International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 18 (2015) pp 39175-39178

Application of the Coordinate Transformation for Cadastral Resurvey Project

Joon-Kyu Park[1], Dae-Wook Park[2*]

[1]Dept. of Civil Engineering, Seoil University, 28, Yongmasan-ro 90-gil, Jungnang-gu, Seoul, Korea
E-mail: jkpark@seoil. ac. kr
[2]Dept. of Civil Engineering, College of Engineering, Kunsan National University
*558, Daehak-ro, Gunsan-si, Jeollabuk-do, Korea * Corresponding author. E-mail: dpark@kunsan. ac. kr*

Abstract
Korean cadastral survey system and geographical survey system are based on each different 'Geodetic Coordinates System'. The former has been made by old Geodetic System, but later by another 'World Geodetic Coordinates System. So both Information System cannot interface each other and expose a lot of numerical errors mutually. Even in one same area, there can be much different estimating results. Therefore the datum was changed from local geodetic system to world geodetic system in Korea. Before a change of the geodetic system, a preliminary study on the coordinate differences for the location values determined from the individual coordinates by selecting a specific area and on the effects of the coordinate differences on the cadastral boundary will enable organic union with the new world geodetic system, breaking away from the traditional local coordinate system. Now, cadastral resurvey project had been performed continuously since 1996. In this study, parameters for coordinate transformation were determined in the study area. For this purpose, static GNSS surveying were accomplished in study area and transformation parameters were calculated using static survey results.

Keywords: GNSS, Coordinate Transformation, World Geodetic Coordinate System, Local Datum, Cadastral Resurvey Project

Introduction

It has been requested a continuous geodetic reference system in positioning in the world because of GNSS technology[1][2]. So, the geodetic reference system was changed from regional geodetic reference system to world geodetic reference system in Korea[3][4]. Recently, with the rapid growth of geospatial information, and the development of the satellite technique of GNSS (Global Navigation Satellite System) such as GPS(Global Positioning System), GLONASS, Galileo, Beidou etc. quick provision of data about the properties and location of individual lots as well as real-time topographic information is required and highly important in terms of the provision of real-time data including human information for the positioning[5]~[7]. In the cadastral survey area, for the highest and best use of the measurements using the GNSS, a change of the plane rectangular coordinate system that was constructed on the basis of the Tokyo geodetic system which is a local coordinate system to the world geodetic system which is a geocentric system of coordinates is necessary[8]~[10]. Before a change of the geodetic system, a preliminary study on the coordinate differences for the location values determined from the individual coordinates by selecting a specific area and on the effects of the coordinate differences on the cadastral boundary will enable organic union with the new world geodetic system, breaking away from the traditional local coordinate system[11]~[13].

In Korea, cadastral resurvey project had been performed continuously since 1996[14]. The purpose of this study is calculating the parameters for coordinate transformation were determined by Helmert transformation as a part of cadastral resurvey project and accuracy analysis of the result of coordinate transformation was performed. Figure 1 shows study flow.

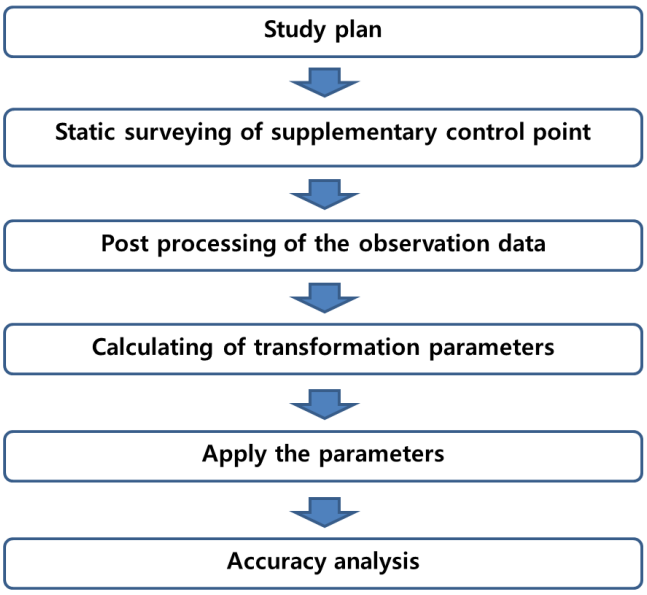

Figure1: Study flow

GNSS Surveying of Control Points

Yeoju was selected as a study area because cadastral resurvey project of that area was performed since 2013. 12 supplementary control points in Neung-seomyeon, Yeoju were selected. And static GNSS surveying were performed more than 2 hours at each points for the surveying. Figure2 shows the study area and table 1 show field note about observation points.

