The Differences Between Land Surveyed Coordinates and the GIS Applied Coordinates in Palestine

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The Differences Between Land Surveyed Coordinates and the GIS Applied Coordinates in Palestine

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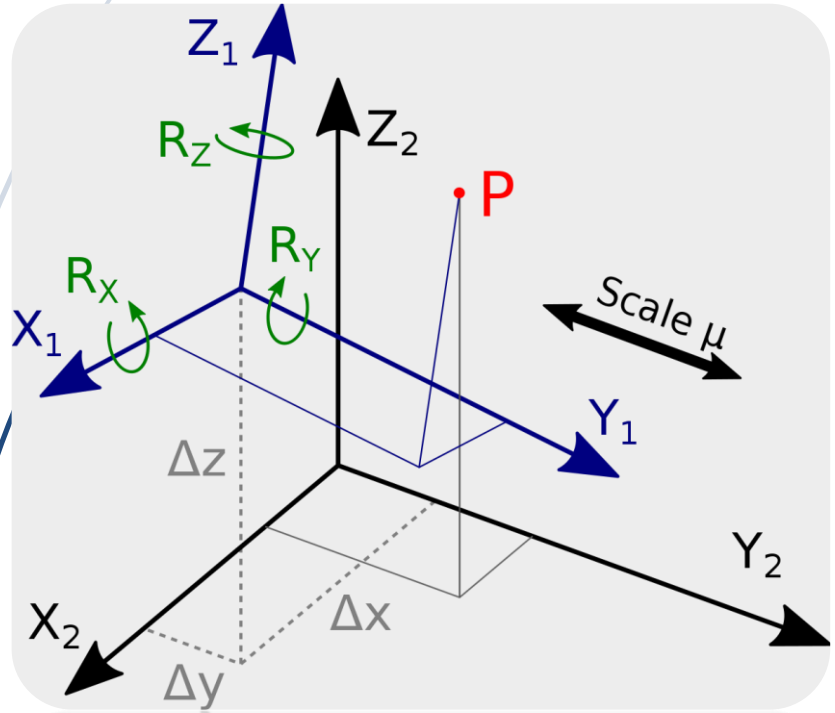
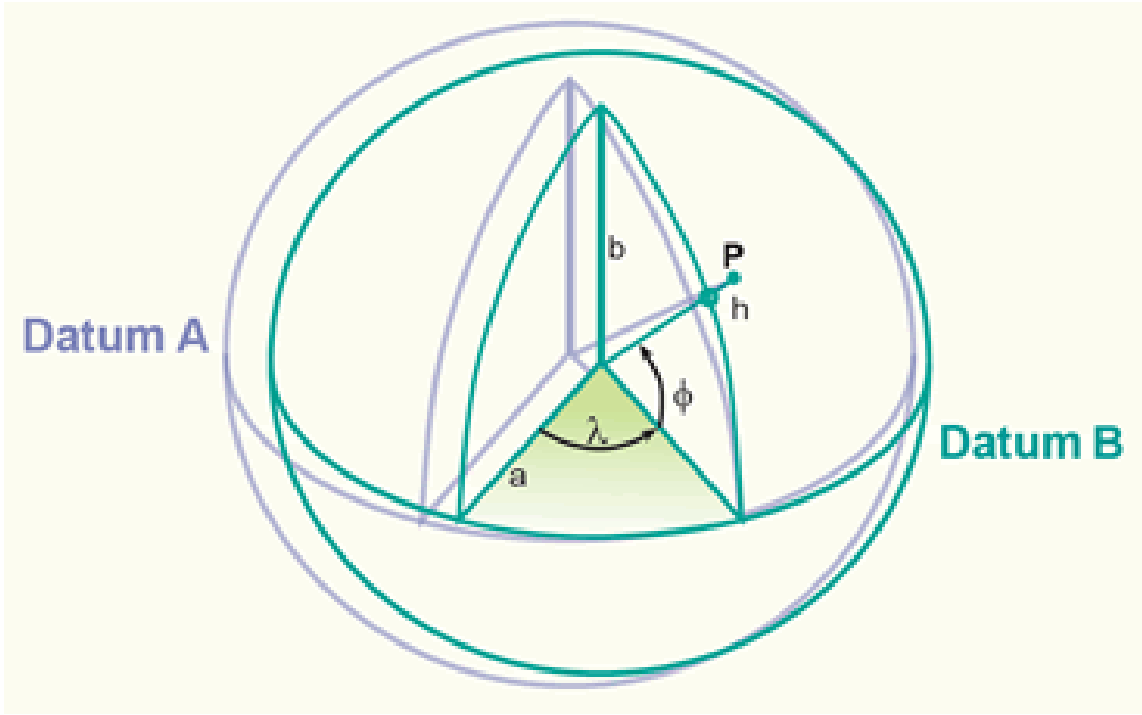
The Problem1: Defined Map Projections

