

Authentic Measurements as a Basis for Cadastral GIS

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introduction

- At present, as in many other countries, the cadastre in Israel is in a transition from a graphical product to a digital and analytical one. In most cases 'analytical cadastre' means to determine the coordinates of the cadastral parcels and blocks.
- The best technique for validating the cadastral coordinates is by gathering and storing all the original cadastral measurements which led to defining and registering the cadastral entities, measurements that will be used as a basis for the analytical cadastral database.

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Research Motivations

- The juridical status of the authentic measurements.
- Unique identification of borders according to Torens method.
- Restoration of lost or obliterated corners ability.
- Ability to discover conflicts in the registration process.
- Coordinates validation as a basis for analytical cadastre.
- Data integration in existing systems and merging neighboring plans.

"The essence of analytical cadastre is by digitally determining the old (historical) cadastral border marks to ensure as best as possible the authentic border's location. "

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Main Research topics

- Comprehensive review of GIS assimilation alternatives.
- Quantitative review, schedules and cost estimations
- Determining instructions for data collection.
- Transfer-tables definition, From field books to GIS.
- *Control net analysis.*
- Finding efficient order of data in the system – Hierarchic model.

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Main Research topics ...(cont.)

- **Determining data and relations tables.**
- **Define and apply control and supervision system for the reliability and correctness of the data.**
- **Giving ability for retroactive corrections for post factum errors.**
- **Accurate and reliable link between different cadastre layers.**
- **Profitability check of cost/benefit ratio for the integration of authentic measurements in the national GIS.**

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Literature review

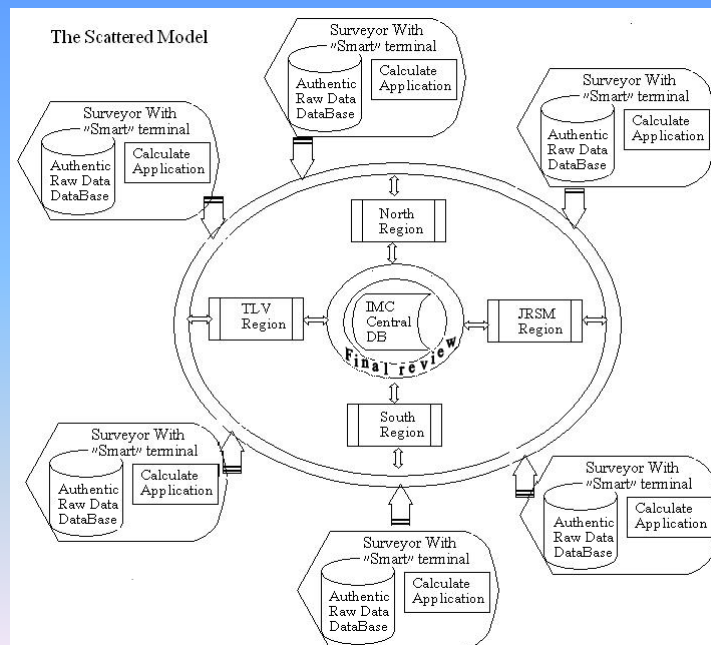
- **Australia and New Zealand: Digital Cadastral Data Base :DCDB**
 - » **New measurements combined with digitized maps.**
 - » **Up to ± 0.25 m in urban areas and ± 1 m in rural areas.**
- **Austria: nationwide digital cadastre**
 - » **Maintenance by 68 local mapping agencies.**
 - » **Based on old cadastre tax maps, new control network and additional measurements.**
- **Canada, Denmark, Holland and other countries surveyed and in none of them authentic measurements and raw data integrated in the GIS.**

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Authentic measurements integration in analytical cadastre

- **Three different alternatives for integration:**
 - » The scattered model.
 - » The centralization model.
 - » The combined half-scattered model.
- **Three participant circles**
 - » The executers circle (usually private surveyors).
 - » The inspectors circle.
 - » The federal agency circle (IMC main office)
- **The main difference: The location of the raw data**

