

Preparing a comprehensive geodatabase for Iraq geodetic networks systems

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Abstract. This paper concerns the subject geodetic networks data in Iraq and the need to put them in specialized spatial databases that can be updated and developed, which makes it much easier for those concerned such as scientific researchers and surveying engineers to access these data and use them in scientific applications and Engineering projects. The practical aspect of this study was divided into three stages, the first stage was limited to the collection of official data related to the main projects of geodetic networks in Iraq, beginning with the first English network 1934, the second English network 1967, the Polish network 1979, the gravitational networks 1963-1984, and ending with the CORS-HARN networks that have been based in their observations and calculations upon the GPS. The second stage consists of sorting the data obtained from the first stage, and then entering the selected data into spatial databases. The third stage includes the reconnaissance, ground survey and verification of data obtained from the second stage. Furthermore, it also showed that all the English networks, the first 1934 and the second 1967, as well as the points of gravity were almost completely extinct and it became difficult to identify any traces of any of its points within this region.

1 Introduction

It is well known that the geodetic networks have fundamental importance in surveying. Generally there are four types of these networks: horizontal, vertical combined 3D System (horizontal and vertical) and gravity, each type has specific trends and applications, in Iraq. From historical point of view, the development of these networks can be categorized as shown in figure 1

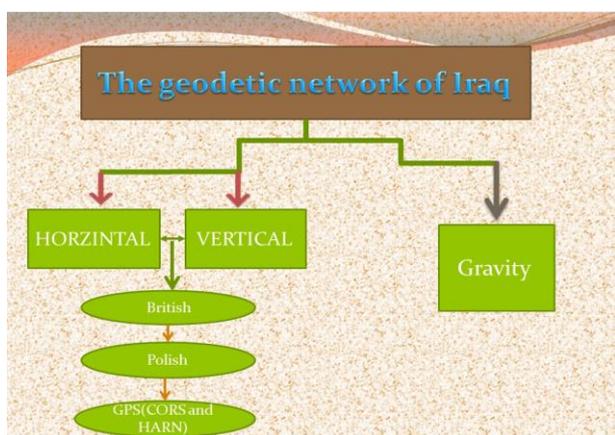


Fig.1. Geodetic network in Iraq

2 Review historical development for Iraqi geodetic networks

2.1 First British network of Iraq 1934

The first geodetic network of Iraq was created by the English oil companies in 1934 and called the name (Nahrwan Datum 1934) on this network as a label Nahrwan is the ratio to the city in southeastern Baghdad, where it was relying on the reference in this region point to be a reference to the system of coordinates the adoption of this network in drawing all first property maps of Iraq and used up to the present time which what is known maps Alcadstro in addition to other different maps have been benefit from it in the planning of infrastructure projects. The flatfish surfaces (CLARKE 1880) have been used Theodolite instrument, settlement and painting and planar chain in the creation of this network has been relying on the sea level (M.S.L) [1]The Primary Triangulation of Iraq.-The primary triangulation of Iraq is only of secondary precision and was executed between 1930-1934. It is divided into two series: the North Series and the South Series. Both the series start with the measured base at Nahrwan (E. of Baghdad). The North Series closes on a measured base at Kirkuk and the South Series at Batha. The measured

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values of the bases have been accepted and discrepancies between the triangulated and measured values have been adjusted. The details are given below:

Table 1. The measured values of the bases in British first Network of Iraq1934

no	Name of base	Data of measurement	Length (m)	Probable Error (mm)
1	Nahrwan	1930	4441.01448	±3.00
2	Kirkuk	1930	2000.30950	±3.34
3	Batha	1930	2012.17679	±2.40

The initial latitude and longitude are the astronomical values of Nahrwin S. End Base:

Latitude 33° 19' 10" .87 ±0" .20 (for N & S. stars)

Longitude 44° 43' 25" .64 ± 0" .69 (from wireless time signals)

2.2 Second British network of Iraq 1967

The establishment of a new system in 1967, flat depends surface flatfish (CLARKE 1880) and projected UTM PROJECTION) The reference point in Nahrawan region called locally "binary system .whereas elevation level depends sea level at FAO as basis for elevation system currently called GTS .This system used until 1980 .but the information about this system was little and it is called nahrwan datum 1976 whereas projection that was used (PROJECTION) has Been projected to use the UTM the following specifications [1]

- 1-Central Meridian = 46°30'00' E
- 2-Origion Latitude = 29°01'34.5560' N
- 3-Scale Factor = 0.9994
- 4-False Easting = 800000m
- 5-False northing =0.00m

2.3 Polish geodetic control networks of Iraq 1974-1979

2.3.1 Horizontal networks

It is the period from 1974-1979, where the one of the competent international companies in this field (Pole Service Company) establishment of a network adjust the horizontal and vertical first-order at the country level extra to do a lot of work surveying Other, These can be one of the best geodetic networks in the region network considered at that time where it was using the latest instruments and techniques in the development of this network has been chosen flounder CLARCK1880andprojectedUTM.The following specifications

1-The horizontal network consisting of 2778 stations distributed in all over the country

2-50 Laplace azimuth/average mean square

error±0.42"

3-8606 distances measured by means of AGA8 /mean square error of distance 5mm+ $1.10^{-6}D$

4-316 distances measured by means of tellurometers /mean square error of distance 15mm+ $3.10^{-6}D$

5-1267 angle /average mean square error ±4^cc the mean square error of the distance after adjustment is equal to 22mm

6- The distances are ranging from 8 to 35 kilometers, while mean distance is about 15 kilometers.

