IOP Conf. Series: Earth and Environmental Science **767** (2021) 012018 doi:10.1088/1755-1315/767/1/012018

Conventional Approach to Harmonious Coordinated Cadastral Database Weakness

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Abstract. The eKadaster system depended solely on the use of coordinated cadastral database known as the National Digital Cadastral Database (NDCDB) with an expected accuracy of ±10cm. Till date, there is an approximately of 7.8 million land parcels and 21.9 million boundary markers in the NDCDB that covers the total area of 132,183 km^2. However, the NDCDB accuracy of ±10cm is still not at a satisfactory acceptance level and the adjustment keeps continuing without carrying out verification to the data sources weakness of varying accuracy and input errors. Thus, the foremost important corrective is to ensure the adjustment input files to have the exact value of the sources by further divided the existing adjustment blocks into smaller blocks to verify the input data line by line. A well distributed cadastral control points and latest NDCDB accessibility are also extensively needed to plan and to strengthen the adjustment network. The comparison result of the randomly picked ground truthing points in the field has shown a significant impact on the displacement accuracy that meet the expected tolerance of ±10cm or better after the data input file is cleaned without input error. And to further strengthen the adjustment network in order to make NDCDB accuracy better, the current cadastral control points shall need to tie to a highest accuracy fundamental network.

1. Introduction

The eKadaster system had been implemented by the Department of Survey and Mapping Malaysia (DSMM) from 1st May 2010. It marked the beginning of a fully automated cadastral survey system where the survey computation procedure depended solely on the coordinated cadastral system (CCS) database known as the National Digital Cadastral Database (NDCDB).

The intention of the NDCDB was to have a homogeneous and seamless database with survey accurate coordinate accuracy of ±10cm [1] reference to the Geodetic Datum of Malaysia (GDM) known as the GDM2000 Geocentric Cassini Soldner system [2]. Previously established Digital Cadastral Database (DCDB) was migrated to NDCDB in 2006 with adjustment from 25,000 Global Satellite Navigation System (GNSS) observed grid-based Cadastral Control Infrastructure (CCI) points and it was further adjusted in 2012. The migration had undergone quality assurance at every level of its formation as shown in figure 1 and figure 2.

During this period, approximately a total of 2,891 adjustment blocks was created following the reserved route in between the land parcels [3]. For example, the adjustment blocks for the state of Pulau Pinang are as shown in figure 3 and figure 4. And to strengthen the existing cadastral control network, DSMM had identified and established additional Cadastral Reference Mark (CRM) from 2012 onwards. At present, there are approximately 100,202 cadastral control points have been established to strengthen the adjustment network.

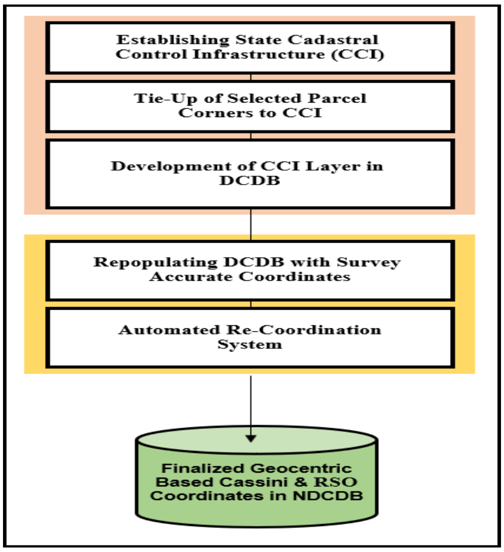

Figure 1. Migration methodology.

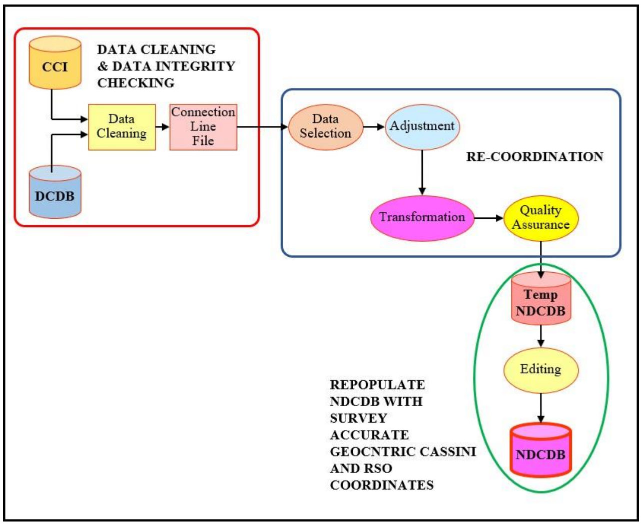

Figure 2. Adjustment methodology.

