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Visualizing Title Uncertainty and Quality Issues in Digital Land Administration Era

Trias Aditya

Geodetic Engineering, Faculty of Engineering, UGM



This work is also supported by
FIG Aubrey Baker Grant



Content

- Cadastre & Quality Improvements
- Quality Issues & Title Uncertainty
- Visual Tools to Improve the Quality
- Uncertainty Maps



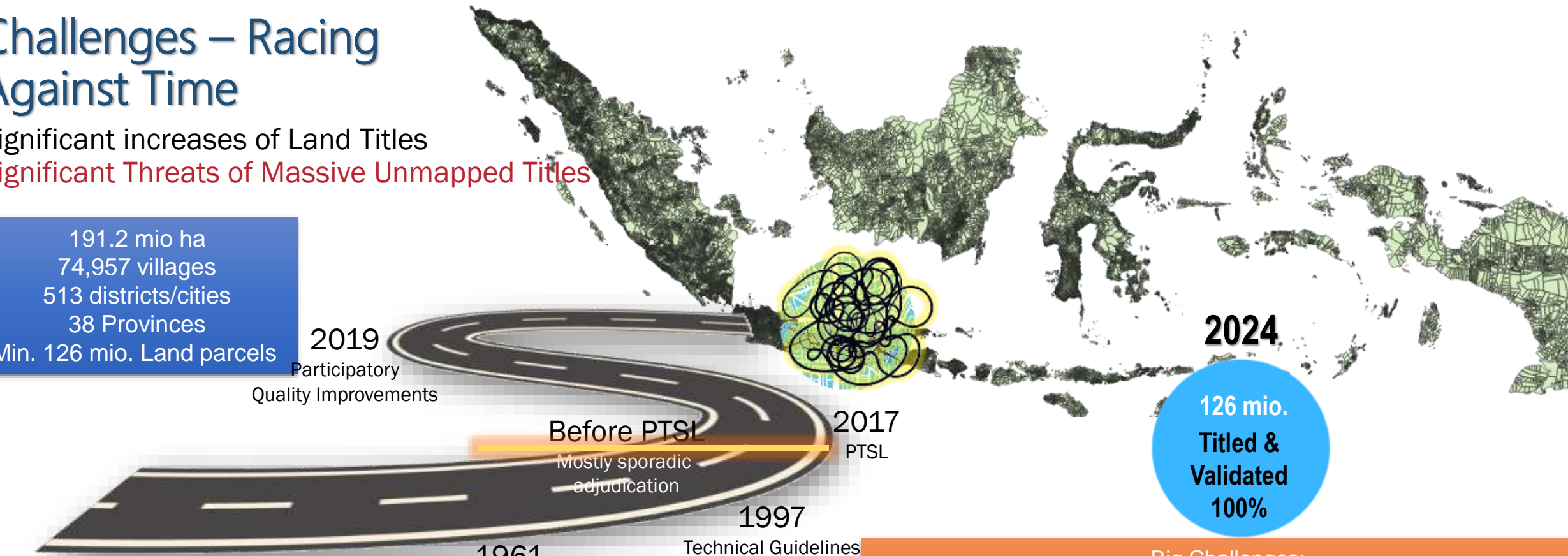
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Challenges – Racing Against Time

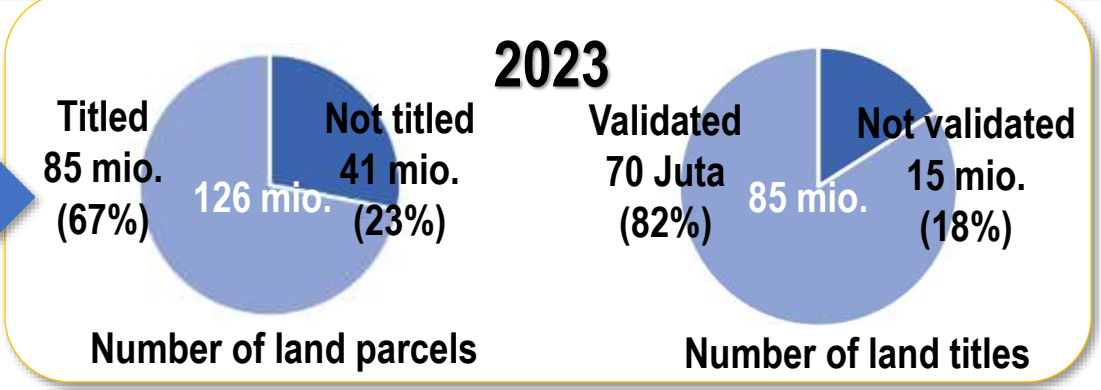
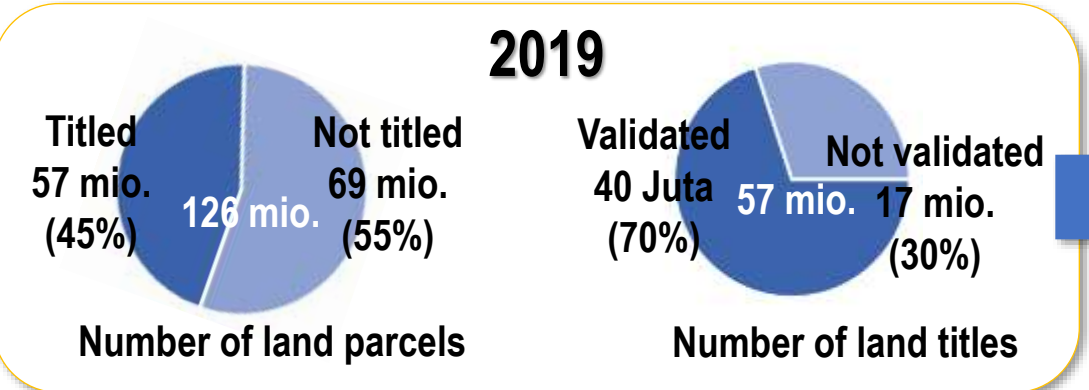
Significant increases of Land Titles
 Significant Threats of Massive Unmapped Titles

191.2 mio ha
 74,957 villages
 513 districts/cities
 38 Provinces
 Min. 126 mio. Land parcels



2024
 126 mio.
 Titled & Validated
 100%

Big Challenges:
 K4 (Unmapped titles: Unknown Boundaries, subject registered)
 K3 (Unfinished registration: Mapped Boundaries, subject not registered)



Racing Against Time



DASHBOARD POTENSI KOTA LENGKAP PER TANGGAL 4 AGUSTUS 2023

No	Nama Karwil	Jumlah BT	KW 4,5,6	KW 4,5,6 (%)	Shp Elektronik (%)	Warkah	Uplod	Rerata Kinerja Layanan Prioritas (%)	Rerata Asesmen Layanan Prioritas (%)
							BT (%)	BU (%)	
1	DKI	1.773.247	35.745	1,70	92,30	42,43	94,08	72,44	92,58
2	Bali	1.935.985	96.898	5,37	84,38	12,84	90,24	83,87	98,01
3	Sulawesi	7.12.861	261.130	35,24	29,82	2,93	37,03	17,74	77,1
4	Kalimantan	1.441.803	153.915	8,86	86,85	33,08	88,94	67,55	85,76
5	Mekulu	434.087	79.338	14,2	97,04	11,62	47,82	31,37	78,63
6	Kaleng	1.229.291	271.058	17,92	94,1	21,24	78,32	57,62	78,4
7	Kobei	1.837.483	378.787	20,47	92,75	30,65	70,85	62,94	80,62
8	Kalbar	2.420.831	515.346	20,76	49,41	30,7	65,39	52,36	82,08
9	Papua	519.805	147.677	22,55	92,84	3,07	42,38	31,91	62,45
10	Sultra	1.268.118	368.309	25,41	95,18	6,27	59,88	34,24	79,93
11	Sumsel	2.504.585	780.077	28,88	45,45	26,11	62,8	46,66	84,81
12	Sulsel	2.717.213	807.122	29,03	90,43	4,83	52,61	39,47	84,65
13	NTT	1.538.026	494.518	29,95	98,78	16,58	79,17	68,7	86,88
14	Coronatai	410.288	75.837	17,23	89,26	13,92	83,43	35,59	68,11
15	NTB	1.748.661	298.491	17,09	49,50	4,22	37,7	21,42	94,28
16	Sumbawa	1.086.145	337.366	25,24	43,05	4,78	45,88	32,96	90,79
17	Lampung	2.941.001	625.295	19,19	68,31	5,67	60,02	35,5	88,57
18	Aceh	1.508.077	304.100	19,25	71,16	7,26	59,6	34,42	87,88
19	Kepri	751.827	30.782	4,0	89,34	8,25	77,87	48,07	92,32
20	Pasu	1.905.991	548.446	27,99	46,74	18,33	69,88	55,18	85,88
21	Sulhery	1.191.791	295.275	21,03	43,91	3,94	47,08	30,11	73,72
22	Jambi	1.584.991	373.312	21,34	63,22	27,01	74,12	50,62	91,18
23	Sumsu	2.438.579	553.034	21,82	55,5	6,11	57,8	35,88	77,14
24	Babe	458.729	30.987	6,12	87,54	7	74,29	48,54	83,79
25	Kelut	463.981	34.349	7,18	87,96	6,48	82,77	37,78	79,34
26	Jabar	13.133.709	1.108.394	8,34	61,51	20,89	62,8	48,27	88,8
27	Bengkulu	866.922	239.057	22,26	62,56	3,82	59,38	33,18	73,68
28	Banten	3.418.473	347.217	9,51	99,5	51,78	81,5	64,08	81,14
29	Jawa	14.027.196	2.012.439	13,25	73,66	31	75,85	48,47	88,13
30	Papua Barat	298.748	80.945	13,79	53,08	2,19	48	39,61	81,18
31	Sulut	704.985	220.794	28,57	45,38	8,48	35,59	18,72	70,85
32	Lampung	16.123.985	2.819.298	16,31	89,79	12,47	74,85	47,41	88,28
33	DKV	2.393.760	487.027	16,38	63,14	14,67	62,93	38,62	84,46

Total: 15 Million of Unmapped Titles
Source: ATR/BPN 2023



Legend

- Validated registered land parcels (C1)
- Validated registered land parcels (C2 & C3)
- Unconfirmed registered land parcels (C4)
- Unregistered land parcels
- Registered land with issues in land records





Looking for a needle in a haystack



**Looking for correct places to map
valid land titles**

LA

Is party recognized
or registered?
Does party still exist?

