

On Reliability of the Annex Map of the 1915 Land Boundary Treaty between Indonesia and Malaysia

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SUMMARY

The 1915 Boundary Treaty Agreement between the Netherlands and Great Britain governments, which was signed in London on 20 June 1891, is the reference used for determination of land boundary between Indonesia and Malaysia in Borneo Island. A few problems surfaced when the reference ellipsoid and map projection of the 1915 treaty annex map is not written down in its legend. Moreover, the 1975-1995 joint surveys between Indonesia and Malaysia indicated that the positions of two outstanding boundary problems (OBP), i.e. Sinapad and Simantipal river estuaries, against $4^{\circ}20'$ N graticule are not the same as those depicted on the 1915 treaty annex map.

This research was conducted to investigate and understand the 1915 land boundary treaty and the reliability of its annex map technical aspect, especially in relation with the outstanding boundary problems of Sinapad and Simantipal rivers. The method used is field surveys, technical analysis on measurement accuracy, map reliability, and interpretation of the 1915 treaty legal document.

The analysis results showed that the assumption that the 1915 treaty annex map is a map based on astronomical coordinates using the reference ellipsoid of Bessel 1841 was not correct. The annex map was found to be adequate with regards to its map structure, content and object pattern. The Dutch and British agreed to use the map as a valid document although the majority of the territory in the annex map was unilaterally surveyed by the Dutch, and there is no survey carried out in segment from Sinapad river estuary to the east, in which the map depiction will not be accurate enough.

1. INTRODUCTION

Republic of Indonesia and Malaysia are the countries of the former Federation of European colonies. Indonesia was once part of the Dutch East Indies colony for 350 years, and at the same time Malaysia became part of the colony of Great Britain (England). In that period the Dutch East Indies and England several times made an agreement that confirms the boundaries of each power embodied in the agreement document, namely: (Dephankam, 1996):

- 1) The Boundary Convention between the Netherlands and the United Kingdom signed in London, dated June 20, 1891.
- 2) The Boundary Agreement 1915 or also called as the 1915 Treaty between the Netherlands and the United Kingdom signed in London, dated 28 September 1915.
- 3) The Boundary Convention between the Netherlands and the United Kingdom signed at The Hague, dated March 26, 1928.

Based on the above three documents agreements, boundaries colony controlled by the Dutch and English are mostly natural objects following the dividing line of water or watershed line along approximately 2004 km (Dittopad, 2005)

Dutch colonial rule over Indonesia ended on August 17, 1945, while Malaysia's independence on 31 August 1957. As an independent and sovereign state, Indonesia and Malaysia have agreed to undertake the assertion borders on land use principles of international law: *Uti Possidetis Juris*. Usage patterns *Uti possidetis juris* principle that colonial powers were forced to pass on the former colonies to the rightful owners of the country. This means that Indonesia and Malaysia have agreed to use a formal and written agreement in advance of the Dutch government and the British government as the ruler of the area which will be confirmed borders. The agreement in question is 1891, 1915 and 1928. Affirmation Agreement limits need to be implemented in order to obtain a guarantee for peace, recognition of the sovereignty and security of the territory of a country (Adler, 1995).

Determination of the land boundary line between Indonesia and Malaysia in Borneo has been carried out by the Dutch and the British. But the physical demarcation on the ground only a small portion of the segment boundary, namely in the area Jagoi in the segment boundary between West Kalimantan and Sarawak as well as GP01, GP02, and GP03 at the boundary between East Kalimantan and Sabah.