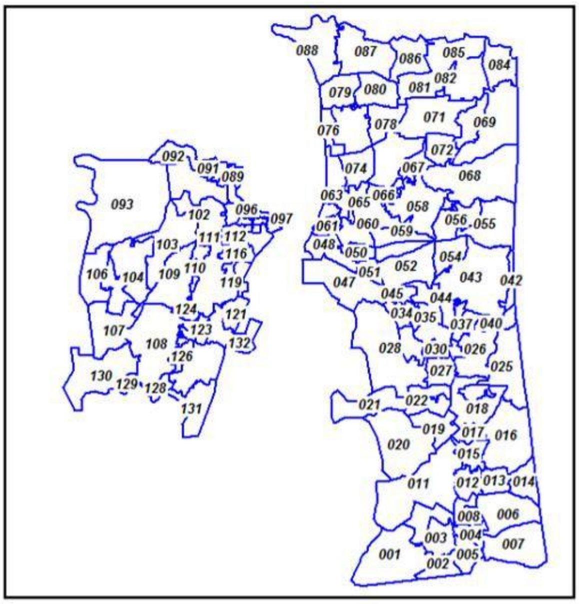

Figure 3. Adjustment blocks for the state ofPulau Pinang.

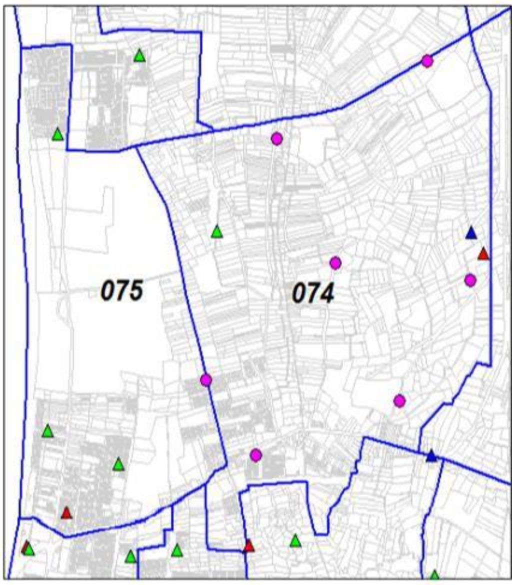

Figure 4. An adjustment block for the stateof Pulau Pinang.

2. Issues

The aim of NDCDB is to achieve the accuracy of ±10cm between the boundary marks in the NDCDB to their respective physical location on the ground. From 2010 till late 2019, block adjustment is continuously processed by entrusting the adjustment input files having no input errors [4].

But lately, DSMM started to realise why its accuracy of ±10cm is far below expectation [5]. This mindful thought has led to the verification of the adjustment input files and found issues among others, are inaccurate or insufficient number of cadastral control points, wrongly geometrical matched the

