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The Legal Element of Fixing the Boundary for Indonesian Complete Cadastre

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Abstract: In 2017, the Indonesian government implemented the systematic land registration (PTSL) process, projected to be finished by 2025. However, this process faces some challenges in the spatial and legal data collection process, resulting in the Indonesian cadastral system still being incomplete. For instance, during the three years of its implementation, out of about 135 million parcels, only 49.5% have been registered. Therefore, the level of completeness needs to be improved. This research aims to assess the compliance of the fixed boundary process' legal elements, such as the parties that locate the boundary, agreement between the adjoining landowners, and boundary markers. This is a piece of qualitative research in which the data were obtained through interviews from questionnaire surveys to land administration policymakers. Subsequently, the research carried out regulation assessments to develop a country-context cadastre typology of the current cadastral mapping activities. Data were obtained from the results of the PTSL campaign in the Madiun regency. The result showed that the high percentage (i.e., 96.61%) of legal elements regarding the boundary agreement in a rural area could be used as a potential enabler towards achieving completion of the Indonesian cadastre.

Keywords: complete cadastre; legal element; fixing boundary; eligible landowner; agreement; boundary marker

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1. Introduction

The United Nations Economic Commission for Europe (UNECE) is one of the five regional commissions under the United Nations Economic and Social Council's jurisdiction to promote economic cooperation and integration. In 1996, this organization introduced land administration terminologies [1]. Furthermore, in the 2000s, several studies relating to the land registration domain reported that the complete cadastral system is an engine that supports its administration, which concisely encompasses land tenure, value, use, and development functions [2–4]. However, since the Dutch colonialization, Indonesia's cadastral system has remained incomplete, although approximately 49.5% of land parcels have been registered [5]. This incompleteness creates a significant barrier to the construction of modern land administration [1].

A complete cadastral domain is not something new, as reported in the 2014 International Federation of Surveyors (FIG) statement on the Cadastre [6] and also in the Bathurst Declaration on Land Administration for Sustainable Development [7]. In the Indonesian context, a complete cadastre is described as an essential component of land reform [8]. The Bogor Declaration (1996) stated that it is considered an underlying infrastructure that supports land reform administration. The high percentage of unregistered lands deters the integration of this system. It was suggested that the Indonesian cadastre needs to include all types of land, namely forests, urban and rural areas. The cadastral framework (which is a map) is a fundamental layer within the National Spatial Data Infrastructure (NSDI) [9].

The government has initiated a process to accelerate land registration through complete systematic land registration (*Pendaftaran Tanah Sistematis Lengkap* or PTSL). It is

national strategic program to register all land parcels in Indonesia starting from 2017 and projected to be finished by 2025. PTSL aims to increase tenure security for all land and to improve economic access. The PTSL standard is based on the "continuum of land rights" philosophy [10]. Its technical book shows that the cadastral mapping of a village includes undisputed land parcels ready for certification (K1). Disputed and undisputed land parcels can be identified using both spatial and legal status of ownership. This includes the disputed land parcels (K2), undisputed land parcels that are not ready for certification (K3), and existing certified land parcels (K4). Land certificate is evidence that the parcel is registered. K4 is a registered land that is inappropriately mapped or lacks spatial information [11] so that its spatial accuracy needs to be improved.

However, the results from PTLS were unable to attain the expected completeness (spatial and legal data). Spatial data are a description of the location, boundaries, and area of the land parcel, while legal information is the legal status, landholders, including the rights of other parties and its encumbrances [12].

The studies relating to cadastre, land registration, and land management to attain sustainable development contributes to the theoretical maturity of the land administration [3,13–15]. The "Land Administration Domain Model (LADM)" [10,16–18], in accordance with the Social Tenure Domain Model (STDM) as its sub-version [19–22], is a prominent example. LADM deals with standardization and facilitates the efficient set-up of land administrations to integrate various spatial data. Subsequently, the "Fit-for-Purpose Land Administration (FFP LA)" [13,14] is also popular. FFP LA focuses on cost-effective data collected quickly, which meet society's needs and are incrementally improved [13,14,23]. Globally, it is believed that the critical bottleneck for the provision of a complete cadastre that serves as infrastructure for an effective land administration system lies in the process of collecting spatial data [24–27]. In addition, land boundaries are a crucial component, and from a legal-societal perspective, it is defined as where a person's interests of the land end and that of the next begins. It is often manifested spatially by visible artifacts such as hedges, stone walls, ditches, or land-use changes [28].

Recent publications and studies reported that the use of a visible boundary concept is adequate and sufficient for incorporating the remaining unregistered parcels, particularly in rural, semi-urban, and forest areas [13,14,29–32]. In this regard, visible marks are evident, and fixed boundaries are used where relevant or for specific purposes, and they are paid for by the landowners or stakeholders. There are several ways of documenting boundaries, from a verbal description of words, a "metes and bounds" approach, depiction on an index map, capturing corners in coordinates, etc. [15]. Boundary determination is a critical aspect of the construction of a land ownership record, which maintains its integrity, reliability, and accuracy. However, Arruñada (2018) supports the voluntary type, rather than the mandatory demarcation [33].

The research aims to identify the distinction between physical (not the spatial) and legal elements in a fixed boundary, as reported by Arruñada (2018). The study describes some of the characteristics of the Indonesian cadastral system and the reason it is still incomplete. A cadastre typology and methodology were proposed to assess the compliance of boundary surveys, in addition, it also contributes to an improved national cadastral system. This research is divided into five sections starting with materials and methods followed by results obtained from the investigation, the assessment outputs, discussion, conclusions, and recommendation.

2. Materials and Methods

This research adopted a case study methodology [34,35] as well as qualitative and quantitative methods, as shown in Figure 1. The subsequent section describes the approaches implemented as follows, (A) an interview was carried out to identify the cadastral system in Indonesia, (B) analysis of the literature and regulations that describe the six cadastral elements in the land registration regime, (C) assessment of the cadastral mea-

surements of PTSL in urban areas using a multivariate clustering tool which resulted in cadastral typologies, and (D) to analyze the issue of incompleteness in this system.

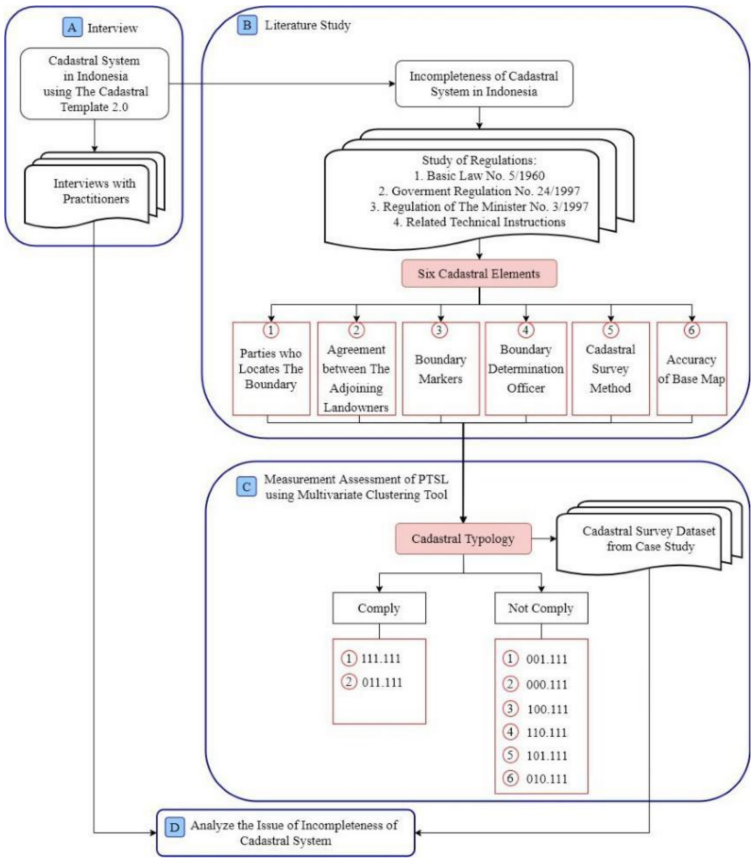

Figure 1. The workflow of the assessment of the legal elements in fixing the boundary in Indonesia.

2.1. Materials

The cadastral template 2.0 was adopted to identify this system [36–39]. A description of Indonesian cadastre, based on The Cadastral Template 2.0 is already available from http://cadastraltemplate.org/indonesia.php. It was completed in 2003. The recording at FIG is not updated. The questionnaire—shown in the blue box (A) in Figure 1—was used to interview five senior executives of the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (ATR/BPN).

