Transformation of Geodetic Coordinates Between Datums Used in Syria by Multiple Regressing Equations

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Abstract:

The geodetic network does not cover the entire area of Syria. This network has been damaged in different areas over years; whether in vacant or damaged places, some of its points have become unreliable and inaccurate. Syria has been utilizing Global Navigation Satellite Systems (GNSS) technology for geodetic applications. In order to apply the GNSS acquired data locally, it is necessary to transform coordinates from the global datum WGS84 to the Syrian local geodetic datum Clarke-1880, but the aforementioned damage to the geodetic network has led to an absence of common transformation parameters in Syria to carry out the transformation from the global to the local reference datums; this further complicates and impedes the use of GNSS measurements and thus necessitates the search for an appropriate method of transformation between the two reference datums used in Syria. In this study, the Multiple Regression Equations technique was applied in 2 dimensions to a sample of points, whose geodetic coordinates are known on the global and local datums, distributed almost equally over the area of Syria. Transformation parameters were calculated using polynomials of the fifth degree by means of the least squares method; these parameters allow for calculating the differences of the geodetic coordinates between the global and local references for any point in Syria. The geodetic coordinates of the points on Clarke-1880 were calculated by adding those differences to the geodetic coordinates measured by the global positioning system (GPS) and then calculating the Cartesian coordinates in the Syrian Stereographic system. The resulting linear Positioning Accuracy of the points is about ±3.81m.

Keywords: GNSS, Multiple Regression Equations, Geodetic Datum, Datum Transformations, Geodetic Coordinates, Least Squares

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تحويل الإحداثيات الجيوديزية بين سطوح الاسناد المستخدمة في سورية بواسطة معادلات الانحدار المتعدد Multiple Regressing Equations

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الملخص:

لا تغطي الشبكة الجيوديزية كامل مساحة سورية وقد تعرضت هذه الشبكة إلى التخريب خلال السنوات الماضية في مناطق متفرقة. إن عدم وجود وسطاء تحويل عامة في سورية للتحويل من المرجع العالميWGS84 إلى المرجع المحلي Clarke 1880 يزيد المسألة تعقيداً ويعيق الاستفادة من قياسات نظام التموضع العالمي GPS سواءً في الأماكن الخالية أو المخربة، الأمر الذي يستدعي البحث عن طريقة مناسبة للتحويل بين المرجعين المستخدمين في سورية. في هذا البحث تم اختيار طريقة Multiple Regression Equations لتحويل الإحداثيات الجيوديزية بين المرجعيين العالمي والمحلي وذلك نظراً لملاءمتها للمساحات الواسعة وكفاءتها العالية في توزيع التشوهات اللاخطية، وقد تم اختيار مجموعة نقاط موزعة بشكل مقبول على مساحة سورية معلومة الإحداثيات الجيوديزية على المرجعين العالمي والمحلي وحساب الفروقات بينها باستخدام كثير حدود من الدرجة الخامسة وتطبيق طريقة التربيعات الصغرى لحساب عوامل وثوابت كثير الحدود التي تسمح بحساب فروق الإحداثيات الجيوديزية بين المرجعين لأي نقطة في سورية. وإضافة تلك الفروقات إلى الإحداثيات المقاسة بواسطة GPS لحساب الإحداثيات الجيوديزية المحلية، فبتطبيق التحويل المباشر من الإحداثيات الجيوديزية المحلية إلى مستوي الارتسام الستيريوغرافي العقاري السوري. أعطت التجربة دقة مكانية للنقاط $\sigma_P = \pm 3.81 \;\; m$.

الكلمات المفتاحية: نظام التموضع العالمي، معادلات الانحدار المتعدد، سطوح الاسناد الجيوديزية، تحويلات هندسية، إحداثيات جيوديزية، التربيعات الصغرى.