Parameter	Pal1923Grid	Pal1923Belt	New Pal-TM[1] 2018
Ellipsoid	Clarck 1880	Clarck 1880	GRS 80
Semi-major axis	6378300.789m	6378300.789m	6378137.00m
Inverse flattening	293.4663155389802	293.4663155389802	298.257222100882
Projection type	Transverse Cylinder	Transverse Cylinder	Transverse Cylinder
Projection Name	Cassini-Soldner	Transverse Mercator	Transverse Mercator
Latitude of origin	31.734096944444 45°	31.734096944444 45°	31.73439361°
Central meridian	35.212080555555 56°	35.212080555555 56°	35.20451694°
False easing	170251.555 m	170251.555 m	169529.584 m
False northing	126867.909 m	126867.909 m	126907.39 m
Scale	1	1	1.0000067
Datum	Palestine_1923	Palestine_1923	ITRF00/2004.75
EPSG code	28191	28192	--
Usage	Cadastral/Engineering	Cartography/Mapping	Cadastral/Engineering

Problem2: Different Reference Datum

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{Local} = (1+s)\begin{bmatrix} 1 & r_z & -r_y \\ -r_z & 1 & r_x \\ r_y & -r_x & 1 \end{bmatrix}\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{WGS84} + \begin{bmatrix} T_x \\ T_y \\ T_z \end{bmatrix}$$





Parameters from different sources

Parameter	Method				
	A	B	C	D	E
Source	Trimble TBC	Esri	Esri/QGIS	GNSS-provider A	GNSS-provider B
(ppm)	0	0	0	8.8471	5.4248
(sec)	0	0	-8.001	-11.1499	-0.33009
(sec)	0	0	-4.42	-8.56249	-1.85269
(sec)	0	0	-11.821	-5.04769	1.66969
(m)	230	219.247	275.722	121.451	-24.0024
(m)	71	73.802	-94.782	114.142	-17.1032
(m)	-273	-269.529	-340.894	-284.684	-17.8444
Ellipsoid	Clarck1880	Clarck1880	Clarck1880	Clarck1880	GRS80
Related Projected coordinates	Pal1923grid (Cassini)	Pal1923grid (Cassini)	Pal1923grid (Cassini)	Pal1923grid (Cassini)	New Pal-TM

Problem3: Datum Definitions

Old Original Palestine Grid	Old Israeli Grid
Palestine_1923_Palestine_Grid WKID: 28191 Authority: EPSG Projection: Cassini False_Easting: 170251.555 False_Northing: 126867.909 Central_Meridian: 35.21208055555556 Scale_Factor: 1.0 Latitude_Of_Origin: 31.73409694444445 Geographic Coordinate System: GCS_Palestine_1923 Datum: D_Palestine_1923 Spheroid: Clarke_1880_Benoit Semimajor Axis: 6378300.789 Semiminor Axis: 6356566.435	Palestine_1923_Israel_CS_Grid WKID: 28193 Authority: EPSG Projection: Cassini False_Easting: 170251.555 False_Northing: 1126867.909 Central_Meridian: 35.21208055555556 Scale_Factor: 1.0 Latitude_Of_Origin: 31.73409694444445 Geographic Coordinate System: GCS_Palestine_1923 Datum: D_Palestine_1923 Spheroid: Clarke_1880_Benoit Semimajor Axis: 6378300.789 Semiminor Axis: 6356566.435