7- The primary control is countrywide-trilateration net, in which all the distances between consecutive points and also some selected angles are measured.

8- 24 Base line which connects Laplace points[2]

2.3.2 Vertical networks

It has been relying on the sea MSL level rate where he was erected two station-Gauge Tide for about two weeks "in the Fow region of the Arabian Gulf and recording the highest elevations readings and took her average per day and record readings lower elevations and took her average per day and then taking those rates and took rate of two per day and then taking the rates of these days and taking the average of the sum of these days to station one and then two rate This is attributed to a zero meters, which depends on the double minute settlement process for the distribution of the vertical grid points, the whole area of the country51 leveling lines from 21 closed perimeters the average length of a line is 180 kilometers, the average length of a perimeter600 kilometers. The bench-marks on precise leveling lines are situated at a distance of about 5 kilometers one from another in rural and desert areas and 2 kilometers in developed and urban areas, which amounts to up to 1984 station bench – marks. The trigonometrically leveling net adjustment comprises 5357 vertical angular observation single or double and was based on leveled point .the mean square error of adjusted height does not exceed 0.5m ,while the average value is 0.3m. [3]

2.4 Gravity basic station network of Iraq1963-1984

Gravity basic station are found mental for regional and detailed gravity surveys previously foreign oil companies conducted regional gravity survey using basic station apparently connected to the Syrian net unfortunately on information could be obtained concerning location values and accuracies of the basic station . First document information available were these of six international basic stations established in Iraq by woolard in 1963 and connected with world gravity net of wiscons in university. Arose to create basic station to carryout regional gravity survey in an covered area of Iraq. So in the period between 1969-1977 some 180 basic station were established and connected with woolard . On the initiative of geophysical determent of Som a five year plane to established gravity basic station

net. Covering the whole territory of Iraq was projecting .462 basic stations distributed all over country, mostly on triangulation point and benchmarks of polservis were established, measured and al aborted during the years 1979-1984. These basic stations were connected to the previously established ones making a total of 648 gravity basic stations covering the territory of Iraq [4]as in figure 2

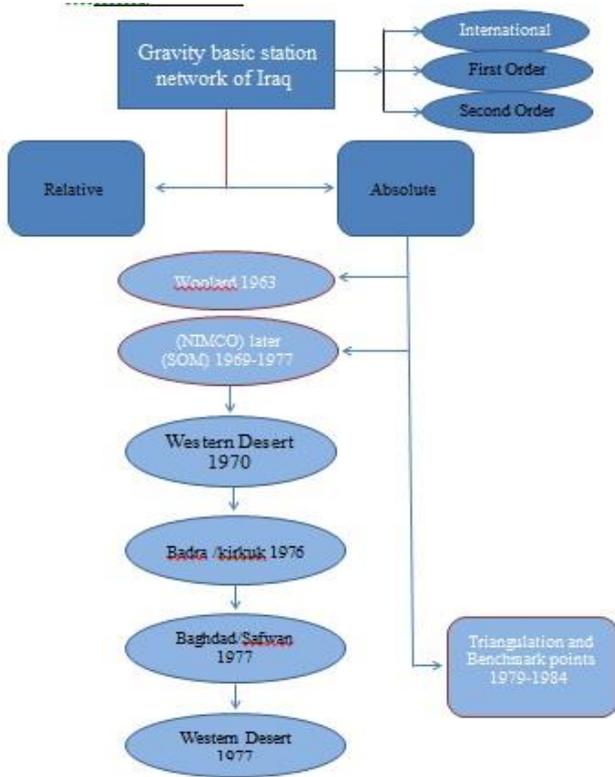


Fig.2. Historical development of gravity basic stations network in Iraq .

2.5 Iraqi geospatial reference system 2004 - 2016

During the period from 2004 to 2005, the American institution for the National Geodetic Survey, which is considered one of the most prestigious Institutions in the competent Geodesy world, prepared the plan for the project geodesy network development in Iraq, The project has been started and the completion of part of it, but without the participation of the Iraqi side and the project was renamed IRAQI GEOSPATIAL REFERENCE SYSTEM (IGRS).

the work done by this institution has been Distinguished by ber formic two major tasks

1-The first is the monument 6 of reference CORS stations

2-The second is erected 64 adjusted Stations of the three-dimensional first-class or as-called points of HARN in four provinces.(southern)

At the beginning of 2007 the Authority General of surveying started to think about completing the stoppage work and the addition of some other important things and already has been moving and start racing to activate the project, but at a slow pace due to lack of expertise

and cadres . In fact such that acts have always been and still carried out by companies and institutions world with experience in this field it has been identified that, the goals of this new project follows as in figure 3

- Adoption of the Universal ITRF system as the basis for a new system of coordinates, according to the recommendation of the US geodesy Authority NGS
- Adoption of flatfish WGS84 Ellipsoid
- The adoption of the Universal projected UTM
- Installed new network is made up of seven reference CORS and world-class associated with the World Wide Web will be the basis for the new system of coordinates of stations and provide a free service for users to fully and be this network is an alternative to the old network because of a stoppage and not to the possibility of re-entry to work in addition to the new network will be controlled by the Directorate General of surveying fully
- Continue to install the ground control stations, three-dimensional HARN (High Accuracy Reference Network) in the provinces and in the same specifications stations which installed previously with some modifications in the site selection process and the establishment of stations. [1]