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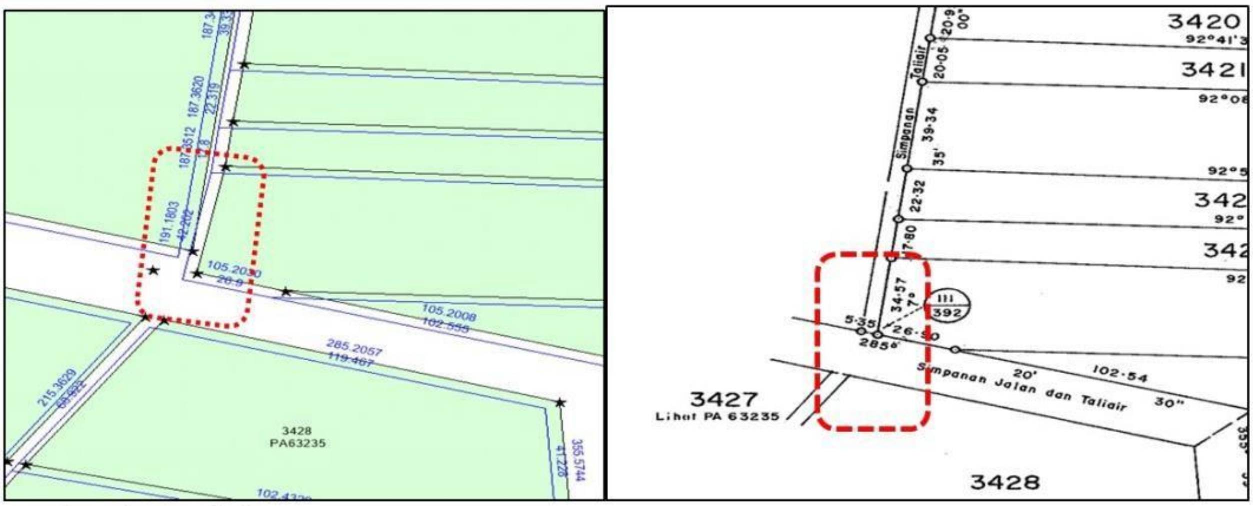
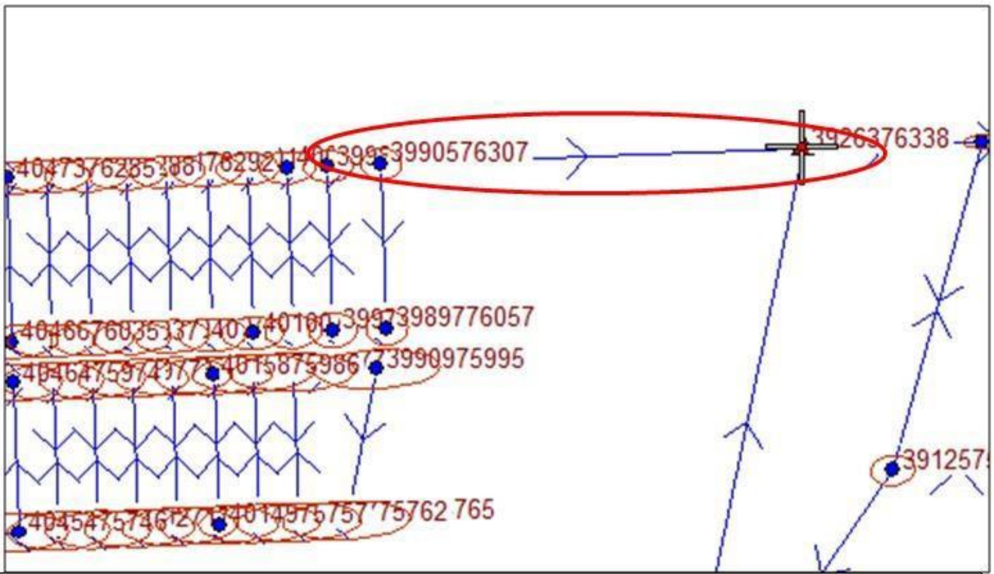
boundary marks, inaccurate connection line resulting features being pushed to wrong location, non-compliance and missing lots resulting incomplete database [3]. Some of the findings are shown in figure 5, figure 6 and figure 7.



Bearing value wrongly input
Bearing from Certified Plan 7 35' 00" and input as 1 18' 03" **(6 16' 57")**
Distance from Certified Plan 34.57m and input as 42.202m **(7.632m)**

Figure 5. Wrongly input of bearing and distance value.



Wrong connection line input value from node 3990576307-3926376338

Figure 6. Wrongly input of connection line value.