The second material (B) is centered on several regulations in ATR/BPN, including the Basic Agrarian Law No. 5 of 1960 (hereafter UUPA) [40], Indonesian Government Regulation No. 24 of 1997 on Land Registration (hereafter PP No. 24/1997) [12], Regulation of Minister for Agrarian Affairs/Head of National Land Agency Regulation No. 3 of 1997, the Implementation of Government Regulation No. 24 of 1997 (hereafter PMNA No. 3/1997) [41], and its technical instructions. Finally, the third material includes cadastral survey datasets (C).

2.2. Methods

This research adopted a qualitative method by interviewing the respondents. This was used to identify the cadastral system according to the decision-makers' perspective in ATR/BPN. The interviews are used as a basis for providing a description of the current administrative structure, rules, and procedures. The literature review was carried out to determine the current and best practice for the fixed boundary demarcation. A multivariate clustering tool was used to group the parcels in ArcGIS Pro into cadastral typology, generated using government regulations, PMNA, and technical guidelines.

The fixed boundary is mandatory in the Indonesian cadastre. However, strict technical requirements are challenging, thereby leading to land registration's slow progress [13,42]. Articles 14 to 22 of PP No. 24/1997 stated six elements related to boundary demarcation, although there are 2 aspects, namely, spatial (some parties identify land parcels, measure and draw their boundaries) and legal (seeking the consent of neighbors) [33].

The six cadastral elements were used to assess the level of compliance during the survey of the PTSL project in 6 villages located at Madiun District, East Java Province. The proportions of cadastral measurements that do not comply with the regulation were determined in this study. A list of cadastral elements and scores are shown in Table 1. A score of assessment using binomial number 1 for "comply" and 0 for "not comply" was used to evaluate the compliance [43,44].

Table 1. Assessment of the Level of Compliance Score of Cadastral Survey at *Pendaftaran Tanah Sistematis Lengkap* (PTSL) Project (Adopted from PP No. 24/1997 and PMNA No. 3/1997) [12,41].

No.	Cadastre Elements	Score
1	Parties that locate the boundary	
	1.1. Landowner or proxy	1
	1.2. Occupant or possessing party	1
	1.3. Local officer *	1
	1.4. Interested or concerned parties	0
	1.5. No one	0
2	Agreement between the adjoining landowners	
	2.1. Yes	1
	2.2. No	0
3	Boundary markers	
	3.1. Concrete fence or wall	1
	3.2. Dike of paddy field, river, ditch, or road	1
	3.3. Monuments from wood or bamboo	1
	3.4. Plant fence or bamboo	0
	3.5. No boundary	0
4	Determination officer	
	4.1. Government Surveyor	1
	4.2. Licensed Surveyor	1
	4.3. Others	0
5	Survey method	
	5.1 Terrestrial	1
	5.2 Photogrammetric	1
	5.3 Others	1
6	Accuracy of the Base Map (Planimetric Accuration $\geq$ 0.3 mm x Scale)	
	6.1. $\leq$30 cm in the urban area	1
	6.2. $\leq$75 cm in the rural area	1
	6.3. $\leq$3 m in the plantation area	1
	6.4. Others	0
	6.5. No Base Map	0

* Note: Local officer represents the village officer who has supplementary function and authority to locate the parcel boundaries in their village in the systematic land registration.

This study assessed the cadastral measurement requirement for boundary determination, both legally and spatially, and 7552 of plots were evaluated using the six elements [33]. This research only focuses on three legal elements (parties that locate the boundary, agreement between the adjoining landowners, and boundary markers) in a rural area. Eight cadastral typologies, obtained from six villages were used as a case study, as shown in Table 2. The intention was to examine the possibility of implementing the FFP approach in rural locations where 78.9% of the population resides [45]. The implementation of its approach will address the challenge regarding the requirement for fixing the boundaries, as stipulated in the current regulation.

Table 2. Cadastral Survey Typology.

No.	Cadastral Typology	Remark
1	111.111	comply
2	011.111	comply
3	001.111	not comply
4	000.111	not comply
5	100.111	not comply
6	110.111	not comply
7	101.111	not comply
8	010.111	not comply

The PTSL surveyed parcel in the case study areas is distinguished with cadastral typology. It is classified as "comply" if the elements met the regulation, as shown in Table 1. It was discovered that eligible landowners' participation during the first land registration was an issue [11]. The eligible landowners are the parties who occupy and have control of the land legally or legitimately that is not contested by others. Legal owners lead to legal demarcation and they are part of the legal demarcation process. Their absence leads to legal demarcation, such as the party that locates the boundary, agreement between the adjoining landowners and the boundary markers. Zevenbergen [15], reported that the absence of right-holders in the case study areas is due to various reasons, including those domiciled in other regions, those that are unwilling for fear of rising taxes, and difficulties in proving ownership.

As shown in Table 1, the first digit refers to the parties that locate the boundary, while the subsequent one is the second element, and the fourth ended in the sixth element. Furthermore, there are three passive values, from the fourth to the sixth, with a score of 1. The three first digits are legal, and the three-second numbers are spatial demarcations, respectively. The absence of right holders or their proxies and the activeness of local officers [11] results in only the values of the first, second, and third elements to becoming active. However, when the cadastral element is unfulfilled, it tends to alter the scores. This research focuses on the legal element of demarcation, which refers to the social aspect of fixing the boundary. The social element leads to physical boundaries that may or may not represent the legal boundary location [46]. Spatial demarcation, which consists of the following elements, cadastre of determination officer, survey method, and the base map's accuracy, were not examined in this study. It was assumed that the spatial demarcation of PTSL complies with regulation as provided by the PTSL contract.

2.3. Assessment of Compliance

The proportion of compliance with the required cadastral elements was carried out using samples obtained from the case study area. A compliance analysis between the cadastral measurements of PTSL and regulation was carried out by calculating the proportion of those complied by the total sample. The outputs of this research were used to develop a strategy to improve the overall cadastral system's effectiveness, which serves as a basic layer for the land administration system. The proportion of surveyed parcels that complies with the cadastral elements required in Government Regulation No. 24/1997 is calculated using the percentage formula, which is stated as follows:

$$\% \, Comply = \frac{\Sigma \, Comply}{Total \; sample} \times 100\%$$

3. Results

3.1. Cadastral System in Indonesia

Indonesia is an archipelago country with a total landmass of 190 million ha. Conversely, 66.3% of the area is forest administered by the Ministry of Environment and Forestry (KLHK), and the remaining (33.7%) is managed by the Ministry of Agrarian Affairs and

Spatial Planning/National Land Agency (ATR/BPN). There are approximately 126 million parcels identified in 2016 and approximately 3.5 million new ones [47] appear yearly.

Historically, the cadastral system aimed to provide legal certainty of land rights. Subsequently, since 1813 (during the colonial era) to the beginning of the republican period, the Land Registry Services were part of the judicial or legal arrangement in the Ministry of Justice. The Cadastral Offices provided services, whereas the Ministry of Finance was in charge of land taxes [5]. In 1988, the National Land Agency (BPN) was established to integrate land registration and cadastre services. It was reported that for more than seventeen decades, the cadastral system served the judiciary rather than the administrative sector [13,14]. In 2014 the Ministry of Agrarian Affairs and Spatial Planning (ATR) was established to administer the functions of land use, previously supervised by the Ministry of Public Works, conversely, The Ministry of ATR acts as the head of BPN.

The Indonesian cadastral system provides spatial and legal data. The land office organizes the public registers (*Daftar Umum*), which consist of cadastral maps (*Peta Pendaftaran*), land registers (*Daftar Tanah*), surveying letters (*Surat Ukur*), land books (*Buku Tanah*), and name registers (*Daftar Nama*). The documents which serve as the basis for registration (*Warkah*) are given an identification number called DI (*Daftar Isian*) 208 and kept as an integral part of the *Daftar Umum.* The cadastral layer has not been integrated with other spatial data such as e-Government, community empowerment, and activities to attain sustainable development [36,48,49]. The cadastral system in Indonesia is reported in Appendix A.

Its main problems are incompleteness and the quality of the cadaster. These lead to the loss of public confidence in the land tenure systems, operational inefficiencies within land administration agencies, including costs and delays in land development processes [50]. Land computerization was implemented to digitalize land services. The challenges are as follows, firstly, some of the cadastral data have not been entered into the system (the *Komputerisasi Kegiatan Pertanahan* or KKP). Secondly, there is a validity issue regarding data quality. Thirdly, there is an analog document (papers-based documents). Fourthly, there are two group entry-levels of spatial data, un-plotted registered parcels (referred to as KW 4, 5, 6) and those which have been plotted (called KW 1, 2, 3). The classification of cadastral content entry levels into the KKP system is shown in Table A3, Appendix B. The quality of land parcels related to KW 1, 2, 3 differs in their accuracy and uncertainty level both relatively. In a position that needs to be improved, in addition, digital services are also still challenging.