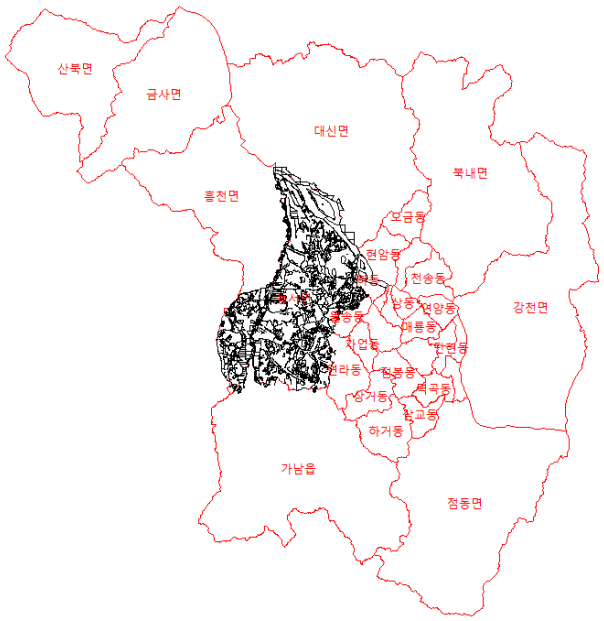

Figure2: Study area

Table 1: Field note about observation points

No.	Point	date	Obs. Start	Obs. End	epoch
1	369	2014. 08. 28	09: 48	12: 00	15sec
2	371	2014. 08. 28	09: 50	12: 01	15sec
3	379	2014. 08. 28	09: 50	12: 00	15sec
4	384	2014. 08. 28	09: 48	12: 00	15sec
5	439	2014. 08. 28	09: 50	12: 00	15sec
6	463	2014. 08. 28	09: 51	12: 00	15sec
7	529	2014. 09. 02	13: 25	15: 35	15sec
8	567	2014. 09. 02	13: 28	15: 30	15sec
9	579	2014. 09. 02	13: 28	15: 32	15sec
10	627	2014. 09. 02	13: 25	15: 30	15sec
11	651	2014. 09. 02	13: 30	15: 31	15sec
12	652	2014. 09. 02	13: 25	15: 30	15sec

The GNSS observation data of study area were processed by relative positioning using 4 CORS(Continuously Operating Reference Station) of NGII(National Geographic Information Institute). CORS were used by reference points with coordinates based on world geodetic system.

TBC(Trimble Business Center) which is data processing software was used. TBC is surveying office software designed toput the newest satellite-receiving technology on users'desktop. With TBC user can effortlessly transfer GNSSfield data into the office for data processing. Figure 3 shows data processing flow and Figure4 shows data processing screen.

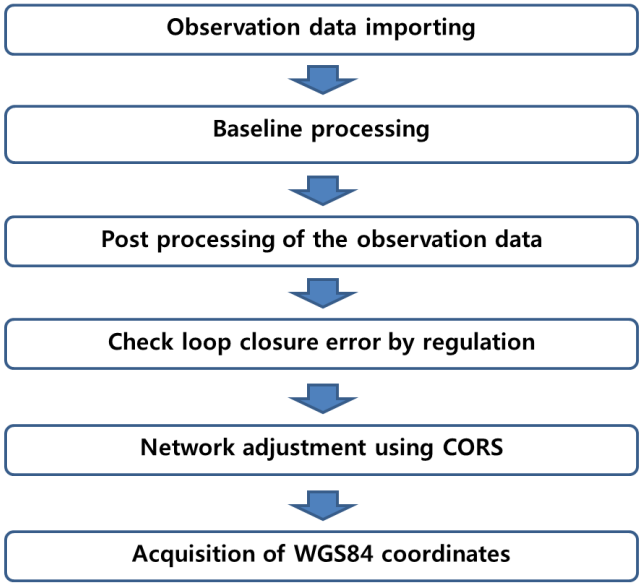

Figure3: Data processing work flow

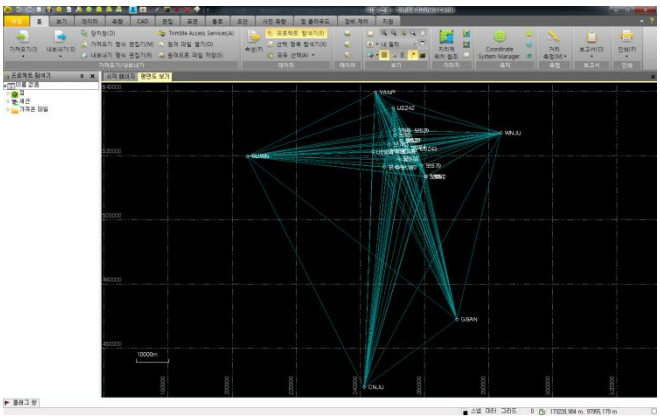

Figure4: Data processing screen

Calculation of Transformation Parameter and Accuracy Analysis

In this study, transformation parameters were calculated, the coordinate transformation parameters were calculated by Helmert transformation methods. And accuracy analyses of parameters were performed using check points. Table 2 shows surveying results and parameters for transformation.