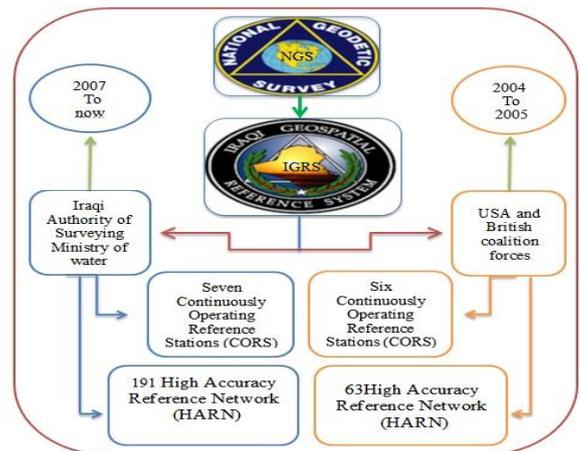


Fig. 3. Iraqi geospatial reference system

2.5.1 Continuously Operating Reference Stations of USA and British (CORS)

The monument 6 of reference CORS stations and connect them with the institution of the NGS which provide data and processing of data for these stations free of charge to users where these stations regarded as the basis of Iraq's new coordinate system, which depends on the center of the globe as a point of reference have been chosen coordinates of ITRF2000 system as a basis for work and according to international standards accredited [1].The distribution points in the military headquarters of the multinational forces, of the table as follows (table-2)

Table-2 distribution the USA CORS stations in Iraq

Code station	Location	Code station	Location
IZ BD	Baghdad	IZTL	Thi Qar
IZ BA	Basrah	IZ AD	Anbar
IZ BL	Salahuddin	IZQW	Nainawa

2.5.2 High accuracy reference network of USA and British (HARN)

Erected 63 Stations Ground adjust the three-dimensional first-class or as-called points of HARN in four provinces, as shown as follows .It utilized to international standards in the establishment and monitoring points and in accordance with the six reference stations and were prepared. Data bases of these points which have been distributed in the province of Basrah, Muthanna, Maysan and Thi Qar.. [1]

(Erbil, Salahuddin, Baghdad, Najaf, Kut, Basra and Zakho).

2.5.4 High accuracy reference network of Iraqi general authority for surveying (HARN)

The High Accuracy Reference System (HARN)is three-dimensional control points be monitored by system of GPS particular way and depending on the stations of the CORS and be given a central geodetic coordinates and quadratic depending on the global system ITRF surface flatfish WGS84 and projected UTM in addition to providing a national level, depending on the Polish network of vertical and most of the points is done through method double accurate leveling thus can rely on these points in the topographic surveys using GPS RTK Technology System .where During 2005 the institution of NGS installed 64 distributed stations in the provinces (Basra, Maysan, Dhi Qar, Muthanna) but without giving the levels depends on the sea level and is currently completing the work in the installed stations in other provinces are currently working shut down due to lack of financial allocations were So far, 191 Have been installed distributed station in the country's governorates. [1]

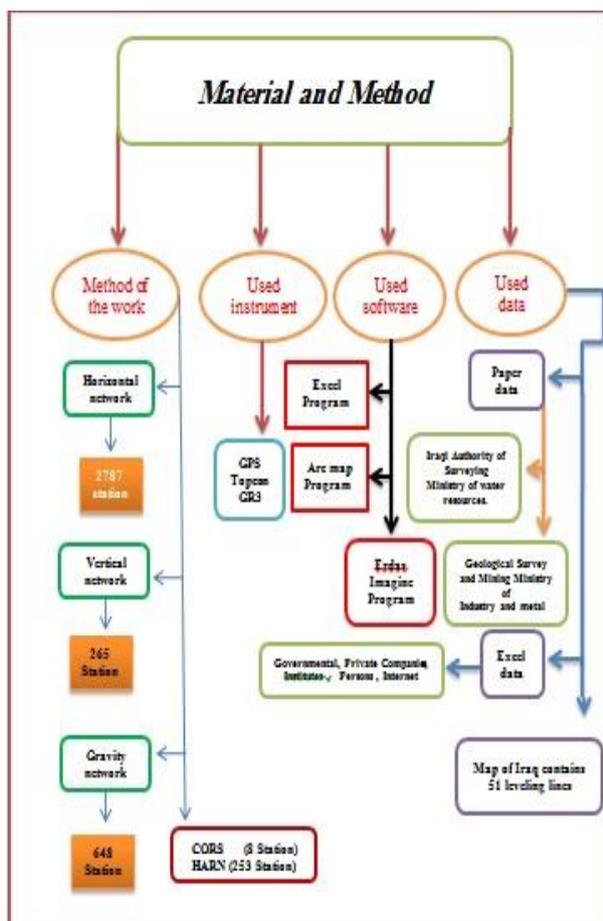


Fig.4. Block diagram The Materials and Methods

2.5.3 Continuously Operating Reference Stations of Iraqi general authority for surveying (CORS)

Seven stations have been installed during the period from 2008 to the end of 2009 in each of the governorates

3 Problem statements

In the past eight decades, different geodetic projects have been planned and implemented within Iraq country, the hypothesis of this thesis based on representing the main problem in these projects was not in their accuracy or in their technical approaches rather than in the official documentation of them. However, two indicators for weak documentation process have been noticed, as follows:

A- Throughout searching in the Internet about the specialized publications of geodetic control networks in Iraq, the acquired documents (technical reports, maps, sketches, theses, papers, datasheets) are too few and do not reflect the reality of these huge geodetic projects that had been implemented in Iraq.