LA Party



Private rights and public rights
owned/applied into a land
parcel



Relationship



What are situations and
dimensions of a parcel boundary
subject to a ownership/use of a
party

LA Parcel



- Indonesia is using “mixed” cadastral systems in the transition to fully digital land services (e.g., mortgage, title check, first registration)
- deeds registration are used (intermediate output), but its strongest ownership proof are titles (ultimate output)
- Pre. Document Sources: Spatial Data Collection (Field Sketches) + Legal Validation (Notary Deed/Underlying documents), Party ID
- Post. Document Sources: Measurement Letters (ML), Land Book (LB), A copy of {ML + LB} is a title given to owner (certificate)
- During decades, some titles are published with no proper survey & measurements; lost in transition from analog to digital
- Quality Improvements = Mapping (Unmapped Titles; Party-Parcel Relationship of all registered LA Parcels)

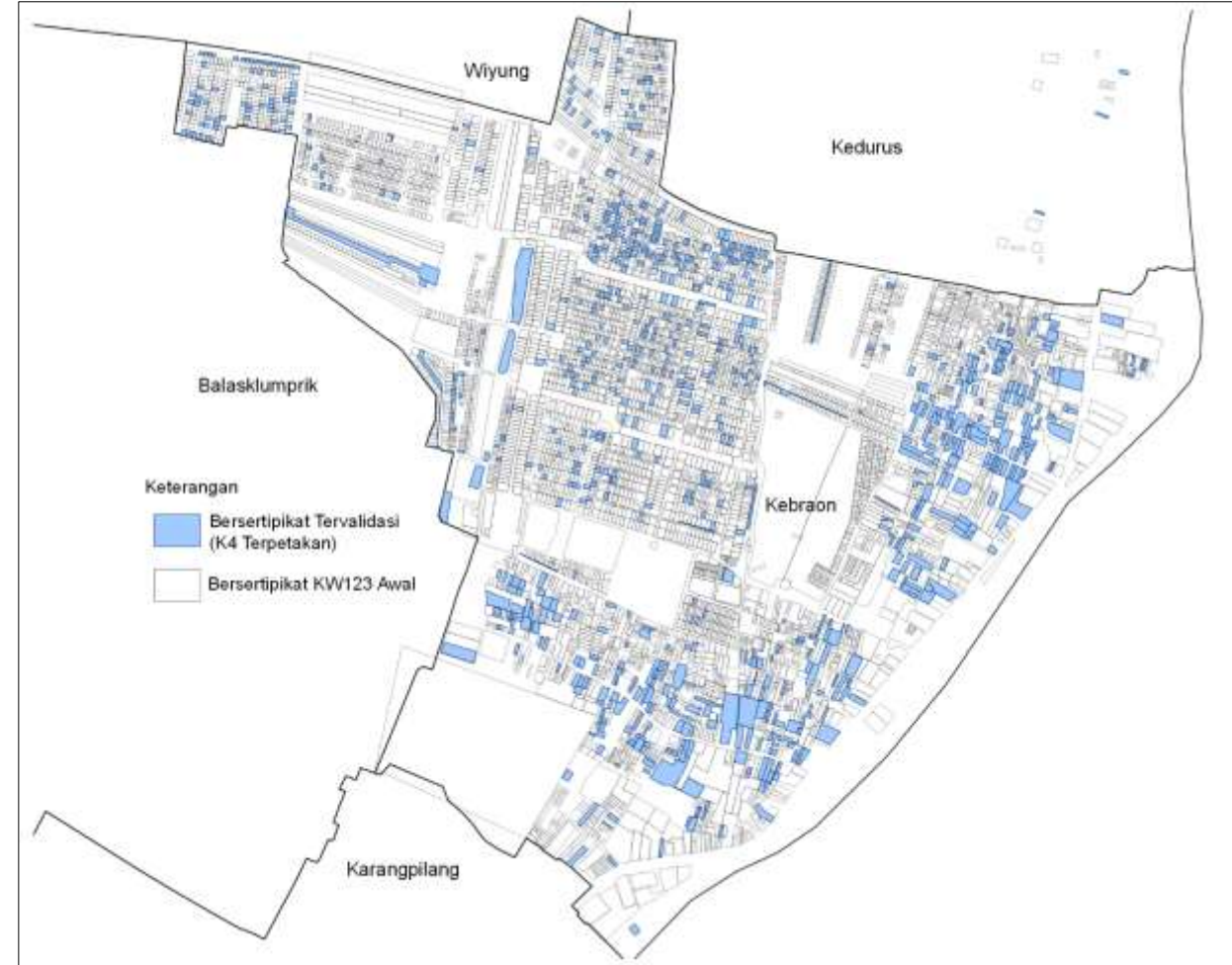
Plotting unmapped titles

Kelurahan Kebraon :



BEFORE

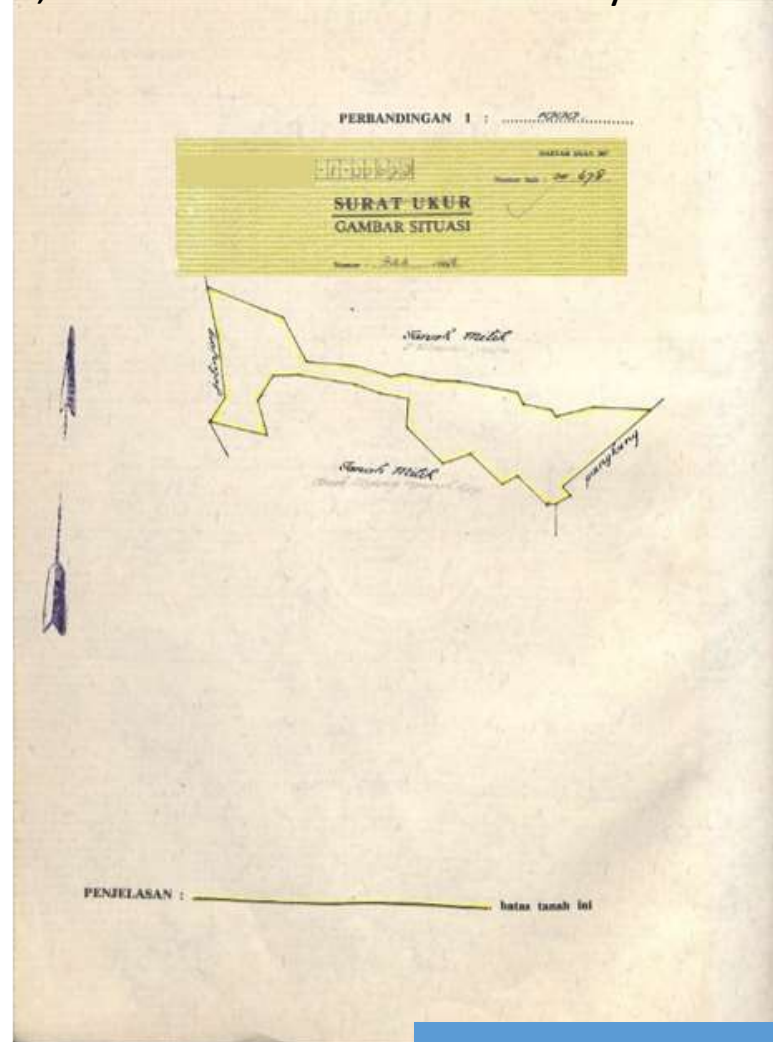
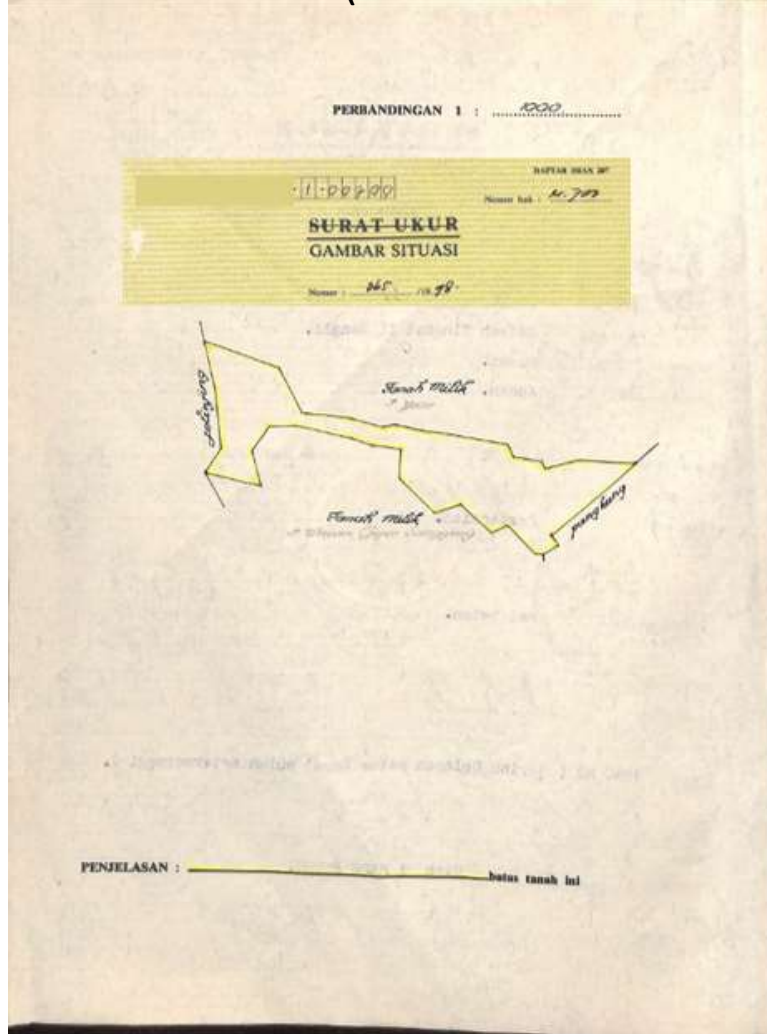
AFTER



922 plotted out of 1,077 unmapped titles

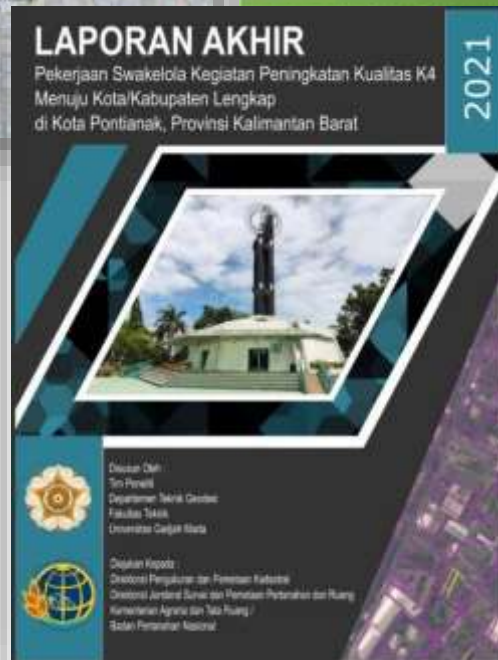
Some examples in data consistency (even for mapped titles):

