longitudes nor astronomic azimuths were observed




Section VII

# Description Of Network (1) – Section VIII (Alamein – Matruh)

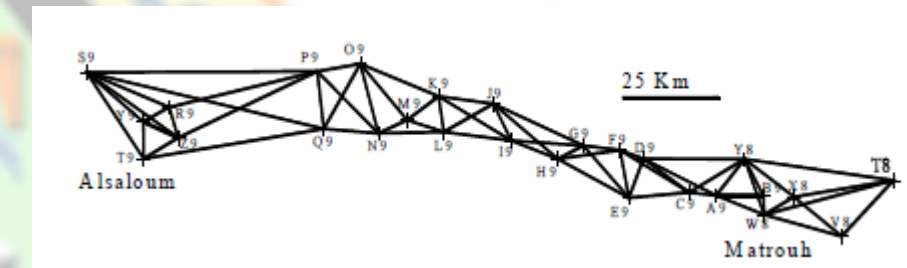
- This section starts from Alamein base line and ends at Matruh.
- The base line (A9B9 = 12.2 Km approximately).
- The length of this section is approximately 200 Km. It consists of 25 stations, the most of them are laying on the seashore.
- Astronomical latitudes were observed at 18 stations. Observations for Laplace Station were Taken at both terminals of the Alamein base line at stations A8 and B8, astronomical latitude, longitude and azimuth were observed at this stations




Section VII

# Description Of Network (1) – Section IX (Matruh – Alsaloum)

- This section starts from Matruh base line and ends at Alsaloum base line (Y9Z9 = 9.8 Km approximately). The length of this section is approximately 160 Km.
- It consists of 22 stations, the most of them are laying on the seashore.
- Astronomical latitudes were observed at 19 stations. Also, four Laplace Stations were observed at both terminals of Matruh and Alsaloum base lines were observed at stations A9, B9, Y9 and Z9 Astronomical latitude, longitude and azimuth were observed at these stations




Section IX

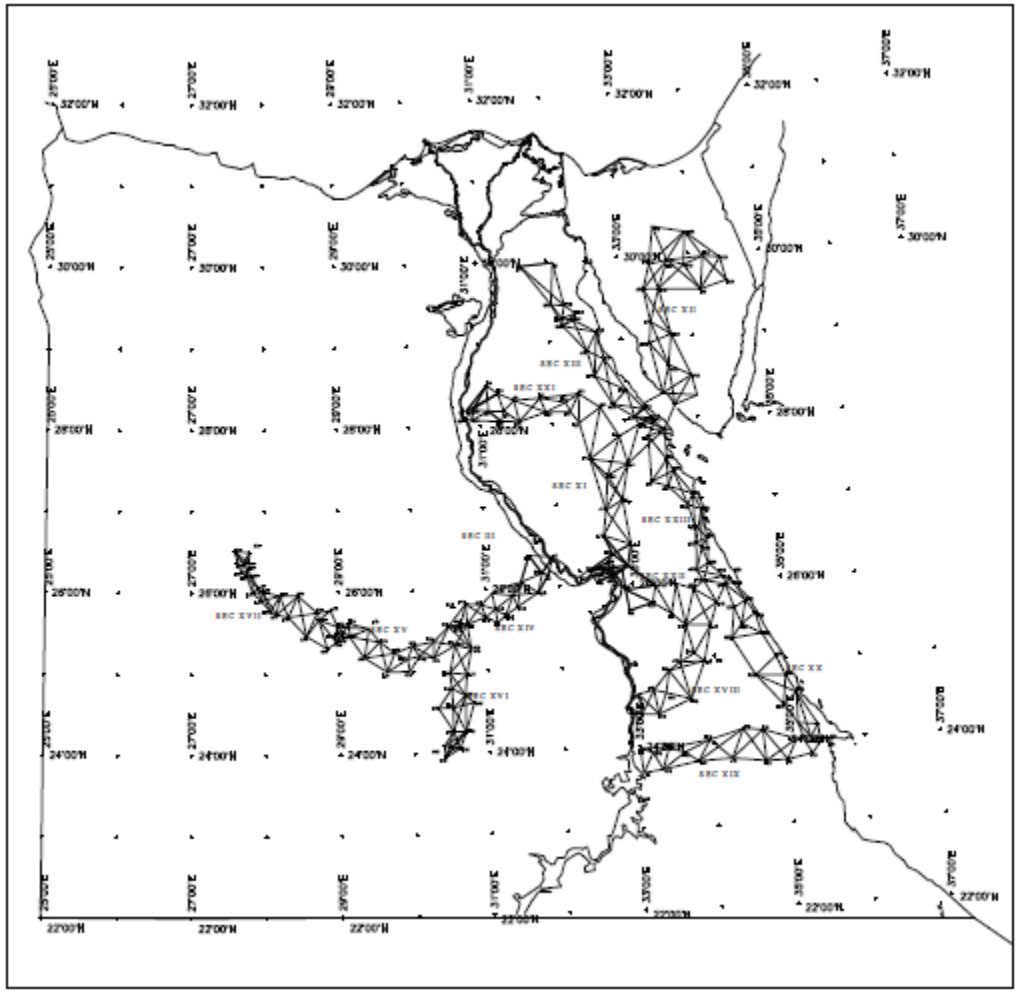
# Summary of Network (1)