To resolve the boundary, Indonesia and Malaysia agreed to carry out a survey and demarcation together in an effort to reinforce the border between the two countries in Borneo. Completion of the border issue began when Indonesia and Malaysia agreed to meet for the first time in the Informal Meeting that was held in Kuala Lumpur, Malaysia in 1972. Through several meetings including organizational MoU JTC (Joint Technical Committee) in 1973 and followed by several other bilateral meetings. Implementation of the survey and demarcation of Indonesia-Malaysia region in Kalimantan started in 1975 (Armed Forces Headquarters, 1983). In the period 1975-1993 there disagreement demarcation survey in the field in interpreting the content of the reference document. The issue was later raised in bilateral negotiations forum and agreed to serve as Outstanding Boundary Problems (OBP). OBP comprises 10 locations of unresolved segments (Figure 1). To facilitate the identification of geographic, OBP is divided into 2 groups according to their location is: 5 OBP segment in the eastern sector of East Kalimantan (Indonesia) with Sabah (Malaysia), namely:

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1. Problem of Sinapad River,
2. Problem of Simantipal River
3. Problem of Sebatik Island,
4. Non-coincidence problem: Regional Priority II (BC) from the point B2700 s / d B3100,
5. Non-coincidence problem: Regional Priority II (CD) from the point C500 s / d C600;

and 4 OBP segment in the Western sector of West Kalimantan (Indonesia) with Sarawak (Malaysia), namely:

1. Problem of Stone Aum,
2. Problem of Nanga Badau,
3. Problem of Buan River,
4. Problem of Gunung Raya;

In addition there is one segment in the western sector of Indonesia proposed to be part of that problem Tanjung Datu OBP. Until now the Malaysian rejected the proposal because the segment has been through the stages made legal with the MoU between the Indonesian government and the government of Malaysia.

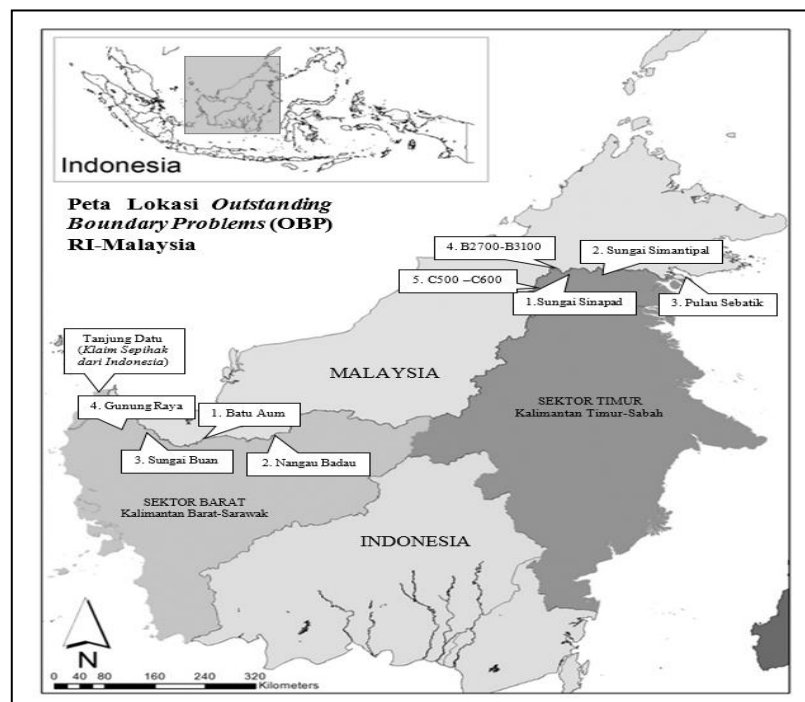


Figure 1. Location of the Outstanding Boundary Problems (OBP)

From 10 OBP segments that are still unresolved, 2 OBP ie rivers and streams Simantipal Sinapad associated with the 1915 Treaty OBP Sinapad rivers and streams Simantipal filed by the Malaysian side for objecting to the content of the map attachment Treaty 1915. The content of the map in question, namely:

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1. Map Appendix Treaty 1915 is an official map that has been agreed to be a reference demarcation, but do not have a description and map projection reference ellipsoid,
2. Position Sinapad and river estuaries Simantipal depicted on the map attachment Treaty in 1915 against graticule 4o20 '(LU) North latitude map is not the same as the position on the field.