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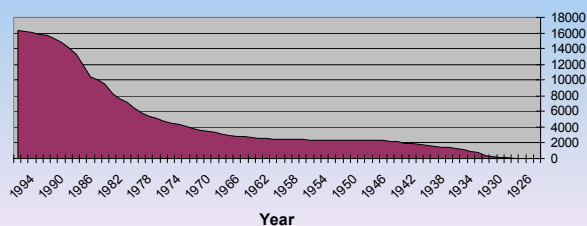


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Quantitative review and data scope estimation

- 1926 Cadastre act starts.
- Surveying equipment development: from chain surveying to GPS.
- Control network strengthening and regulations changing.

Block accumulateness along years



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Data collections direction and tables feeding

- Collecting: Field books, field sheets, mutations sheets...
- Field measurements. (for restoring lost corners)
- Details measurements, control net strengthen, determining transformations parameters.
- Transfer/translate tables feeding.
- The old control net.
- Chain surveying data.
- GPS, Total station etc. field measurements
- Geometrical constrains and supplementary information.

5 Blocks pilot built with 3,891 records and 26,669 fields.

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The Data Base

- Control points and traverse network
- Chain surveying measurements and other field measurements.
- Geometrical constrains: distances crossing, lines and parallels crossings, fronts and auxiliary measurements.
- Parcels definitions.

Cross Lines	Fronts	Run/Offsets	Meas. lines	Blocks	Calc Order
35	173	87	143	11502	1
78	80	832	333	11509	2
65	60	377	316	11501	3
55	50	421	260	11506	4
28	20	303	174	11507	5
261	383	2020	1226		Total
8	9	5	9		Records/Fields
2088	3447	10100	11034		Total fields

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A piece of original control net calculation notebook

SURVEY OF PALESTINE						
TRAVERSE COMPUTATION						
Village: <i>Dahyat el Harmil</i>				Traverse No.: <i>77</i>		
Sub-District:				Books No.: <i>2270</i>		
Point (D.P.)	Reduced Distance S	Azimuth (α) Angle Corr.	Sin (α) Cos (α)	Y S. Sin (α) Corr.	X S. Cos (α) Corr.	Point (D.P.)
675		262°	Jan. 76			
674	437.1	260.4140 1.895951	+892061 +451921	155319319 126221	23232782 6491	674
692	409.8	267.3140 1.895951	+44014 +758531	15532142 3109	23239279 2670	692
693	58.0	164.80 1.895952	-40726-27 +966861	15535251 5646	23236009 1491	693
694	137.60	223.5110 1.895952	-25531 71174718	15540597 107631	23235115 8605	694
671		138.60 1.895952	+781071 62445	15551661	23226513	671
670	380.92	0 -0.764421	Jan. 76 corr: -0.42" (3'14")	corr: +0.02 d=0.02(0.50)	corr: +0.01	

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Building traverses storage

- Entering data to a spreadsheet.
- Macro running for error debugging and data completion.
- Converting raw data to authentic measurements in ASCII field book structure.
- Conversion to ArcInfo Shape file tables.
- Running a macro (VisualBasic) for finding traverses errors.
- Characteristically Data display.

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Point's table and traverse's table

FID	Shap	ld	uid	point	qush	East	North	Elev	sc	mc	tc	hor	ver	DA	uuid
244	Point	0	245	861D	0	156953.48	232112.83	485.25	1	0	11	4	0	N>	0
245	Point	0	246	864D	0	158373.83	232246.88	438.829987	1	0	11	4	0	N>	0
246	Point	0	247	865D	0	157268.33	230838.21	414.859985	1	0	11	4	0	N>	0
247	Point	0	248	866D	0	156298.26	231630.05	463.640015	1	0	11	4	0	N>	0
272	Point	0	273	DK/1	0	157219.3	233182.53	0	2	0	12	7	0	N>	0
274	Point	0	275	DK/2	0	157236.4	232984.3	0	2	0	12	7	0	N>	0
276	Point	0	277	DK/3	0	157228.76	232799.79	0	2	0	12	7	0	N>	0