B- If anyone could visit the scientific libraries of the specialized directorates in geodetic surveying, he will not find the standardized archiving for the documents related with geodetic control networks in Iraq.

4 Materials and methods

To study in depth the thesis problem, different materials and methods in figure 4 are to be prepared and arranged as follows:

A- The authorized documents including maps, sketches, technical reports, datasheets in both hardcopy and digital formats

B- Utilizing ArcGIS software package to design and implement the required spatial data base for geodetic control networks (with their different types, i.e.

traditional horizontal, traditional vertical, gravity and CORS-HARN),

C- Other software packages have been used in minor operations that are required in preparing the geodetic geodatabases, as follows:

1- ERDAS Imagine: has been used in coordinates transformations of geodetic control points within different networks.

2- Microsoft Excel: was required in initial editing of the tabular data that are related with the geodetic geodatabases.

D- Geodetic GPS device (Topcon GR3 model) has been used as ground truth by field re-surveying for selected geodetic control points within two Governorates (Babil and Kerbala) .

5 Result

According to the availability of the Iraqi geodetic data, a comprehensive geodatabase has been prepared (using the ArcGIS software package), this geodatabase consists of different datasets as shown in figures 5-16 and tables 3-6

5.1 Polish geodetic control networks of Iraq 1974-1979

5.1.1 Polish geodetic horizontal networks

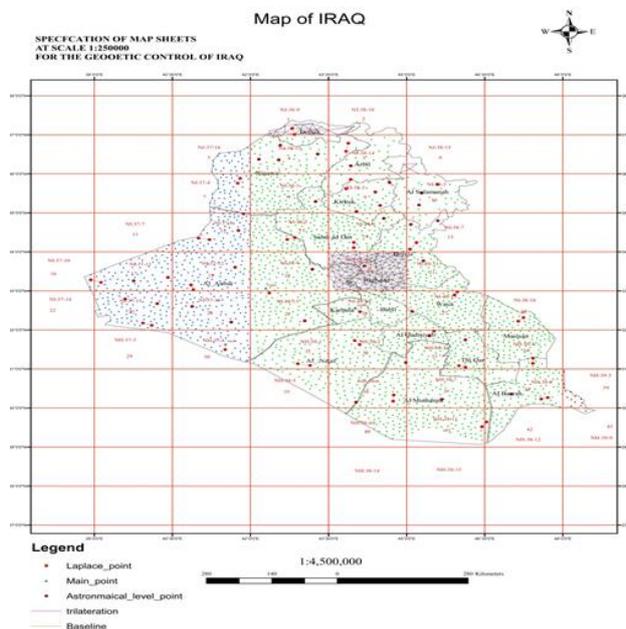


Fig.5. Map of polish geodetic horizontal networks

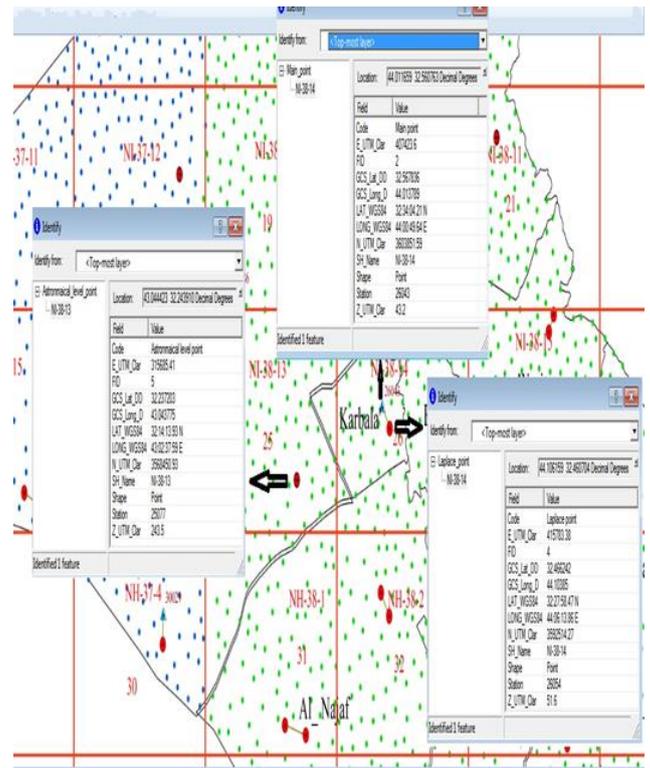


Fig.6. Geodatabase for polish geodetic horizontal networks

Table.3 Geodatabase for polish geodetic horizontal networks

StNr	E_utm	N_utm	Height	Dist_o bsv	Angle_ obs
1001	339329. 9	412832 0	2161.6	AGA_8	Wild_T 3
1002	323013. 5	412405 1	1766.2	AGA_8	Wild_T 3
1003	310354. 8	412619 1	1982.8	AGA_8	Wild_T 3
1004	293071. 5	412233 5	870.6	AGA_8	Wild_T 3
1005	355135. 2	411829 9	1548.6	AGA_8	Wild_T 3
1006	304670. 1	411552 5	753.1	AGA_8	Wild_T 3
1007	319781	411432 5	969.4	AGA_8	Wild_T 3
1008	336084. 7	411306 0	1412.2	AGA_8	Wild_T 3
1009	345411. 7	411142 4	2086.7	AGA_8	Wild_T 3
1011	275681. 8	410753 1	1071.3	AGA_8	Wild_T 3
1012	292036. 2	410402 3	1117.5	AGA_8	Wild_T 3
1013	321854. 3	410232 4	966.9	AGA_8	Wild_T 3
1014	308403. 1	409790 1	1385.8	AGA_8	Wild_T 3
1015	341059. 4	409659 4	1508.4	AGA_8	Wild_T 3