| Sec No. | Approx. length (Km) | No. of station | Base lines | Observed Latitudes (Φ) | Observed Longitudes (Λ) | Observed Azimuth (A) | No of laplace stations |
|---|---|---|---|---|---|---|---|
| I | 100 | 14 | 1 | 8 | 2 | 2 | 2 |
| II | 200 | 24 | 1 | 7 | -- | 4 | -- |
| III | 300 | 23 | 1 | 18 | -- | -- | -- |
| IV | 200 | 18 | 1 | 15 | -- | 2 | -- |
| V | 280 | 20 | 2 | 19 | 3 | 3 | 3 |
| VI | 130 | 13 | 1 | 13 | 2 | 2 | 2 |
| VII | 300 | 24 | 1 | 21 | 2 | -- | -- |
| VIII | 200 | 25 | 1 | 18 | 2 | 2 | 2 |
| IX | 160 | 22 | 2 | 19 | 4 | 4 | 4 |
| X | 250 | 12 | 1 | 12 | 2 | -- | -- |
| **Sum** | | **195** | **12** | **150** | **17** | **19** | **13** |

# NETWORK (2)

# DESCRIPTION OF NETWORK (2)

- In 1952, the Egyptian Survey Authority (ESA) set out a plan for the second network (2 ) to cover the area of the Red sea, where there are oil fields and mineral working and to cover also most of the western desert, to cultivate and inhabit this area.
- Network (2) was constructed and observed from a year 1955 and finished in a year 1968.
- It was connected to Network (1) through nineteen common stations (I2, K2, L2, H3, K3, N3, O3, P3, S3, R3, J3, I4, N4, R4, D5, D6, I6, H10 AND I10).
- It covers the area of the Eastern Desert, Red Sea cost, part of Sinai and part of the Western Desert. This net consists of 207 stations forming three main blocks, divided into 13 sections,



The first order geodetic control network (2) of Egypt

# DESCRIPTION OF NETWORK (2)

| Sec No. | Approx. length (Km) | No. of stations | Base lines | Observed Latitudes ( Φ ) | Observed Longitudes ( Λ ) | Observed Azimuth (A) | No of laplace stations |
|---|---|---|---|---|---|---|---|
| 11 | 170 | 14 | 1 | 1 | 1 | 1 | 1 |
| 12 | 250 | 17 | -- | -- | -- | -- | -- |
| 13 | 240 | 15 | -- | -- | -- | -- | -- |
| 14 | 140 | 18 | -- | 1 | -- | -- | -- |
| 15 | 200 | 21 | -- | 1 | -- | -- | -- |
| 16 | 130 | 13 | -- | -- | -- | -- | -- |
| 17 | 180 | 22 | -- | -- | -- | -- | -- |
| 18 | 220 | 18 | 1 | -- | -- | -- | -- |
| 19 | 240 | 17 | -- | 1 | 1 | 1 | 1 |
| 20 | 240 | 15 | 1 | 1 | 1 | 1 | 1 |
| 21 | 80 | 17 | -- | -- | -- | -- | -- |
| 22 | 200 | 5 | -- | -- | -- | -- | -- |
| 23 | 170 | 15 | -- | -- | -- | -- | -- |
| **Sum.** | | **207** | **3** | **5** | **3** | **3** | **3** |