FID	Shape	ld	UUID	UId	Spoly n	station	point	poly n	directio	distance
0	Polylin	0	0	0	114	DK/740	D/1151	114	63.065	52.22
1	Polylin	0	0	1	114	DK/740	DK/741	69	155.234	0
2	Polylin	0	0	2	114	DK/740	DK/739	69	0	189.88
3	Polylin	0	0	3	114	DK/1151	DK/740	114	0	0
4	Polylin	0	0	4	114	DK/1151	D/1139	114	224.1	42.34
5	Polylin	0	0	5	114	DK/1139	D/1151	114	0	0
6	Polylin	0	0	6	114	DK/1139	D/1138	114	93.261	52.68
7	Polylin	0	0	7	114	DK/1138	D/1139	114	0	0
8	Polylin	0	0	8	114	DK/1138	DK/894	114	170.16	91.51
9	Polylin	0	0	9	114	DK/894	D/1138	114	0	0
10	Polylin	0	0	10	114	DK/894	854D	114	94.502	0
11	Polylin	0	0	11	110	DK/895	852D	110	0	0
12	Polylin	0	0	12	110	DK/895	DK/874	110	316.595	117.48

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Authentic measurements database

- **Collecting: Field books, field sheets, mutations sheets, control points, blocks sheets...**
- **Fixing block calculation order (for shared borders).**
- **determining calculation order inside each block. (usually chronological order).**
- **Borders calculation due to data hierarchy and geometrical constrains. (least squares adjustment)**
- **Error debugging and parcel definition.**
- **Conversion to ArcInfo Shape file tables.**
- **Characteristically Data display.**
- **Macro applications for data analysis and data control.**

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Measurement-lines + Run-Offset tables

FID	Shape	ld	uuid	*uid	corder	qush	*from	*to	meas len
0	Polylin	0	1	1181	2030	11507	DK/76	DK/75	327.2
1	Polylin	0	2	1182	2031	11507	IS/996	IS/995	232.2
2	Polylin	0	3	1183	2032	11507	DK/75	DK/74	258.6
3	Polylin	0	4	1184	2033	11507	IS/996	IS/997	87.6

FID	*Shape	ld	uid	qush	*kav med	raz	nizav	*pnt
147	Polyline	0	148	11507	1257	42	2.6-	173A
148	Polyline	0	149	11507	1257	58	6.4-	174A
149	Polyline	0	150	11507	1258	85.7	0	P1000
150	Polyline	0	151	11507	1259	38.6	0	700A

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Distances crosses + lines crosses table

FID	*Shape	ld	uid	corder	qush	*from	*to	raz1	radius	raz2	radius2	*pnt
0	Polyline	0	1	2132	11507	P350	P300	0	40.2	0	44.2	2HR
1	Polyline	0	2	2133	11507	P300	IS/983	0	22.2	44.2	0	178S/7
2	Polyline	0	3	2181	11507	205A	208A	0	76.2	0	54.75	206KK
3	Polyline	0	4	2182	11507	205A	32L	0	46.6	0	71	209A

FID	*Shape	ld	uid	corder	qush	*from1	*to1	paralel1	*from2	*to2	paralel2	*pnt
79	Polyline	0	40	2271	11507	120A	119A	3	119A	117L	3	119R
80	Polyline	0	41	2272	11507	160A	160AA	3	159A	160A	0	160R
81	Polyline	0	41	2272	11507	160A	160AA	3	159A	160A	0	160R
82	Polyline	0	42	2273	11507	155A	157A	2	155A	156A	0	155L

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Fronts table and parcel definition table

