Towards the Establishment of New Coordinates System in Palestinian

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Presentation Structure

- **Overview**

- **Evaluation of Control Points**

- **How errors affect our life?**

- **Solution: New Palestinian National Grid**
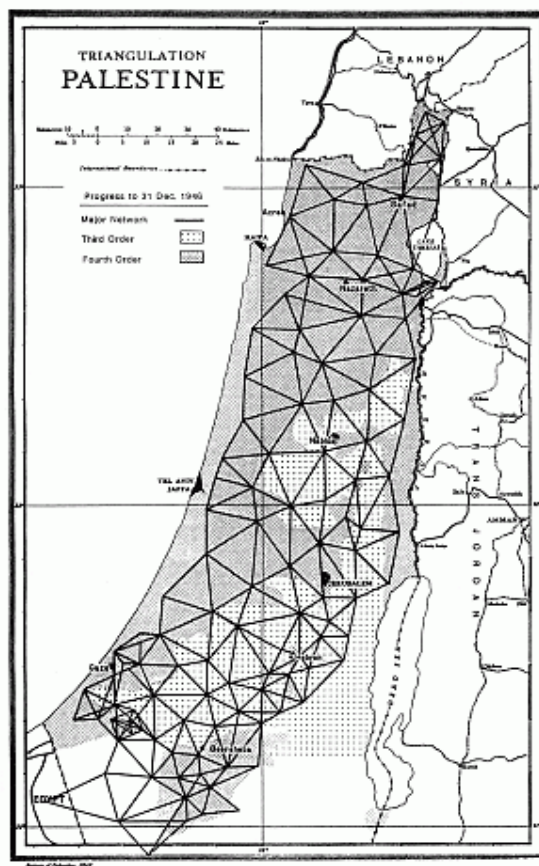
- **Conclusions**

- **Acknowledgments**

Overview

- British Survey of Palestine during 1920 - 1948 results in the establishment of horizontal and vertical networks

- **Horizontal Network**: consists of several points distributed in Palestine in different orders.
  - Chain was used in measurement of baseline
  - Theodolite was used in measurement of angles

- **Vertical Network**:
  - Precise leveling – few points
  - Trigonometric leveling – horizontal points

Overview: Survey of Palestine

The **Major** Triangulation system in Palestine (left) and measurement taken from point 2M of the Palestine Major triangulation base line (right).

Source: http://www.pef.org.uk/monographs/the-survey-of-palestine-under-the-british-mandate-1920-1948 (14-05-2010)

Evaluation of Control Points

Topcon Hiper+ GNSS receiver in Real Time Kinematic (RTK) was used.

Evaluation of Control Points

- **British Network**
  - **<u>Assessment of Trig Points:</u>**

Station:	430G	Fix			
Point:	**956X**	Distance:	2,788.766m		
GPS Sat.	8	GLN. Sat.	5		
Precision, H:	1cm			V:	1.3cm
Diff.	**E=**	**10.5cm**	**N=**	**4.4cm**	**H=**	**7.3cm**

Evaluation of Control Points

- **British Network**

  - **Assessment of Trig Points:**

Station:	1017X	Fix			
Point:	**430G**	Distance:	2,769.349m		
GPS Sat.	8	GLN. Sat.	5		
Precision, H:	0.2cm			V:	0.5cm
Diff. E=	**0.4cm**	**N=**	**0.2cm**	**H=**	**-20.6cm**

Evaluation of Control Points

- **British Network**
  - **Assessment of Trig Points:**

Station:	1017X	Fix			
Point:	**1059X**	Distance:	2,214.298m		
GPS Sat.	8	GLN. Sat.	5		
Precision, H:	0.2cm			V:	0.5cm
Diff. E=	**42cm**	N=	**16.9cm**	H=	**19.7cm**

Evaluation of Control Points

- **Jordanian Network**
  - **<u>Densification of the British Horizontal Network using Theodolite</u>**