To be able to know the process of preparing the 1915 Treaty Map Appendix agreement and answer the issues raised in OBP and Simantipal Sinapad river, this study conducts research related to technical analysis and measurement survey is the aspect of the map projection system and the use of a reference ellipsoid

2. DATA AND METHODS

As the main data, this study uses Map Appendix Treaty 1915 (Figure 2) by using several assumptions, namely:

1. Map Appendix Treaty in 1915 is a map with the astronomical coordinate system based on survey instruments listed in the 1915 Treaty document.
2. Reference ellipsoid used was Bessel in 1841, based on the information in the documents Treaty in 1915 that most of the survey carried out unilaterally by the Netherlands.

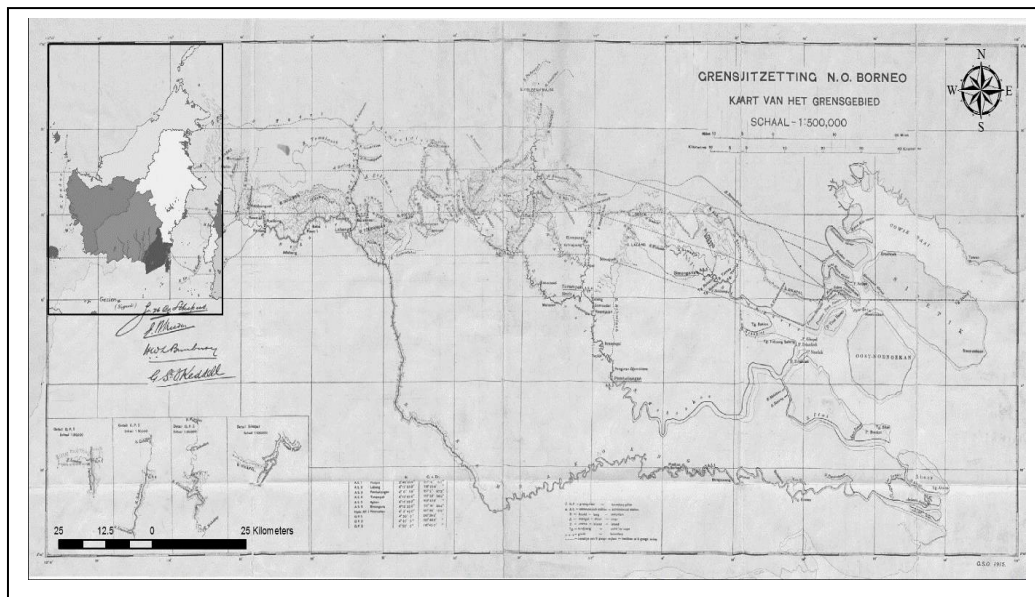


Figure 2. Map Appendix Treaty 1915

On the basis of assumptions made, technical analysis and mapping surveys conducted in this study realized by several phases of activities, namely:

1. Coordinates transformation from map of the 1915 Treaty Appendix Astronomical coordinates in 1841 Bessel geodetic coordinates to the WGS 1984 using vertical deflection components.

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2. Register Map Appendix Treaty in 1915 into Geodetic Coordinate System WGS 1984.
3. Digitizing Map Appendix Treaty 1915.
4. The results of digitizing Map Overlay Attachment 1915 Treaty with Indonesia.
5. Topographic Map (RBI) scale 1: 50,000 and GeoEye Satellite Imagery.
6. Comparative analysis and pattern position objects on the Map Appendix Treaty in 1915 with Map RBI and GeoEye Satellite Imagery.
7. Analysis of the position graticule 4° 20 'N Astronomically.