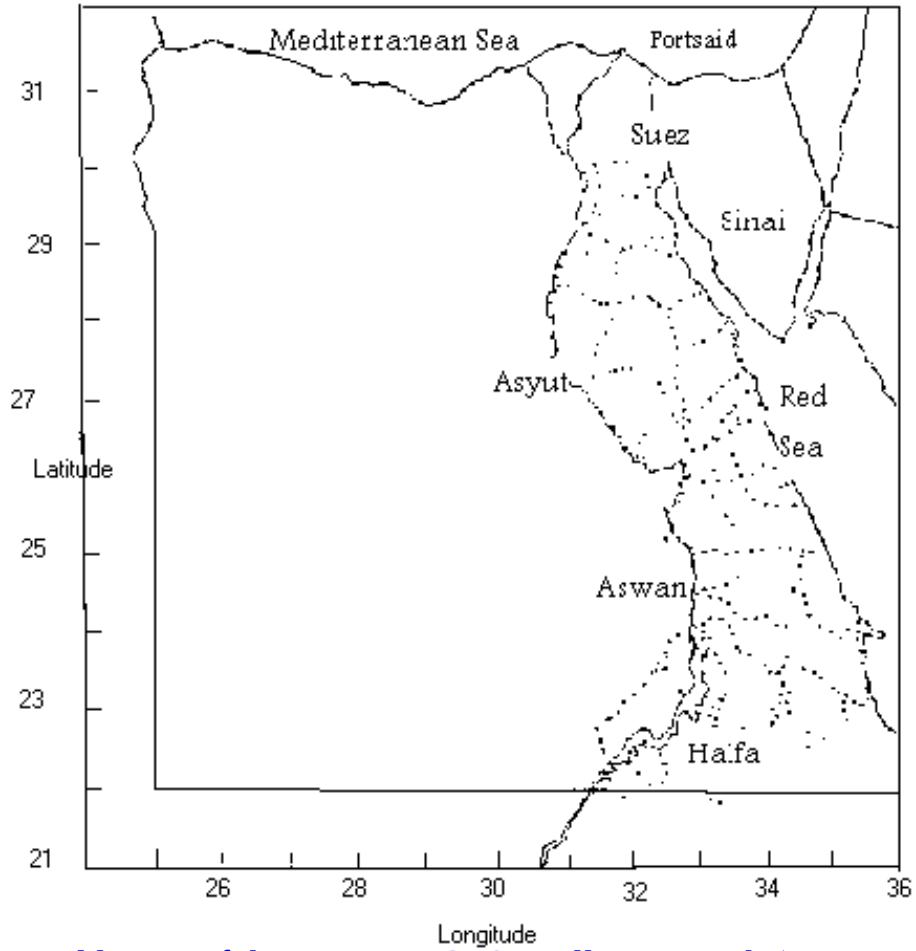
# Description Of Some Satellite Networks In Egypt

# Description Of Satellite Networks - The Finnish Project

- The objective of the project was to provide the necessary ground control in a part of the Egyptian Eastern Desert to produce 1:50,000 topographic maps of the area using aerial photogrammetry.
- The project was awarded to Finnish surveying company (Finnmap).
- ESA decided to densify the existing primary geodetic network originally.
- The observed points are 31 GPS stations classified as first order using base line solution, in cooperation with ESA personnel.
- The project started on July 1987, and the densification process produced the 389 points observed by Finnmap.