Introduction

In the broad spectrum of activities covered by geodesy, one of the primary tasks is the establishment of a well-defined geodetic networks featuring high accuracy and reliability. Those networks are considered an essential basis for all precise surveying works and have a variety of uses in the field of both scientific and applied geodesy. Previously, geodetic networks were established through conventional surveying techniques such as theodolites and Electronic Distance Measurement devices (EDM). Recently, there is growing interest in positioning techniques based on Global Navigation Satellite Systems (GNSS) such as Global Positioning System (GPS) which can be used to establish new geodetic networks or to densify and update old ones due to its cost effectiveness, speed, and accuracy compared to the conventional surveying methods. However, up until now, Syria has not been able to fully utilize the enormous potential of GNSS due to some limitations. One of the core contributing factors is the issue of having multiple, inaccurate sources of geodetic network (France, Russia, Syria) as well as the lack of coverage (it only covers 70% of the total area of Syria) This is further complicated by the fact that in some areas there is no network or the network has been vandalized. Consequently, the use of modern surveying techniques which utilize GPS is significantly undermined due to there being no general transformation parameters in Syria between the global and local datum. The Syrian geodetic network does not provide a total coverage of its area. This network was severely damaged over the years, which led to tampering of the network and loss of a considerable number of its points. The insufficiency of geodetic network points, whether in vacant or ruined places, justifies the need to look for one of the methods of converting coordinates between geodetic datums. The direct transformation method using Multiple Regression Equations has been selected out because it is suitable for large areas and more effective in distributing distortions almost equally, given that the behavior of the differences between the geodetic coordinates between the global and local references is non-linear [1]. For this purpose, seventy points on both global and local references, with known geodetic coordinates, were chosen and distributed in line with permitted circumstances of the corresponding country. These differences between global and local data were used in solving polynomials of the fifth degree and calculating parameters by the method of least squares. These parameters allow the calculation of the differences between the geodetic coordinates measured by the GPS and the unknown geodetic coordinates on Clarke-1880 for any point by adding them to the GPS measurements to obtain the geodetic coordinates on Clarke-1880. By applying the direct transformation formulas [2] between the local datum and the Syrian national mapping coordinate system, which is 2D projected grid coordinates of easting and northing based on stereographic projection called the Syrian Stereographic System, the Cartesian coordinates of the points in the local system are obtained. This can be used if there is a need to implement plane surveys at project sites to produce topographical maps with different scales to be used in planning, studying and implementing these projects.

The research aims to determine the direct transformation parameters between the geodetic coordinates measured by GPS and the geodetic coordinates the local ellipsoid Clarke1880 using the Multiple Regression Equations technique, and to estimate the accuracy of the conversion in the Syrian stereographic system.

1. Methodology

1.1. Study Area

The study area is Syria, which is located in the Middle East, with a coastline at the eastern Mediterranean Sea, between latitudes 32˚.5-37˚.5 and longitudes 35˚.4-42˚.3. The country occupies an area of 185,180 km². There are seventy points distributed acceptably on different parts of Syria. Its local rectangular coordinates in the Syrian Stereographic System are determined; its geodetic coordinates on WGS84 are measured Fig.1 shows the distribution of points in the study area.

V; the normalized geodetic longitude of the compotation point.

(ϕ, λ): global geodetic latitude and global longitude (in degrees), respectively of the compotation point.

(ϕc, λc): geodetic coordinate at or near the center of the study area (in degrees).

K: the degrees-to-radians scale factor.

K is a selected scale factor to reduce the equations and usually takes the value of (π/180), or its multiples, so that the value becomes $-1<U<1$ ، $-1<V<1$. The aim of this simplification is to obtain parameters with acceptable values that are neither large nor small [3].

In some literature, researchers [4] used two scale factors: K_1 for geodetic latitude and K_2 for geodetic longitude. This method is justified when the study area is elongated, meaning the length is much greater than the width; some researchers [5] also recommend using intermediate coordinates and considering them as the coordinates of the center of the points in the project area when calculating U and V as follows.

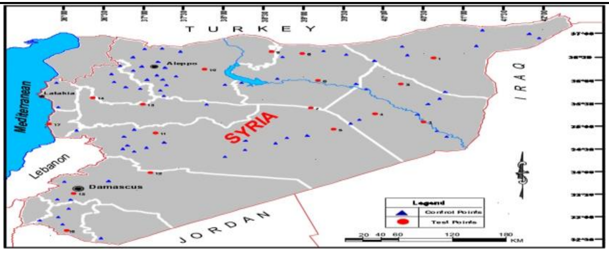
$$\phi_c = \frac{(\phi_{max}+\phi_{min})}{2} \qquad \lambda_c = \frac{(\phi\lambda_{max}+\lambda_{min})}{2}$$

In this study, a single scale factor K was chosen because the study area isn't elongated .its value is (5π/180), and the center of the points (ϕc, λc) is the center of the Syrian stereographic projection located in the middle of Syria $(34^\circ 12', 39^\circ 09')$ as the points distributes over the entire area of syria therefor this point can be considered as the center of the points in the study area .