5-1-2 Polish geodetic vertical networks

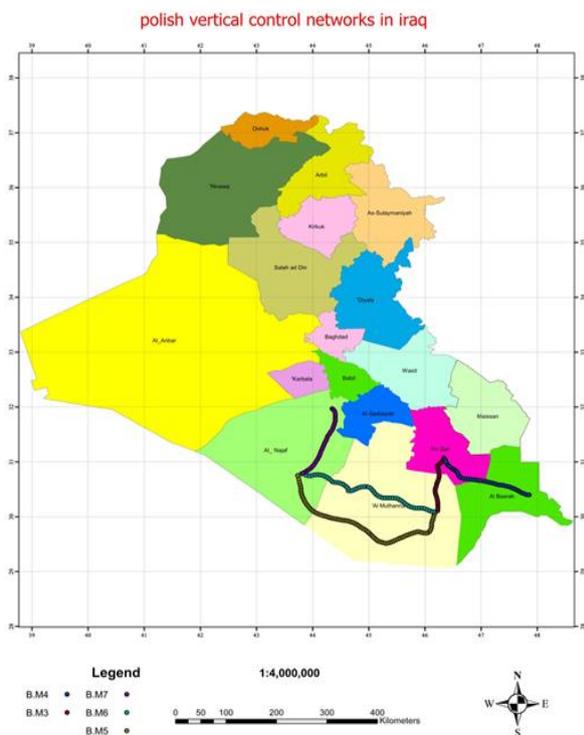


Fig.7. Map of polish geodetic vertical networks

Table.4 Geodatabase for lines bench mark in polish geodetic vertical networks

B.M_no	Dis_KM	Final_H_M	GCS_Long_Deg_Min_Sec	GCS_Lat_Deg_Min_Sec
1-4	4.99	3.7432	46.359541	31.034796
2-4	10	4.7711	46.376435	30.991966
3-4	15.56	4.6174	46.401419	30.947708
4-4	18.45	3.8859	46.421645	30.930338
5-4	21.92	3.9189	46.446867	30.909874
6-4	27.22	4.8185	46.483749	30.878941
7-4	29.91	4.5325	46.504926	30.867044
8-4	32.99	2.6631	46.528483	30.852291
9-4	36.03	3.5782	46.549422	30.833493
10-4	39.07	2.8296	46.571789	30.816599
11-4	43.93	4.2632	46.59249	30.774959
12-4	48.95	8.5594	46.613191	30.731653
13-4	53.03	18.0333	46.645076	30.711665
14-4	57.81	18.5569	46.685527	30.695247

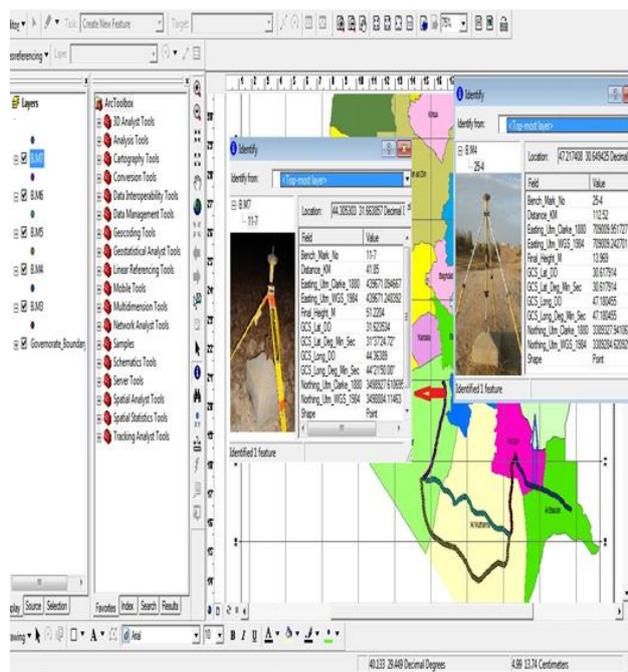


Fig.8 Geodatabase for polish geodetic vertical networks

5.2 Gravity basic station network of Iraq1963-1984

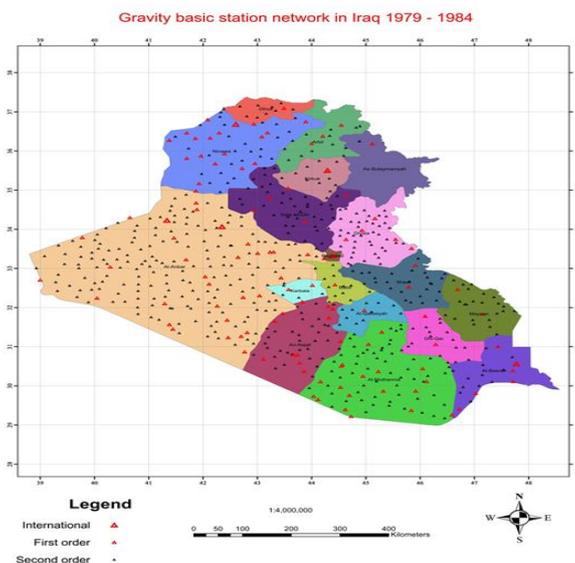


Fig.9. Map for gravity basic stations network

Table.5 Geodatabase for gravity basic stations network.