Table 2: Surveying results and parameters for transformation

No.	Point	Local Geodetic System		Global Geodetic System	
		X(m)	Y(m)	X(m)	Y(m)
1	369	415788. 34	251507. 78	516094. 447	251578. 490
2	371	418170. 84	252322. 08	518476. 960	252392. 789
3	379	420878. 79	251502. 18	521184. 889	251572. 875
4	384	422006. 84	254352. 94	522312. 952	254423. 607
5	439	415985. 82	247380. 01	516291. 937	247450. 769
6	463	422987. 30	248970. 52	523293. 383	249041. 219

7	529	427248. 79	255454. 47	527554. 879	255525. 100
8	567	420843. 34	247789. 50	521149. 385	247860. 220
9	579	416439. 06	259128. 31	516745. 269	259198. 961
10	627	424236. 97	252766. 47	524543. 071	252837. 138
11	651	412957. 20	260273. 36	513263. 414	260344. 041
12	652	413017. 01	260549. 25	513323. 229	260619. 933
Parameters		Sxy	Rxy	Tx	Ty
		0. 999993	-0. 0000069	100307. 3	75. 34998
Precision		Sxy	Rxy	Tx	Ty
		0	0	0. 0000009	-0. 0000009
RMSE		dX(m)		dY(m)	
		0. 0134		0. 0071	

As shown in Table 2 the parameters for transformation were calculated. Sxy is scale factor, Rxy is rotation in X-Y plane, Tx and Ty are translations of X-axis, Y-axis. These parameters could be used for the coordinate transformation from local geodetic system to global geodetic system. If additional study about accuracy verification using check point would be performed, the transformation parameters would be great help to the cadastral resurvey project. So, 5 check points were selected in study area and the coordinates in World Geodetic Coordinate System were calculated. Table 3 shows results of transformation and Figure 5 shows deviation between surveying and transformation.

Table 3: Results of coordinate transformation

No	Surveying		Transformation	
	X	Y	X	Y
1	526228. 073	250849. 371	526228. 075	250849. 352
2	527772. 759	250592. 885	527772. 773	250592. 901
3	518917. 370	251984. 771	518917. 400	251984. 730
4	521131. 173	251106. 663	521131. 191	251106. 681
5	524550. 596	252639. 965	524550. 601	252639. 941

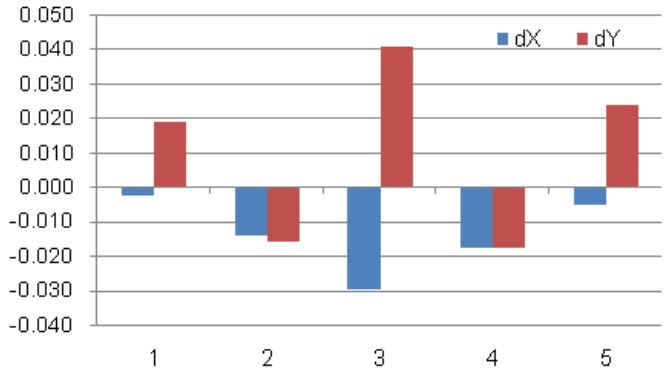

Figure5: Deviation between surveying and transformation

As shown in Figure5, results of deviation by transformation showed-0. 03~+0. 04m compared with results of surveying. These are value within the allowable error about cadastral survey. Table 4 shows allowed error by the enforcement regulation of cadastral surveying.

Table 4: Allowed error by the enforcement regulation of cadastral surveying

Case	Allowed Error
Cadastral Triangulation Point	<0. 2m
Subsidiary Cadastral Triangulation Point	<0. 25m
Boundary Point	<0. 10m
Supplementary Control Points	**<0. 15m**

This result shows coordinate's transformation for datum conversion can possible. Through further study, if the accuracy of coordinate's transformation in wide area will proved, time and cost will decrease about cadastral resurvey project.