FID	Shape	ld	uid	qush	from	to	length
0	Polyline	0	1	11507	115/9	143A	101.8
1	Polyline	0	2	11507	DK/71	157A	1.8
2	Polyline	0	3	11507	157A	158A	120.35
3	Polyline	0	4	11507	158A	159A	20.8

FID	Shape	ld	uid	qush	lot num	taba	area	pen clr	pen type	bord ont
28	Polygon	0	29	11507	F29		2.571	3	0	69A,2BC,5SR,11M
29	Polygon	0	30	11507	F30		1.507	3	0	67A,4SR,3SR,74A
30	Polygon	0	31	11507	F31		1.018	3	0	47A,74A,3SR,245
31	Polygon	0	32	11507	F32		2.24	3	0	47A,49A,50A,65A

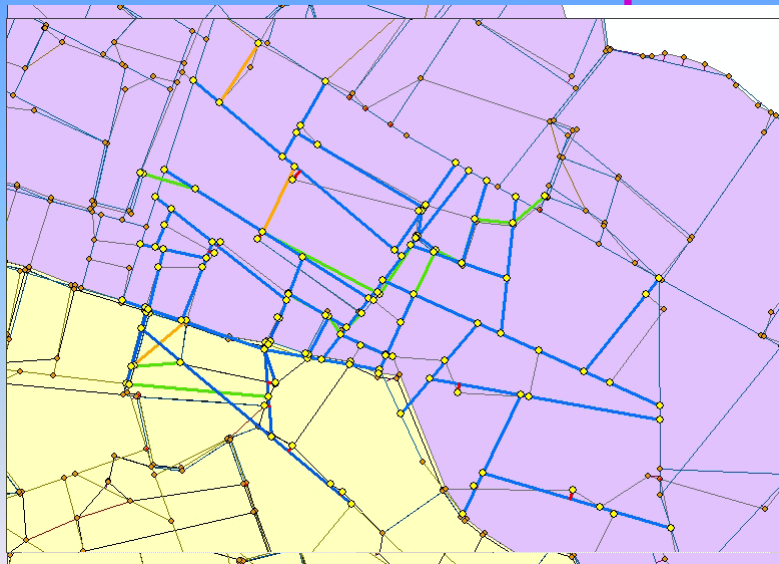
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Spatial and tabular queries comparison

- **Exceptional lines (due to regulations criteria)**
- **Exceptional parcels (due to regulations criteria)**
- **Forward search: find affected elements from changing in point location.**
- **Backward search: find all elements influence a certain point creation.**
- **Searching reports and reliability of data report (Integrity_Report) .**

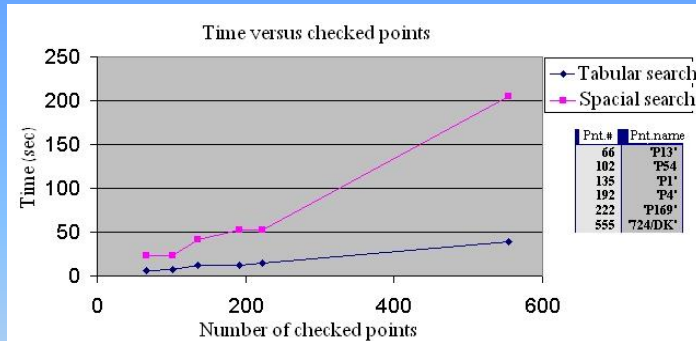
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Forward search example



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Spatial and tabular query comparison



Cross Distances	Cross Lines	Run & Offsets	Meas. Lines	Affected Points	Points checked	Spatial search time	Tabular search time	Block	Point
17	0	17	10	36	66	23.11	6.02	11506	P13
0	40	13	6	46	102	22.75	7.44	11501	P54
3	46	37	18	82	135	41.23	12.06	11502	P1
1	24	50	19	80	192	52.78	12.73	11509	P4
1	16	64	23	84	222	52.36	14.48	11509	P169
11	118	114	47	185	555	205	39.35	11509	724/DK