The target and realization of PTSL from 2017 to 2019 are shown in Table A4 Appendix B. It implies that the higher realization versus the target does not guarantee the completeness of cadastre data. According to Enemark (2018), this target is only achieved by using an FFP approach. It was reported that FFP solutions tend to modify the current approach in Indonesia, which includes systematic registration with aerial mapping and participatory land adjudication, visual boundaries and areas calculated on the map, integrated land management based on a one map policy (OMP), and the use of locally trained land officers acting as trusted intermediaries [14]. The introduction of FFP land administration in Indonesia is supported by the President, who issued a land policy to boost tenure security and economic development [47]. However, its legal and institutional reform is still challenging.

3.2. The Fixed Boundaries

The term "boundary" refers to either the spatial objects that mark a parcel's limits or an imaginary line that divides two adjoining estates. It is also described as a surface marking or as defining the division between two legal interests, it also implies "the dividing line between contiguous parcels" [3]. Land boundaries are defined by laws and regulations, with several variations across countries and even states or provinces within a country [3].

This research distinguishes between spatial and legal demarcation [33]. According to the regulation, these characteristics are elaborated based on the six cadastral elements in the fixed boundary procedure as shown in the blue box (A) in Figure 1. The fixed boundaries

are not an aspect of the technical exercise for surveying and mapping, rather it is legal. These activities, which include the party that locates the boundary, agreement between the adjoining landowners, boundary markers, boundary determination officer, cadastral survey method, and the accuracy of the base map, are shown in Figure 2. The differences between spatial and legal elements are distinguished by red and blue frames.

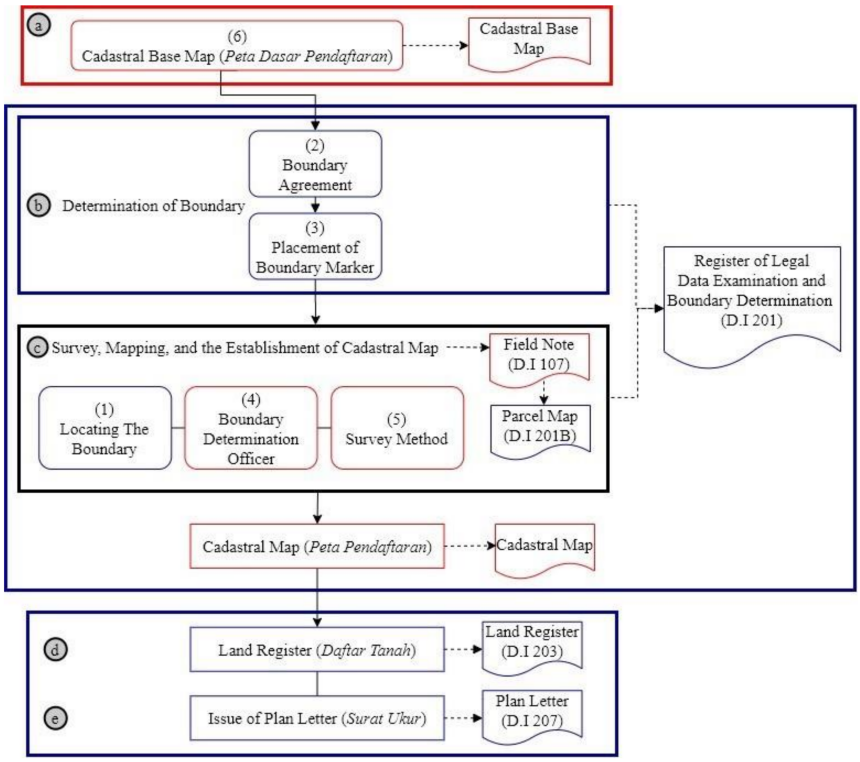

Figure 2. The workflow of spatial and legal elements in fixing the boundary. The spatial elements are marked by the red frames (4, 5, 6), and legal elements (1, 2, 3) by the blue frames.

The determination of boundaries is recorded in the register of legal data examination and boundary determination ("*Risalah Penelitian Data Yuridis dan Penetapan Batas* or *Daftar Isian 201"*). PMNA No. 3/1997 article 140 stipulates that the registers of spatial data are initiated with one, legal by two, and administration by three. Article 58 states that after the determination of the boundary and installation of its markers, the exercise of survey completion and mapping of the land parcels needs to be carried out, however, this separation is apparent.

3.3. Cadastral Typologies

This study provides a cadastre typology to assess the compliance of the boundary survey with that of cadastral regulation in Indonesia, which contributes to an improved understanding of the complexity, thereby forming the basis for adopting the best practices and a tool to improve national cadastral systems [37]. Furthermore, the continuum of accuracy is based on the cadastral typologies in terms of improving data quality.

This research only analyzes three legal elements (parties that locates the boundary, agreement between the adjoining landowners, and boundary markers). The study resulted eight cadastral typologies as follows:

1. Parties that locate the boundary (1), agreement between the adjoining landowners (1), boundary markers (1).
2. Parties who locate the boundary (0), agreement between the adjoining landowners (1), boundary markers (1).

3. Parties who locate the boundary (0), agreement between the adjoining landowners (0), boundary markers (1).
4. Parties who locate the boundary (0), agreement between the adjoining landowners (0), boundary markers (0).
5. Parties who locate the boundary (1), agreement between the adjoining landowners (0), boundary markers (0).
6. Parties who locate the boundary (1), agreement between the adjoining landowners (1), boundary markers (0).
7. Parties who locate the boundary (1), agreement between the adjoining landowners (0), boundary markers (1).
8. Parties who locate the boundary (0), agreement between the adjoining landowners (1), boundary markers (0).

The three-second numbers are a spatial demarcation (determination officer, survey method, and accuracy of base map) and were not investigated in the paper.

3.4. Assessment of Compliance

This research could be used to potentially facilitate the completion of the Indonesian cadastre, particularly in rural areas. In addition, it could be used to develop a strategy to improve the overall cadastral system's effectiveness as a basic layer of the land administration system.

3.4.1. The Participation of Eligible Landowners

The participation of eligible landowners during parcel registration is minimal, despite the compulsory legal requirement to register their lands in a systematic registration such as PTSL. Subsequently, the parties that locate the land boundary (the detailed number attached in Appendix C) are shown in Figure 3. Only 36.06% of the landowners or their proxy located the boundary of 7522 parcels. The majority of them, approximately 59.68%, believe in the use of local officers to locate their boundaries, while 0.62% are occupants. Since the systematic registration is compulsory, the local officer and the occupant tend to identify the boundary by regulation. The interested parties, e.g., the potential buyers, are ineligible to locate the boundary. This occurs when a local officer does not accompany the surveyor, and this was realized for approximately 2.17% of the data. Conversely, when the land has no occupant, it is difficult to locate the boundary, and this was realized for 1.47% of the data.

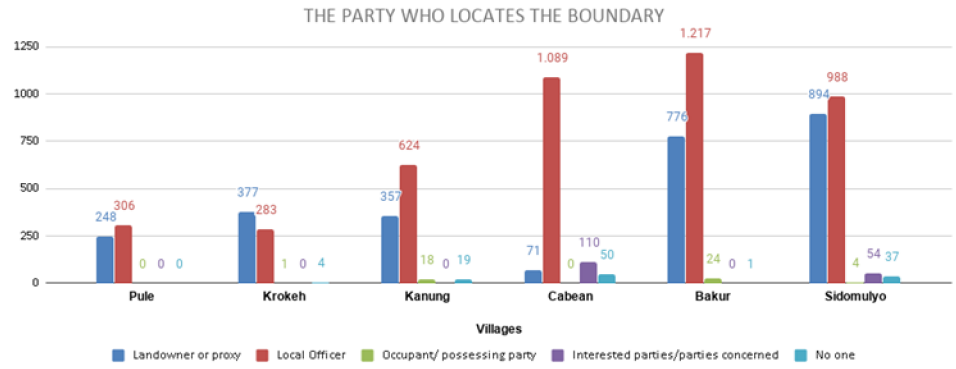

Figure 3. The party that locates the boundary.

The findings from PTSL in the case study area show that the minimum number of eligible landowners that were actively able to locate their boundaries disclosed essential factors that are crucial in completing the cadastral system in the future, and this is reported as follows

- Landholders feel safe, they do not directly locate the boundaries of their parcels. They trust both the local and land officers and based on the interview that was carried out,

and it shows that fixed boundary concerning the exact coordinate is unimportant to them.

- The compulsory obligations stipulated in the regulations were not perceived as such by the right-holders. On the contrary, the obligatory enforcement was also not carried out, and the right holders who did not certify their land even at the systematic registration were not sanctioned.
- The parties must be eligible to locate the boundary and need to carry out such an act before ascertaining the truth through the procedure of determining the rights of the landowner. This logical sequence is important for the purposes of the land information system, which needs to be completed before accepting the general boundary. However, this assumes the boundary determination is based on agreements that are not between the actual owners, and rather, are between people that occupy or use the land, therefore making the legal basis of the agreement invalid.