3. RESULTS AND DISCUSSION.

Map Appendix Treaty in 1915 as part of the 1915 Treaty of legal documents. Official status as the embodiment of the contents of this treaty ownership limits in the region of Borneo (Kalimantan) between the Dutch and the British. When documents are incorporated 1915 Treaty between Indonesia and Malaysia, found differences in the position of Sinapad River and River Simantipal against astronomical graticule 4 °20 '. To determine whether there is an error in the depiction of the map or systematic errors occur due to differences in the coordinate system, technical testing and measurement survey with map overlay method Attachment Treaty in 1915 with the latest map data base which can represent the condition and position in the area around the River and River Sinapad Simantipal . To perform an overlay process needs to be done before the coordinate transformation process. Map Appendix Treaty in 1915 is assumed to be in the Astronomical Coordinate System with reference ellipsoid Bessel 1841, while the base map used for comparison is the Indonesian Topographic Map 1: 50,000 scale and GeoEye satellite imagery in 2011 in geodetic coordinate system to WGS 1984 datum. To be able to change the astronomical coordinates to geodetic coordinates used correction formula equation using a vertical deflection component by Heiskanen and Moritz (1967) (Equation 1 and 2).

$$\begin{aligned} \xi &= \phi - \varphi \dots\dots\dots 1 \\ \eta &= (\Lambda - \lambda) \cos \varphi \dots\dots\dots 2 \end{aligned}$$

Where :

- ξ : Vertical Deflection Components longitude
- η : Vertical Deflection Components Latitude
- Φ : Longitude Astronomically
- Λ : Latitude Astronomically
- φ : Geodetic longitude
- λ : Geodetic latitude

As for determining the value of the components of the vertical deflection through harmonic formulas of Vening Meinez, Rapp (1982) (Equation 3 and 4).

$$\xi(\Phi, \lambda, r) = -\frac{kM}{\gamma \cdot R^2} \sum_{n=2}^{\infty} \left(\frac{a}{r}\right)^n \sum_{m=0}^n \{ \bar{C}_{nm} \cos m\lambda + \bar{S}_{nm} \sin m\lambda \} \frac{d\bar{P}_{nm}(\sin \Phi)}{d\Phi} \dots\dots\dots 3$$

$$\eta(\Phi, \lambda, r) = -\frac{kM}{\gamma \cdot R^2 \cos \Phi} \sum_{n=2}^{\infty} \left(\frac{a}{r}\right)^n \sum_{m=0}^n m \{ \bar{C}_{nm} (-\sin m\lambda) + \bar{S}_{nm} \cos m\lambda \} \bar{P}_{nm}(\sin \Phi) \dots\dots\dots 4$$

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Where :

$\bar{C}_{nm}, \bar{S}_{nm}$ = potential coefficient normalized

γ = normal gravity

\bar{P}_{nm} = normalized Legendre functions

R = average radius of the earth

Global Geoid models are used for the calculation of the vertical deflection component is the Earth Gravitational Model (EGM) in 2008 with components obtained from the site NASA / GSFC (2014). While the data processing is done to modify the software Harmonic Synthesis WGS 1984 by Simon A.Holmes and Nikolaos K Pavlis in Fortran77 programming languages.

Point tie is used as a reference in the registration process map is 4 points at the threshold of the map (Table 1). The point is further transformed from 1841 Bessel astronomical coordinates into geodetic coordinates and the UTM WGS 1984 (Table 2) for further implemented the registration process map.

Table 1. Tied point for Registration Process Map

No	Position	Longitude Astronomical (U)	Latitude Astronomical (E)
1	North - East	4°40'00"	118°00'00"
2	Shouth - East	3°40'00"	118°00'00"
3	Shouth - West	3°40'00"	115°40'00"
4	North - West	4°40'00"	115°40'00"

Table 2 The results Geodetic Coordinate Transformation Bessel UTM WGS 1841 to 1984.