According to snyder[6] , Increasing the degree of the polynomial does not improve the accuracy. However a polynomial of the sixth degree was examined and gave the same accuracy, therefore a polynomial of the fifth degree was utilized to reduce the constants and increase the redundant measurements.

After considering these hypotheses and substituting the differences of the geodetic coordinates in Eq. (1) and Eq. (2) and solving the polynomial by least-squares method, the transformation parameters needed to transform the geodetic coordinates from the global to Clarke-1880 shown in Table 1 are set.

Therefore, Eq. (1) and Eq. (2) can be written as follows:



Fig(1) Distribution of studied points

1.2. Data Acquisition

The data used in this study were those of seventy points. Their geodetic coordinates on WGS84 were obtained by GPS measurements, and their Cartesian coordinates (x, y) in the Syrian stereographic system are also known. The geodetic coordinates on Clarke-1880 were calculated by indirect transformation formulas [2]. The geometric parameters of relevant ellipsoids are

1.3. Method Used

The direct transformation parameters between the geodetic coordinates measured by GPS on WGS84 and the geodetic coordinates on Clarke-1880 utilizing the Multiple Regression Equations technique spans several stages and requires the calculation of the geodetic coordinate differences between the global and local datums. The aim of calculating the geodetic coordinates differences between the two datums is to solve polynomials of the fifth degree by the least squares method as well as to determine transformation parameters of geodetic coordinates from the global to the local datum according to the following formulas.

$$[\Delta\varphi]^{''} = A_0 + A_1 U + A_2 V + A_3 U^2 + A_4 UV + A_5 V^2 + \cdots + A_{19} U V^4 + A_{20} V^5 \qquad (1)$$

$$[\Delta\lambda]^{''} = B_0 + B_1 U + BV + B_3 U^2 + B_4 UV + B_5 V^2 + \cdots + B_{19} U V^4 + B_{20} V^5 \qquad (2)$$

Where:

U=K (ϕ-ϕc) ; V=K (λ- λc)

whereas

A0, B0, A1, B1…An, Bn: coefficients to determine in the development.

U; the normalized geodetic latitude of the compotation point.

$$\Delta\varphi'' = 0.00083 - 0.01374U + 0.00685V + 0.14918U^2 - 0.11805\,UV + 0.00534V^2 - 0.51695\,U^3 + 0.67733\,U^2V + 0.19055UV^2 - 0.19693V^3 - 0.39163U^4 - 0.87079\,U^2V^2 - 1.46308U^3V + 2.70475UV^3 - 0.89422V^4 + 3.71262U^5 - 2.15224U^4V + 2.51631U^3V^2 - 6.7207U^2V^3 + 4.1358UV^4 - 1.18451V^5 \quad (3)$$

$$\Delta\lambda'' = -0.00148 + 0.00845U - 0.00429V - 0.11417U^2 + 0.07832\,UV - 0.00504V^2 + 0.52145\,U^3 - 0.59582\,U^2V + -0.0247UV^2 + 0.1086V^3 - 0.62425U^4 + 2.145036\,U^2V^2 - 0.115153U^3V - 1.24441UV^3 + 0.35528V^4 - 0.79653U^5 - 3.1433U^4V + 0.49393U^3V^2 + 3.29948U^2V^3 - 1.78168UV^4 + 0.177911V^5 \quad (4)$$

Where:

$U = K(\phi - 34°.2)$,$V = K(\lambda - 39°.15)$

K=0.0872664626.