Station:	430G	Fix	
Point:	**1568BC**	Distance:	372.418m
GPS Sat.	7	GLN. Sat.	0
Precision, H:	1.8cm	V:	0.9cm
Diff. E=	**3.7cm**	N=	**32.2cm**

Evaluation of Control Points

- **During Israel Occupation**
  - **Densification of the British Horizontal Network using Traverse**
  - **Accumulated error**
  - **Allowed error in traverse of 3582.87m is 2.35m**

Station:	558C	Fix	
Point:	**601T**	Distance:	1,860.936m
GPS Sat.	7	GLN. Sat.	5
Precision, H:	0.3cm	V:	0.6cm
Diff. E=	**0.1cm**	**N=**	**6.8cm**

Evaluation of Control Points

- **During Palestinian Authority**
  - **Still use traverse**
  - **Start using GPS**
    - **Every surveyor measures a polygon in his area**
    - **Israel GPS companies compute 7 transformation parameters**
    - **Example: Ramallah and Bethlehem parameters**

Parameter	Ramallah	Bethlehem	Units
dx	121.451	123.649	m
dy	114.142	67.957	m
dz	-284.684	-406.173	m
Rx	-11.1499	-11.6318	sec.
Ry	-8.56249	-5.32853	sec.
Rz	-5.04769	-5.62189	sec.
scale	8.8471	22.2106	ppm

How errors affect our life?

Cause large errors in property boundaries and accumulated errors in engineering projects.

Solution: New National Grid – PG10

There is a serious need to establish a precise National Geodetic Network (Palestine Grid 2010 – PG10) to replace the traditional networks with a superior GPS-based solution.

Solution: New National Grid – PG10

Previous Work

- **In 1999, Ordnance Survey (OS) team, from the U.K., have a reconnaissance visit and they recommended to establish a new geodetic network for West Bank and Gaza.**

- **In 2000, Norway Mapping Palestine project:**
  - **Measured two polygons: one in Nablus and the other in Ramallah.**
  - **The result of this work was a list of adjusted coordinates based on the current coordinates system.**
  - **They recommended to carry on similar work in Jenin, Tulkarim, Qalqilia and Hebron.**
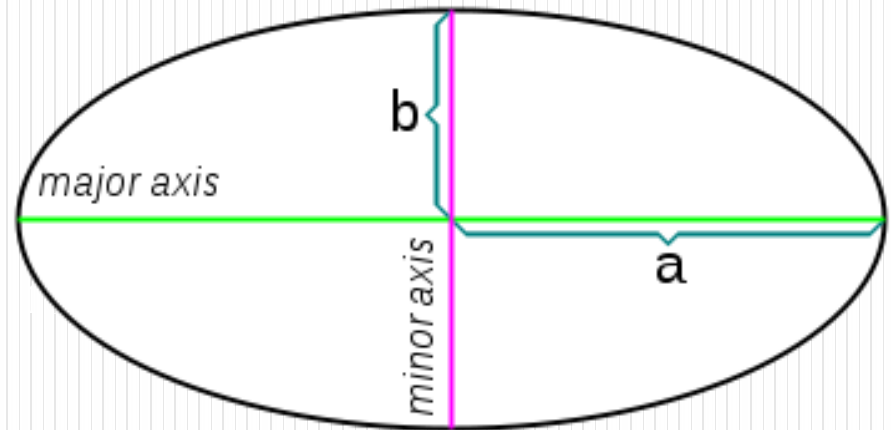
Solution: New National Grid – PG10

Background:

- **GPS provides with 3D Cartesian coordinates (X,Y,Z) (Earth Center Earth Fix –ECEF– coordinates)**

- **To convert these coordinates to Grid coordinates (E,N), we need a map projection (Horizontal coordinates)**

- **Map projection requires the definition of a reference ellipsoid and a projection type**

- **A transformation is required to convert between old and new coordinates system**

- **We need a vertical datum for heights**

Reference Ellipsoid

- **Ellipsoid parameters:**
  - *a*: **semi-major axis**
  - *b*: **semi-minor axis**
  - **or** *f*: **flattening , f=(a-b)/a**
    - *f* **expressed as 1/f**