# Description Of Satellite Networks - The Finnish Project

- The breakdowns of these points were as follows:
- 31 GPS stations classified as first order using base line solution. Among these stations six are common with the terrestrial geodetic network.
- 340 second order control points.
- 16 third order control points.
- 2 Photo stations




General layout of the Egyptian GPS satellite network (Finnmap)

# Description Of Satellite Networks - The American Project

- The American Project started in December 1989.
- It has been made by the ESA in cooperation with a team from the United States.
- The main objective was to enable Egypt's civil requirements for surveys and maps in the 21st century.
- The project provided technical assistance and ESA acquired through the project modern surveying and mapping equipment to achieve the main objective of the project.
- The American project provided a widespread GPS primary control network with densities and distributions served best the area to be covered by aerial triangulation for production 1:4000 – 1:10,000 scale maps.
- In addition, terrestrial surveys were linked to the GPS control network using modern equipment Total Stations (TS) for producing detail and large scale maps 1:2500 – 1:1000 for four governorates, namely Beheira, Sharkeya, Sohag and Asyuit.
- This GPS control network now covers the whole Nile Delta, Fayoum governorate and the Nile Valley between Sohag and Asyuit

# Description Of Satellite Networks - The American Project

- During the observation of the GPS primary control network, GPS receivers occupied several first order triangulation stations along the Nile Valley whose coordinates were available in EGD30.
- GPS receivers occupied several first order GPS stations that were previously observed by the Finnish project in the Eastern Desert.
- The results of the baseline were of superior order of accuracy as compared to both first order triangulation and the Finnish project.
- Several benchmarks within the first order levelling network were occupied and observed by GPS, in order to provide the means of providing vertical control referenced to Mean Sea Level (MSL) as adopted by ESA.

General layout of the Egyptian GPS satellite network (Finnmap)

# Description Of Satellite Networks - The American Project

- The current GPS primary control network is composed of 52 control points, which has been observed within the American project, as follows:
- A number of 19 new GPS primary control points observed by the American project.
- A number of 10 GPS previously determined by the Finnish project and observed by the American project.
- A number of 4 first order triangulation stations that has levelling surveys performed concurrent with the GPS observation activities.
- A number of 8 first order triangulation stations that has been previously observed also with trigonometric levelling by ESA, along with GPS observations by the American project.
- A number of 6 second order triangulation stations that has levelling surveys performed concurrent with the GPS observation activities.
- A number of 3 second order triangulation stations that have levelling surveys performed by ESA, with GPS observation by the American project.
- A number of 2 second order triangulation stations that have been previously observed also with trigonometric levelling by ESA, along with GPS observations by the American project.

