Real Geodetic Map (Map without Projection)

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Abstract
The earth as a planet is geometrically represented as an ellipsoid or a sphere where geodetic computations should be followed. In small areas and as a special case, the considered area can be treated as a plan and plan metric computations are followed. The surveying elements to be introduced to the user could be distances, bearings, azimuths, and areas. These elements can be obtained by computing them from either map (projected) coordinates or from geodetic coordinates. In the past, not everybody could deal with the geodetic coordinates, so map projection has been introduced to facilitate dealing with the map using metric units. Nowadays computers and computer programming enable us to deal easily with geodetic computations and geodetic maps. In this research, the proposed computerized real geodetic map is introduced. The computations which have been done to clear the idea of the proposed map and their results are tabulated and illustrated.
Keywords: Map, Projection, Geodetic datum, Ellipsoid, Distortion, Scales, Coordinates

1. Introduction

Surveying nowadays could be generally divided into modern (satellite based) and traditional ways. In modern way, the required geodetic coordinates are obtained directly related to the specified geodetic datum. In the surveying traditional way, the required geodetic coordinates cannot be directly observed. They are obtained by computing them from taken traditional observations.

The traditional observations are distances, vertical angles, and horizontal angles. Those observations are taken related to the direction of actual gravity, while the geodetic computations will be carried out on the surface of the reference ellipsoid. Thus fictitious observations related to the direction of the normal to the ellipsoid should be obtained from the taken observations. It is therefore convenient to reduce the taken observations to the used reference ellipsoid. The new observations after reduction can then be used to calculate the geodetic coordinates (ø, λ), [Shaker, 1990 b].

Map projection is used to transform the obtained geodetic coordinates into plan (map) coordinates. In map projection process, distortion in distance, azimuth, area, or shape must happen. It is difficult to the user and not convenient to the specialist to deal with this distortion, [Iliffe J., 2003].

In the past, the computations and drawing the maps were manually done. Nowadays, computations and map production are automatically done by using electronic computers. Therefore it is the time now to draw the map using the geodetic coordinates directly and to avoid the noisy distortion. The proposed map will be computerized soft copy one and will be plotted whenever needed.

Parallels and meridians will be the background of the proposed map. Points will be represented by their geodetic coordinates (ø, λ). The needed surveying elements, (distances, azimuths, and areas), will be obtained by computing them using ad joint functions. Those functions (computer programs) will be part of the proposed electronic map. Just push button (hot keys) to obtain the needed element.

In the same datum, any point on the earth has unique geodetic value of coordinates; latitude and longitude (ø, λ). In projection systems like UTM (universal) and ETM (national); the same point lying at the border between two zones like longitude 33 E in ETM (between red and blue zones) and also longitude 12 E in UTM (between zones 32 and 33) has two different pairs of coordinates. Pair of (E, N) from the first zone and another different pair (E, N) from the second adjacent zone will be obtained. The same values of (E, N) are repeating in the sixty zones of UTM.

In large projects like petroleum pipe lines and international roads, when the project is located in two zones, a problem happens. One project should belong to one coordinate system but the projection makes it in two different zones or systems of coordinates. The followed solution is to relate the whole project to one zone or system of coordinates despite the resulting great value of distortion.

Distances from the proposed maps do not involve scale distortion. The shape of the feature in the proposed map will not differ from the corresponding feature's shape in the projected map. Parallels and meridians will be straights in the proposed map with its all scales. For example, the line of 60,000m, as an ellipsoidal distance, has 60019.879m, as a projected distance, in the map of 1:100,000. The difference between the two values in the map is approximately (20/100000) m i.e. 0.2mm which cannot even measured by a ruler.

The proposed automatic real map is digital map presented by Parallels and Meridians and calculation of distances, azimuths, and areas will be done using the appropriate geodetic equations by hot keys ad joint to the map; these points are known in geodetic datum like WGS84. The map could be plotted whenever a hard copy is needed.

2. Ellipsoidal Versus Plan Distances

The earth as a planet has a curved surface. In geodesy, that curved surface is geometrically represented by an ellipsoid or a sphere. This means that the geodetic computations are the default and it should be followed. In the surveying field and when small areas are considered, the plan surveying computations are followed. The area is considered small when the curvature of the earth does not appear, i.e. when the difference between the curved area and its plan surface is not significant compared to the required accuracy. When viewing an image of a small area in Google Earth, it looks like a flat area although the curvature of the earth exists.

The chord and curved distances between the same two points are computed with varying the distances from 1000 m till 100,000 m. The difference between chord and its arc distance for the same two points on the earth is very small in short lines. Table (1) shows the relation between chords and their corresponding arc distances as parts from great circles (minimum distance between two points on sphere) of the earth as sphere with R = 6,371,000 m, [M. R. SPIEGEL, 1968].

From the values in the table; Difference between arc and its corresponding chord distance reached 1 mm at distance 10 km, 10 cm at distance 45 km, and 1 m at distance 100 km.

Table 1. Relation between Chords and their corresponding Arc distances

Chord Dis. (m)	10,000	45,000	60,000	100,000
Arc Length (m)	10,000.001	45,000.093	60,000.223	100,001.026
Scale Factor	1.000000103	1.000002079	1.000002566	1.000010266

When using the smallest scale map 1:100,000 which covers 60 km * 40 km in one sheet while the differences of 22cm and 6.5cm at distances 60km and 40km respectively. Difference between Distances of 60,000.22m and 60,000m both drawn at scale 1:100,000 will not be noticeable to the user eye. Therefore using the geodetic coordinates directly in mapping will not show difference with mapping the same area using plan coordinates. I.e. differences between curves and straights will not appear on the map.

This part is computed and illustrated here to prove that the background of the proposed geodetic map (grid of latitudes and longitudes) will still be straights and not curves. The mapped features using ø, λ will not also differ in their form from their corresponding form in the projected map in all the surveying map scales.

3. Geodetic Versus Projected Maps in Different Surveying Scales

The computations on WGS84 (World Geodetic System 1984) and UTM (Universal Transverse Mercator) are done. In zone number 31 of UTM, two main groups of maps are chosen for the study, one of these groups is at the central meridian of the zone and the other group is at the zone border. The differences in the distances and azimuths at the surface of the ellipsoid and the map are studied on various scales 1: 1000, 1:2500, 1:5000, 1: 10,000, 1: 25,000, 1: 50,000, and 1:100,000.