Table (1) transformation parameters between the global and local datum

a_i		b_i	
a_0	0.00083	b_0	-0.00148
a_1	-0.01374	b_1	0.00845
a_2	0.00685	b_2	-0.00429
a_3	0.14918	b_3	-0.11417
a_4	-0.11805	b_4	0.07832
a_5	0.00534	b_5	-0.00504
a_6	-0.51695	b_6	0.52145
a_7	0.67733	b_7	-0.59582
a_8	0.19055	b_8	-0.02470
a_9	-0.19693	b_9	0.10860
a_{10}	-0.39163	b_{10}	-0.62425
a_{11}	-0.87079	b_{11}	2.14504
a_{12}	-1.46308	b_{12}	0.11515
a_{13}	2.70475	b_{13}	-1.24441
a_{14}	-0.89422	b_{14}	0.35528
a_{15}	3.71262	b_{15}	-0.79653
a_{16}	-2.15224	b_{16}	-3.14330
a_{17}	2.51631	b_{17}	0.49393
a_{18}	-6.72070	b_{18}	3.29948
a_{19}	4.13580	b_{19}	-1.78168
a_{20}	-1.18451	b_{20}	0.17791

Eq. (3) and Eq. (4) allow calculating the difference of the geodetic coordinates (Δφ, Δλ) for any point in Syria whose global geodetic coordinates are known, then calculating their geodetic coordinates on Clarke-1880 according to the following Eq. (5) and Eq. (6):

$$\varphi_{clarke1880} = \varphi_{wgs84} + \Delta\varphi \qquad (5)$$

$$\lambda_{clarke1880} = \lambda_{wgs84} + \Delta\lambda \qquad (6)$$

Finally, transforming to the rectangular coordinates (x, y) in the Syrian stereographic system by direct transformation formulas [1]. In this research, an experiment was applied on a sample of 17 points Fig.1. The Geodetic coordinates WGS84, and Cartesian coordinates (x, y) in the Syrian stereographic system are known, Table 2.

Table (2) Point Coordinates in WGS84 and Syrian Stereographic System

point	Stereographic		WGS-84	
	$x_{(m)}$	$y_{(m)}$	$\varphi_{(deg)}$	$\lambda_{(deg)}$
1	131735.78	245492.18	36.404125	40.620241
2	120391.72	90876.16	35.011933	40.470910
3	95264.06	182645.33	35.841966	40.206174
4	66497.67	110575.36	35.194547	39.881800
5	20121.84	73053.69	34.858153	39.371441
6	2955.36	190951.04	35.921481	39.184153
7	-5363.37	124362.17	35.321057	39.092338
8	-14736.85	256426.64	36.511514	38.986920
9	-49354.01	260809.88	36.549884	38.600211
10	-123529.85	218336.45	36.160627	37.778361
11	-178319.35	63872.85	34.760270	37.202768
12	-184153.15	-32384.32	33.891533	37.159501
13	-192582.74	133431.85	35.384657	37.031129
14	-248417.52	149412.54	35.516601	36.411948
15	-269634.92	-82366.47	33.422667	36.251013
16	-277358.71	-180190.77	32.539083	36.198006
17	-297116.28	85863.71	34.931018	35.897891

The following steps describe the methodology adopted:

First Step: Calculate the geodetic coordinate's differences for sample points between the global and local ellipsoids by solving the polynomial of the fifth degree by Eq. (3) and Eq. (4), after taking into account the assumptions mentioned in paragraph (4).

Second Step: transforming (shift) the geodetic coordinates from the global to the local ellipsoid by Eq. (5) and Eq. (6), Table 3.

Third Step: transforming (translate) the geodetic coordinates on the local ellipsoid to the Cartesian coordinates in the Syrian stereographic system by applying direct transformation formulas [1]. Table 4 shows the calculated Cartesian coordinates of the points.

Table(3) Geodetic Coordinates in Clarke-1880

point	differences		Clarke-1880	
	$\Delta\varphi_{(deg)}$	$\Delta\lambda_{(deg)}$	$\varphi_{(deg)}$	$\lambda_{(deg)}$
1	0.000661	-0.001513	36.404787	40.618728
2	0.000568	-0.001386	35.012502	40.469524
3	0.000593	-0.001453	35.842559	40.204721
4	0.000522	-0.001368	35.195069	39.880432
5	0.000478	-0.001308	34.858631	39.370133
6	0.000466	-0.001399	35.921947	39.182754
7	0.000423	-0.001319	35.321481	39.091019
8	0.000479	-0.001436	36.511994	38.985484
9	0.000493	-0.001429	36.550378	38.598782
10	0.000416	-0.001412	36.161042	37.776949
11	0.000332	-0.001247	34.760602	37.201521
12	0.000172	-0.001155	33.891705	37.158346
13	0.000365	-0.001363	35.385022	37.029766
14	0.000200	-0.001336	35.516800	36.410612
15	0.000100	-0.001240	33.422667	36.251013
16	0.000064	-0.001283	32.539083	36.198006
17	0.000165	-0.001157	34.931018	35.897891