Code of Basic Station	Order	Y UTM	X UTM	Elev. UTM	Absolute gravity value (mgal)	Old of Basic Station
NCDa2	2nd	4106113.000	267007.000		794.27	Fish Khabour
NCDab1	2nd	4113279.000	293873.000		794.82	Zach
NCDb2	2nd	4120868.000	361428.000		794.572.14	Kani Masi
NCDb1	2nd	4115383.000	323417.000		794.660.83	Batuf
NDa3	2nd	4110307.000	346518.000		794.590.70	Bame
1	1st	4105909.000	365726.000		794.579.16	Ama
NDa4	2nd	4100033.000	352139.000		794.624.78	Sersa
NDb1	2nd	4103002.000	380723.000		794.697.75	Balen
NB1	2nd	4062054.000	763469.000	377.700	794.775.99	TP 03001
NCDa1	2nd	4097362.000	262357.000	484.300	794.775.73	TP 04001
NC1	2nd	4084396.000	260461.000		794.805.23	Wadi Swedi
2	1st	4076827.000	239781.000		794.780.38	Rabia
NBC	2nd	4062092.000	267189.000		794.792.90	Tel Awainat

5.3 Continuously operating reference stations of USA and British (CORS)

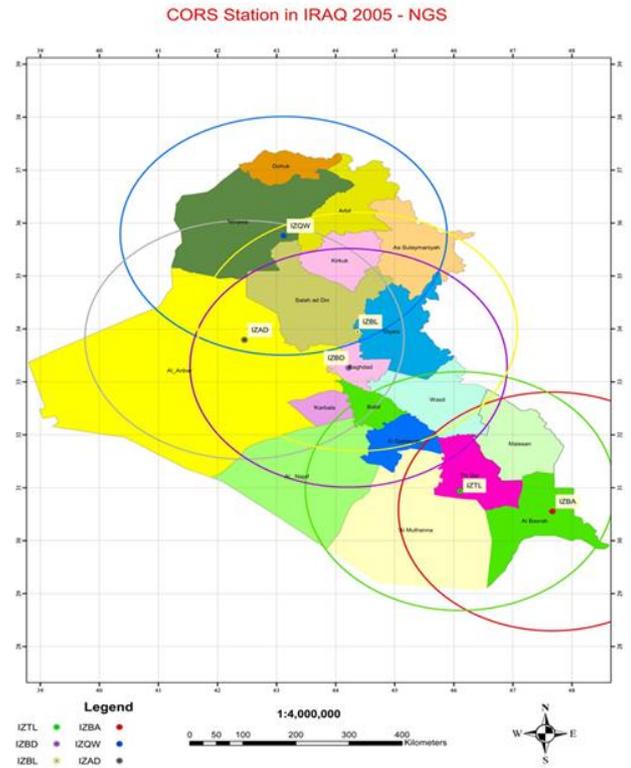


Fig.11. Map the (CORS) network 2005 in Iraq – NGS

5.4 High accuracy reference network of USA and British (HARN)

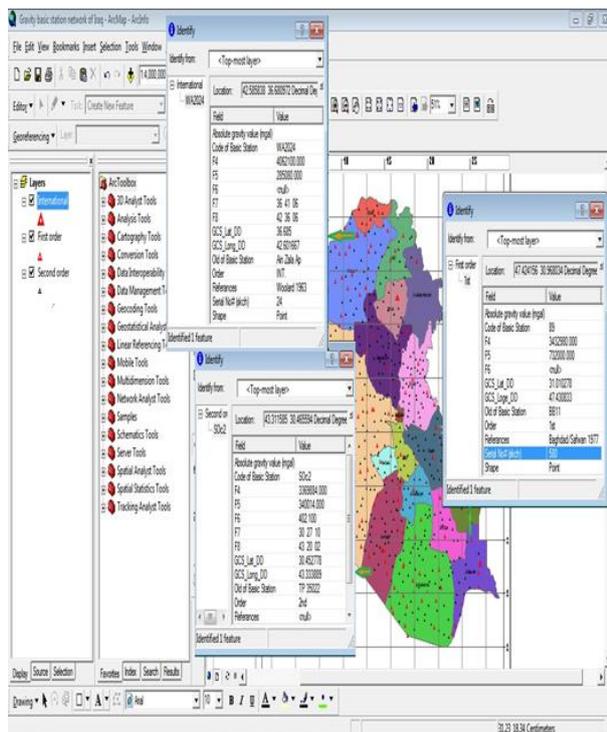


Fig.10. Geodatabase for gravity basic stations network

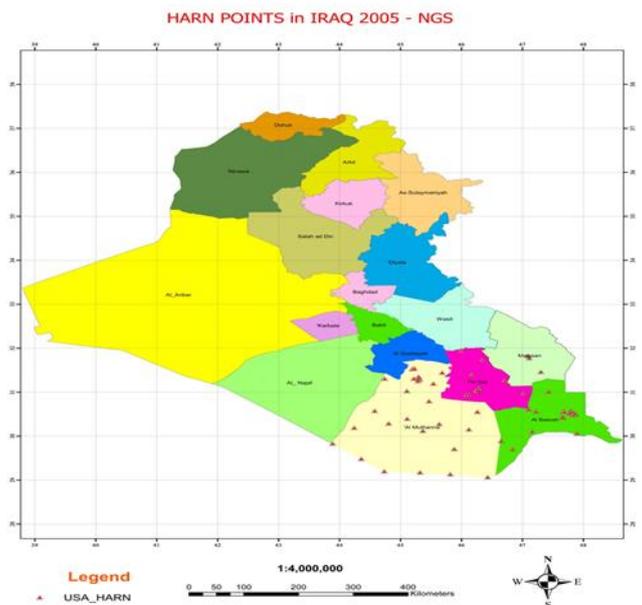


Fig.12 Map for high accuracy reference network (HARN) in Iraq 2005

5.5 Continuously operating reference stations of Iraqi general authority for surveying (CORS)

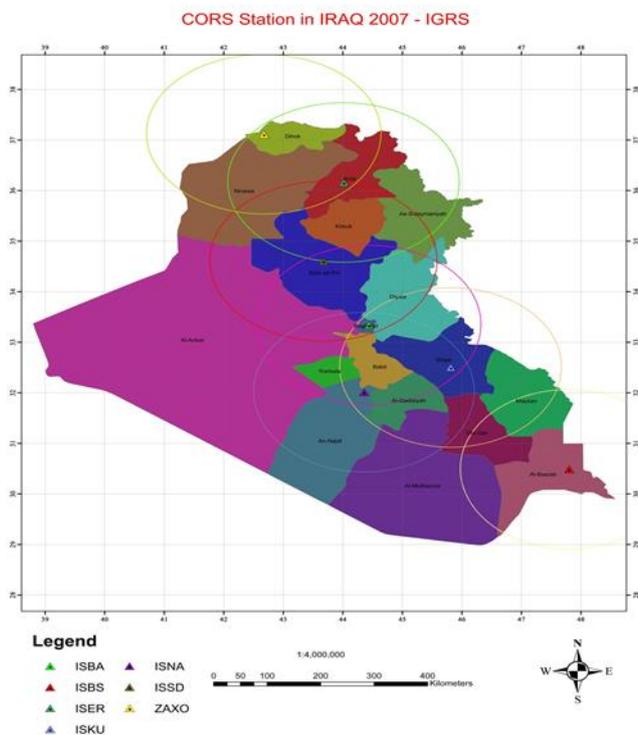


Fig.13.Map for (CORS) network in Iraq – IGRS

5.6 Continuously operating reference stations of Iraqi general authority for surveying (CORS)

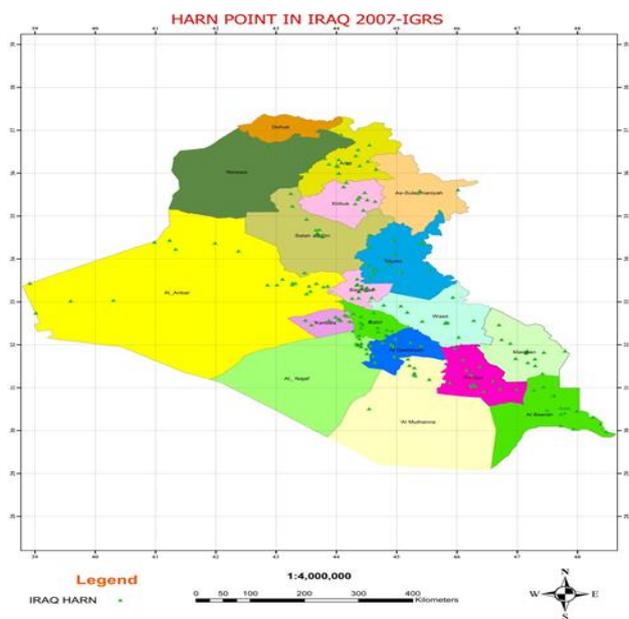


Fig.14. Map for high accuracy reference network (HARN) in Iraq 2007 to 2016