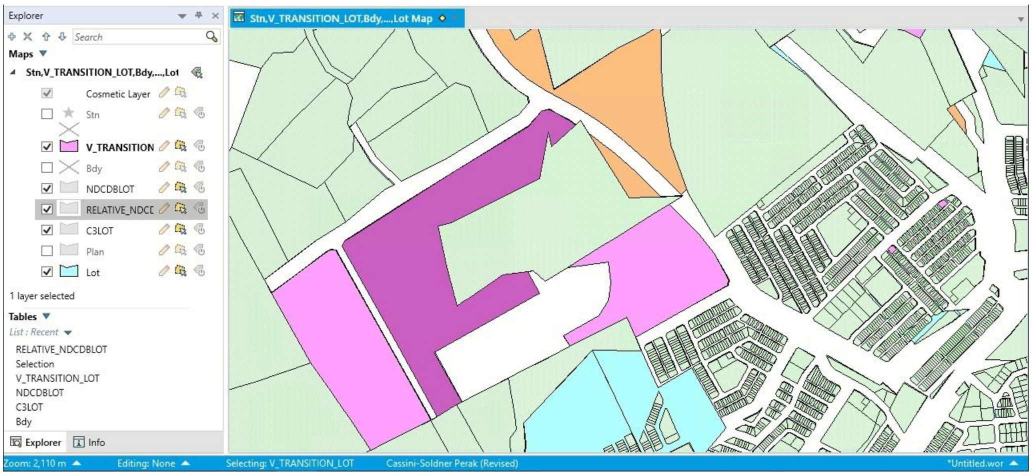


Figure 7. Incomplete database in multiple layers.

3. The Approach

DSMM need to determine the adjustment input files to have the exact value as those shown in the Certified Plans which are the source data for adjustment. It is a tedious process to verify the input data line by line and to ease the verification process, the previous 2,891 adjustment blocks are further divided into smaller blocks of 5,163 as shown in table 1 [3]. This is to enable the line by line checking for data input errors.

The need to include non-compliance and missing lots cadastral fabrics from multiple layers into NDCDB is also important to portrait the latest NDCDB for control network planning and adjustment. Once the adjustment block is confirmed free from data input error, then the distribution of the cadastral control points will need to identify in order to strengthen its adjustment network. The availability of the traverse lines from current survey files and their cadastral control points tie-up are also used as additional input data as shown in figure 8.

With this verification procedure, DSMM will have a higher confidence level of the adjustment result and to plan for the next course of action. The tasks are done using a customised application named Localised Adjustment and Append Module (LAAM) as shown in figure 9.

Table 1. New smaller adjustment blocks.

NO.	STATE	NEW BLOCK OF ADJUSTMENT
1.	PERLIS	84
2.	LABUAN	10
3.	MELAKA	230
4.	N. SEMBILAN	364
5.	P. PINANG	244
6.	PAHANG	466
7.	WPKL/PUTRAJAYA	141
8.	KEDAH	378
9.	PERAK	868
10.	KELANTAN	444
11.	SELANGOR	692
12.	TERENGGANU	413
13.	JOHOR	829
	TOTAL	**5163**