No	Bessel 1841						WGS 1984							
	λ (N)			ϕ (E)			λ (N)			ϕ (E)			Northing (m)	Easting (m)
	°	'	''	°	'	''	°	'	''	°	'	''		
1	4	39	53.431	118	0	2.191	4	40	14.0405	117	59	58.5312	516328.1864	610868.2556
2	3	39	49.098	117	59	58.832	3	40	9.9359	117	59	55.1771	405649.322	610905.1982
3	3	39	43.914	115	39	56.786	3	40	4.7435	115	39	53.7739	405538.5592	351729.8271
4	4	40	8.938	115	40	14.748	4	40	29.5354	115	40	11.7306	516864.7798	352471.9049

As a medium of comparison in the overlay process used 2 pieces of the map are:

- 1) Indonesian Topographic Map 1: 50,000 scale corridor 5 km from the boundary line derived from Geospatial Information Agency (BIG) corridor 5 km from National Border.
- 2) The satellite imagery GeoEye 2011 (Res 2 m) obtained from the National Agency for Border Management (BNPP) as a complement of RBI Map .

Based on the results of coordinate transformations, Map Appendix subsequent 1915 Treaty registered to Geodetic Coordinate System in WGS 1984, made the object digitizing maps, and

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map overlay with an Indonesian Topographic Map and GeoEye Satellite Imagery. The analysis is done by comparing the Map Appendix Treaty in 1915 with Indonesian Topographic Map and Satellite Imagery:

- 1) Position Sinapad estuary, Simantipal River Estuary and River Sembakung-Pesiangan-Sedalir.
- 2) The object pattern river and watershed (water separator line).

The results obtained in the comparison of the position of objects on the map with the 1915 Treaty Appendix Indonesian Topographic Map and Satellite Imagery GeoEye generate random shift position (Table 3). Three (3) object than its position does not indicate the value of the distance and direction of the same azimuth, so that this error is not an error but a systematic error that acak. Beberapa sources of errors that cause these differences include:

- 1) Map Appendix Treaty ber 1915 not 1841 reference ellipsoid Bessel.
- 2) The registration process map with 4 points ally inadequate thus need plus point allies again.
- 3) The quality of the 1915 Treaty of digitizing Map Appendix unfavorable.
- 4) There is an error in the preparation of Annex Map 1915 Treaty.
- 5) Deformation position of the river.
- 6) The error resulting from the process of transformation of the astronomical coordinates to geodetic geoid model approach EGM2008.

Table 3 .Comparison of object position in Indonesian Topographic map and Map Appendix Treaty 1915

No	Objec	Map	Coordinat		Shifting	
			Northing (m)	Easting (m)	Distance (m)	Azimuth
1	River estuary Sinapad	RBI	406015.409	479660.12	3803.9782	74 ⁰
		<i>Treaty 1915</i>	402369.769	478610.71		
2	River estuary Simantipal	RBI	432849.631	478647.82	2933.3943	300 ⁰
		<i>Treaty 1915</i>	430302.537	480102.85		
3	T-junction Sembakung River, Pesiangan and Sedalir	RBI	435068.448	474753.1	2531.7381	302 ⁰
		<i>Treaty 1915</i>	432912.274	476079.98		

Next analysis is the comparison object pattern associated with OBP Sinapad River and River Simantipal. The results of the comparison are:

- 1) Sedalir River on the Map Appendix Treaty in 1915 is not appropriate overlap with Maps RBI and GeoEye Satellite Imagery, but the direction of the flow is in the same path that the east-west axis direction (Figure 3).