Double certificates (different number of rights, number of ML for the exactly same location)



Data Source:
Own analysis

LESSONS LEARNED FROM THE QUALITY IMPROVEMENT WORK WITH ATR/BPN

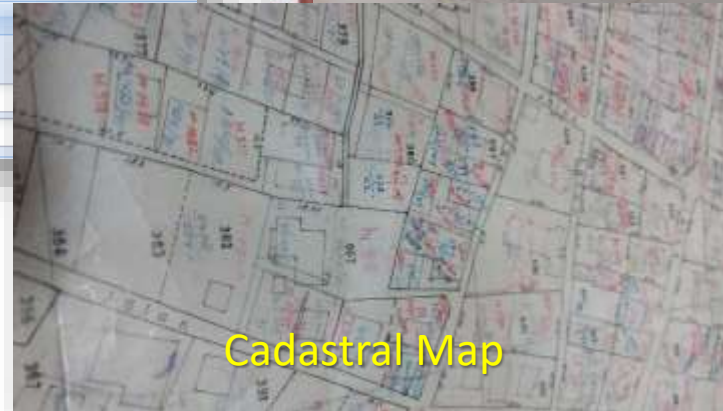


Business Operation: The output is analog, the business operation is digital

No. Seri:	Pilih No Seri	NIB						
Propinsi:	Jawa Tengah	NIB	Luas M2	Desa/Kelurahan	PP	TT	SS	
Kabupaten/Kota:	SURAKARTA	11020107.00660	823	PURWOSARI	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Kecamatan:	LAWEYAN	Surat ukur						
Desa/Kelurahan:	PURWOSARI	Nomor	Desa					
DI. 307:	775 / 1967	10/07/1967	00713/2008					PURWOSARI
DI. 208:	130 / 1967	10/07/1967	Pemilik pertama					
Nomor Hak:	11020107100189		NIK	Nama	Tempat, Tgl Lahir			
Asal Hak:	Konversi		MARTOMIJONO ALIAS MIJO		-, 01/01/1900			
Alas Hak:			Penandatanganan Pembukuan					
DI. 202:	Nomor / Tahun	Tanggal	Tgl. Pembukuan:	10/07/1967				
Surat keputusan:	Nomor	Tanggal	Jabatan:	<input type="checkbox"/> An. Kepala Kantor				
No. Permohonan:	Nomor / Tahun	Tanggal	Nama:	R. SOEGONO				

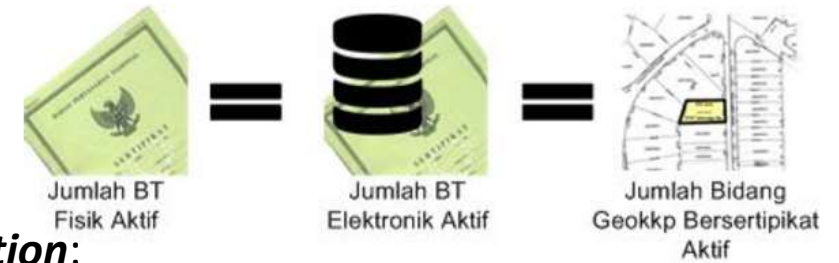
Issues hindering completeness & reliability

- ✓ Sporadic activities
- ✓ Incomplete digitalization
- ✓ Paper & electronic records synchronization



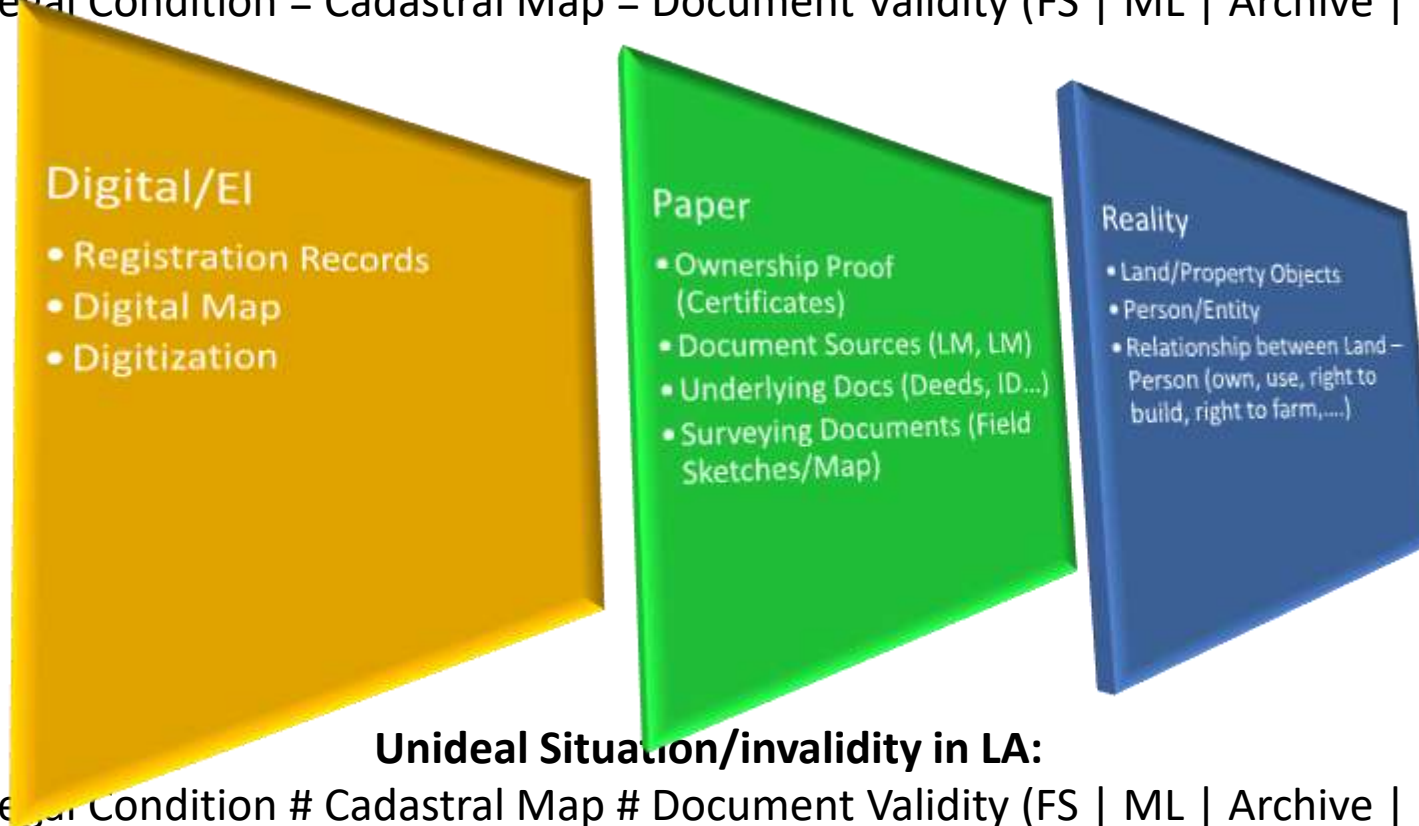
ATRBPN.GO.ID

Single Source of Truth?



Ideal Situation/Validity for *Land Administration*:

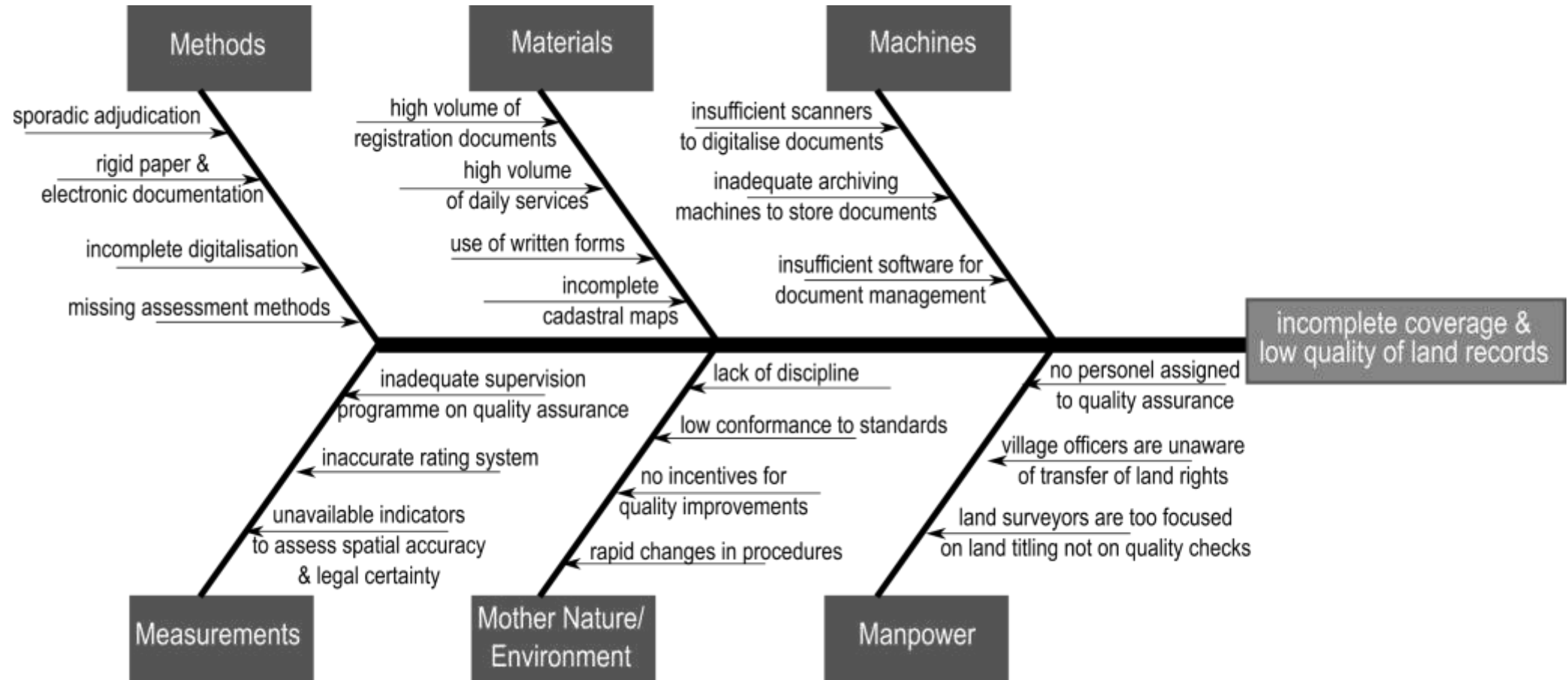
Field situation = Legal Condition = Cadastral Map = Document Validity (FS | ML | Archive | LB) = Digital Data