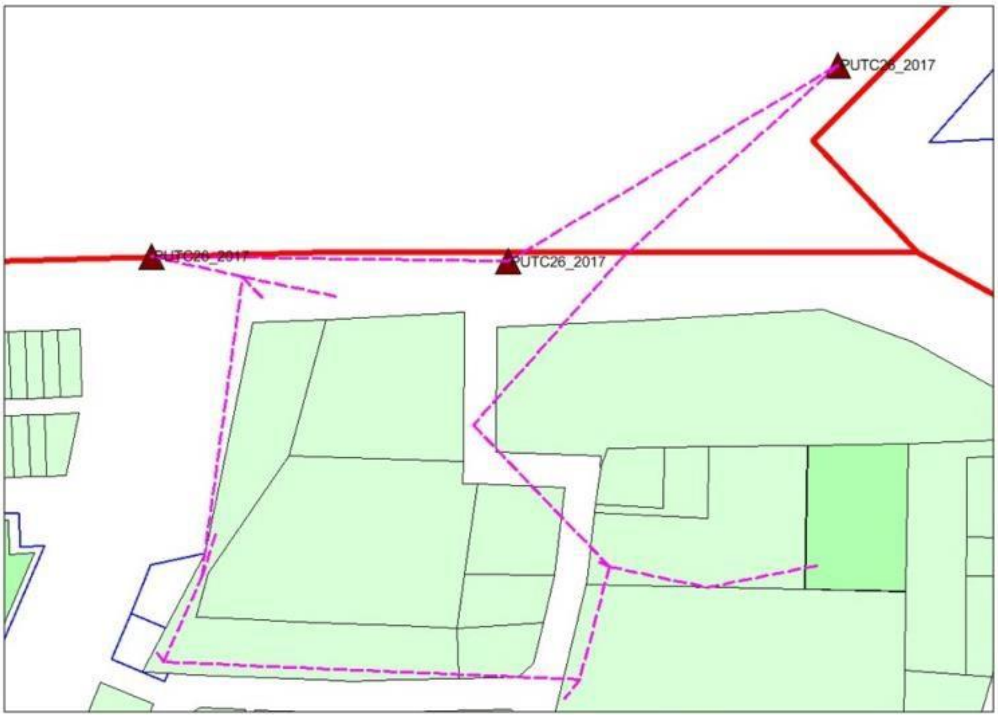


Figure 8. Current traverse lines and cadastral control points tie-up

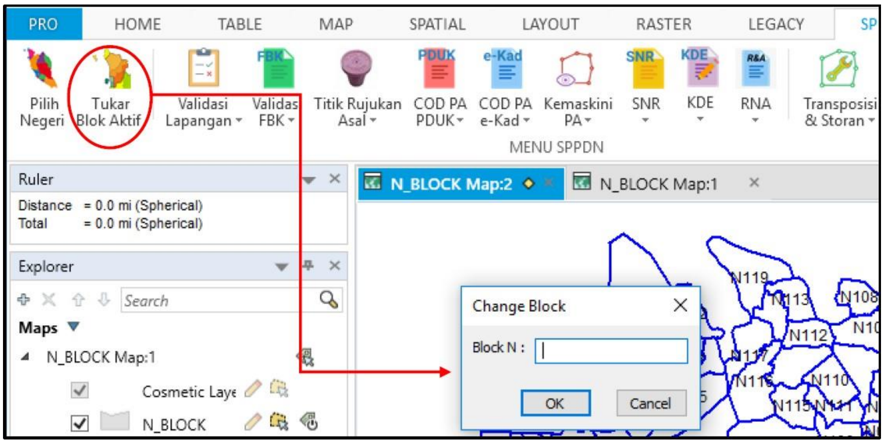


Figure 9. Localised Adjustment and Append Module (LAAM) application.

4. Findings

After the data input file for the respective block is cleaned then it is used to perform the adjustment. The adjustment result will then compare with randomly picked ground truthing points in the field. Table 2 and figure 10 shown the displacement result before the data input file is cleaned. Table 3 and figure 11 shown the displacement result after the data input file is cleaned.

Table 2. Maximum displacement of 1.856m before cleaned for block T02001.