New Original Palestine Grid	New Israeli Grid
Palestine_Grid_1923_Modified_TM WKID: 103699 Authority: Esri Projection: Transverse_Mercator False_Easting: 169529.584 (-50000) False_Northing: 126907.39 (-500000) Central_Meridian: 35.204516944 Scale_Factor: 1.0000067 Latitude_Of_Origin: 31.734393611 Geographic Coordinate System: GCS_Israel Datum: D_Israel Spheroid: GRS_1980 Semimajor Axis: 6378137.0 Semiminor Axis: 6356752.314	Israel_TM_Grid WKID: 2039 Authority: EPSG Projection: Transverse_Mercator False_Easting: 219529.584 False_Northing: 626907.39 Central_Meridian: 35.204516944 Scale_Factor: 1.0000067 Latitude_Of_Origin: 31.734393611 Geographic Coordinate System: GCS_Israel Datum: D_Israel Spheroid: GRS_1980 Semimajor Axis: 6378137.0 Semiminor Axis: 6356752.314

Problem4: Different Data Sources

- **After 2018, GNSS field measurement with New-Pal-TM coordinates**
- **GNSS field measurements with WGS84 coordinates Transformed by different software types to Pal1923Grid**
- **Global Data with WGS84 coordinates**
- **Photogrammetric Data with Pal1923Grid defined system and GNSS Control Points.**
- **Classic new and old surveys , as well old basemaps, cadastral and property survey based Pal1923Grid.**
- **Use background Satellite Images / OpensteetMaps**
- **In GIS: assume all Pal1923Grid or Blind Transformations on-the-fly**