The computations are done in sub groups G1 & G2 at equator, G3 & G4 at latitude 30^0N, G5 & G6 at latitude 60^0 N, G7 & G8 at latitude 70^0 N, and G9 & G10 at 80^0 N, figure(1). In UTM, zone width is 6 degrees. Chosen maps for the study have the following dimensions:

- 1:100,000 as 40' x 30' with approximate dimensions 74,200 m x 55,300 m at equator and 64,300 m x 55,400 m at latitude 30° and 37,200 m x 55,700 m at latitude 60°.
- 1:50,000 as 20' x15' with approximate dimensions 37,100 m x 27,650 m at equator and 32,150 m x 27,700 m at latitude 30° and 18,600 m x 27,850 m at latitude 60°.
- 1:25,000 as 10' x 7' 30" with approximate dimensions 18,550 m x 13,825 m at equator and 16,075 m x 13,850 m at latitude 30° and 9300 m x 13,925 m at latitude 60°.
- 1:10,000 as 4' x 3' with approximate dimensions 7420 m x 5530 m at equator and 6430 m x 5540 m at latitude 30° and 3720 m x 5570 m at latitude 60°.
- 1:5000 as 2' x 1' 30" with approximate dimensions 3710 m x 2765 m at equator and 3215 m x 2770 m at latitude 30° and 1860 m x 2785 m at latitude 60°.
- 1:2500 as 1' x 45" with approximate dimensions 1855 m x 1382 m at equator and 1608 m x 1385 m at latitude 30° and 930 m x 1392 m at latitude 60°.
- 1:1000 as 24" x 18" with approximate dimensions 742 m x 553 m at equator and 643 m x 554 m at latitude 30° and 372 m x 557 m at latitude 60°.

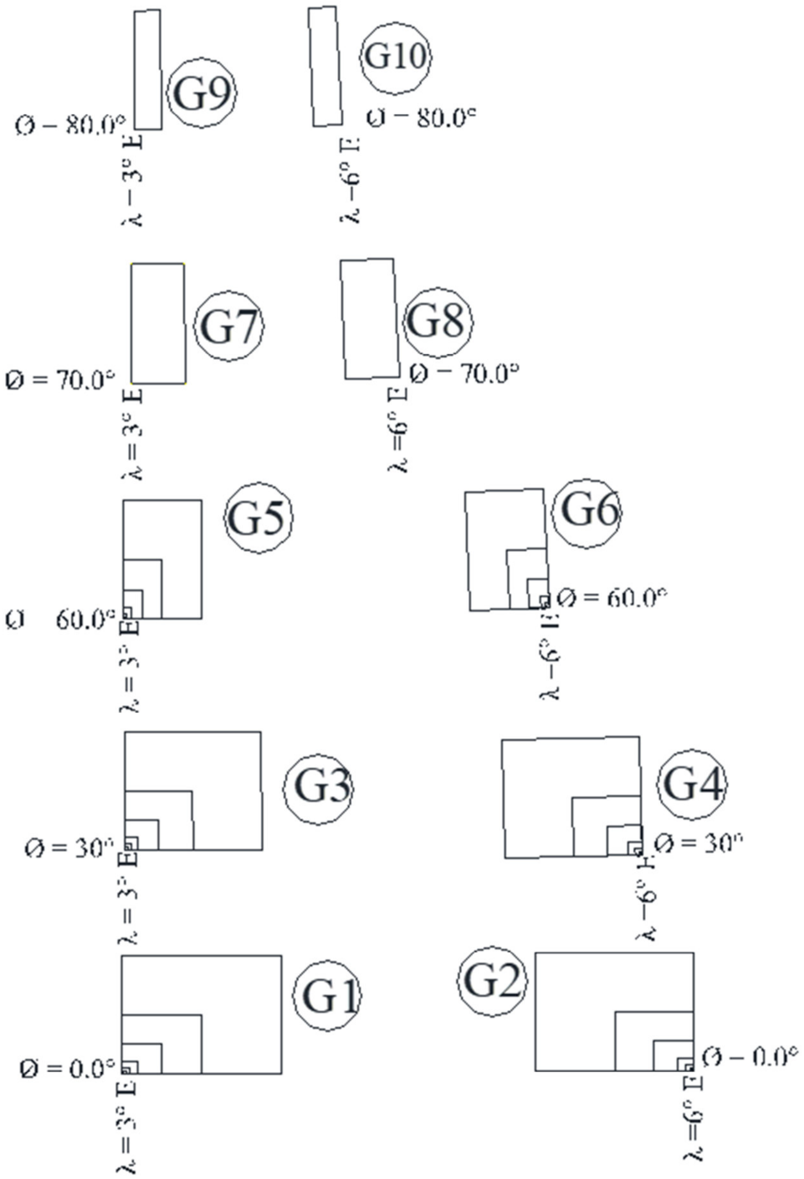

Figure 1. The distribution of Groups.

The geodetic coordinates of the corner points of the studied maps related to WGS84 and the corresponding projected values (UTM) at different scales for G1 and G2 at equator are computed, G1 & G2 Maps are distributed as in figure (2). These data are also prepared at latitude 30° N as Groups (3) & (4) and at latitude 60°N as Groups (5) & (6) and the data of Groups (7), (8), (9) and (10) at latitude 70°N, 80°N.

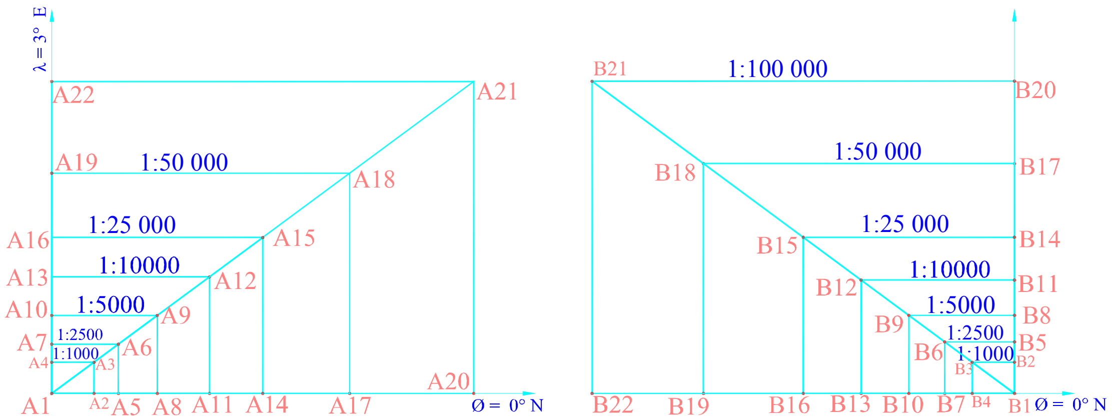

Figure 2. Groups G1 and G2 maps at equator

Maps are usually represented in map sheet of approximately 75 cm x 56 cm.

- Figure (3) shows in scale 1:1000, G1 and G2, with dimensions of 24" x 18".
- Figure (4) shows in scale 1:2500, G1 and G2, with dimensions of 1' x 45”.
- Figure (5) shows in scale 1: 5000, G1 and G2, with dimensions of 2' x 1’30”.
- Figure (6) shows in scale 1:10000, G1 and G2, with dimensions of 4' x 3’.
- Figure (7) shows in scale 1:25,000, G1 and G2, with dimensions of 10' x 7’ 30”.
- Figure (8) shows in scale 1:50,000, G1 and G2, with dimensions of 20' x 15’.
- Figure (9) shows in scale 1: 100,000, G1 and G2, with dimensions of 40' x 30’.