The low level of participation of right-holders can be addressed through identification and delineation of boundaries using satellite/aerial imagery, as suggested in the FFP approach.

3.4.2. The Agreement between the Adjoining Landowners

Article 19 to 23 of PMNA No. 3/1997 regulates the agreement between the adjoining landowners before the survey and mapping activities. In addition, the majority of the respondents (96.61%) gave consent, as shown in Figure 4. The high number of agreements contradicts the low level of right-holders' participation. Most of them agree with adjacent right holders. Therefore:

- The boundary agreement does not significantly impede land registration.
- Only a few of them (3.39%) stated that they have not obtained boundary consensus. Based on the interview with landowners and local officer, they reported that boundary disputes are relatively rare. Most respondents stated that it is difficult to obtain approval from landowners that do not reside on the site.
- A total of 496 (6.57%) parcels signed agreements without proper boundary markers or even lacked boundaries.

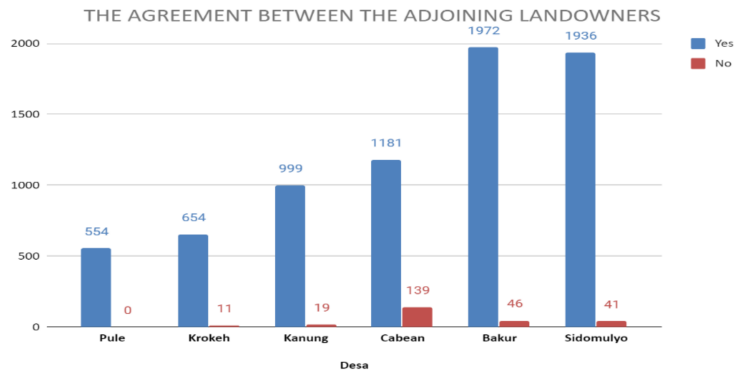

Figure 4. The agreement between the adjoining landowners.

Article 26 of PMNA No. 3/1997 regulates that the boundary of land parcels can be identified by aerial imagery. However, a field survey is mandatory, but this is too costly, time consuming, and capacity demanding.

Arruñada (2018) reported that irrespective of the method and precision used to define a land boundary, the neighbors need to be involved in this type of agreement.

3.4.3. The Boundary Markers

Based on PMNA 3/97, the boundary markers need to be installed by the right-holder, after obtaining an agreement from the actual landowner of the adjacent parcel. The various

types of boundary markers are regulated in article 22. The majority of the parcels (92.47%) meet these requirements, as shown in Figure 5. Subsequently, only a few numbers of parcels do not comply (4.14% use plant fences or bamboo, and 3.39% have no borders at all). The majority of the landowners (65.81%) install permanent boundary markers (fixed boundary). It is surprising that the other nonpermanent boundary markers (34.19%) are plant fences or bamboo, the dike of a paddy field, rivers, ditches or roads, a monument made from wood or bamboo (which was unexpected). The landholders stated that fixed boundaries (permanent boundary markers) are considered inessential.

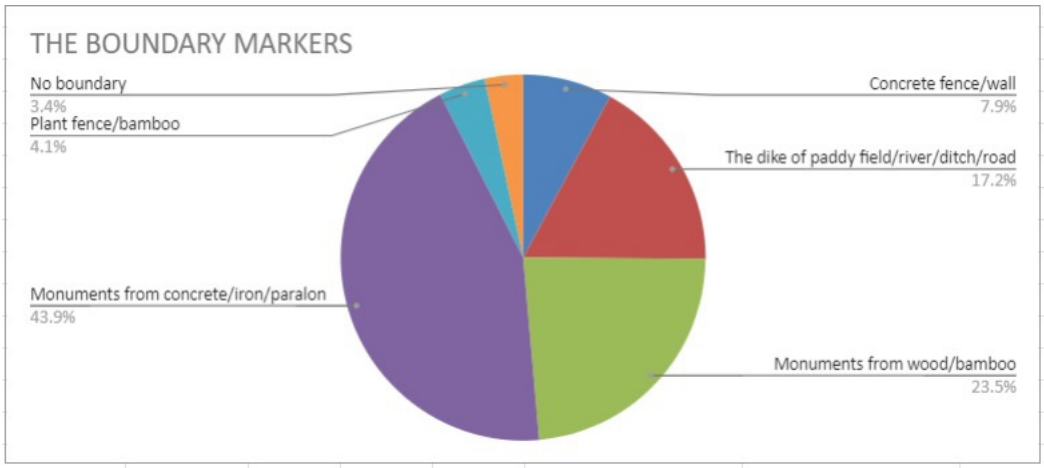

Figure 5. The boundary markers.

Based on the interview with the landowners and the local officer regarding the boundary agreement, it was discovered that they are satisfied. It was also reported that even though the boundary mark is "not fixed", they were not worried and assumed the marks got lost, damaged, or moved since the agreement with the adjoining landowners had been obtained.

The significant number of boundary monuments that did not comply (34.19%) with the fixed boundary regulation confirmed that the boundary monument is too costly for rural citizens. As suggested by the FFP approach, the regulation should accept general boundaries instead of fixed boundaries.

Appendix C provides information on the structure of the land parcels of the villages. It appears that large parts of a village district is made up of narrow, elongated land parcels, while other sections are subdivided by more square land parcels. The eastern part of Kanung Village consists of family houses. The cadastral elements addressed by the study will be improved if supplemented to include different boundary types, for example: the village boundary, road boundary, boundaries of sections of built-up land parcels, boundaries of sections of strip-shaped land parcels, boundaries of individual built-up land parcels, and boundaries of individual strip-shaped land parcels. This would require landholders of built-up land parcels to be much more able and willing to engage in boundary determination. However, this main scope of this research is the legal element of fixing the boundary that is regulated in the PP No. 24/1997 and PMNA No. 3/1997.

3.4.4. The Compliance of Cadastre Elements

As stated in the methods section, this research adopted three cadastral elements, namely, the party that locates the boundary, its markers, and the agreement between the adjoining landowners. In addition, the compliance of cadastre elements is shown in Table 3. The percentage formula described in Section 2.3 was used to calculate the proportion of surveyed parcels that comply with the cadastral elements, as stated in the Government Regulation No. 24/1997.

Table 3. The compliance of all data.

Village	The Party Who Locates the Boundary					The Greenment between the Adjoining Landowners		The Boundary Markers						Remark		Total
	Landowner or Proxy	Local Officer	Occupant/ Possessing Part	Intetested Parties/ Parties Concered	No One	Yes	No	Concrete Fence/Wall	The Diky of Paddy/River/ Ditch/Road	Mounments from Concrete/ Iron/Paralon	Mounments from Wood/Bamboo	Plant Fence/ Bamboo	No Boundary	Comply	Not Comply	
Kanung	357	624	18	0	19	999	19	117	182	607	93	3	16	996	22	1018
Krokeh	377	283	1	0	4	654	11	83	28	324	191	39	0	615	50	665
Pule	248	306	0	0	0	554	0	32	10	291	182	39	0	515	39	554
Sidomulyi	894	988	4	54	37	1936	41	0	241	1422	173	5	136	1797	180	1977
Cabean	71	1089	0	110	50	1181	139	228	253	610	11	127	91	1021	299	1320
Bakur	776	1217	24	0	1	1972	46	135	586	1121	63	100	13	1859	159	2018
Total	2723	4507	47	164	111	7296	256	595	1300	4375	713	313	256	6803	749	7552

It was discovered that the majority of the parcels (90.08%) comply with the requirements. Further analysis from PTSL suggested a review of the field survey requirements to measure the boundaries that did not comply with the regulation. The proportion of non-compliance tends to be higher when the spatial elements in the boundary determination, e.g., determination officer, survey method, and base map accuracy, are also included. The distribution of land parcels that do not comply with the cadastral requirements and its cadastral typology is shown in Appendix C.

4. Discussion

The first land registration (PTSL) aims to register all land parcels in Indonesia by 2025. However, the requirement for fixing the boundaries, as stipulated in the regulation, is still a challenge. This research disclosed that the participation of eligible landowners in the first land registration and local officers' activeness during boundary determination are important factors of cadastral elements. This is consistent with the studies carried out by Aditya (2020) [11] and Zevenbergen (2002) [15].