BIL	NO_FAIL	STN_ID	STN_NO	STN_TYPE	GP_T	GP_U	BLOCK	BEZA_T	BEZA_U	ANJAKA	ID_BATU	NOS
33	PUT1711_2016	2263063327	20		12,262.414	-6,334.457	T02001	-0.625	-1.748	1.856	2263063327	
24	PUT770_2016	3075441827	6		13,075.433	-4,182.330	T02001	0.852	-1.638	1.846	3075441827	
32	PUT1711_2016	2193663847	30		12,193.116	-6,386.526	T02001	-0.634	-1.733	1.845	2193663847	
3643	PUT1711 / 2016	2264263219	17.0000	BKL	12,264.050	-6,322.106	T02001	-0.607	-1.738	1.841	2264263219	
3642	PUT1711 / 2016	2224063177	11.0000	BKL	12,223.899	-6,317.981	T02001	-0.600	-1.739	1.840	2224063177	
3644	PUT1711 / 2016	2184063140	8.0000	BKL	12,183.849	-6,314.189	T02001	-0.597	-1.734	1.834	2184063140	
12	PUT1005_2015	1779745890	31		11,779.738	-4,588.504	T02001	0.843	-1.564	1.777	1779745890	
3908	PUT1731 / 2016	2093950204	9.0000	BKL	12,094.830	-5,021.949	T02001	0.898	-1.512	1.759	2093950204	
3905	PUT1728 / 2016	2093950204	9.0000	BKL	12,094.830	-5,021.949	T02001	0.898	-1.512	1.759	2093950204	
3909	PUT1731 / 2016	2118450011	8.0000	BKL	12,119.311	-5,002.667	T02001	0.892	-1.514	1.757	2118450011	
3906	PUT1728 / 2016	2118450011	8.0000	BKL	12,119.311	-5,002.667	T02001	0.892	-1.514	1.757	2118450011	
3907	PUT1731 / 2016	2181350798	23.0000	BKL	12,182.240	-5,081.344	T02001	0.882	-1.513	1.751	2181350798	
3904	PUT1728 / 2016	2181350798	23.0000	BKL	12,182.240	-5,081.344	T02001	0.882	-1.513	1.751	2181350798	
9	PUT478_2015	1886741021	4		11,886.255	-4,102.127	T02001	0.837	-1.534	1.747	1886741021	
1975	PUT478 / 2015	1853739555	13.0000	BKL	11,854.566	-3,957.007	T02001	0.832	-1.532	1.743	1853739555	
2061	PUT1005 / 2015	1738046286	33.0000	BKL	11,739.677	-4,628.202	T02001	0.734	-1.575	1.738	1738046286	
1976	PUT478 / 2015	1862338740	17.0000	BKL	11,863.110	-3,875.492	T02001	0.819	-1.533	1.738	1862338740	
8	PUT478_2015	1953839616	33		11,954.656	-3,963.128	T02001	0.832	-1.514	1.728	1953839616	
1974	PUT478 / 2015	1953839616	33.0000	BKL	11,954.656	-3,963.128	T02001	0.832	-1.514	1.728	1953839616	
	PUT1728_2016	2093950204	9		12,094.838	-5,021.909	T02001	0.906	-1.472	1.728	2093950204	
4078	PUT1273 / 2016	2477248691	5.0000	BKL	12,477.433	-4,868.304	T02001	0.928	-1.450	1.722	2477248691	
4077	PUT1273 / 2016	2496348760	6.0000	BKL	12,496.523	-4,875.273	T02001	0.923	-1.447	1.716	2496348760	
4079	PUT1273 / 2016	2460348407	7.0000	BKL	12,460.471	-4,839.981	T02001	0.922	-1.432	1.703	2460348407	
13	PUT1273_2016	2460348407	7		12,460.471	-4,839.981	T02001	0.922	-1.432	1.703	2460348407	
2063	PUT1005 / 2015	1550945229	21.0000	BKL	11,552.617	-4,522.476	T02001	0.761	-1.508	1.689	1550945229	
10	PUT1005_2015	1396446374	4		11,395.776	-4,637.392	T02001	0.837	-1.463	1.686	1396446374	
	PUT718_2018	0599943068	4		10,599.559	-4,306.532	T02001	1.072	-1.300	1.685	0599943068	
2062	PUT1005 / 2015	1585244923	22.0000	BKL	11,586.919	-4,491.864	T02001	0.762	-1.502	1.684	1585244923	
19	PUT149_2019	1133853092	16		11,133.258	-5,309.162	T02001	0.870	-1.429	1.673	1133853092	
7	PUT420_2015	4492336990	21		14,493.711	-3,700.189	T02001	0.926	-1.320	1.612	4492336990	
5	PUT420_2015	4326136915	4		14,328.526	-3,690.678	T02001	0.812	-1.291	1.525	4326136915	
2121	PUT1158 / 2015	1144363277	20.0000	BKL	11,144.262	-6,327.519	T02001	-0.434	0.714	0.836	1144363277	