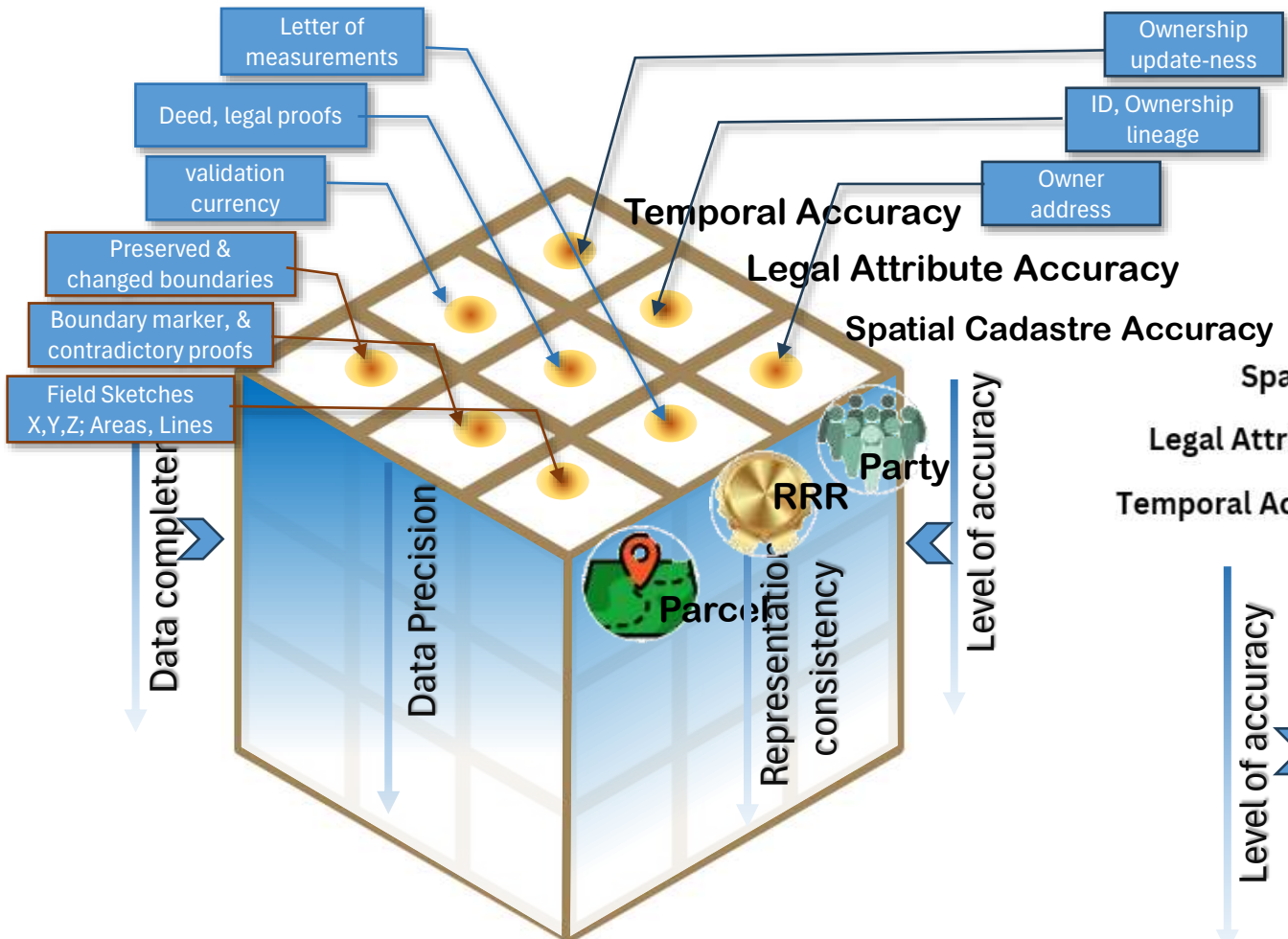
Unideal Situation/invalidity in LA:

Field situation # Legal Condition # Cadastral Map # Document Validity (FS | ML | Archive | LB) # Digital Data

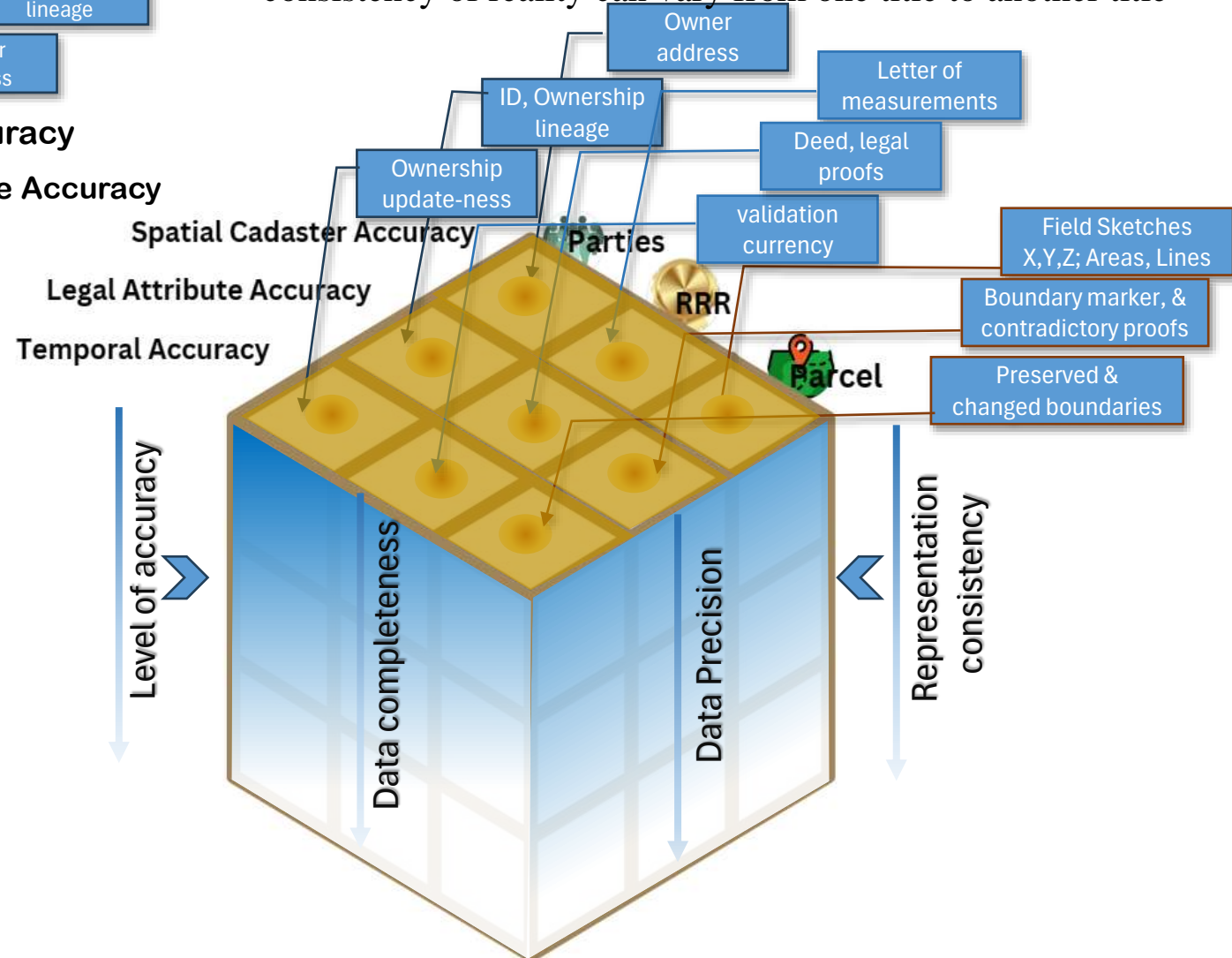
6M - Roots of Problems for Incompleteness & Uncertainty



Title Uncertainty



The concept of title uncertainty as a composite of **location**, **attribute** and **temporal** accuracy from multidimensional data related to owner/parties, the association between owner and parcel (right-restrictions-responsibilities), and the parcel boundary by which the level of precision, completeness, and the representation consistency of reality can vary from one title to another title



The ultimate goal = title certainty

The screenshot displays a digital land information system interface. On the left, a map shows a grid of land parcels with various colors (purple, green, brown) representing different land uses or ownership. On the right, a table lists parcel details. The table has columns for 'No', 'Luas', 'Kategori', 'No', 'Status', and 'Luas'. The data rows show parcel numbers ranging from 21 to 38, all categorized as 'TENGAH' with varying area values.

No	Luas	Kategori	No	Status	Luas
21			14010001.00011	TENGAH	72
22			14010001.00014	TENGAH	216
23			14010001.00010	TENGAH	211
24			14010001.00010	TENGAH	70
25			14010001.00010	TENGAH	102
26			14010001.00010	TENGAH	70
27			14010001.00041	TENGAH	1.280
28			14010001.00042	TENGAH	680
29			14010001.00044	TENGAH	402
30			14010001.00046	TENGAH	70
31			14010001.00047	TENGAH	84
32			14010001.00048	TENGAH	216
33			14010001.00049	TENGAH	71
34			14010001.00052	TENGAH	726
35			14010001.00055	TENGAH	103
36			14010001.00058	TENGAH	204
37			14010001.00057	TENGAH	71
38			14010001.00056	TENGAH	75
39			14010001.00059	TENGAH	71



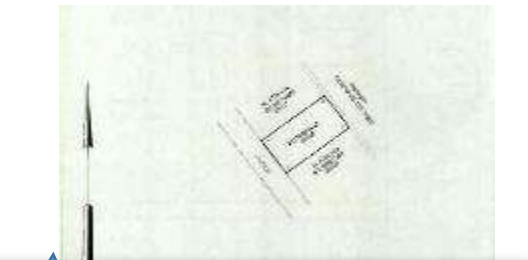
Spatial Representation Matches w/ reality