Several Parameters from different sources

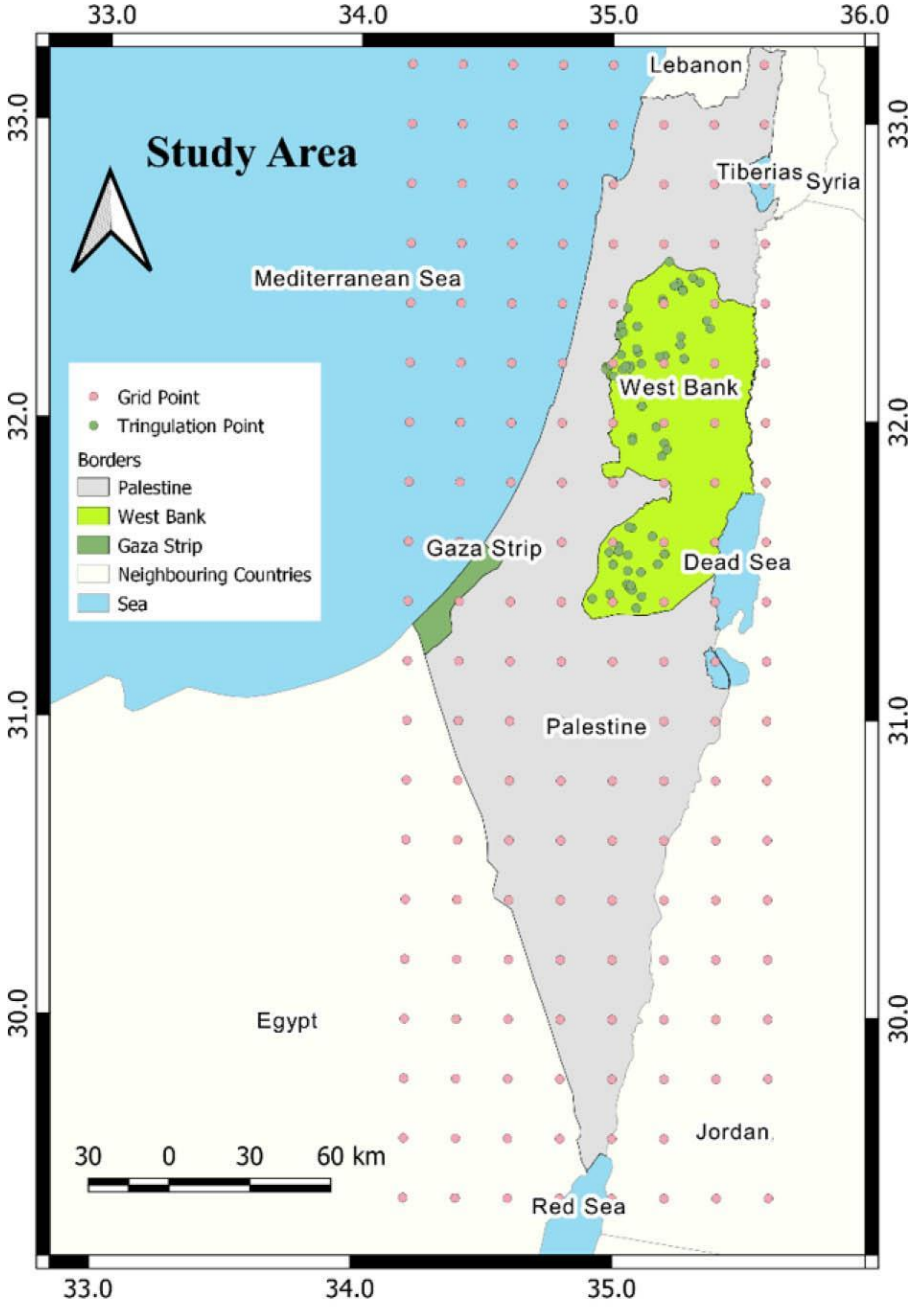
Parameter	Method				
	A	B	C	D	E
Source	Trimble TBC	Esri	Esri/QGIS	GNSS-provider A	GNSS-provider B
(ppm)	0	0	0	8.8471	5.4248
(sec)	0	0	-8.001	-11.1499	-0.33009
(sec)	0	0	-4.42	-8.56249	-1.85269
(sec)	0	0	-11.821	-5.04769	1.66969
(m)	230	219.247	275.722	121.451	-24.0024
(m)	71	73.802	-94.782	114.142	-17.1032
(m)	-273	-269.529	-340.894	-284.684	-17.8444
Ellipsoid	Clarck1880	Clarck1880	Clarck1880	Clarck1880	GRS80
Related Projected coordinates	Pal1923grid (Cassini)	Pal1923grid (Cassini)	Pal1923grid (Cassini)	Pal1923grid (Cassini)	New Pal-TM

In addition: New Pal-GRF project

Methodology

- Comparing different Transformations methods using field surveyed control points (Trig-points) based on WGS84 and converted locally to Pal1923Grid
- Relative comparison between the different transformation methods using regular virtual points