Table(4) calculated Cartesian coordinates

point	Stereographic	
	$x_{(m)}$	$y_{(m)}$
1	131737.93	245495.58
2	120392.99	90876.89
3	95264.81	182650.92
4	66497.57	110576.29
5	20122.01	73049.02
6	2955.51	190954.29
7	-5361.33	124355.50
8	-14736.55	256426.94
9	-49351.75	260811.21
10	-123530.23	218338.25
11	-178317.80	63873.88
12	-184154.74	-32387.76
13	-192579.54	133434.36
14	-248418.16	149410.96
15	-269635.79	-82369.17
16	-277363.05	-180193.09
17	-297120.26	85859.32

2. Accuracy Assessment

The accuracy of the Multiple Regression Equations technique utilized was analyzed using statistical indices. This was done by quantifying the differences (Δx, Δy), As shown in Table 5, obtained when the Multiple Regression model results Table 4 were subtracted from the existing projected grid coordinates Table 2. The statistical indices used are arithmetic mean, the root mean square error, mean absolute error, median horizontal position error and the correlation factor.

The analysis includes the following:

2.1. Statistical analysis of errors about X-axis

In this research, the main indicators of point accuracy represented by the arithmetic mean, the mean squared error, the arithmetic mean error, and the median were studied.

After arranging the sample in ascending order. The middlemost number of the range was determined as follows [8].

For even numbered n;

$r_x = \frac{\Delta x_i + \Delta x_{i+1}}{2}$, where $i = \frac{n}{2}$

For odd numbered n;

$r_x = \Delta x_i$, where $i = \frac{n+1}{2}$

in this study, n=17, it is therefore r_x=1.27 m. To accept the potential error, the t_2 factor obtained by dividing the root mean squared error by the median must be calculated and compared with its theoretical value $t_2 \approx 1.48$

$$t_2 = \frac{m_x}{r_x} \approx \frac{1.99}{1.27} 1.56 \approx 1.48 \quad \textit{reached}$$

The realization of the arithmetic mean error and mean absolute error are further indications that the errors about the X -axis are random errors that follow the law of normal distribution.

2.2. Statistical analysis of errors about Y-axis

As mentioned in paragraph (3.1), to study the errors around the Y axis, to analyze them and judge their accuracy, the arithmetic mean must be calculated first:

- Arithmetic Mean

$\overline{\Delta Y} = \frac{\sum_1^n \Delta y_i}{n} = \frac{-4.88}{17} = -0.29\ m$

the systematic errors in the measurements around the Y-axis must be checked out by the following inequality [7].

$|[\Delta Y]| \leq 0.25 \times [|\Delta Y|]$

Giving

$4.88 \leq 0.25 \times 46.62 \Rightarrow 4.88 \leq 11.66$ Reached

Thus, the hypothesis of neglecting the systematic errors can be accepted and the errors committed in the measurements about the Y-axis are random errors.

- The Root Mean Squared Error

$m_y = \sqrt{\frac{\sum_1^n \Delta y_i}{n}} = \sqrt{\frac{179.71}{17}} = 3.25\ m$

- The Mean Absolute Error

$v = \frac{\sum_1^n |\Delta y_i|}{n} = \frac{46.62}{17} = 2.74\ m$

To accept the mean absolute Error, the factor K_1 obtained from dividing the mean squared error by Median must be calculated and compared with its theoretical value $t_1 \approx 1.25$ [7].