Digital Data Ready for LA Services



Valid Land Book



Valid Measurement Letter





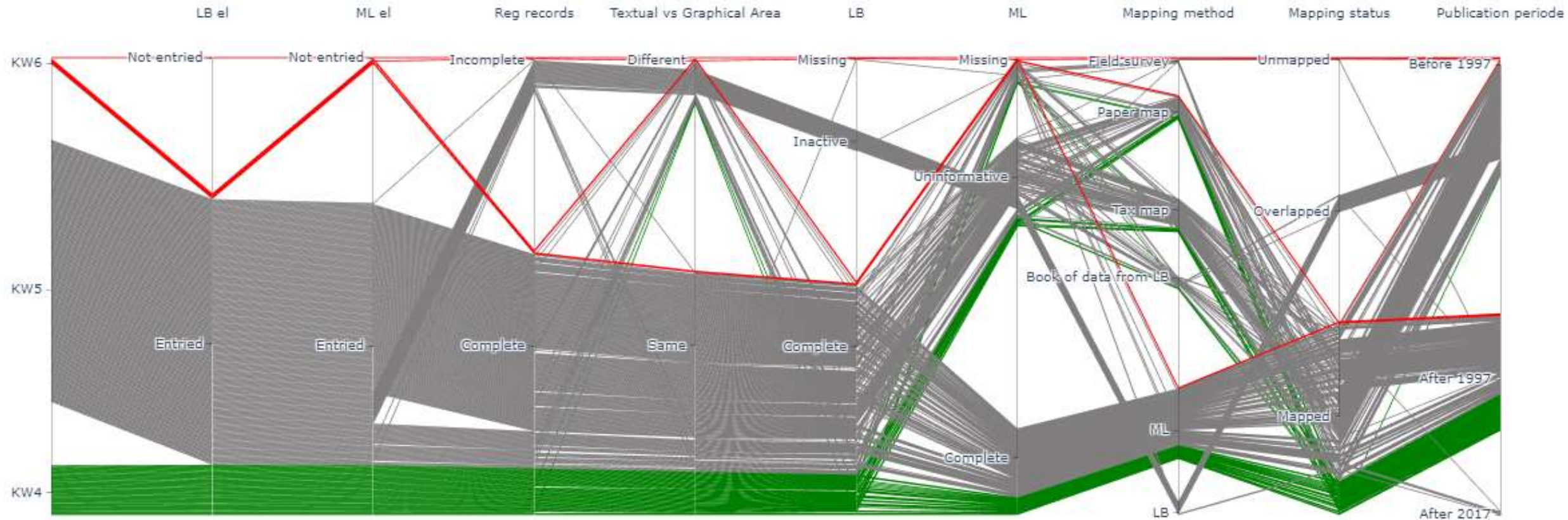
**Visualizing Title
Uncertainty to accelerate
the quality improvement
works**



Department of Geodetic Engineering
faculty of Engineering

PCP - Parallel Coordinate Plots

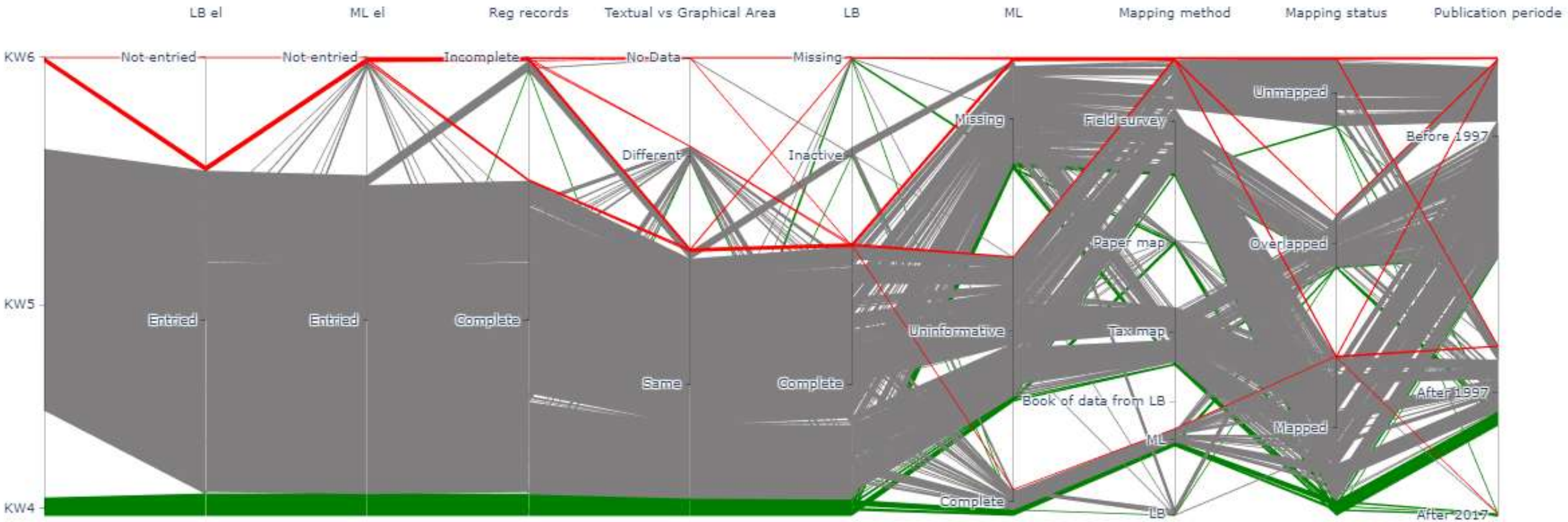
An Urban Case: A Sub District in Surabaya



282 cases of unmapped titles in Benowo Subdistrict, Surabaya (2022)

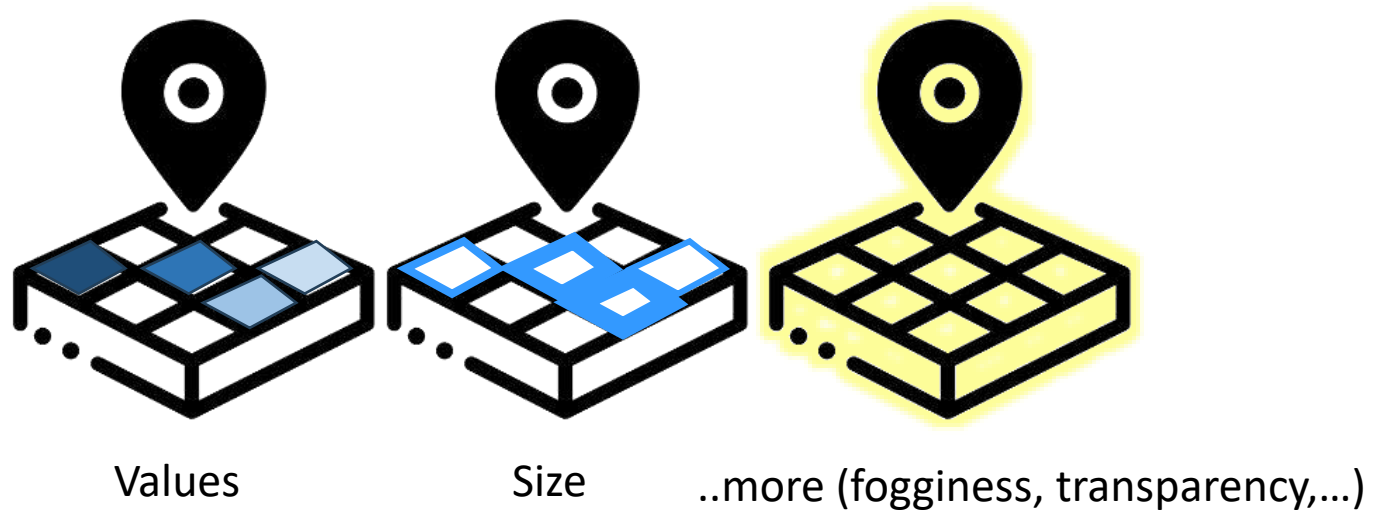
PCP - Parallel Coordinate Plots

A Rural Case: A Sub District in Bangli, Bali



1609 cases of unmapped titles in Banjarangkan Subdistrict, Bangli (2021)