- **Old System: Clarke 1880 Palestine**

- **(a=6378300.789m, 1/f= 293.466)**

- **New System: WGS84 datum surface**

- **(a = 6378137.00m, 1/f=1/298.257223563)**

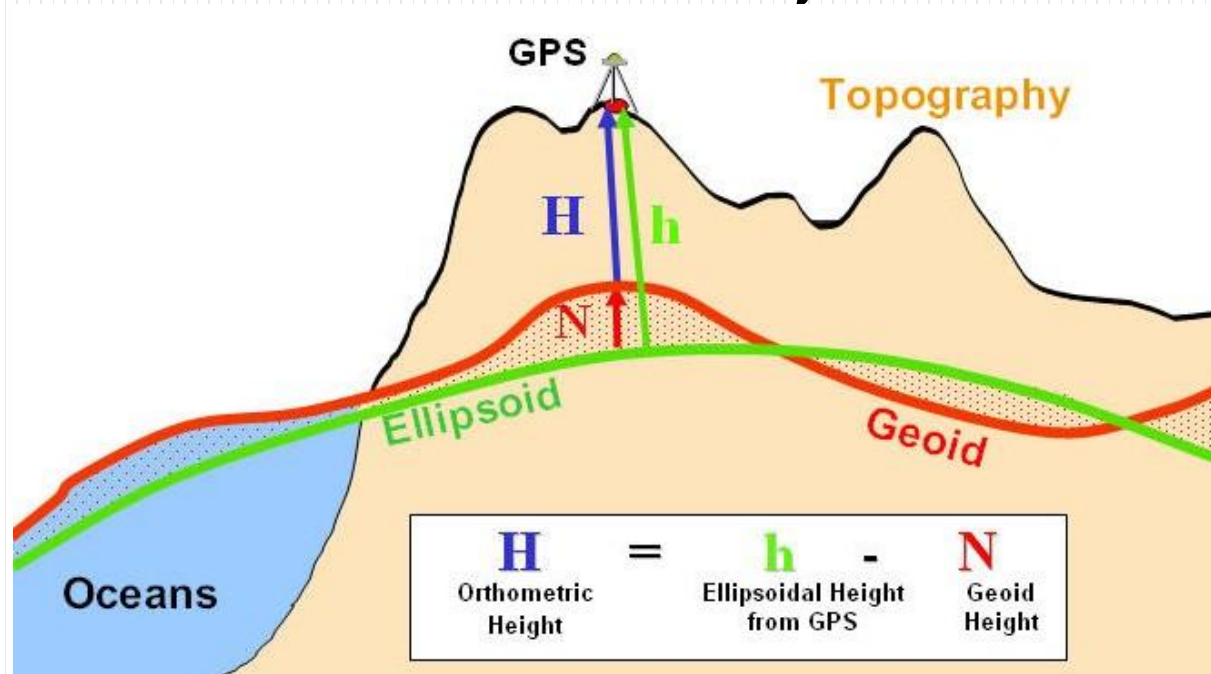# Solution: New National Grid – PG10

Projection Type

- **Old System: Cassini Soldner**
- **New System: Transverse Mercator which is best suited for north–south areas like Palestine**
- **Central Meridian (main datum point): as in the old projection, crosses through Jerusalem (82M)**
- **New Zero at 34°00'00"E, 29°00'00"N to avoid negative values in the south**
- **Main grid point values**
  - **False Easting (m): 170251.5545 (old), ≈114600.00 (New)**
  - **False Northing(m): 126867.9090 (old), ≈305000.00(New)**
- **New Grid Scale factor: 1.0000067**

Solution: New National Grid – PG10

Vertical Datum

- **Can be either Ellipsoid or Geoid**
- **Start with Ellipsoid (same as horizontal: WGS84 datum)**
- **Then we can use Geoid when ready**

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Solution: New National Grid – PG10

Where to start from?