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Rigorous and approximate Adjustment Examples

SNo	Op	F	Command	Ln	uP1	uP2	Length	Length Units	sAur	Run Units	sMin	sMax	sAur	Off Units	sMin	sMax	n	uP
19	480	1	MeasLine	18	11 P1	P13	1761.0L	LNK	421.0L	LNK	84.2	84.2	0.0L	LNK	0	0	1	P5
20	482	1	MeasLine	18	11 P1	P13	1761.0L	LNK	764.0L	LNK	152.8	152.8	0.0L	LNK	0	0	1	P6
21	484	1	MeasLine	18	11 P1	P13	1761.0L	LNK	1200.0L	LNK	240	240	0.0L	LNK	0	0	1	P7
22	486	1	MeasLine	18	11 P1	P13	1761.0L	LNK	1214.0L	LNK	242.8	242.8	0.0L	LNK	0	0	1	P8
23	488	1	MeasLine	18	11 P1	P13	1761.0L	LNK	1314.0L	LNK	262.8	262.8	0.0L	LNK	0	0	1	P9
24	491	1	MeasLine	19	7 156/DK	P3	1059.0L	LNK	260.0L	LNK	52	52	0.0L	LNK	0	0	1	P19
25	493	1	MeasLine	19	7 156/DK	P3	1059.0L	LNK	642.0L	LNK	128.4	128.4	0.0L	LNK	0	0	1	P25
26	495	1	MeasLine	19	7 156/DK	P3	1059.0L	LNK	648.0L	LNK	129.6	129.6	0.0L	LNK	0	0	1	P24
27	498	1	MeasLine	20	5 P5	P25	1056.5L	LNK	392.0L	LNK	78.4	78.4	0.0L	LNK	0	0	1	P22
28	500	1	MeasLine	20	5 P5	P25	1056.5L	LNK	580.0L	LNK	116	116	0.0L	LNK	0	0	1	P23
29	503	1	MeasLine	21	5 P6	P19	1295.0L	LNK	667.0L	LNK	133.4	133.4	0.0L	LNK	0	0	1	P21
30	505	1	MeasLine	21	5 P6	P19	1295.0L	LNK	1103.0L	LNK	220.6	220.6	0.0L	LNK	0	0	1	P20
31	508	1	MeasLine	22	3 157/DK	156/DK	554.0L	LNK	282.0L	LNK	56.4	56.4	0.0L	LNK	0	0	1	P17
32	511	1	MeasLine	23	5 P17	P8	1643.0L	LNK	250.0L	LNK	50	50	0.0L	LNK	0	0	1	P16
33	513	1	MeasLine	23	5 P17	P8	1643.0L	LNK	1240.0L	LNK	248	248	0.0L	LNK	0	0	1	P15

SNo	uP	uId	vSC	uTC	uDC	uY	uX	uYX Units	uH	uH Units	uR
1	1/02	Unknown	0	0	0	156785.18	232379.75	METER.CM			6
2	1/2	Unknown	0	0	0	165887.83	232401.18	METER.CM			1
3	1/502	Unknown	0	0	0	167473.89	231325.19	METER.CM			1
4	1/8	Unknown	0	0	0	156737.59	232249.57	METER.CM			10
5	1/L	Unknown	0	0	0	167555.97	231908.89	METER.CM			6
6	1/P1	Unknown	0	0	0	157388.84	232126.78	METER.CM			5

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Inter Alia Accomplishments

- **The ability to draw the measurement plan (cadastral block or mutation plan) in an improved uniform, consistency and accuracy format.**
- **A more flexibility in the connection of neighboring plans.**
- **The ability to restore the registration act and then to accurately carry out the reparcellation.**
- **The ability to find contradictions in the registration process and help solving them.**
- **The ability to have fluent and updated information on the reliability of cadastral entities.**
- **Enlargement of the legacy and juridical validity of the GIS data.**

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