Visual variables for Representing Title Uncertainty

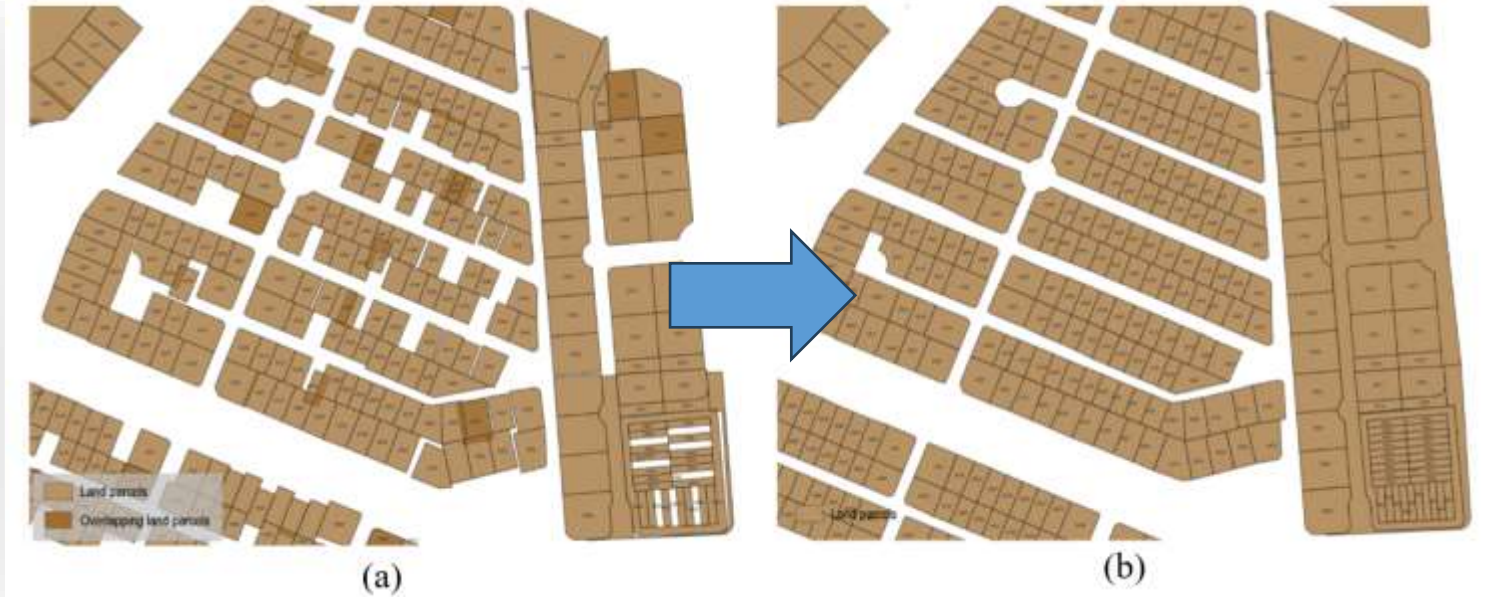


Transparency

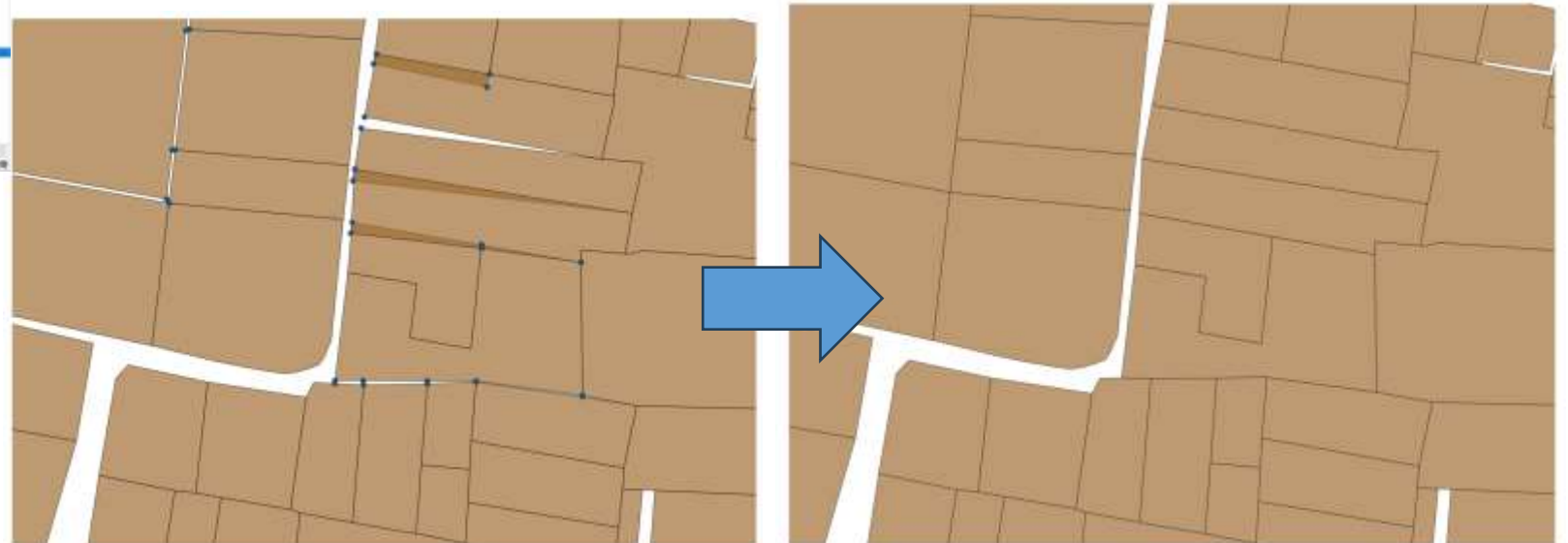
To detect gaps and overlaps



Developing a **QGIS Plugin**
PEREKAT
to Accelerate Spatial Adjustments



Visual Checks for gaps & overlaps



Before and after Spatial Adjustments

Values

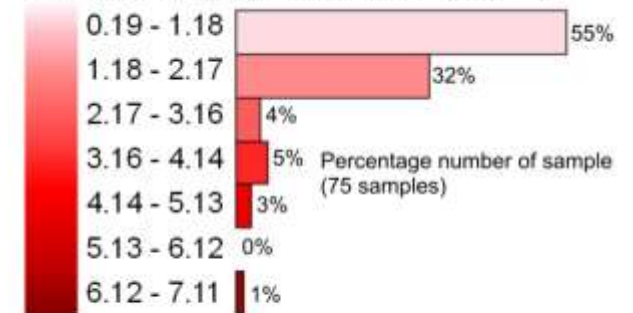
To represent point accuracy

Boundary Point Precision/Plot Errors

Boundary Point as a Spatial Accuracy Indicator



Distance of displacement vector (meters)



● Adjusted point to field coordinates

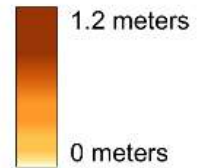
— Boundary parcel

Data Source:
Kelurahan Petojo Utara, Kecamatan Gambir, Kota
Jakarta Pusat (2022)

Heatmaps

To represent point accuracy

Heatmap of difference values



— Boundary parcel

Boundary Point Precision/Plot Errors
Boundary Point as a Spatial Accuracy Indicator

Data Source:
Kelurahan Petojo Utara, Kecamatan Gambir, Kota
Jakarta Pusat (2022)



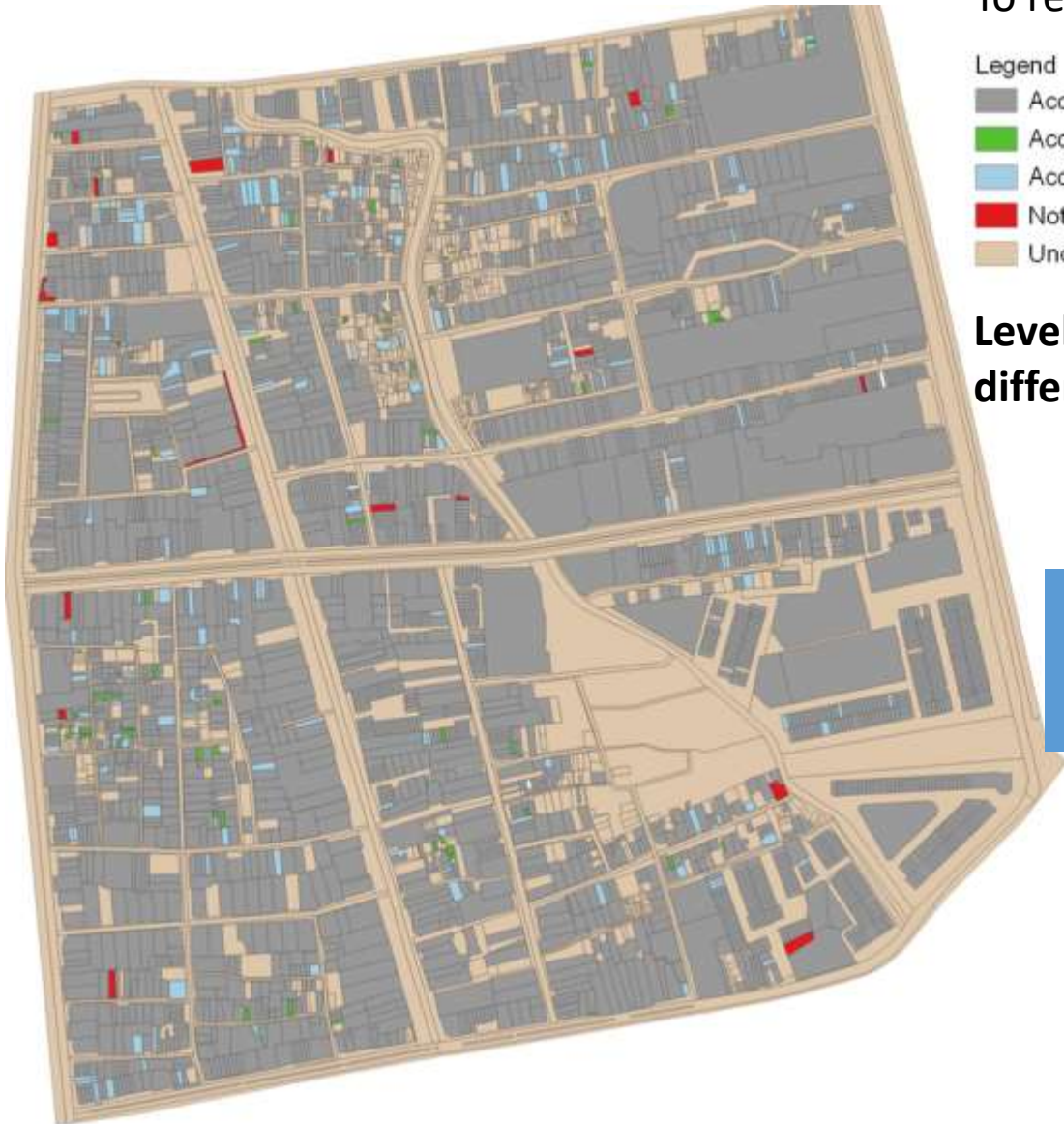
Values

To represent area accuracy

Legend

- Accepted for a half of square root area tolerance
- Accepted for under 5% of area tolerance
- Accepted for under 10% of area tolerance
- Not accepted (over 10% area tolerance)
- Uncertificate parcel

Level of acceptance to textual vs spatial area differences in Petojo Utara



Data Source:
Kelurahan Petojo Utara, Kecamatan Gambir, Kota
Jakarta Pusat (2022)

Uncertainty Represented with Use of Multi Visual Variables

Completeness of parcel information
(BT, SU, GU, similarity area values)

- Good (0,8 - 1)
- Middle (0,5 - 0,79)
- Bad (0 - 0,49)
- Uncertificate parcel

Reliability of boundary markers
(Parties that locate the boundary, Agreement
between the adjoining landowners, location of
tie point, boundary markers, determination office)

- Good (0,8 - 1)
- Middle (0,5 - 0,79)
- Bad (0 - 0,49)
- Uncertificate parcel
- Certificate parcel



Uncertainty Represented with Use of Multi Visual Variables



Completeness of parcel information '
(BT, SU, GU, similarity area values)

- Good (0,8 - 1)
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- Bad (0 - 0,49)
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Data Source:
Kelurahan Petojo Utara, Kecamatan Gambir, Kota
Jakarta Pusat (2022)