Lack of compliance with the cadastral element causes the land office to lack confidence in implementing the PTSL completely and systematically as regulated. This is due to the fact that they are afraid of the consequences involved in issuing a parcel map—*Peta Bidang Tanah* (PBT)—that has "not comply" with legal requirements provided in the regulation. This skepticism is quite reasonable, the PBT with no certificate issued yet (K3) needs to be prepared for certification in the years ahead (K1). The dilemma was discussed as follows, supposing the PBT is used to issue a certificate, it implies some elements have not been fulfilled and probably deemed defective. Conversely, such deficiencies simply mean no eligible boundary locater, agreement, or markers. However, assuming it is refinanced to issue a new PBT, they tend to be afraid of double budgeting, and that published in PTSL becomes useless. The regulation in fixing the boundary consists of distinguishing between spatial and legal elements, as reported by Arruñada (2008) [33]. Legal elements have negative legal implications, assuming they are not fulfilled. After seventeen decades of the cadastral system in Indonesia, improvements are still needed, e.g., the judicial instead of administrative sector [36]. The interview and spatial analysis of PTSL show that fixing boundary determination slows down the progress of PTSL, even though the survey is carried out sporadically [5].

This research identifies that boundary determination using a fixed boundary is mandatory in the Indonesian cadastre [12,41]. Figure 2 shows that the six cadastral elements consist of the legal element (blue frame) and spatial element (red frame). The fixing boundaries are not merely related to technical surveying and mapping practices; rather there are closely related to the legal element. The legal aspect may be created by an agreement, followed later by the survey [46]. The six case studies in rural areas show that an agreement is reached in 96.61% of cases, and only 36.06% of the landowners' directly located boundaries are legally sufficient. Furthermore, the interview shows that the agreements could be obtained using aerial imagery instead of a field survey during the publication of the register of legal data examination and boundary determination. These data show that the fixed boundary concerning the exact coordinate, including survey method and accuracy of base map as required by regulation, is not important to people in the rural area.

Moreover, the provisions on the boundary determination when registering land is mandatory, as stated in PMNA 3/97. The aim is to develop a complete land information system, and ATR/BPN has initiated discussions using general boundaries for its land registration. Parts of the land information system may include general boundaries, and it could be argued that the Land Information System (LIS) could not be completed without them. The interviews with senior land officers revealed that the boundary determination between the non-landowners (e.g., people that occupy or use the land) is not valid. Therefore, land information is inaccurate.

The acceptance of the general boundary was started in England. Earlier attempts to introduce fixed boundaries in 1862 failed, although it was only after introducing the principle

of general boundaries and avoiding expensive surveys (1875), adding selective compulsory registration (1897), simplifying the substantive land law (1925), and making conversion mandatory on transfers in designated areas that the system swung into action [15].

The purpose of this research is centered on the use of a visible boundary concept, particularly in rural and semi-urban areas. The results of the research are in line with other scientific papers dealing with methods for collecting cadastral parcel data based on visible boundaries in African countries with the purpose of increasing the speed of mapping and reducing the costs of land rights registration. Fixed boundaries are then used where relevant or necessary for any specific purposes or when required and paid for by the landowner or stakeholders [20,21,33,39–41].

5. Conclusions

Boundary demarcation consists of a six element cadastre in the legal and spatial elements recorded in the legal activity registers. The research in the case study area found a high percentage of the second element, an agreement between the adjoining landowners. This social aspect of fixing the boundary can be used as a potential method enabling the completion of the Indonesian cadastre by enshrining a legal and spatial framework of the FFP approach in Indonesian regulation.

The boundary determination using a fixed boundary is mandatory in the Indonesian cadastre. However, the research shows that the fixed boundary concerning the exact coordinate, including survey method and accuracy of the base map required by regulation, is not considered important to people in rural areas.

6. Recommendation

The ministry regulation should adopt aerial imagery in its regulation to build a complete spatial cadastre and also require government regulation to use the complete spatial cadastre as a basic layer in land administration system by integrating land tenure, value, use, and development functions.

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Appendix A

Table A1. List of Materials in Country Context Section (Adopted from the "Cadastral Template 2.0") [38].

Country Context	Statement
Purpose of Cadastral System	The cadastral system's primary purpose is to support the registration of land by providing legal security rights and facilitating the transfer of rights in the land tenure function.
Types of Cadastral System	Different institutions administer other cadastral systems to register forest area, fiscal cadastre, more discrete rights and responsibilities, such as mining rights and concessions, to carry out land activities. These cadastral systems generally use different systems for base data.
Cadastral Concept	The principal cadastral unit is a surveyed and boundary marked parcel, with spatial data, such as location, boundaries, and an area. The fixed boundary is mandatory. *Nomor Identifikasi Bidang* (NIB) is a parcel consisting of 13 digits, the first eight digits are the code of the province, district, sub-district, and *kelurahan*/village where it is located, and the last five digits are the parcel number. The administration area code is determined through the ministerial decree. The title rights unit is issued in accordance with the parcels defined in the survey system. Three distinct categories of land rights were registered, namely (a) the three real property rights specified in the *Undang-Undang Pokok Agraria* (UUPA), i.e., ownership right (*hak milik*), the right to build (*hak guna bangunan*), and the right of exploitation (*hak guna usaha*), (b) the pre-1960 land rights on former "western" and "Indonesian" land that has been "converted" to one of the three UUPA rights mentioned above, and (c) three additional types of land rights introduced after enactment of the UUPA, i.e., the right of use on state land (*hak pakai*), the "development right" (*hak pengelolaan*), and the strata title (*hak milik atas satuan rumah susun*). Properties differ from parcels and titles. The term "property" is used for administration and taxation purposes.
Content of Cadastral System	The principal cadastral components are spatial and legal data. To present these data, the land office organizes the public registers (*daftar umum*) consisting of registration maps (*peta pendaftaran*), land registers (*daftar tanah*), surveying letters (*surat ukur*), land books (*buku tanah*), and name lists (*daftar nama*). *Warkah* is defined as the documents used as evidentiary tools, and the basis for registration with identification kept as an integral part of the *daftar umum*. The *daftar umum*, in particular, *buku tanah* is a comprehensive and functional electronic database for checking all encumbrances, caveats, charges, or privileges affecting a registered property's encumbrances. Land offices maintain a hardcopy of *peta pendaftaran*, some of which are already in fully digital and stored at the Komputerisasi Kegiatan Pertanahan (KKP) system. *Peta pendaftaran* roles as a geographic information system (a fully digital geographic representation of the land plot)—an electronic database for recording boundaries, checking plans, and providing cadastral information on land ownership and maps, which are kept in a single database. Both the *buku tanah* and the *peta pendaftaran* use the same NIB as an identifier number to describe the same parcel. Information is accessed by mentioning the NIB, or land rights number (*nomor hak*), or based on the landmark on the *peta pendaftaran*, or the name of the right-holder, and not through the address.
Cadastral Map	Cadastral map in the form of *peta pendaftaran* illustrates the parcels of land for the purposes of recording/bookkeeping. It contains information on the shape, boundary, location, and NIB, as well as the existence of buildings when necessary. The parcel is the smallest unit surveyed and registered in the *peta pendaftaran*. The fixed boundary is mandatory. It is accomplished by boundary determination procedures stipulated in the regulation, which means that there needs to be an eligible landowner to locate the boundary markers, agreements between the adjoining landowners, determination officer, cadastral survey methods, and accuracy of the base map. The activity of fixing boundaries is not part of the technical exercise of surveying and mapping, rather it is legal. *Peta pendaftaran* is based on the cadastral base map—*peta dasar pendaftaran*—which is a map that contains technical base points and geographical elements, such as rivers, roads, buildings, and spatial boundaries of parcels. The *peta dasar pendaftaran* has a scale of 1: 1,000 or higher for urban areas, 1: 2,500 or higher for agricultural areas, and 1: 10,000 or smaller for large plantation areas. Planimetric accuracy is determined to be higher or equal to 0.3 mm on the map scale. The national coordinate system uses the Transverse Mercator projection with a zone width of 3 ° (three degrees) called TM-3. ° The central meridian zone TM-3 ° is located 1.5 ° (one point five degrees) to the east and west of the central meridian of the concerned UTM zone. The scale factor magnitude in the central meridian (k) used is 0.9999. Pseudo zero points used are east (x) = 200,000 m, and north (y) = 1,500,000 m. Earth's mathematical model as a reference field is a spheroid in the WGS-1984 datum with parameters a = 6,378,137 m and f = 1 / 29,825,722,357.
Example of a Cadastral Map	*Peta pendaftaran* can be seen at https://bhumi.atrbpn.go.id/ *Peta pendaftaran* comprises an incomplete thematic layer, such as spatial planning and overlaid land value zone map, that cannot be seamlessly interoperable. The role of *peta pendaftaran* is still limited to land tenure function services. The integration of the Land Information System at the national, provincial, or district/city level, and its role for other thematic mappings, are still discouraging.
Role of Cadastral Layer in SDI	The cadastral layer has not been integrated with other spatial data such as e-Government, community empowerment, and activities to attained sustainable development.
Cadastral Issues	The main problems currently addressed by the cadaster are the issues of incompleteness and the quality of content.