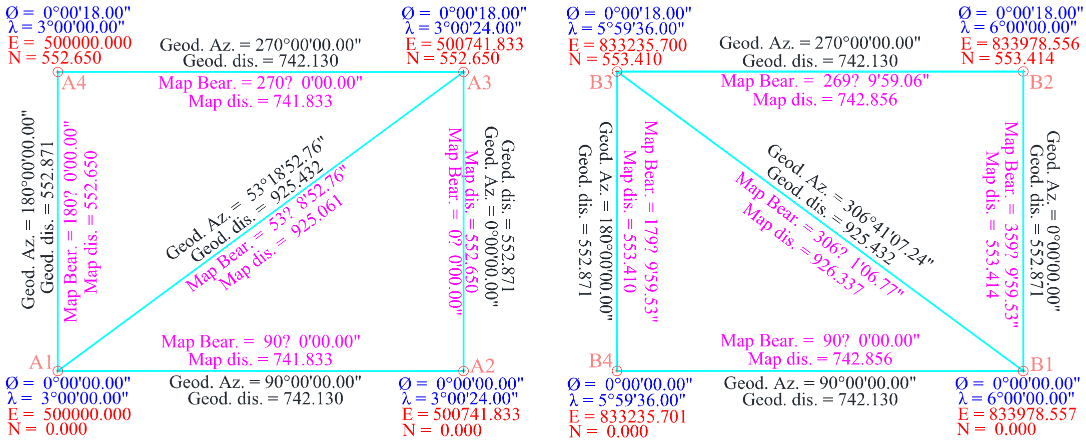

Figure 3. Map scale 1: 1000 in G1 and G2

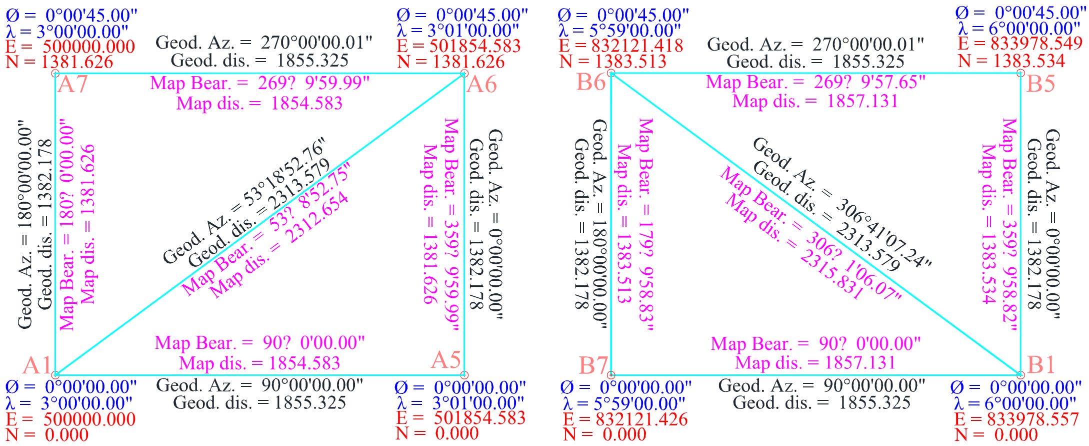

Figure 4. Map scale 1: 2500 in G1 and G2

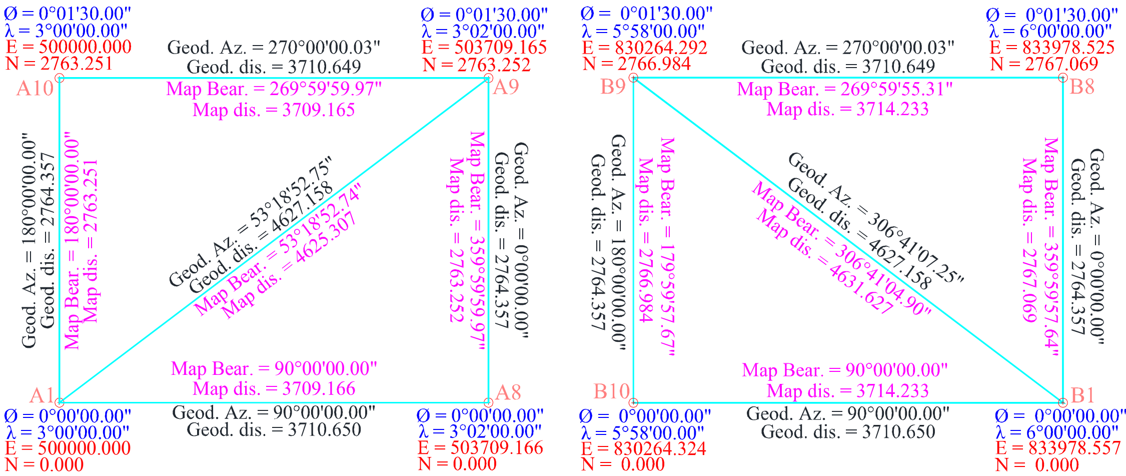

Figure 5. Map scale 1: 5000 in G1 and G2

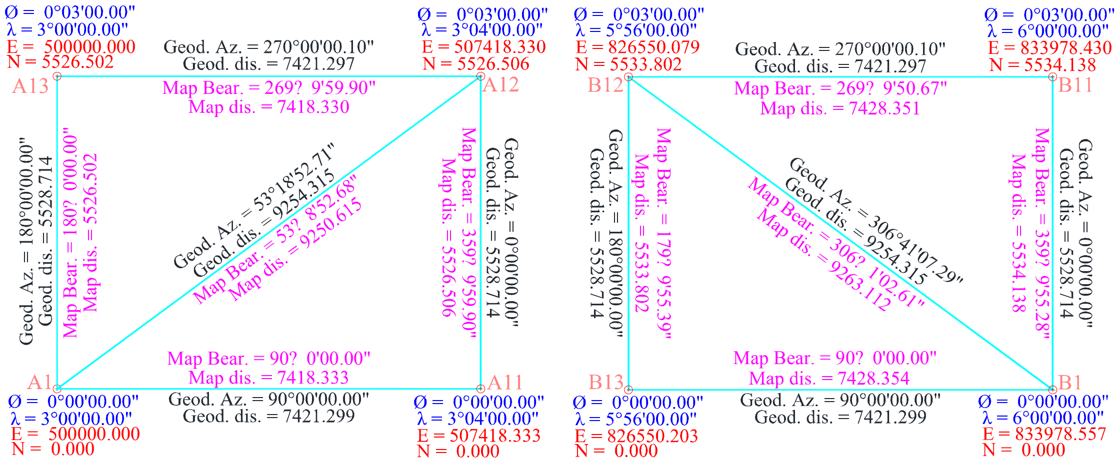

Figure 6. Map scale 1: 10,000 in G1 and G2

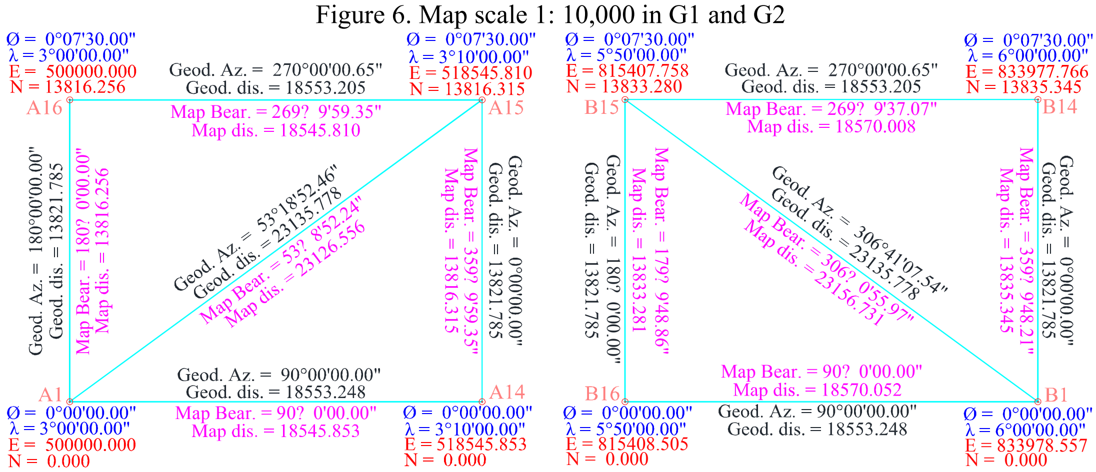

Figure 7. Map scale 1: 25,000 in G1 and G2

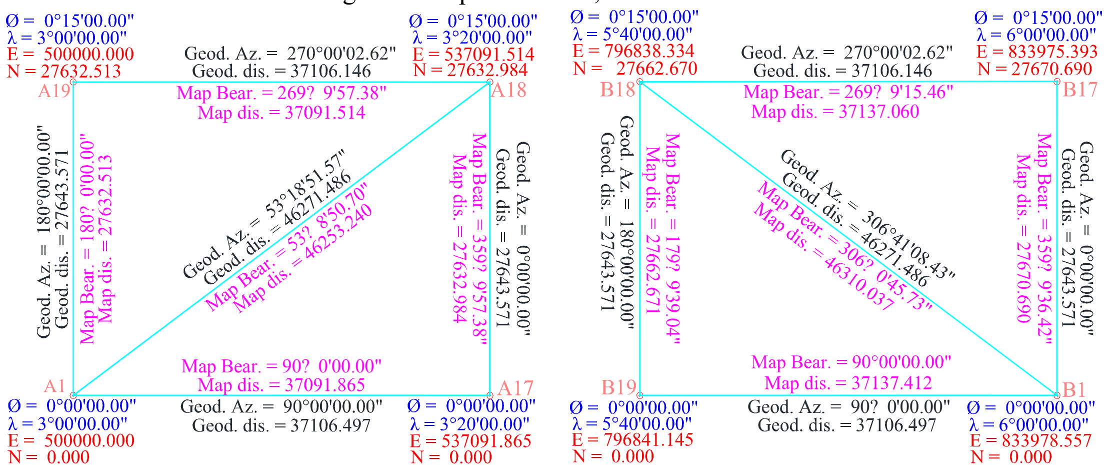

Figure 8. Map scale 1: 50,000 in G1 and G2

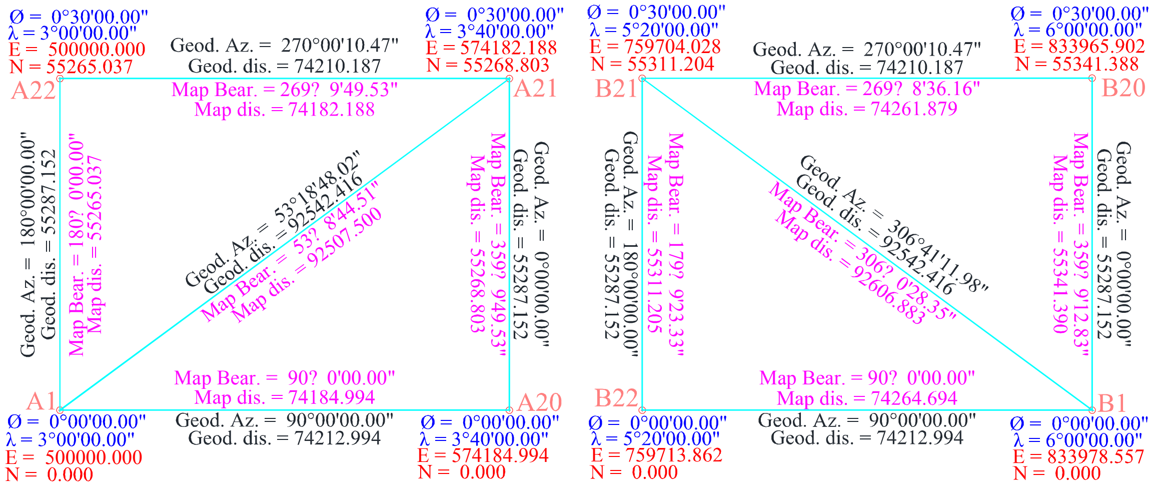

Figure 9. Map scale 1: 100,000 in G1 and G2

- Table (4) and table (5) include the geodetic and projected data in different used scales of Group (1) and Group (2) at equator.
- Table (6) and table (7) include geodetic and projected data in different used scales of Group (3) and Group (4) at latitude 30 N.
- Table (8) and table (9) include geodetic and projected data in different used scales in Group (5) and Group (6) at latitude 60 N.
- Table (10) includes geodetic and projected data in different used scales in groups (7, 8, 9, and 10) at latitudes 70° N and 80°N.

Considering the data and results in pervious figures and next tables and concerning the deference between geodetic and map distances; the differences seem significant as absolute values but they are not noticeable as drawn in the map. It means one cannot notice a difference between geodetic and plan metric maps for the same area.

In map scale 1:1000 at equator, distortion value of 37 cm at G1 & 90 cm at G2 in 925.432 m is obtained. This is a big value especially when precise EDM is used in measuring distances in the field. The user does not know about distortion and the surveyor himself should bay attention while dealing with projected map and the scale factor while using Total Station in the field. This problem can vanish by using geodetic Total Station in the field and the proposed geodetic map. In the 1:1000 map itself, 37 & 90 cm differences in 925m will appear as (37 & 90 cm/1000m) which is not noticeable. More about geodetic total station, one can refer to [Saad, A.A., 2002].

Distortion is variable in map from point to another; to resolve this issue practically we take an average value of distortion in limited region. The problem is more complex in case of international and intercontinental projects such international roads and petroleum pipelines. Again the problem can vanish by using the proposed geodetic mapping system especially in the presence of WGS84 as global geodetic coordinate system and GNSS as global observation tools.