# Description Of Satellite Networks - The German Project

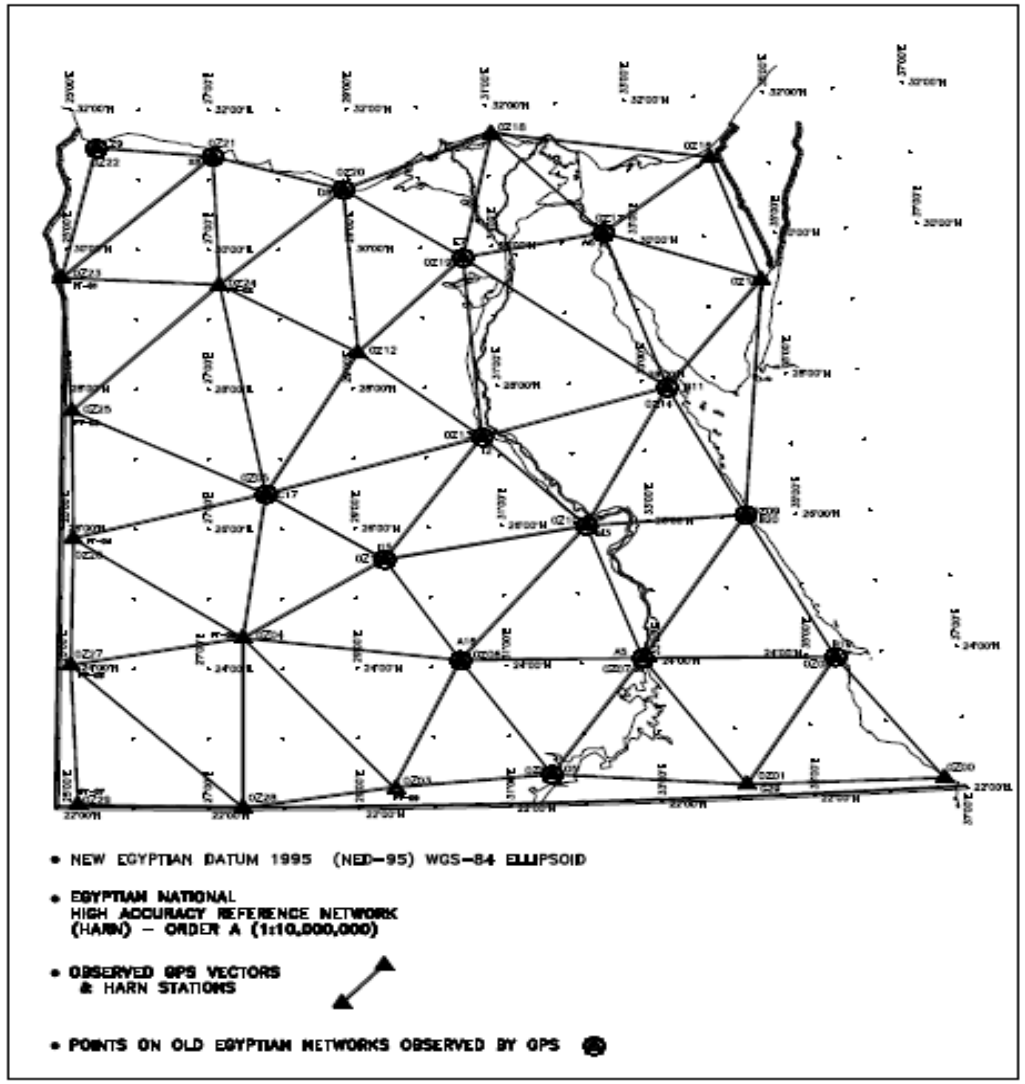
- The German Project started in May 1990. The goal of the project was to provide a local GPS network for supporting the local cadastral surveys in Upper Egypt. Mainly in the area of Kom Ombo. The project objective was to explore, through these activities, producing a plot Land Information System (LIS) in the area. The project was funded by the German Aid Funding Agency (GTZ). The German team decided to establish about 64 GPS points, these points were tied to three control points in the first order triangulation network, namely A5, G21 and G22. The intention was to provide levelling information for all points. The densfication process produced the GPS control point owned by the German team. The experience gained from this project could be summarized in establishing a blueprints for geodetic and survey practices as related to establishing LIS projects.

# Description Of Satellite Networks - Survey Research Institute Project

- GPS measurements have been taken in Sinai by Survey Research Institute (SRI). The objective was to establish a horizontal control network using GPS survey that met the requirements of mapping in Sinai Peninsula. In addition, the network was intended to support resource planning, development and management. The project was funded by United Nations Development Program (UNDP). The Survey Research Institute (SRI) decided to first densify the existing primary geodetic network in Northern Sinai using GPS surveys. The first phase of the project started at February 1989 and ended at December 1991.
- The observed points, 74 control points, were tied to three control points in the first order triangulation network to have the ability to tie the WGS84 and the Egyptian Geodetic datum EGD30. These points are A6, B10 and A360 at the time of GPS observations in the region, B10 monumentation was missing.

# Description Of Satellite Networks - High Accurate Reference Network (HARN)

- In 1995 ESA has made new project called New Egyptian Datum 1995, which depends on GPS observations (High Accuracy Reference Network, HARN) order "A").
- This network consists of 30 control points, which are distributed around all Egypt.
- Among them are 15 points from the Egyptian triangulation network defined on the Old Egyptian Datum.
- The spacing distance between points were approximately 200 km, the accuracy of this network (1:10,000,000).
- The network is observed using Dual frequency GPS receivers, the observation sessions were long enough, precise ephemeris are used, and the network is connected with 4 international geodynamic GPS stations.



## End Of Presentation

# Thank You For Attention!