Conclusions

In this study, parameters for coordinate transformation were determined in the study area. For this purpose, Yeoju was selected as a study area because cadastral resurvey project of that area was performed since 2013. 12 supplementary control points in Neung-seomyeon, Yeoju were selected. Static GNSS surveying were accomplished in study area and transformation parameters were calculated using static survey results. The parameters Sxy, Rxy, Tx, Ty are respectively 0. 999993,-0. 0000069, 100307. 3 and 75. 34998. These parameters could be used for the coordinate transformation from local geodetic system to global geodetic system. If additional study about accuracy verification using check point would be performed, the transformation parameters would be great help to the cadastral resurvey project. So, In this study, 5 check points were selected in study area and the coordinates in World Geodetic Coordinate System were calculated. Results of deviation by transformation showed-0. 03~+0. 04m compared with results of surveying. These are value within the allowable precision about cadastral survey. This result shows coordinate's transformation for datum conversion can possible. However, the area that may be applied to the value was not large administrative district. So, more study would be needed for coordinate transformation about large area. Through further study, if the accuracy of coordinate's transformation in wide area will proved, time and cost will decrease about cadastral resurvey project. Because the proportion of coordinate transformation is large in the cadastral resurvey project in Korea, additional analytic study about coordinate transformation parameter is required for wide area.

Acknowledgments

This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Science, ICT and Future Planning(No. NRF-2015R1A1A1A05001366).

References

[1] Janssen, V., Haasdyk, J., and McElroy, S., 2015, "CORSnet-NSW: State Infrastructure for GNSS Applications and Applied Research", Proceedings of IGNSS Symposium 2015, International Global Navigation Satellite System Society, pp. 1-17.

[2] Pacina, J., 2015, "Geodetic surveying as a tool for discovering the prehistoric settlement in Sudan (the 6th Nile cataract)", Geoinformatics, 14(1), pp. 47-64.

[3] Alkan, R. M., İlçi, V., Ozulu, İ. M, and Saka, M. H., 2015, "A comparative study for accuracy assessment of PPP technique using GPS and GLONASS in urban areas", Measurement, 69, pp. 1-8.

[4] Angrisano, A., Gaglione, S., and Gioia, C., 2013, "Performance assessment of GPS/GLONASS single point positioning in an urban environment", ActaGeodGeophys, 48, pp. 149-161.

[5] McNellie, M. J., Oliver, I., and Gibbons, P., 2015, "Pitfalls and possible solutions for using geo-referenced site data to inform vegetation models", Ecological Informatics, pp. 1-5.

[6] Boucher, C., Pearlman, M., and Sarti, P., 2015, "Global geodetic observatories", Advances in Space Research, 55(1), pp. 24-39.

[7] Abidin, H. Z., Haroen, T. S., Adiyanto, F. H., Andreas, H., Gumilar, I., Mudita, I., and Soemarto, I., 2015, "On the establishment and implementation of GPS CORS for cadastral surveying and mapping in Indonesia", Survey Review, 47(340), pp. 61-70.

[8] McGill, S. F., Spinler, J. C., McGill, J. D., Bennett, R. A., Floyd, M. A., Fryxell, J. E., and Funning, G. J., 2015, "Kinematic Modeling of fault slip rates using new geodetic velocities from a transect across the Pacific-North America plate boundary through the San Bernardino Mountains, California", Journal of Geophysical Research, 120(4), pp. 2772-2793.

[9] Georgopoulos, G. D., and Telioni, E. C., 2015, "Determination of local geoid model in Attica Basin Greece", Survey Review, 47(341), pp. 109-114.

[10] Kim, U., and Choi, S., 2014, "Study on the Way of Improvement by Analyzing the Problem Revealed in Current Cadastral Resurvey Project", Journal of the Korean Society of Surveying, Geodesy, Photogrammetry and Cartography, 32(4-2), pp. 431-442.

[11] Lee, B., Yoon, J., and Son, J., 2014, "Effectiveness Analysis According to the Affiliation of Linear SOC Projects and Cadastral Resurvey Project", Journal of the Korean Society of Surveying, Geodesy, Photogrammetry and Cartography, 32(4-2), pp. 393-400.

[12] Park, C., Park. K., and Hong, S., 2013, "Accuracy Analysis of Network RTK Surveying for Cadastral Re-survey Project", Journal of the Korean Society for Geospatial Information Science, 21(4), pp. 117-123.

[13] Kim, S., and Kim, H., 2012, "Industrial spread effect analysis of Korean cadastral resurvey project: focused on the cadastral information related industry", Journal of the Korean Society of Cadastre, 28(2), pp. 127-142.

[14] Park, J., and Park, D., 2015, "Determination of the Parameter for Transformation of Local Geodetic System to the World Geodetic System using GNSS", Proceedings of International Workshop Architecture and Civil Engineering 2015, 100, pp. 118-122.