For every map scale and concerning G1 maps which are adjacent to the central meridian of the used zone at equator, the maximum difference between the ellipsoidal and the corresponding distances are shown in the table 2 and table 3 beside their values as will appear in the map. The next table shows these results:

Table 2. Max differences between ellipsoidal and map distances for G1 maps adjacent to the central meridian of the zone and at Equator

Map Scale	1:1000	1:2500	1:5000	1:10000	1:25000	1:50000	1:100000
Max diff (m) (ellipsoidal dis-map dis)	0.37	0.92	1.85	3.70	9.22	18.25	34.92
Max diff drawn in the map (mm)	0.37	0.37	0.37	0.37	0.37	0.36	0.33

Table 3. Max differences between ellipsoidal and map distances for G2 maps adjacent to the edge of the zone and at Equator

Map Scale	1:1000	1:2500	1:5000	1:10000	1:25000	1:50000	1:100000
Max diff (m) (ellipsoidal dis-map dis)	0.90	2.25	4.46	8.80	20.95	38.55	64.47
Max diff drawn in the map (mm)	0.90	0.90	0.89	0.88	0.84	0.77	0.64

Again, in all scales in group G2 and other groups the differences, drawn in the map, are not noticeable. This means again that the form of the proposed geodetic map will not differ from its corresponding projected one.

Table 4. Geodetic and projected data in different used scales in Group (1) at equator

Map	From	To	Geodetic Azimuth	Geodetic Dis.(m)		Map Bearing.	Map dis.(m)		Diff. bet. Dis. (m)
(1/1000)	A1	A2	90°00'00"	742.130		90°00'00"	741.833		0.297
	A2	A3	0°00'00"	552.871		0°00'00"	552.650		0.221
	A3	A4	270°00'00"	742.130		270°00'00"	741.833		0.297
	A4	A1	180°00'00"	552.871		180°00'00"	552.650		0.221
	A1	A3	53°18'53"	925.432		53°18'53"	925.061		0.371
(1/2500)	A1	A5	90°00'00"	1855.325		90°00'00"	1854.583		0.742
	A5	A6	0°00'00"	1382.178		0°00'00"	1381.626		0.552
	A6	A7	270°00'00"	1855.325		270°00'00"	1854.583		0.742
	A7	A1	180°00'00"	1382.178		180°00'00"	1381.626		0.552
	A1	A6	53°18'53"	2313.579		53°18'53"	2312.654		0.925
(1/5000)	A1	A8	90°00'00"	3710.650		90°00'00"	3709.166		1.484
	A8	A9	0°00'00"	2764.357		0°00'00"	2763.252		1.105
	A9	A10	270°00'00"	3710.649		270°00'00"	3709.165		1.484
	A10	A1	180°00'00"	2764.357		180°00'00"	2763.251		1.106
	A1	A9	53°18'53"	4627.158		53°18'53"	4625.307		1.851
(1/10000)	A1	A11	90°00'00"	7421.299		90°00'00"	7418.333		2.966
	A11	A12	0°00'00"	5528.714		0°00'00"	5526.506		2.208
	A12	A13	270°00'00"	7421.297		270°00'00"	7418.330		2.967
	A13	A1	180°00'00"	5528.714		180°00'00"	5526.502		2.212
	A1	A12	53°18'53"	9254.315		53°18'53"	9250.615		3.700
(1/25000)	A1	A14	90°00'00"	18553.248		90°00'00"	18545.853		7.395
	A14	A15	0°00'00"	13821.785		359°59'59"	13816.315		5.470
	A15	A16	270°00'01"	18553.205		269°59'59"	18545.810		7.395
	A16	A1	180°00'00"	13821.785		180°00'00"	13816.256		5.529
	A1	A15	53°18'52"	23135.778		53°18'52"	23126.556		9.222
(1/50000)	A1	A17	90°00'00"	37106.497		90°00'00"	37091.865		14.632
	A17	A18	0°00'00"	27643.571		359°59'57"	27632.984		10.587
	A18	A19	270°00'03"	37106.146		269°59'57"	37091.514		14.632
	A19	A1	180°00'00"	27643.571		180°00'00"	27632.513		11.058
	A1	A18	53°18'52"	46271.486		53°18'51"	46253.240		18.246
(1/100000)	A1	A20	90°00'00"	74212.994		90°00'00"	74184.994		28.000
	A20	A21	0°00'00"	55287.152		359°59'50"	55268.803		18.349
	A21	A22	270°00'10"	74210.187		269°59'50"	74182.188		27.999
	A22	A1	180°00'00"	55287.152		180°00'00"	55265.037		22.115
	A1	A21	53°18'48"	92542.416		53°18'45"	92507.500		34.916

Table 5. Geodetic and projected data in different used scales in Group (2) at equator

Map	**From**	**To**	**Geodetic Azimuth**	**Geodetic Dis.(m)**		**Map Bearing.**	**Map dis.(m)**		**Diff. bet. Dis. (m)**
(1/1000)	B1	B2	0°00'00"	552.871		0°00'00"	553.414		-0.543
	B2	B3	270°00'00"	742.130		269°59'59"	742.856		-0.726
	B3	B4	180°00'00"	552.871		180°00'00"	553.410		-0.539
	B4	B1	90°00'00"	742.130		90°00'00"	742.856		-0.726
	B1	B3	306°41'07"	925.432		306°41'07"	926.337		-0.905
(1/2500)	B1	B5	0°00'00"	1382.178		359°59'59"	1383.534		-1.356
	B5	B6	270°00'00"	1855.325		269°59'58"	1857.131		-1.806
	B6	B7	180°00'00"	1382.178		179°59'59"	1383.513		-1.335
	B7	B1	90°00'00"	1855.325		90°00'00"	1857.131		-1.806
	B1	B6	306°41'07"	2313.579		306°41'06"	2315.831		-2.252
(1/5000)	B1	B8	0°00'00"	2764.357		359°59'58"	2767.069		-2.712
	B8	B9	270°00'00"	3710.649		269°59'55"	3714.233		-3.584
	B9	B10	180°00'00"	2764.357		179°59'58"	2766.984		-2.627
	B10	B1	90°00'00"	3710.650		90°00'00"	3714.233		-3.583
	B1	B9	306°41'07"	4627.158		306°41'05"	4631.627		-4.469
(1/10000)	B1	B11	0°00'00"	5528.714		359°59'55"	5534.138		-5.424
	B11	B12	270°00'00"	7421.297		269°59'51"	7428.351		-7.054
	B12	B13	180°00'00"	5528.714		179°59'55"	5533.802		-5.088
	B13	B1	90°00'00"	7421.299		90°00'00"	7428.354		-7.055
	B1	B12	306°41'07"	9254.315		306°41'03"	9263.112		-8.797
(1/25000)	B1	B14	0°00'00"	13821.785		359°59'48"	13835.345		-13.560
	B14	B15	270°00'01"	18553.205		269°59'37"	18570.008		-16.803
	B15	B16	180°00'00"	13821.785		179°59'49"	13833.281		-11.496
	B16	B1	90°00'00"	18553.249		90°00'00"	18570.052		-16.803
	B1	B15	306°41'08"	23135.778		306°40'56"	23156.731		-20.953
(1/50000)	B1	B17	0°00'00"	27643.571		359°59'36"	27670.690		-27.119
	B17	B18	270°00'03"	37106.146		269°59'15"	37137.060		-30.914
	B18	B19	180°00'00"	27643.571		179°59'39"	27662.671		-19.100
	B19	B1	90°00'00"	37106.497		90°00'00"	37137.412		-30.915
	B1	B18	306°41'08"	46271.486		306°40'46"	46310.037		-38.551
(1/100000)	B1	B20	0°00'00"	55287.153		359°59'13"	55341.390		-54.237
	B20	B21	270°00'10"	74210.186		269°58'36"	74261.879		-51.693
	B21	B22	180°00'00"	55287.152		179°59'23"	55311.205		-24.053
	B22	B1	90°00'00"	74212.993		90°00'00"	74264.694		-51.701
	B1	B21	306°41'12"	92542.415		306°40'28"	92606.883		-64.468