NEW IRAQ HARN POINTS 2005-2016

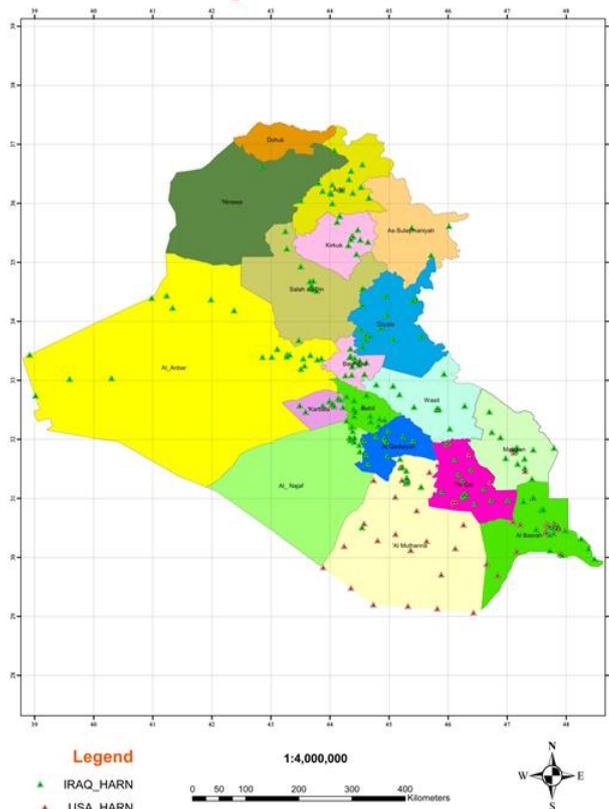


Fig.15. map for high accuracy reference network (HARN) in Iraq 2005 to 2016

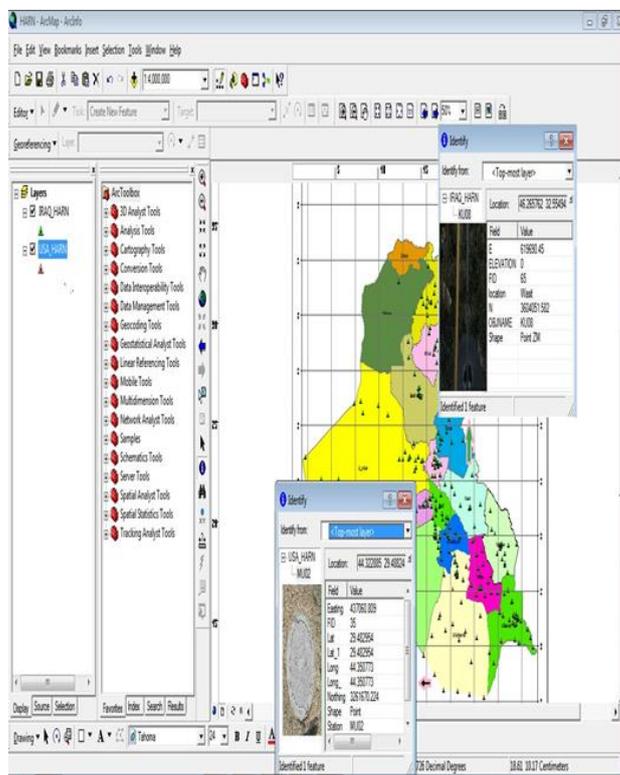


Fig.16.Geodatabase for high accuracy reference network (HARN) in Iraq 2005 to 2016

Table.6 Geodatabase for high accuracy reference network (HARN)

point	Code	Location	East.	North.	ELEV.
01	DQ01	Thi Qar	621452.078	3438594.909	5.299
02	DQ02	Thi Qar	618568.200	3432954.322	6.508
03	DQ03	Thi Qar	618053.464	3435422.901	4.180
04	DQ04	Thi Qar	611159.108	3475960.042	1.296
05	DQ05	Thi Qar	618011.963	3463616.072	1.725
06	DQ06	Thi Qar	604723.820	3503133.510	6.023
07	DQ07	Thi Qar	690793.343	3427588.589	9.367
08	DQ08	Thi Qar	664627.161	3427978.998	9.404
09	DQ09	Thi Qar	652368.232	3448873.044	9.091
10	DQ10	Thi Qar	591378.678	3531492.574	4.127
11	DQ11	Thi Qar	638578.686	3420464.993	6.535
12	DQ12	Thi Qar	624745.393	3435122.974	6.025
13	DQ13	Thi Qar	631242.612	3485316.793	4.190
14	DQ14	Thi Qar	584681.384	3442576.912	5.438
142	BS12	Al Basrah	761711.744	3334676.016	10.404
143	BS13	Al Basrah	781884.881	3326610.608	9.007
144	BS14	Al Basrah	255952.921	3318774.347	0.140
145	BS15	Al Basrah	247020.348	3338235.728	3.385
146	BS16	Al Basrah	760550.287	3364410.957	7.986
147	BS01	Al Basrah	772378.358	3380094.345	11.280

References

1. W. Hussein, National geodetic networks of Iraq Between the past and the present (2011).
2. K. AlKadimi, Gravity control measurement to on basic station along Baghdad Basrah – Safwan road, Baghdad, Som (1977).