$t_1 = \frac{m_y}{v} \approx \frac{3.25}{2.74} 1.19 \approx 1.25 \quad \textit{reached}$

Table (5) coordinate differences used in statistical analysis

Point	Differences		Point	Differences	
	$\Delta x_{(m)}$	$\Delta y_{(m)}$		$\Delta x_{(m)}$	$\Delta y_{(m)}$
1	2.15	3.40	10	-0.38	1.80
2	1.27	0.72	11	1.55	1.03
3	0.75	5.59	12	-1.59	-3.44
4	-0.10	0.93	13	3.20	2.51
5	0.17	-4.67	14	-0.64	-1.58
6	0.15	3.25	15	-0.87	-2.69
7	2.04	-6.67	16	-4.34	-2.32
8	0.30	0.30	17	-3.98	-4.39
9	2.26	1.33			

- Arithmetic Mean

$\overline{\Delta X} = \frac{\sum_1^n \Delta x_i}{n} = \frac{1.95}{17} = 0.11\ m$

After calculating the arithmetic mean, the systematic errors in the measurements must be checked out. These systematic errors represent an amount of displacement of the arithmetic mean of the errors around zero. The study of systemic errors can be neglected if the following inequality is true [7]:

|[ΔX]|≤0.25×[|ΔX|]

Giving

1.95≤0.25×25.74 1.95≤6.44 Reached

The inequality is verified, therefore the hypothesis of neglecting the systematic errors can be accepted, and the errors committed in the measurements about the X-axis are random errors.

- The Root Mean Squared Error

$m_x = \sqrt{\frac{\sum_1^n \Delta x_i}{n}} = \sqrt{\frac{67.40}{17}} = 1.99\ m$

- The Mean Absolute Error

$v = \frac{\sum_1^n |\Delta x_i|}{n} = \frac{25.74}{17} = 1.51\ m$

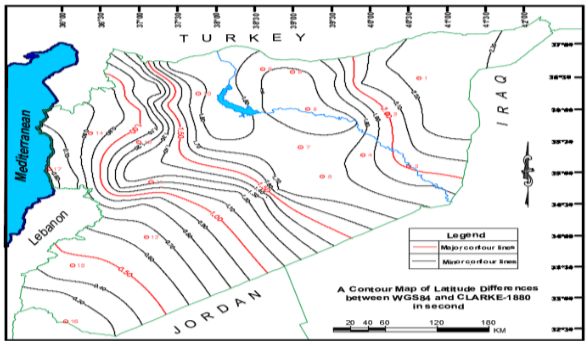
To accept the Median, the factor t1 obtained from dividing the mean squared error by Median must be calculated and compared with its theoretical value $t_1 \approx 1.25$ [7].

$t_1 = \frac{m_x}{v} \approx 1.25$

$t_1 = \frac{m_x}{v} \approx \frac{1.99}{1.51=} 1.32 \approx 1.25 \quad \textit{reached}$

- The Median

contour maps, but also extra information can be inferred from them. The contour interval between any two consecutive contours depends on whether the nature of the ground is flat or sleep, the scale of the map, and purpose of the survey. The accuracy of the height of a point on the Earth's surface can be determined by the internal averaging between these lines and it is equal to third of the contour interval (0.3e) [9]. In this study, Contours can be generated for geodetic latitude and longitude differences Fig.2 and Fig.3 respectively between the global and local ellipsoid calculated from 70 points with a contour interval of 0.1″e.



Fig(2) contour map of latitude differences between WGS84 and Clarke1880

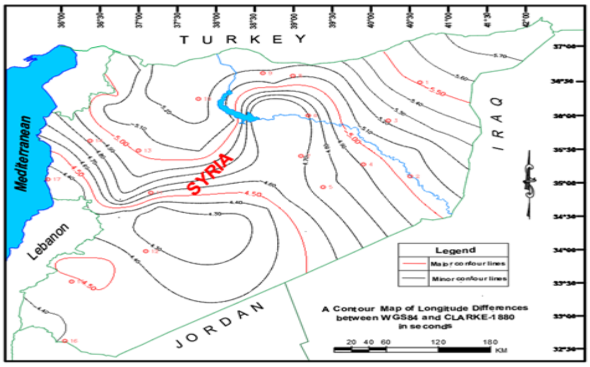


Fig (3) contour map of longitude differences between WGS84 and Clarke1880

Depending on the contours, the rectangular coordinates of any point in Syria can be calculated in the Syrian stereographic system according to the following steps:

1- Determining the geodetic latitude and longitude differences of the point by Eq. (3) and Eq. (4).