Stage 1:

- **Measure several control points (30-40 km apart) distributed all over West-Bank using GPS.**

- **Tied into the International Terrestrial Reference Frame (ITRF) through the IGS (International GPS Service) stations**

- **These points will form the zero order control points of the new system**

Solution: New National Grid – PG10

Stage 2:

- **Densification of passive and active stations.**
- **The passive stations consists of publicly accessible control points.**
- **The active stations consists of permanent GPS reference stations.**
- **The data from the active stations can be used to produce a real time positioning through a Virtual Reference Station System (VRS)**

# Solution: New National Grid – PG10

What have been done so far?

- **Form a National Surveying Committee to put new surveying standards and to organize all surveying issues in Palestine**

- **Start Planning the location of the control points**

- **Preliminarily agreement with Nablus Municipality to fund a pilot project (Nablus First) of four reference stations to cover Nablus district.**

What have been done so far?

- **A home made software called Najah Surveying Suite (NSS) has been developed to compute the 7 transformation parameters using least squares.**
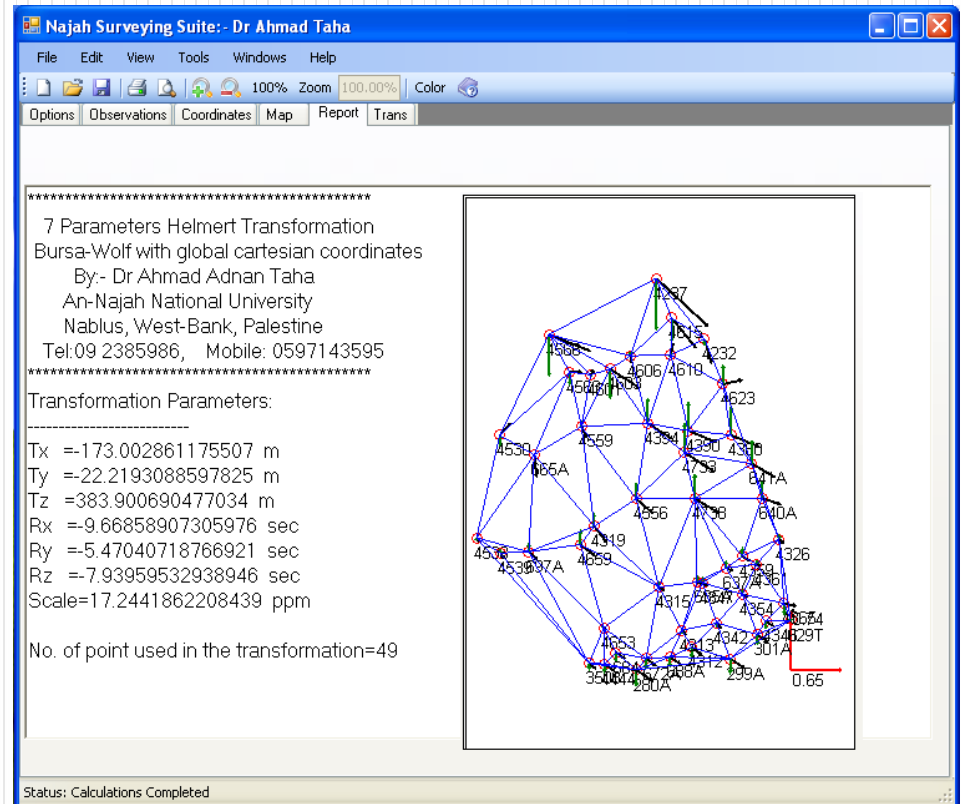
Conclusions

- **Large errors up to 40cm in the horizontal control points and up to 20cm in the vertical controls.**

- **Accumulated errors can affect our life seriously and caused large errors of more than 1.0m.**

- **Solution for such errors can be through the establishment of new National Grid in Palestine.**

- **Parameters of the proposed Palestine Grid 2010 (PG10) have been determined.**

- **Planning and preparation stages have been started.**

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