Table 6. Geodetic and projected data in different used scales in Group (3) at latitude 30°N

Map	From	To	Geodetic Azimuth	Geodetic Dis.(m)		Map Bearing.	Map dis.(m)		Diff. bet. Dis. (m)
(1/1000)	C1	C2	89°59'54"	643.242		89°59'54"	642.985		0.257
	C2	C3	0°00'00"	554.262		359°59'48"	554.041		0.221
	C3	C4	270°00'06"	643.210		269°59'54"	642.952		0.258
	C4	C1	180°00'00"	554.262		180°00'00"	554.041		0.221
	C1	C3	49°14'50"	849.086		49°14'50"	848.746		0.340
(1/2500)	C1	C5	89°59'45"	1608.105		89°59'45"	1607.461		0.644
	C5	C6	0°00'00"	1385.657		359°59'30"	1385.103		0.554
	C6	C7	270°00'15"	1607.903		269°59'45"	1607.260		0.643
	C7	C1	180°00'00"	1385.657		180°00'00"	1385.103		0.554
	C1	C6	49°14'37"	2122.668		49°14'37"	2121.819		0.849
(1/5000)	C1	C8	89°59'30"	3216.209		89°59'30"	3214.923		1.286
	C8	C9	0°00'00"	2771.316		359°59'00"	2770.208		1.108
	C9	C10	270°00'30"	3215.403		269°59'30"	3214.117		1.286
	C10	C1	180°00'00"	2771.316		180°00'00"	2770.208		1.108
	C1	C9	49°14'15"	4245.186		49°14'15"	4243.488		1.698
(1/10000)	C1	C11	89°59'00"	6432.419		89°59'00"	6429.847		2.572
	C11	C12	0°00'00"	5542.643		359°58'00"	5540.429		2.214
	C12	C13	270°01'00"	6429.192		269°59'00"	6426.621		2.571
	C13	C1	180°00'00"	5542.643		180°00'00"	5540.426		2.217
	C1	C12	49°13'32"	8489.767		49°13'32"	8486.373		3.394
(1/25000)	C1	C14	89°57'30"	16081.045		89°57'30"	16074.630		6.415
	C14	C15	0°00'00"	13856.687		359°54'59"	13851.188		5.499
	C15	C16	270°02'31"	16060.853		269°57'29"	16054.446		6.407
	C16	C1	180°00'00"	13856.687		180°00'00"	13851.144		5.543
	C1	C15	49°11'23"	21219.880		49°11'23"	21211.414		8.466
(1/50000)	C1	C17	89°55'00"	32162.082		89°55'00"	32149.354		12.728
	C17	C18	0°00'00"	27713.638		359°49'58"	27702.905		10.733
	C18	C19	270°05'02"	32081.162		269°54'58"	32068.465		12.697
	C19	C1	180°00'00"	27713.638		180°00'00"	27702.553		11.085
	C1	C18	49°07'47"	42424.591		49°07'47"	42407.801		16.790
(1/100000)	C1	C20	89°50'00"	64324.096		89°50'00"	64299.460		24.636
	C20	C21	0°00'00"	55428.335		359°39'51"	55408.976		19.359
	C21	C22	270°10'09"	63999.192		269°49'51"	63974.669		24.523
	C22	C1	180°00'00"	55428.335		180°00'00"	55406.164		22.171
	C1	C21	49°00'34"	84788.221		49°00'31"	84755.733		32.488

Table 7. Geodetic and projected data different used scales in Group (4) at latitude 30°N

Map	From	To	Geodetic Azimuth	Geodetic Dis.(m)		Map Bearing.	Map dis.(m)		Diff. bet. Dis. (m)
(1/1000)	D1	D2	0°00'00"	554.262		358°29'56"	554.613		-0.351
	D2	D3	270°00'06"	643.210		268°30'01"	643.616		-0.406
	D3	D4	180°00'00"	554.262		178°30'08"	554.611		-0.349
	D4	D1	89°59'54"	643.242		88°30'02"	643.648		-0.406
	D1	D3	310°45'10"	849.085		309°15'06"	849.621		-0.536
(1/2500)	D1	D5	0°00'00"	1385.657		358°29'55"	1386.534		-0.877
	D5	D6	270°00'15"	1607.903		268°30'09"	1608.912		-1.009
	D6	D7	180°00'00"	1385.657		178°30'25"	1386.519		-0.862
	D7	D1	89°59'45"	1608.105		88°30'11"	1609.114		-1.009
	D1	D6	310°45'23"	2122.668		309°15'18"	2124.001		-1.333
(1/5000)	D1	D8	0°00'00"	2771.316		358°29'54"	2773.071		-1.755
	D8	D9	270°00'30"	3215.403		268°30'22"	3217.401		-1.998
	D9	D10	180°00'00"	2771.316		178°30'54"	2773.008		-1.692
	D10	D1	89°59'30"	3216.209		88°30'26"	3218.210		-2.001
	D1	D9	310°45'45"	4245.186		309°15'39"	4247.825		-2.639
(1/10000)	D1	D11	0°00'00"	5542.643		358°29'52"	5546.151		-3.508
	D11	D12	270°01'00"	6429.192		268°30'48"	6433.111		-3.919
	D12	D13	180°00'00"	5542.643		178°31'52"	5545.899		-3.256
	D13	D1	89°59'00"	6432.419		88°30'56"	6436.347		-3.928
	D1	D12	310°46'28"	8489.767		309°16'20"	8494.948		-5.181
(1/25000)	D1	D14	0°00'00"	13856.687		358°29'46"	13865.447		-8.760
	D14	D15	270°02'31"	16060.854		268°32'07"	16070.083		-9.229
	D15	D16	180°00'00"	13856.687		178°34'47"	13863.901		-7.214
	D16	D1	89°57'30"	16081.045		88°32'27"	16090.326		-9.281
	D1	D15	310°48'37"	21219.880		309°18'23"	21232.101		-12.221
(1/50000)	D1	D17	0°00'00"	27713.638		358°29'36"	27731.122		-17.484
	D17	D18	270°05'02"	32081.162		268°34'18"	32097.786		-16.624
	D18	D19	180°00'00"	27713.638		178°39'39"	27725.123		-11.485
	D19	D1	89°55'00"	32162.082		88°34'57"	32178.899		-16.817
	D1	D18	310°52'13"	42424.591		309°21'50"	42446.682		-22.091
(1/100000)	D1	D20	0°00'00"	55428.335		358°29'15"	55463.158		-34.823
	D20	D21	270°10'09"	63999.191		268°38'45"	64025.585		-26.394
	D21	D22	180°00'00"	55428.335		178°49'27"	55440.633		-12.298
	D22	D1	89°50'00"	64324.096		88°39'57"	64351.161		-27.065
	D1	D21	310°59'26"	84788.221		309°28'45"	84823.601		-35.380