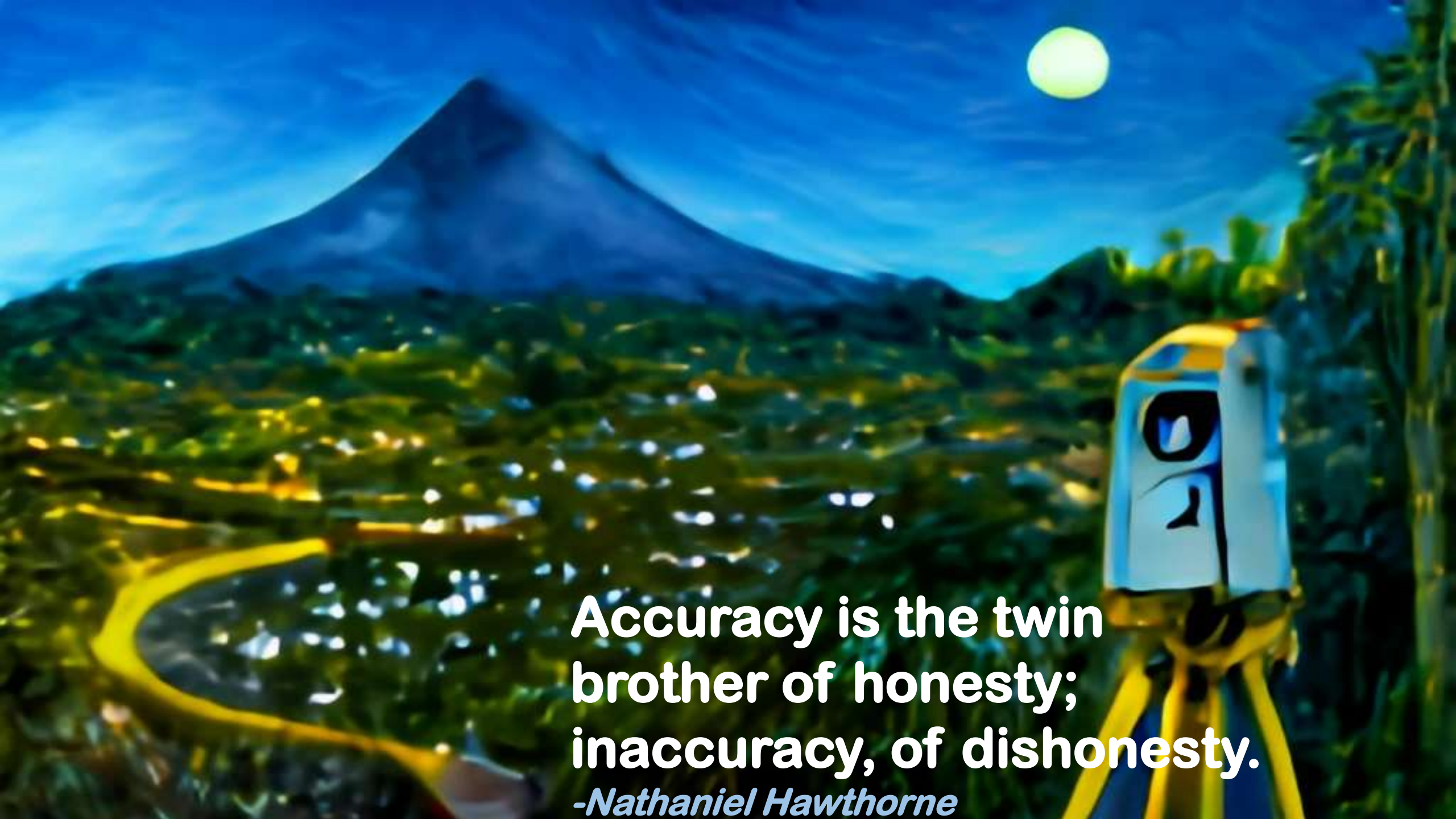
Title Certainty Before Digital Land Services

Main Challenges

- ✓ Plotting unmapped titles
- ✓ Improving title certainty of certified land parcels
- ✓ Data integrity enforcements (single identity management, data immutability, private/public data access)

Further Work

- ✓ Exploring effective & efficient visual variables for accelerating quality improvements
- ✓ PCP is effective to provide visual summary about the roots of problems and solutions
- ✓ The visualization strategy will be used for creating the map resulting from QGIS plugin for improving spatial cadastre
- ✓ Use of values and transparency can provide a summary for visualizing Title uncertainty (party, RRR, spatial). What can be more?



**Accuracy is the twin
brother of honesty;
inaccuracy, of dishonesty.**

-Nathaniel Hawthorne

Spatial Cadastre - Quality Steps

Level 0 : *Island*

Sporadic parcel mapping, heterogeneity in references, methods, survey measurements and coverage → islands

Decades of Practices

Level 1 : *Rubber Sheeting*

Visual no gaps no overlaps with no reference to document sources

PTSL

Level 2 : *Spatial Adjustment*

Document sources as the reference to improve quality

Unmapped Titles
Quality Improvements

Level 3 : *Block Adjustment*

Field survey = document sources = cadastral map

Block adjustment

Level 4 : *Block Adjustment terikat*

0: islands

1: rubbersheet

2: spatial adjustment




3: Block adj

4: Legal Coords





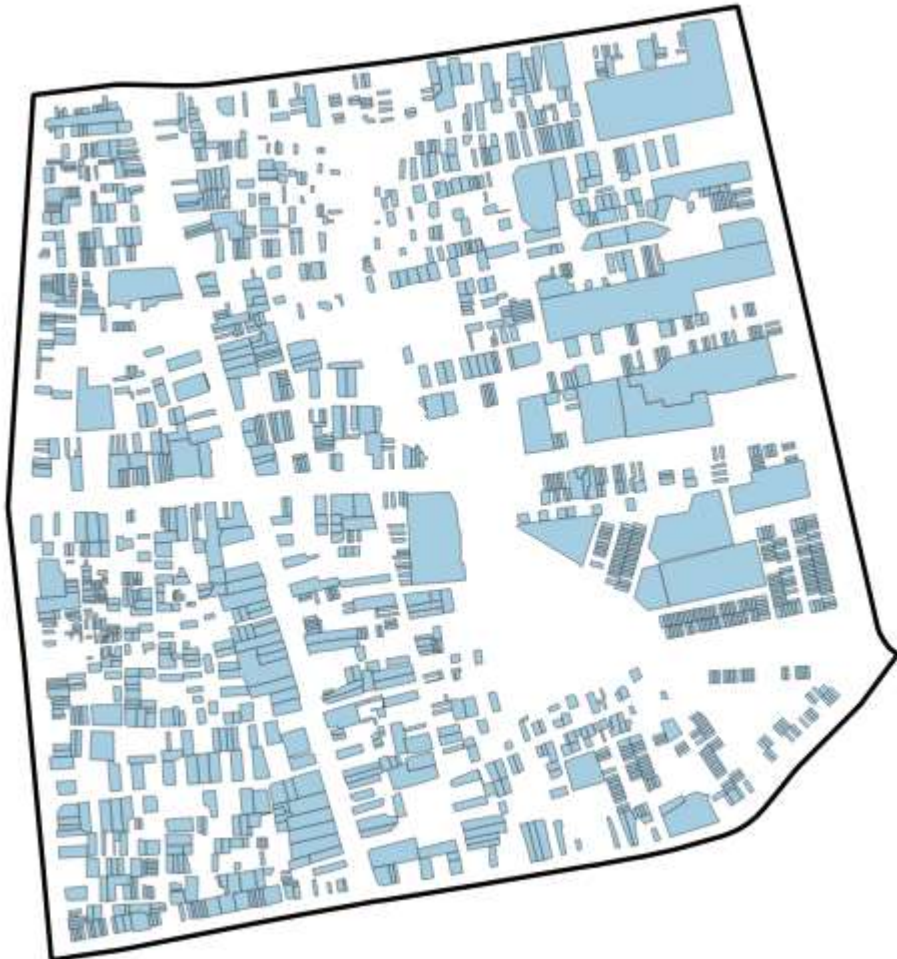
Keterangan gambar:

-  Bidang Tanah Terdaftar
-  Bidang Hasil PTSL
-  K4 Terpetakan

1

Peningkatan Kualitas

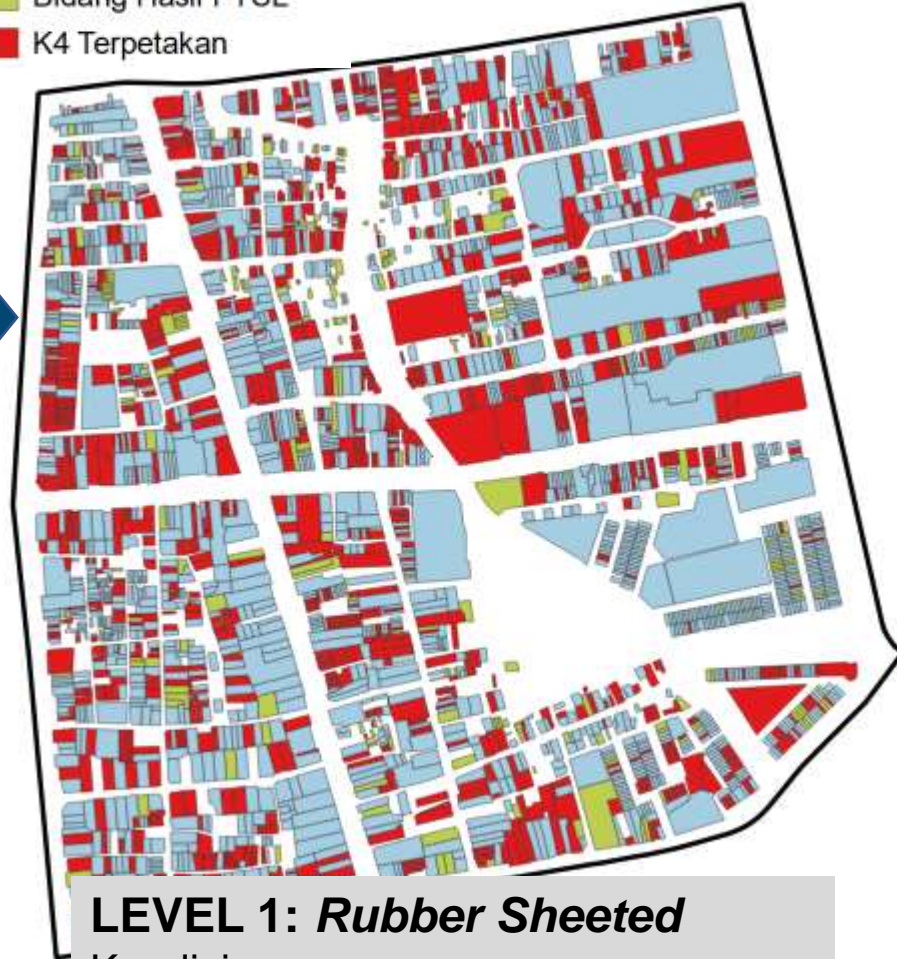
- Plotting K4 (Forensik Kadaster)
- Pendaftaran tanah K1 (PTSL)



LEVEL 0: ISLAND

Kondisi:

- Masih terdapat K4 belum terpetakan
- Program pendaftaran tanah K1 belum tuntas

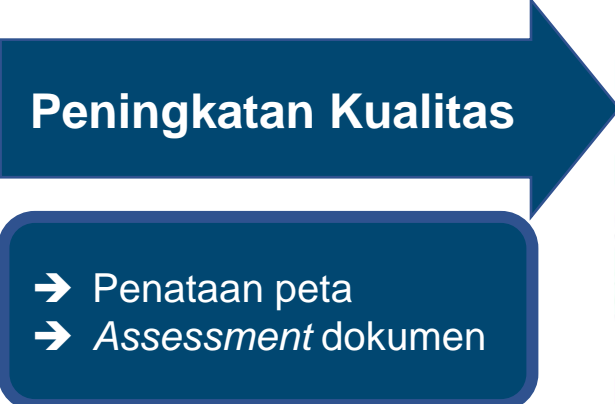
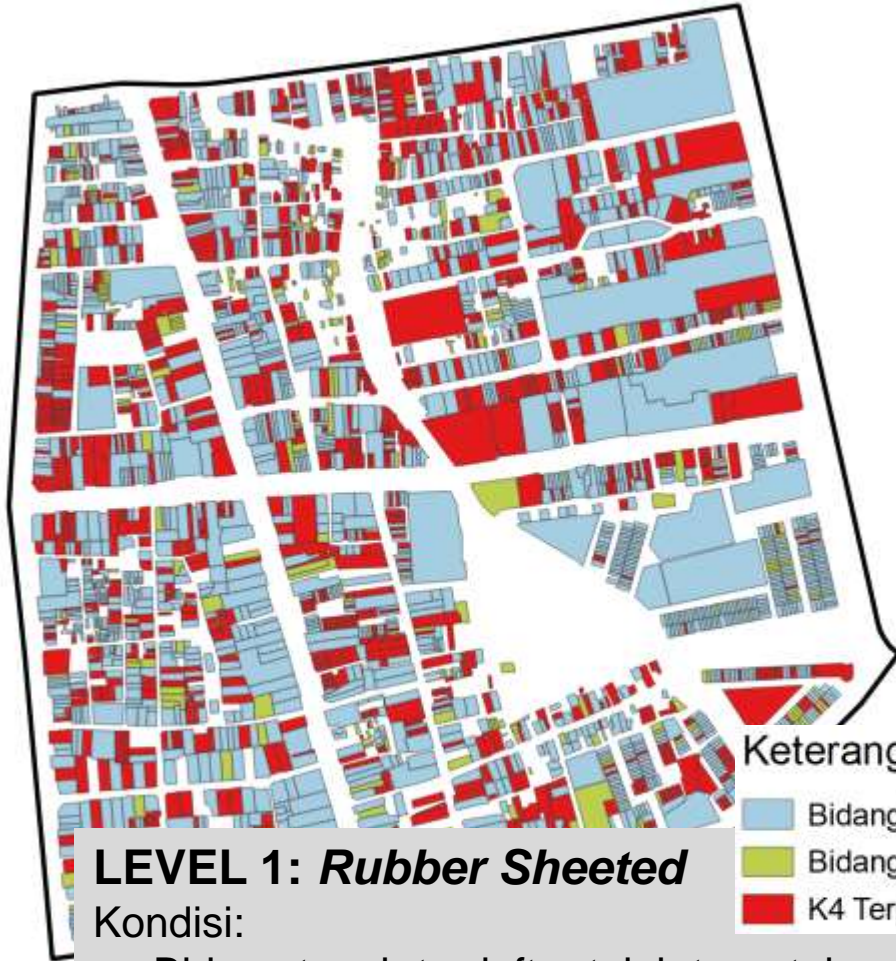


LEVEL 1: Rubber Sheeted

Kondisi:

- K4 telah *landing*
- K1 telah terukur dan terpetakan
- Bidang tanah terdaftar telah ditata (*no gaps no overlaps*)

Level 1 → Level 2



Keterangan gambar:

- Bidang Tanah Terdaftar
- Bidang Hasil PTSL
- K4 Terpetakan

LEVEL 1: *Rubber Sheeted*

- Kondisi:
- Bidang tanah terdaftar telah terpetakan
 - Objek geografis & sisa bidang kosong belum terpetakan
 - Konsistensi logis spasial dan tekstual ?
Peta = dokumen = KKP ?

LEVEL 2: *Spatial Adjusted*

- Kondisi:
- Semua bidang tanah telah terdeliniasi
 - Konsistensi logis spasial dan tekstual
peta = dokumen = KKP

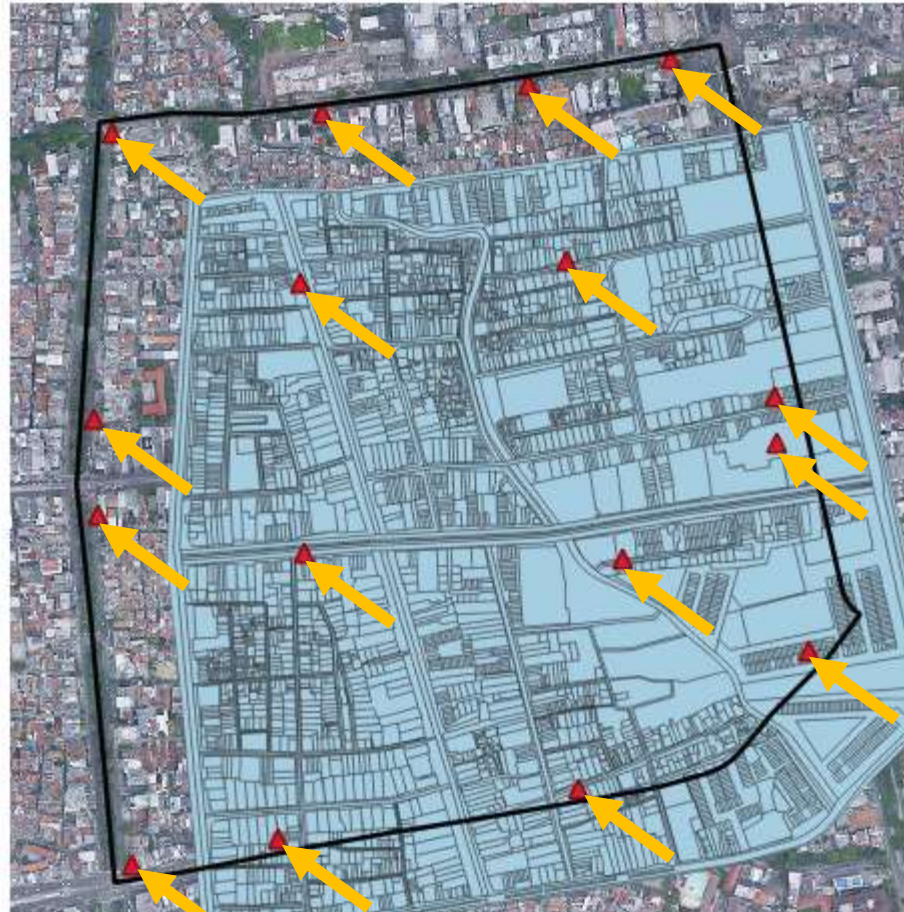
3

Peningkatan Kualitas

- Pengukuran titik kontrol lapangan
- *Block Adjustment*
- Uji statistik dan akurasi

Keterangan gambar:

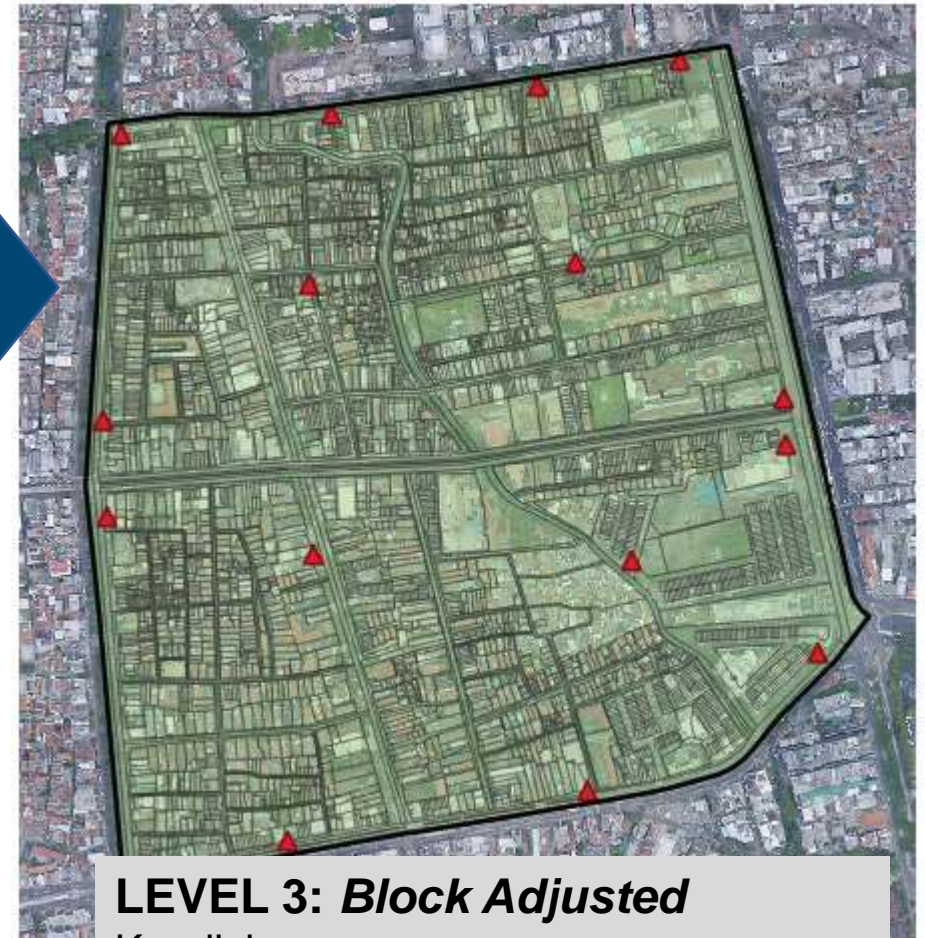
▲ Titik Kontrol Lapangan



LEVEL 2: *Spatial Adjusted*

Kondisi:

- Memiliki konsistensi logis spasial dan tekstual
Peta = dokumen = KKP
- Koordinat peta tidak sama dengan lapangan
Peta \neq lapangan



LEVEL 3: *Block Adjusted*

Kondisi:

- *No gaps No Overlaps*
- Peta = dokumen = KKP = lapangan
(selisih minimal)
- Teruji terhadap koordinat lapangan