- The Median

After arranging the sample ascendingly and taking the value in the middle of the range, it is then determined as r_y=2.51 m.

To accept the potential error, the t_2 factor obtained by dividing the mean squared error by the potential error must be calculated and compared with its theoretical value t_2≈1.48

$$t_2 = \frac{m_y}{r_y} \approx \frac{3.25}{2.51} 1.29 \approx 1.48 \quad taken$$

The realization of the arithmetic mean error and mean absolute error are further indications that the errors about the Y -axis are random errors that follow the law of normal distribution.

2.3. Correlation factor ρ

In order to judge whether the random errors distributed about the X- axis and the -Y axis are independent or not, the correlation factor ρ between these errors about the two axes has to be calculated according to the following formula:

$$\rho = \frac{\sum_1^n(\Delta x_i)(\Delta y_i)}{(n-1)m_x m_y} = \frac{46.85}{16\times1.99\times3.25} = 0.45$$

Then calculating correlation factor error

$$m_\rho = \frac{(1-\rho^2)}{\sqrt{n}} = \frac{(1-0.45^2)}{\sqrt{17}} = 0.19$$

correlation reliability can be determined as follows

$$|\rho| \geq 3m_\rho \Rightarrow 0.45 \geq 3\times0.19 \Rightarrow 0.45 \geq 0.57$$

And, consequently , the inequality is non-detective which means that the errors around the X-axis are independent of the errors around the Y-axis. After completing the study of the accuracy indicators about the X and Y axes, the mean squared error of the position of the point can be calculated as follows:

$$M_P = \sqrt{m_x^2 + m_y^2} = \sqrt{1.99^2 + 3.25^2} = 3.85\ m.$$

It represents the accuracy in the Syrian Stereographic System resulting from the transformation parameters calculated from the Multiple Regression Equations.

3. Contours for geodetic latitude and longitude differences:

Contours are often used in survey to represent the topography of the Earth's surface. They facilitate the depiction of the terrain in a two-dimensional map called a contour map. Not only can many phenomena can be expressed and represented by

2- Adding the differences to the known global geodetic coordinates of the point.

3- Calculating its local geodetic coordinates by Eq.5 and Eq.6, then calculating its rectangular coordinates in the Syrian stereographic system [2].

This method was applied to the experiment points (17 points) and its accuracy was estimated as indicated in paragraph (3) . The linear positioning accuracy of the point was M p = 4.93 m.

4. Experimental Results and Discussion:

- It is noticeable in Fig.2, that the differences of latitudes between the two ellipsoid increase from the south-west by 0.3sec towards the north and north-east to become its greatest value of 2.3sec.
- It is noticeable in Fig.3, that the differences of longitudes increase from the south-west by -4.4 sec towards the north and north-east to become its largest value of - 5.7sec with negative value.
- The linear positioning accuracy is 3.85m; this is acceptable in many engineering applications and projects, such as Geographic information system GIS applications, land reclamation and irrigation projects, and initial planning for linear engineering construction projects, such as road projects, main irrigation canals, oil and gas pipelines, and the like.
- The linear positioning accuracy calculated from geodetic latitude and longitude is 4.93 m.
- The reduced in the accuracy of the resulting coordinates in the Syrian Stereographic System when using the contour lines is attributed to the fact that the contour lines include the error in calculating the coordinate differences together with the error deducing these differences from the contours.
- Using contours is more accessible than polynomials, as it does not require high experience. Consequently, it can be adopted in works that do not require high accuracy.

5. Conclusion:

It is recommended to recalculate new transformation parameters of Syria when the Syrian geodetic network is restored with its various degrees, and it is possible to obtain a considerable number of points distributed almost evenly to improve the accuracy. This method allows for the calculation of the rectangular coordinates of the points in the Syrian stereographic system, whose coordinates are measured by GPS using polynomials of the fifth degree by Eq (3) and Eq (4) vandalized areas and cleared areas from control points. This paper has suggested to calculate the rectangular coordinates of the points measured by GPS in the Syrian stereographic system using contours Fig.2 and Fig.3 in the event polynomial relations are inapplicable.

This research presents a study on the area of Syria as a case study.In later studies, it is possible to divide Syria into zones, and study the conversion of the coordinates of each zone separately.

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