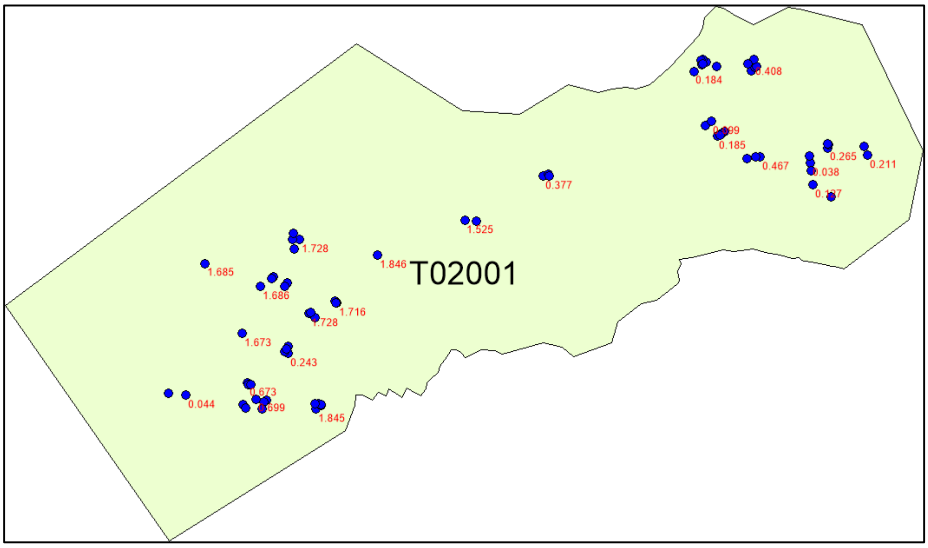


Figure 10. Maximum displacement of 1.856m before cleaned for block T02001.

Table 3. Maximum displacement of 0.068m after cleaned for block T02001.

BIL	NO_FAIL	STN_ID	STN_NO	STN_TYPE	GP_T	GP_U	BLOCK	BEZA_T	BEZA_U	ANJAKA	ID_BATU
1286	PUT92/ 2020	8481813855	12.0000	BKL	18,482.082	-1,384.882	T02001	0.031	-0.061	0.068	8481813855
4018	PUT228 / 2017	8614839263	13.0000	BKL	18,614.860	-3,926.380	T02001	-0.006	-0.060	0.060	8614839263
3907	PUT1731 / 2016	2181350798	23.0000	BKL	12,182.240	-5,081.344	T02001	-0.014	-0.048	0.050	2181350798
8501	PUT1509 / 2018	9295229777	39.0000	BKL	19,295.751	-2,977.820	T02001	0.050	0.000	0.050	9295229777
8894	PUT1509 / 2018	9295229777	39.0000	BKL	19,295.751	-2,977.820	T02001	0.050	0.000	0.050	9295229777
3904	PUT1728 / 2016	2181350798	23.0000	BKL	12,182.240	-5,081.344	T02001	-0.014	-0.048	0.050	2181350798
4019	PUT228 / 2017	8680238938	24.0000	BKL	18,680.207	-3,893.865	T02001	-0.008	-0.047	0.048	8680238938
3906	PUT1728 / 2016	2118450011	8.0000	BKL	12,119.311	-5,002.667	T02001	-0.010	-0.040	0.041	2118450011
3908	PUT1731 / 2016	2093950204	9.0000	BKL	12,094.830	-5,021.949	T02001	-0.008	-0.040	0.041	2093950204
3909	PUT1731 / 2016	2118450011	8.0000	BKL	12,119.311	-5,002.667	T02001	-0.010	-0.040	0.041	2118450011
3905	PUT1728 / 2016	2093950204	9.0000	BKL	12,094.830	-5,021.949	T02001	-0.008	-0.040	0.041	2093950204
1088	PUT1302 / 2019	7863422720	4.0000	BKL	17,866.221	-2,271.657	T02001	0.030	0.014	0.033	7863422720
9896	PUT964 / 2019	7739213795	9.0000	BKL	17,739.527	-1,379.549	T02001	-0.032	-0.005	0.032	7739213795
9897	PUT964 / 2019	7767314376	6.0000	BKL	17,767.693	-1,437.747	T02001	0.000	-0.031	0.031	7767314376
22	PUT1433_2018	0076361691	13		10,076.669	-6,169.817	T02001	0.021	0.017	0.027	0076361691
1102	PUT1569 / 2019	8496314934	17.0000	BKL	18,496.507	-1,492.915	T02001	-0.019	0.019	0.027	8496314934
21	PUT1433_2018	0324961936	8		10,324.995	-6,194.324	T02001	0.021	0.017	0.027	0324961936
9895	PUT964 / 2019	7791614235	4.0000	BKL	17,792.006	-1,423.712	T02001	0.014	-0.019	0.024	7791614235
1088	PUT1302 / 2019	7986524622	10.0000	BKL	17,989.065	-2,461.446	T02001	-0.019	-0.004	0.019	7986524622
1292	PUT2261/ 2019	7747614490	61.0000	BKL	17,747.972	-1,449.125	T02001	0.008	-0.015	0.017	7747614490
4038	PUT231 / 2017	1749455618	9.0000	BKL	11,749.826	-5,561.942	T02001	0.009	-0.014	0.017	1749455618