3. J. Gazdzicki, H. Kwiatkowshi , New Geodetic Control Network In Iraq Design, Surveys, And Data Processing , (1977).
4. K. AlKadimi , Gravity Basic Station Network of Iraq (1985).

6 Recommendations

To continue the research work in the future, and to go strongly toward solving the technical and administrative problems that are related with geodetic control networks, especially in the field of preparing their required corrected updated spatial data bases, the following recommendations are to be taken in considerations:

1- Enhancing the courses of Geodetic Control Networks for both undergraduate and postgraduate programs within all departments of colleges that are related with geomatics subject).

2- Preparing and supporting the advanced and practical training courses for scientific researchers and geomatics engineers in the field of Geodetic Control Networks, throughout increasing the scientific coordination between the academic sector (geomatics wised colleges) and the applied sector (specialized directorates in geodetic surveying).

3- Establishing the Iraqi higher council for geodetic and cartographic activities, it could be helpful in the improvement of the technical and financial managements for the geodetic control networks projects.

4- Establishing the Digital Iraqi Gate for Geodetic Control Networks, this gate is specialized web. site, it will manage , control the accessibility and downloading for all geodetic official documents (datasheets, sketches, photos, technical reports), this gate could be run by the Iraqi higher council mentioned in the recommendation number 3 above.