Method				
A	B	C	D	E
Trimble TBC	Esri	Esri/QGIS	GNSS-provider A	GNSS-provider B

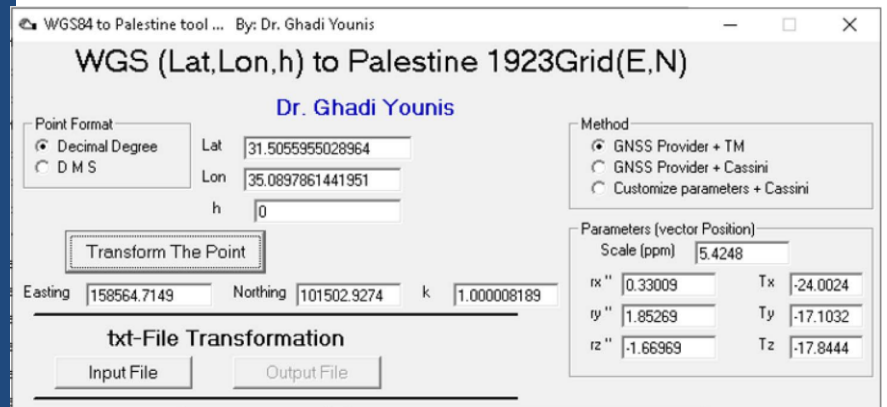


Accuracy based on reference Trig-points

Value (m)		Method A	B	C	D	E
Easting	Min	-3.085	-11.575	0.526	-0.395	-0.502
	Max	5.902	-2.580	1.524	0.460	0.405
	RMSE	2.950	8.004	1.028	0.207	0.235
Northing	Min	3.631	-3.068	1.424	-0.435	-0.609
	Max	7.930	1.154	2.614	0.822	0.630
	RMSE	5.915	1.450	2.021	0.307	0.311
Radial	Min	4.767	3.103	1.693	0.050	0.048
	Max	8.185	11.581	2.868	0.822	0.672
	RMSE	6.610	8.134	2.267	0.370	0.390

Differences between calculated coordinates of methods D and E

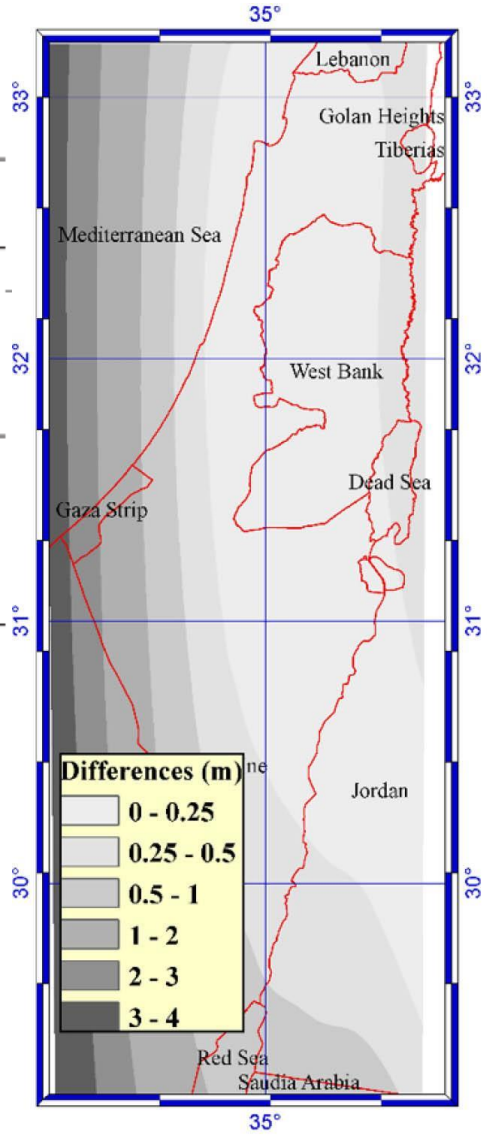
	Value	Differences
Easting	Min	0.020
	Max	0.115
	RMSE	0.088
Northing	Min	0.164
	Max	0.202
	RMSE	0.180
Radial	Min	0.173
	Max	0.228
	RMSE	0.201