Table A1. *Cont.*

Country Context	Statement
Current Initiatives	Since 2017, the government has accelerated land registration through systematic land registration (PTSL), which was launched as mandated by the President through President Instruction No. 2/2018 and mandated to be completed by 2025. All land parcels are expected to be measured and mapped. It is categorized as existing certified land parcels (K4), undisputed land parcels not ready for certification (K3), disputed land parcels (K2), and undisputed land parcels ready for certification (K1). K4 means that land offices need to take action to improve the quality of land records. This is because previously, the land titles were either not mapped correctly or with no spatial information (known as floating titles). The computerization has been implemented in stages, both in the form of scanned documents and fully digital. However, several challenges still need to be resolved in the digital transformation of cadastral content. Firstly, not all cadastral content data have been completely entered into the KKP system, or divided into the six classifications of each entry-level. Secondly, the data quality is not entirely "valid" in accordance with the contents recorded in the analog document (papers). It is associated with various factors, such as incompleteness or analog data errors, data entry errors, double numbering, etc. The suitability status of electronic data with analog data for every parcel needs to be validated. Thirdly, there are two groups of entry-level spatial data, namely, the un-plotted registered parcels (called KW 4, 5, 6) and plotted (called KW 1, 2, 3). The quality of land parcels of KW 1, 2, 3 differs in their accuracy/uncertainty level, both relative and positional, which needs to be improved. https://www.atrbpn.go.id/

Table A2. List of Features Covered by Cadastral Country Principles and Statistics (Adopted from the "Cadastral Template 2.0") [38].

Cadastral Principles and Statistics	Categories
Type of registration system	Title registration.
Legal requirement for registration of land ownership	Compulsory and optional.
Approach for the establishment of cadastral records	Both systematic and sporadic.

Appendix B

Table A3. Classification of Cadastral Content Entry Levels into the KKP System.

Entry Levels (*KW*)	Parcel Plotted on *Peta Pendaftaran*	*Surat Ukur* (Spatial)	*Surat Ukur* (Spatial)	*Buku Tanah*
1	√	√	√	√
2	√	×	√	√
3	√	×	×	√
4	×	√	√	√
5	×	×	√	√
6	×	×	×	√

√ (Entered); × (not entered yet).

Table A4. Target and Realization of PTSL in the Year 2017–2019.

Year	Target	Realization (K1 + K2 + K3 + K4)
2017	5,000,000	5,069,513
2018	7,000,000	8,854,797
2019	9,000,000	8,963,415
Total	**21,000,000**	**22,887,725**

Appendix C

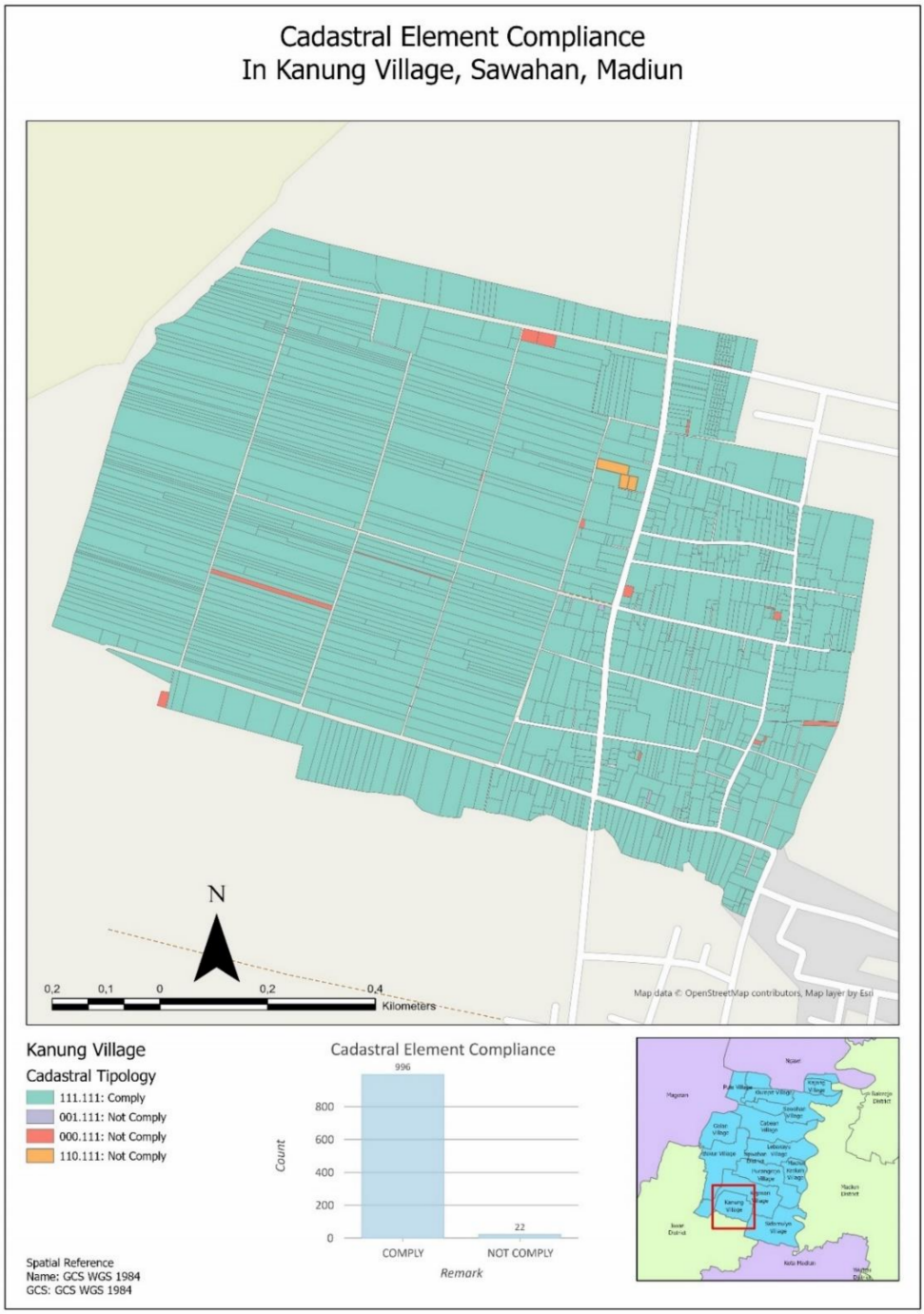

Figure A1. The distribution of non-compliance parcels and its cadastral typology in Kanung.