Table 8. Geodetic and projected data in different used scales in Group (5) at latitude 60°N

Map	From	To	Geodetic Azimuth	Geodetic Dis.(m)		Map Bearing.	Map dis.(m)		Diff. bet. Dis. (m)
(1/1000)	E1	E2	89°59'49"	372.000		89°59'49"	371.851		0.149
	E2	E3	0°00'00"	557.061		359°59'39"	556.838		0.223
	E3	E4	270°00'10"	371.944		269°59'50"	371.795		0.149
	E4	E1	180°00'00"	557.062		180°00'00"	556.839		0.223
	E1	E3	33°43'47"	669.836		33°43'47"	669.568		0.268
(1/2500)	E1	E5	89°59'34"	930.000		89°59'34"	929.628		0.372
	E5	E6	0°00'00"	1392.654		359°59'08"	1392.097		0.557
	E6	E7	270°00'26"	929.649		269°59'34"	929.277		0.372
	E7	E1	180°00'00"	1392.655		180°00'00"	1392.098		0.557
	E1	E6	33°43'21"	1674.533		33°43'21"	1673.863		0.670
(1/5000)	E1	E8	89°59'08"	1860.000		89°59'08"	1859.256		0.744
	E8	E9	0°00'00"	2785.312		359°58'16"	2784.198		1.114
	E9	E10	270°00'52"	1858.597		269°59'08"	1857.853		0.744
	E10	E1	180°00'00"	2785.312		180°00'00"	2784.198		1.114
	E1	E9	33°42'36"	3348.874		33°42'36"	3347.534		1.340
(1/10000)	E1	E11	89°58'16"	3720.000		89°58'16"	3718.512		1.488
	E11	E12	0°00'00"	5570.635		359°56'32"	5568.408		2.227
	E12	E13	270°01'44"	3714.385		269°58'16"	3712.900		1.485
	E13	E1	180°00'00"	5570.636		180°00'00"	5568.407		2.229
	E1	E12	33°41'08"	6696.977		33°41'08"	6694.298		2.679
(1/25000)	E1	E14	89°55'40"	9299.998		89°55'40"	9296.281		3.717
	E14	E15	0°00'00"	13926.669		359°51'20"	13921.113		5.556
	E15	E16	270°04'20"	9264.892		269°55'40"	9261.189		3.703
	E16	E1	180°00'00"	13926.669		180°00'00"	13921.099		5.570
	E1	E15	33°36'44"	16736.656		33°36'44"	16729.967		6.689
(1/50000)	E1	E17	89°51'20"	18599.981		89°51'20"	18592.567		7.414
	E17	E18	0°00'00"	27853.601		359°42'39"	27842.577		11.024
	E18	E19	270°08'41"	18459.469		269°51'19"	18452.111		7.358
	E19	E1	180°00'00"	27853.602		180°00'00"	27842.461		11.141
	E1	E18	33°29'23"	33453.998		33°29'22"	33440.663		13.335
(1/100000)	E1	E20	89°42'41"	37199.844		89°42'41"	37185.174		14.670
	E20	E21	0°00'00"	55708.261		359°25'16"	55686.907		21.354
	E21	E22	270°17'24"	36637.084		269°42'36"	36622.630		14.454
	E22	E1	180°00'00"	55708.261		180°00'00"	55685.978		22.283
	E1	E21	33°14'39"	66830.543		33°14'37"	66804.176		26.367

Table 9. Geodetic and projected data in different used scales in Group (6), at latitude 60°N

Map	From	To	Geodetic Azimuth	Geodetic Dis.(m)		Map Bearing.	map dis.(m)		Diff. bet. Dis. (m)
(1/1000)	F1	F2	0°00'00"	557.062		357°24'05"	557.030		0.032
	F2	F3	270°00'10"	371.944		267°24'15"	371.922		0.022
	F3	F4	180°00'00"	557.058		177°24'25"	557.026		0.032
	F4	F1	89°59'51"	372.000		87°24'17"	371.979		0.021
	F1	F3	326°16'13"	669.836		323°40'18"	669.798		0.038
(1/2500)	F1	F5	0°00'00"	1392.655		357°24'04"	1392.575		0.080
	F5	F6	270°00'26"	929.649		267°24'30"	929.594		0.055
	F6	F7	180°00'00"	1392.652		177°24'56"	1392.567		0.085
	F7	F1	89°59'35"	930.000		87°24'31"	929.945		0.055
	F1	F6	326°16'39"	1674.533		323°40'44"	1674.434		0.099
(1/5000)	F1	F8	0°00'00"	2785.314		357°24'04"	2785.154		0.160
	F8	F9	270°00'52"	1858.597		267°24'54"	1858.483		0.114
	F9	F10	180°00'00"	2785.311		177°25'48"	2785.131		0.180
	F10	F1	89°59'08"	1860.000		87°24'57"	1859.887		0.113
	F1	F9	326°17'24"	3348.874		323°41'27"	3348.669		0.205
(1/10000)	F1	F11	0°00'00"	5570.636		357°24'02"	5570.315		0.321
	F11	F12	270°01'44"	3714.385		267°25'44"	3714.142		0.243
	F12	F13	180°00'00"	5570.635		177°27'30"	5570.231		0.404
	F13	F1	89°58'16"	3720.000		87°25'49"	3719.760		0.240
	F1	F12	326°18'52"	6696.977		323°42'54"	6696.541		0.436
(1/25000)	F1	F14	0°00'00"	13926.669		357°23'59"	13925.857		0.812
	F14	F15	270°04'20"	9264.892		267°28'13"	9264.168		0.724
	F15	F16	180°00'00"	13926.669		177°32'39"	13925.343		1.326
	F16	F1	89°55'40"	9299.998		87°28'25"	9299.294		0.704
	F1	F15	326°23'16"	16736.656		323°47'15"	16735.369		1.287
(1/50000)	F1	F17	0°00'00"	27853.602		357°23'53"	27851.942		1.660
	F17	F18	270°08'41"	18459.469		267°32'23"	18457.654		1.815
	F18	F19	180°00'00"	27853.602		177°41'14"	27849.953		3.649
	F19	F1	89°51'20"	18599.981		87°32'45"	18598.238		1.743
	F1	F18	326°30'37"	33453.998		323°54'31"	33450.793		3.205
(1/100000)	F1	F20	0°00'00"	55708.261		357°23'41"	55704.797		3.464
	F20	F21	270°17'24"	36637.084		267°40'43"	36632.110		4.974
	F21	F22	180°00'00"	55708.261		177°58'26"	55697.364		10.897
	F22	F1	89°42'41"	37199.844		87°41'25"	37195.098		4.746
	F1	F21	326°45'21"	66830.543		324°09'05"	66821.788		8.755