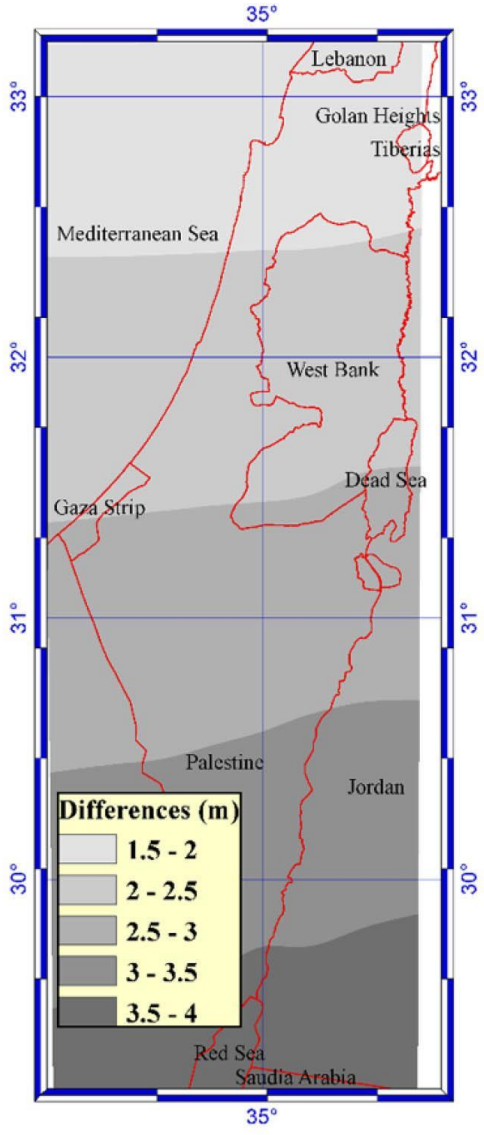
Method				
A	B	C	D	E
Trimble TBC	Esri	Esri/QGIS	GNSS-provider A	GNSS-provider B

Comparison of regular points to Method D

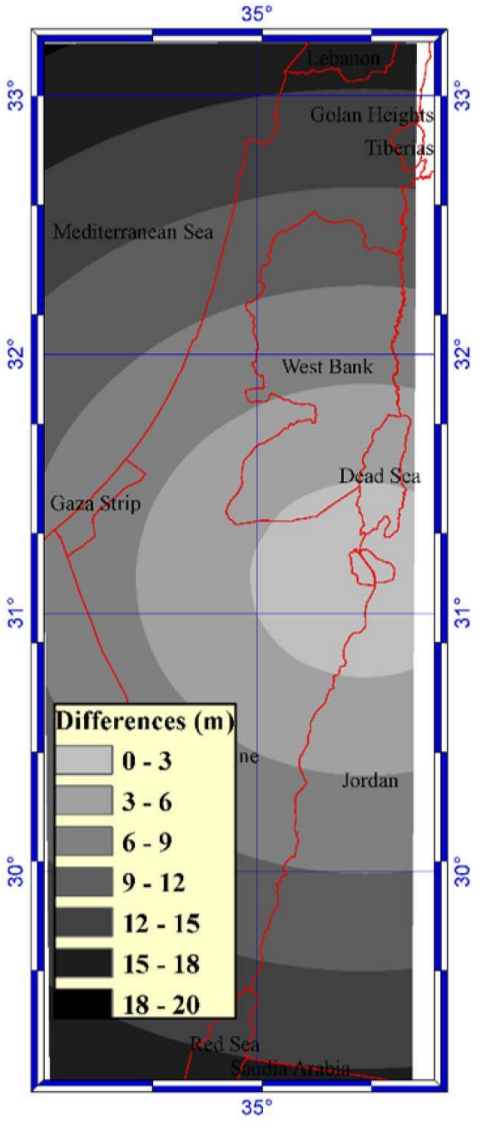
Value		Method A	B	C	E
Easting	Min	-8.832	-17.260	0.543	-0.335
	Max	23.883	15.369	2.541	4.493
	RMSE	12.113	9.5573	1.557	1.592
Northing	Min	-3.760	-10.228	1.242	-0.652
	Max	10.033	3.203	3.320	0.084
	RMSE	4.695	4.762	2.262	0.245
Radial	Min	0.752	0.558	1.592	0.013
	Max	24.614	18.267	3.921	4.540
	RMSE	12.991	10.692	2.746	1.559



(a) Method D – Method E



(b) Method D – Method C



(c) Method D – Method B

Recommendations

- Any Map/Plan must have defined coordinates system/Date/Datum
- The Definition of Modern National Datum and Geodetic static and active Networks With a national Datum/Projection
- A review of old maps coordinates system and surveying method and applying national/or local transformation methods.

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Thank you

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