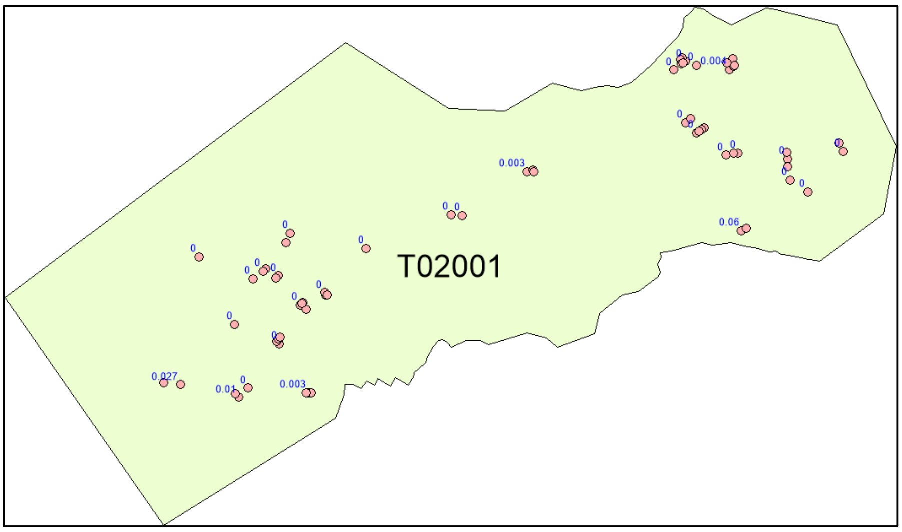


Figure 11. Maximum displacement of 0.068m after cleaned for block T02001.

The comparison result has shown a significant impact on the displacement accuracy before and after the data input file is cleaned. The displacement between the ground truthing with NDCDB which is adjusted from the cleaned data input file meet the expected tolerance of ±10cm or better.

5. Conclusion and the way forward

To conclude the finding from the adjustment result above has led to how the NDCDB should be developed to meet the expected accuracy of ±10cm. The foremost important aspect to achieve the needed accuracy is to input the data free from error compare to its sources and not only depending on the control network's density alone. Of course, a well-planned cadastral control network with the highest accuracy will not make NDCDB better if the data source to develop the NDCDB contain

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errors. Thus, to strengthen the cadastral control network, DSMM has planned to establish the highest accuracy Positional Reference Mark (PRM) as the fundamental network in 2022. The PRM is based on GNSS technique and is made to support the NDCDB adjustment. This will be in addition to the current available CRM as control points for the adjustment. And the PRM is an additional to the current sixty-five (65) RTK CORS Stations or zero-order network available in the Peninsular Malaysia. The CRM established previously will then tie to this PRM in order to strengthen the control network for adjustment. The establishment of CRM is a continuing process with more to build within an adjustable block to improve the quality of the NDCDB.

References

[1] Survey and Mapping Director General Circular Vol. 6/2009 (KPUP 6/2009) *Garis Panduan Amalan Kerja Ukur Kadaster Dalam Persekitaran eKadaster*

[2] Survey and Mapping Director General Circular Vol. 9/2005 (KPUP 9/2005) *Garis Panduan Mengenai Penggunaan Perkhidmatan Malaysia RTK GPS Network (MyRTKnet)*

[3] K S Looi *et al* 2020 *Cadastral Database Accuracy Enrichment* (Amsterdam: GEO Smart Asia)

[4] A Zakaria 2018 *Digital Cadastral Database (NDCDB) In Selangor – The Way Forward* (Adelaide: GEO Smart Asia)

[5] Survey and Mapping Director General Circular Letter Vol. 1/2010 (SPKPUP 1/2010) *Isu-IsuPengukuran Dalam Persekitaran eKadaster Dan Kaedah Penyelesaiannya*