Table 10. Geodetic and projected data in 1:100000 map scales in Groups (7, 8, 9, and 10) at latitude 70°N& 80°N

Map	From	To	Geodetic Azimuth	Geodetic Dis.(m)		Map Bearing.	Map dis.(m)		Diff. bet. Dis. (m)
(1/100000)	G1	G2	89°41'12"	25457.567		89°41'12"	25447.452		10.115
	G2	G3	0°00'00"	55782.582		359°22'21"	55760.700		21.882
	G3	G4	270°18'51"	24846.692		269°41'09"	24836.816		9.876
	G4	G1	180°00'00"	55782.582		180°00'00"	55760.269		22.313
(1/100000)	H1	H2	89°41'12"	25457.567		87°29'38"	25450.626		6.941
	H2	H3	0°00'00"	55782.582		357°10'34"	55768.998		13.584
	H3	H4	270°18'51"	24846.692		267°29'10"	24839.767		6.925
	H4	H1	180°00'00"	55782.582		177°48'14"	55765.551		17.031
(1/100000)	I1	I2	89°40'18"	12928.920		89°40'18"	12923.757		5.163
	I2	I3	0°00'00"	55830.799		359°20'35"	55808.575		22.224
	I3	I4	270°19'44"	12288.687		269°40'16"	12283.779		4.908
	I4	I1	180°00'00"	55830.799		180°00'00"	55808.467		22.332
(1/100000)	J1	J2	89°40'18"	12928.920		87°22'26"	12924.172		4.748
	J2	J3	0°00'00"	55830.799		357°02'36"	55810.659		20.140
	J3	J4	270°19'44"	12288.687		267°22'11"	12284.136		4.551
	J4	J1	180°00'00"	55830.799		177°42'01"	55809.794		21.005

4. Steps of Automatic Real Map Production

In the case of 2D, the computations will be done on the adopted reference ellipsoid. Hence, the results will be point coordinates in the geodetic 2D form.

$$\phi_2, \lambda_2, \alpha_{21} = f\,(a, f, \phi_1, \lambda_1, \alpha_{12}, S_{12}) \qquad (1)$$ [Rechard H. Rapp, (1976)]

Also in the case that the computations will be done in 3D, the local horizon system coordinates (u, v, w) will be first obtained as:

$$u, v, w = f\,(\alpha_{12}, s_{12}, z_{12}) \qquad (2)$$

$$\left(\Delta X_{12}, \Delta Y_{12}, \Delta Z_{12}\right) = f\,(u, v, w) \qquad (3)$$

$$X_2 = X_1 + \Delta X_{12}$$
$$Y_2 = Y_1 + \Delta Y_{12} \qquad (4)$$
$$Z_2 = Z_1 + \Delta Z_{12}$$

[Nassar, 1994 and Shaker, 1982]

Now curve-linear coordinates could be computed from the obtained rectangular coordinates:

$$(\phi, \lambda, h) = f\,(X, Y, Z, a, f) \qquad (5)$$ [W.E. Featherstone and S. J. Classens, 2007]

After obtaining the geodetic coordinates (Ø, λ) for each of the project points, the map could be drown and stored in its digital form, it could be also plotted when needed. The two axes of the map are chosen at the south-west corner of the map. Then the difference of latitude and longitude between the concerned point and the corner of the map is defined. All the above mentioned equations used in computations are programmed and ad joint to the map as an essential part of it. Any needed information can be obtained from the proposed automatic real map using hot keys (push button). The required information will be obtained directly from the geodetic coordinates and the projection distortion will be totally avoided

5. The Description and Facilities of the Designed Program

The program for producing Automatic Real Map is created by Visual basic 6 & third party component, this is available in some programs like AutoCAD and Microsoft office. In AutoCAD, to draw the map using latitude and longitude is possible;

- The map is recorded as points and lines in Microsoft excel tables.
- The map data can be imported from total station and GPS as points, lines, polylines and arcs which are connecting between these points.
- The points are recorded by actual latitudes and longitudes.
- Base point (map corner or any point) is specified to calculate the differences in latitude and longitude between that base point and all other points.
- Latitude and longitude differences are computed in meter units using suitable geodetic equations.
- Then all points are represented and connected to each other by lines and polygons if needed.
- The line between any two points can be drawn and then selected and using certain program keys to get its azimuth and distance.
- All properties of any line (geodetic distance, azimuth, rectangular and geodetic coordinates for its two terminal points, difference in latitude and longitude, difference in rectangular coordinates also spatial distance) can be obtained once pushing the specified key.
- Any point can be selected and using point properties key, point properties (geodetic and rectangle coordinates, orthometric and ellipsoidal heights) can be obtained if ζ, η, N are available and stored in the program.
- A polyline between 3 points can be drawn as triangle; then it is selected by specified key to compute the ellipsoidal area and also the geodetic circumference.
- The closed polyline between several points can be drawn and then selected. The enclosed ellipsoidal area can be computed using the specified area key; also the geodetic circumference can be obtained.
- The user can add new point to the map by;
  - Free hand
  - Geodetic distance and geodetic azimuth from chosen point
  - Spatial distance and geodetic azimuth from chosen point
  - Latitude and longitude differences from chosen point
  - Rectangular coordinates X, Y, Z.

6. Conclusions

In order to draw a map, some factors should be regarded:

- The accepted paper size for dealing and trading
- The dimensions of the mapped area
- The required drawing scale

The projected map does not represent the reality because of the well-known distortion. Every country, in the old system of projection, has its own system beside that often every country is divided into different zones. Data (projected coordinates) from different countries or inside the same country but in different zones cannot be used (collected) together. The same conclusion can be drawn on the Universal Transverse Mercator (UTM).

Nowadays, universal surveying field tools like satellite positioning missions (GNSS), satellite imagery, and satellite gravity missions are widely used. The produced coordinates and coordinates based services are related to a worldwide geodetic datum like WGS84. So, the field tools of collecting data became global and the reference geodetic datums became global too but the mapping system not yet.

This research is proposing a real geodetic map in an electronic computerized copy. The proposal is a universal mapping system, and unlike the old system, will enable:

- Collecting the maps of one country together
- Collecting the maps from different neighboring countries together
- Using surveying (geodetic) data wherever on the globe in one system without transformation
- Computing distances, azimuths, and areas between any points on the globe without distortion
- The map scale will not affect the accuracy of the extracted elements from the map (distance, azimuth, and area). They will be calculated from the geodetic coordinates with their observed accuracies.

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