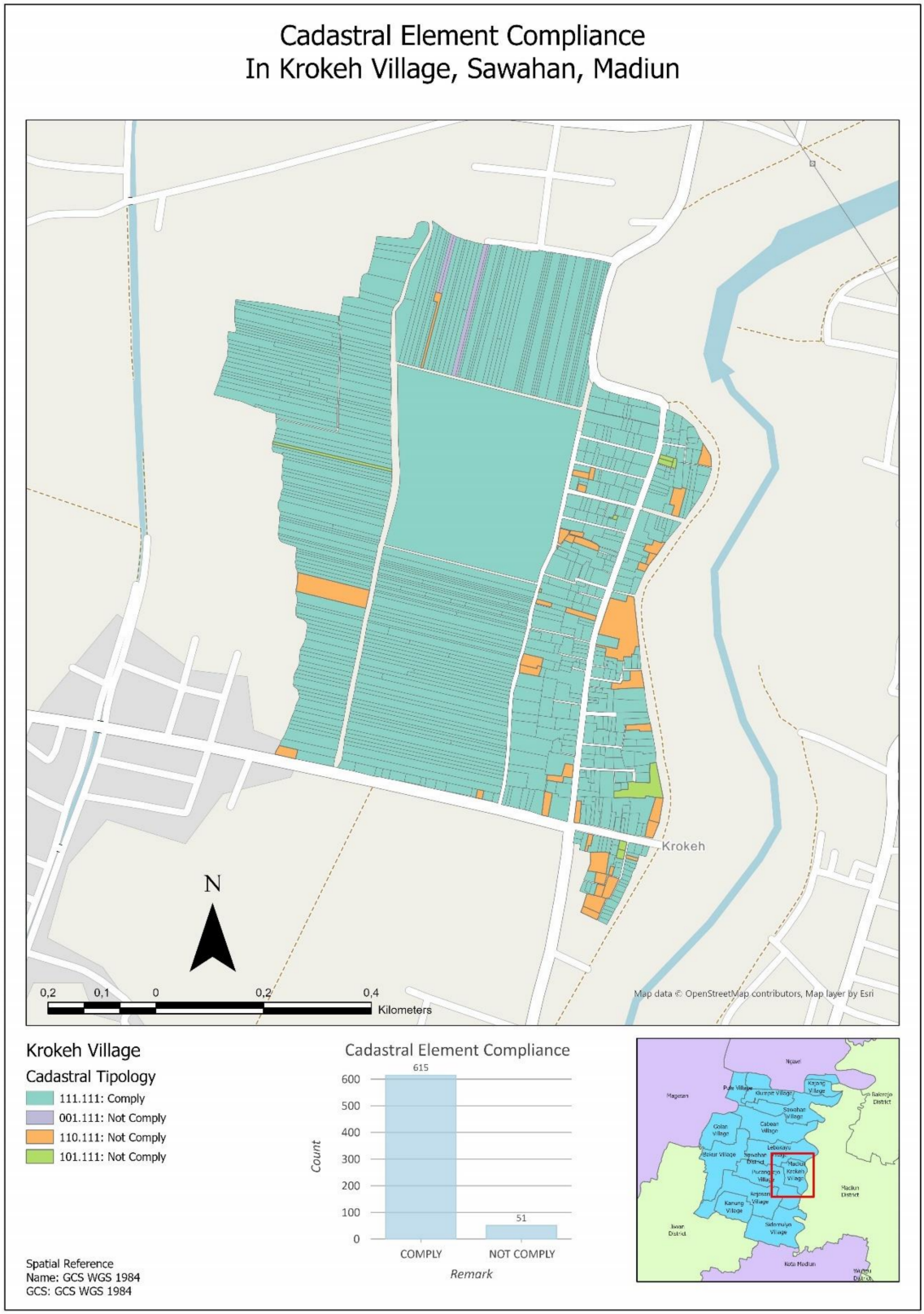

Figure A2. The distribution of non-compliance parcels and its cadastral typology in Krokeh.

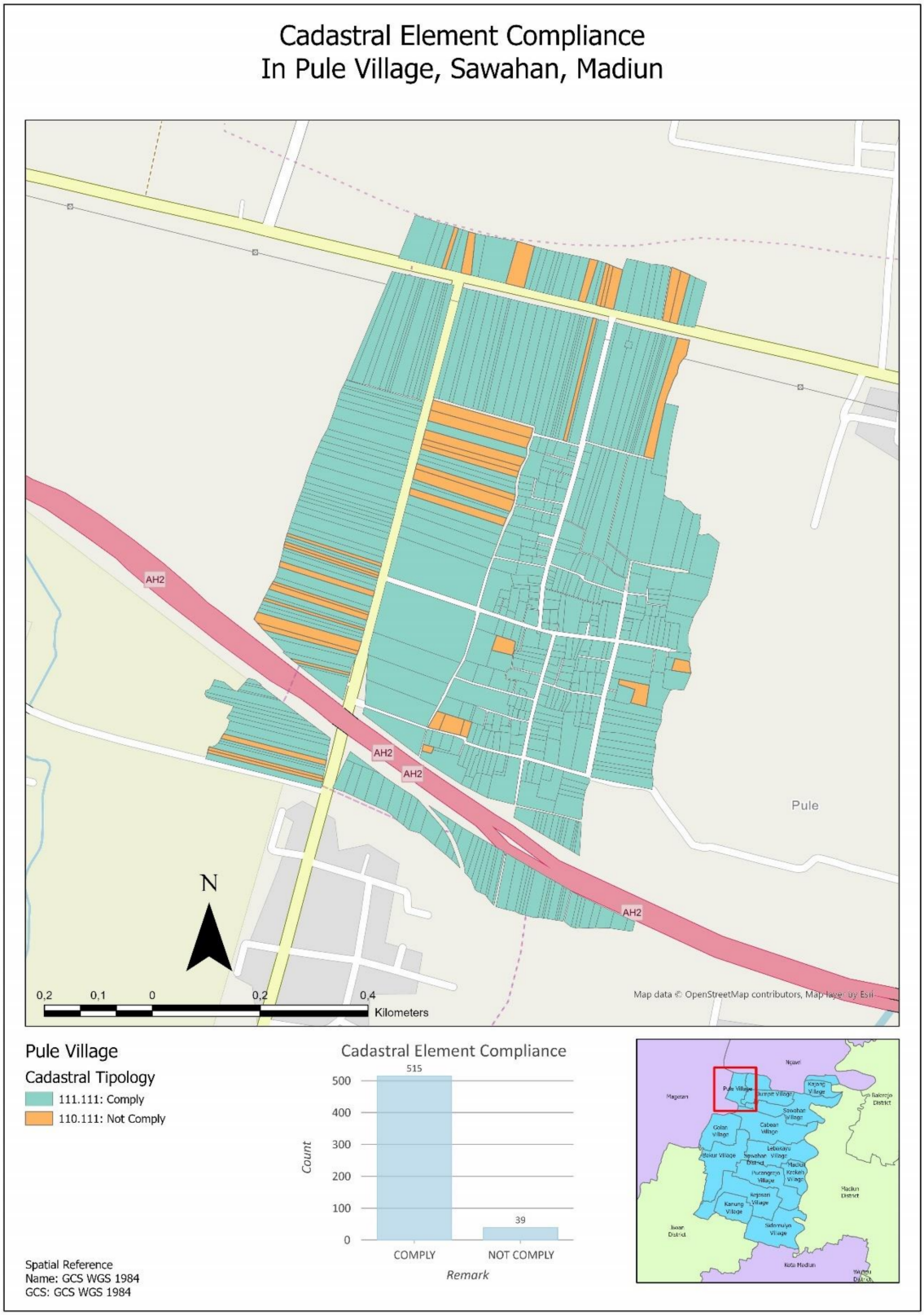

Figure A3. The distribution of non-compliance parcels and its cadastral typology in Pule.

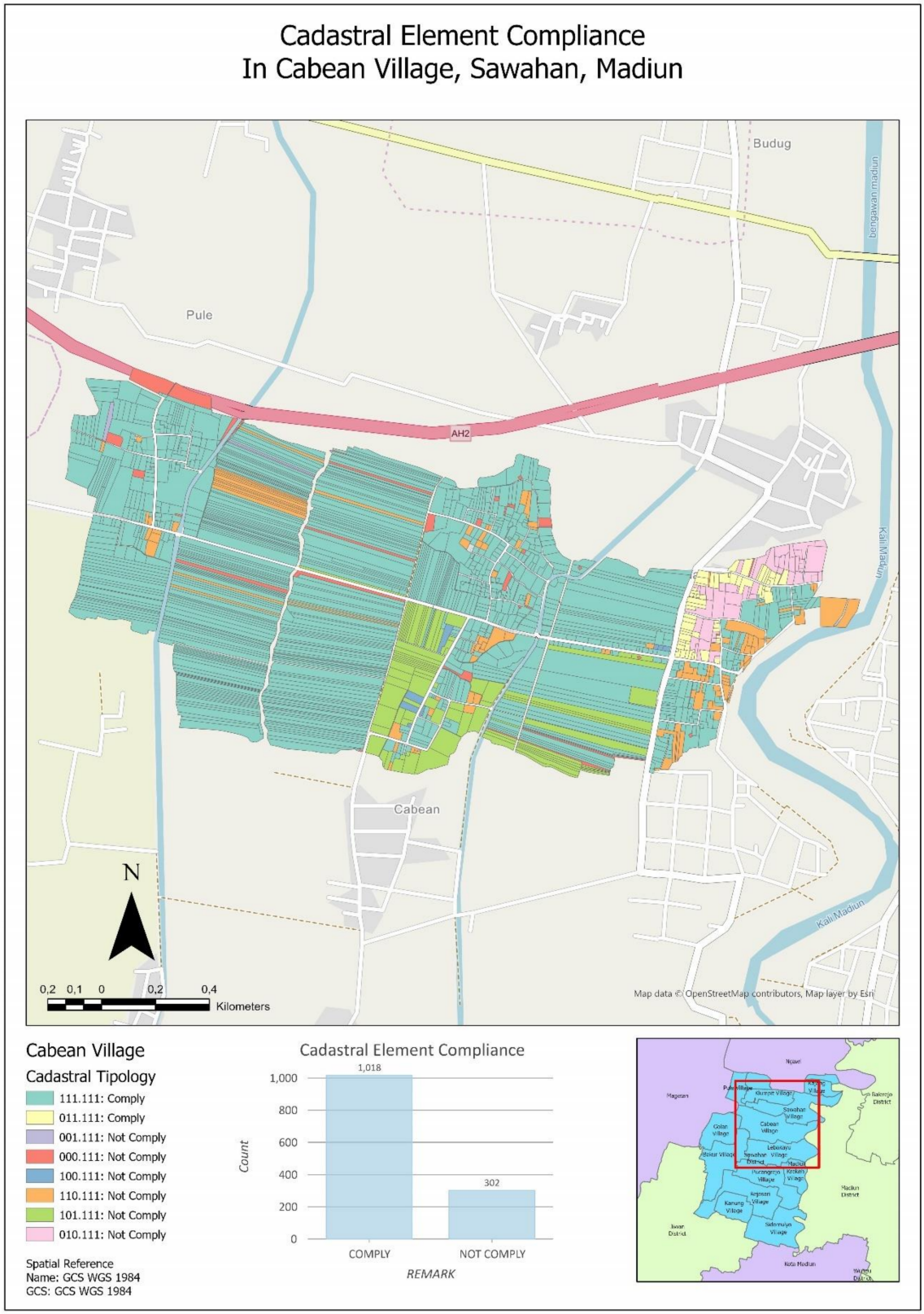

Figure A4. The distribution of non-compliance parcels and its cadastral typology in Cabean.

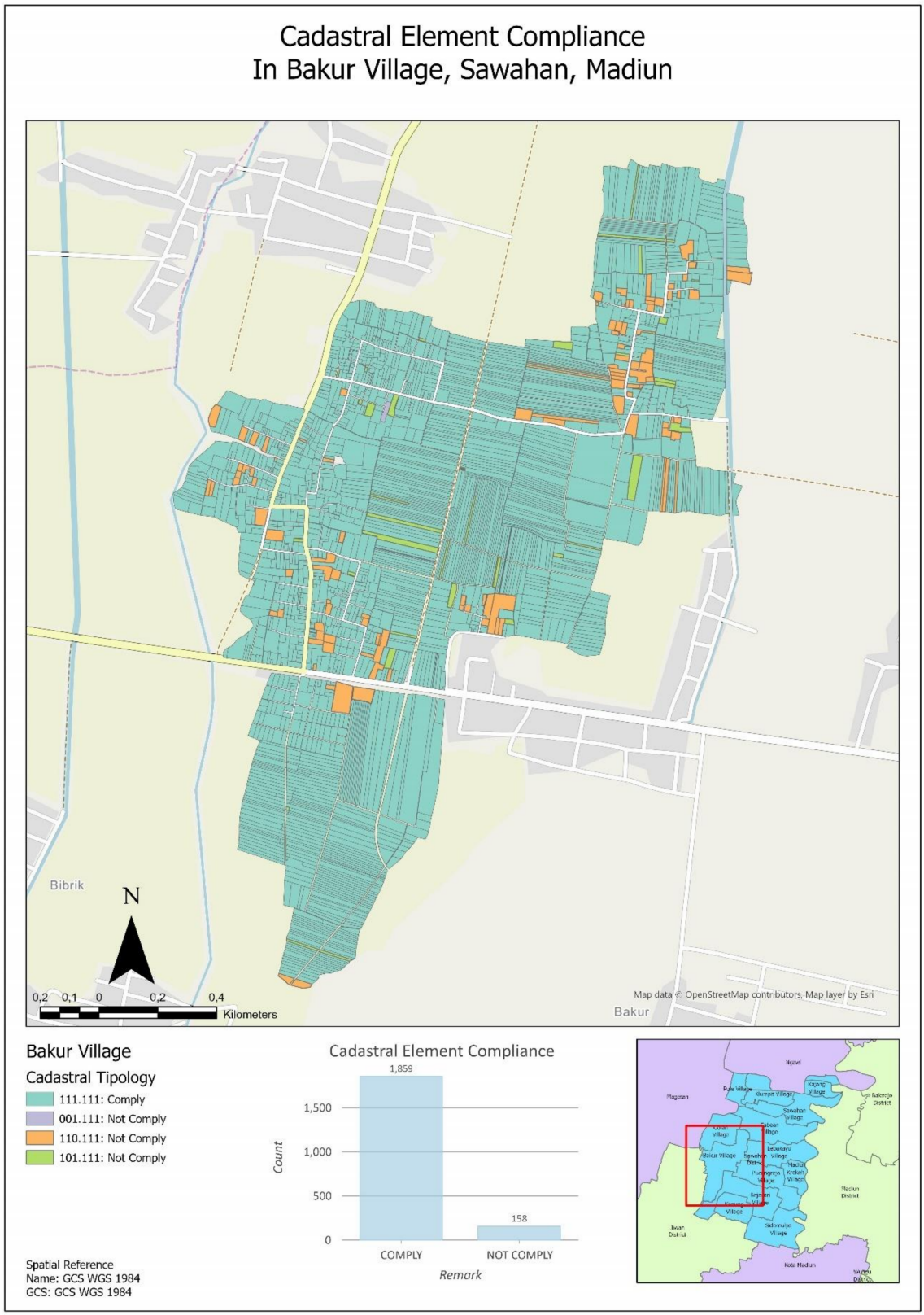

Figure A5. The distribution of non-compliance parcels and its cadastral typology in Bakur.

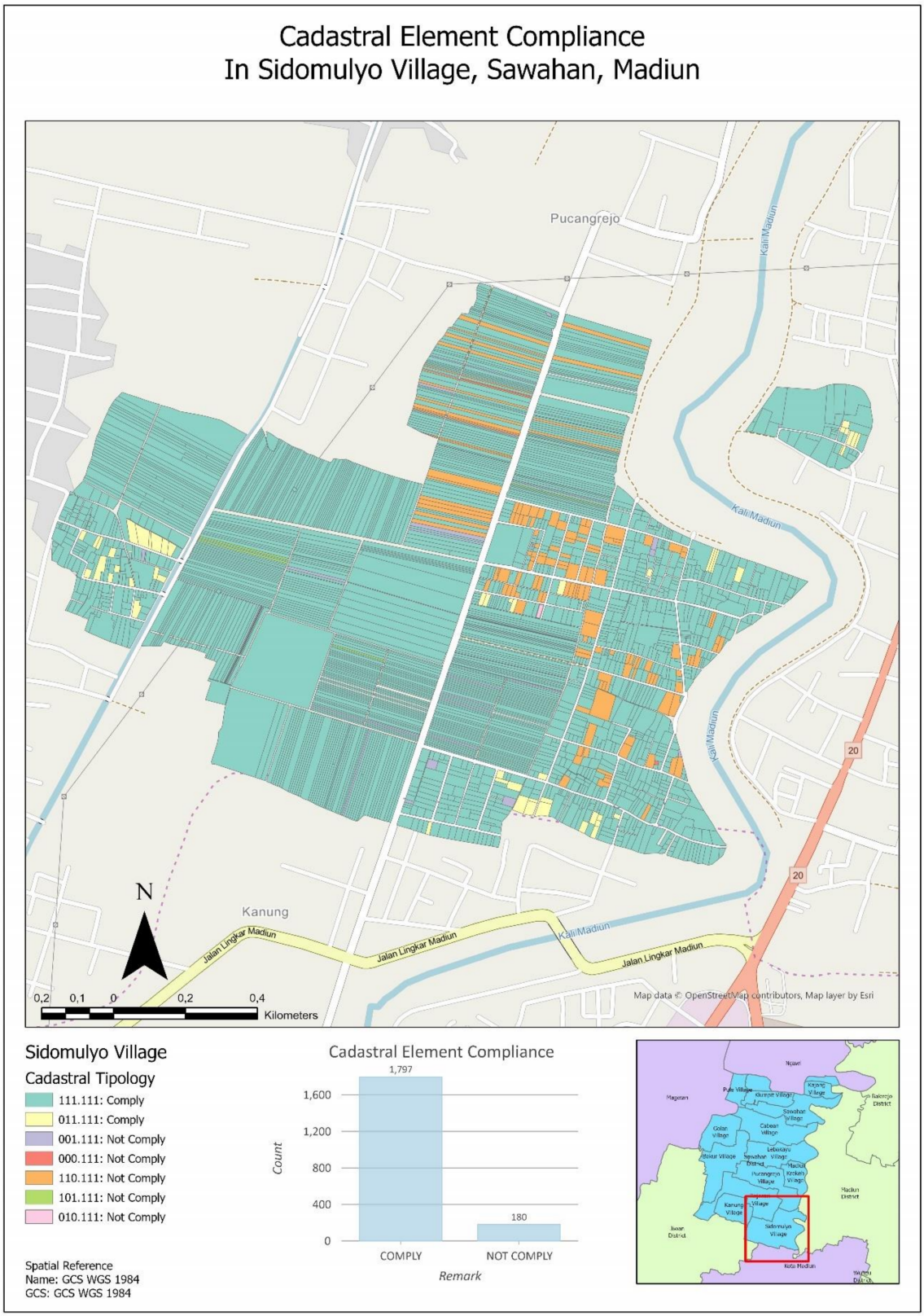

Figure A6. The distribution of non-compliance parcels and its cadastral typology in Sidomulyo.

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