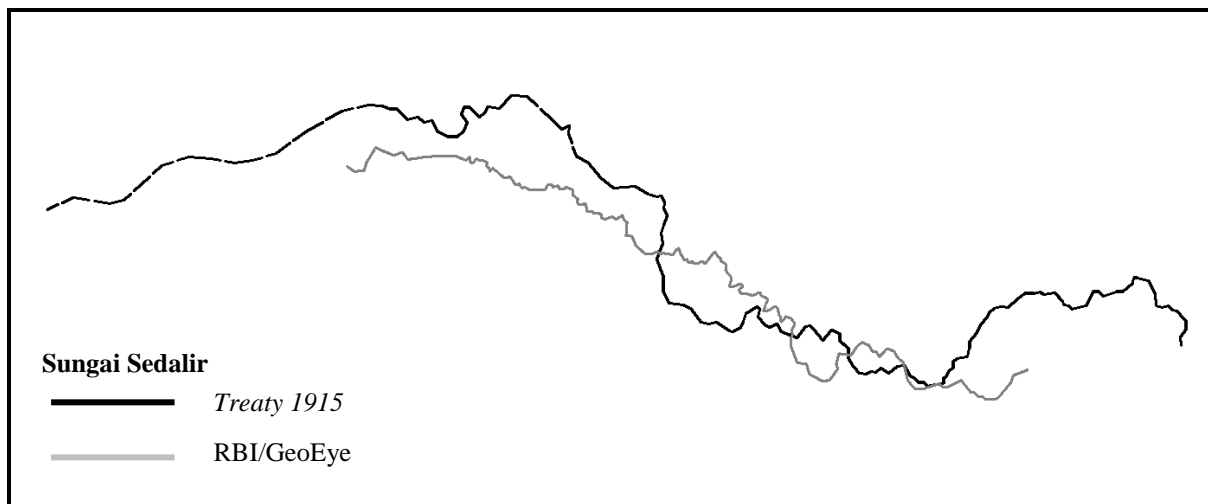


Figure 3. Sedalir River in Indonesian Topographic Map, Map Appendix Treaty 1915 and GeoEye Imagery

- 2) Similar to the position in Sedalir River, Sinapad River improper overlap but showed the same direction of flow. (Figure 4).

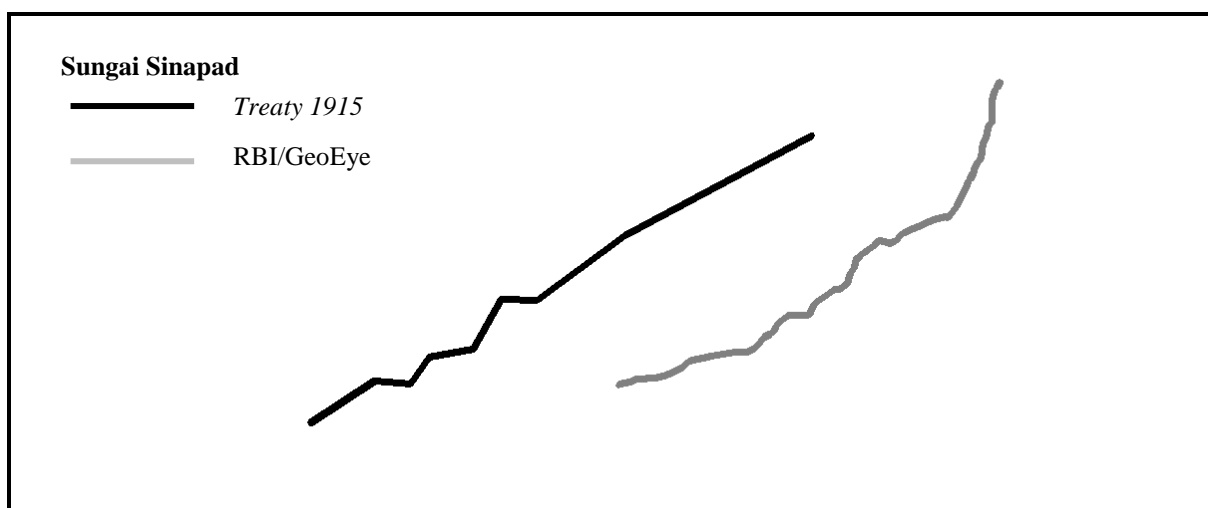


Figure 4. Sinapad River in Indonesian Topographic Map, Map Appendix Treaty 1915 and GeoEye Imagery

- 3) Data Simantipal River on Map RBI limited to 5 km corridor, while at GeoEye Satellite Image flow is not visible because of the river, including the type of the stream lines. With the limited data obtained similar results with the previous object that does not overlap but the same flow direction. (Figure 5).

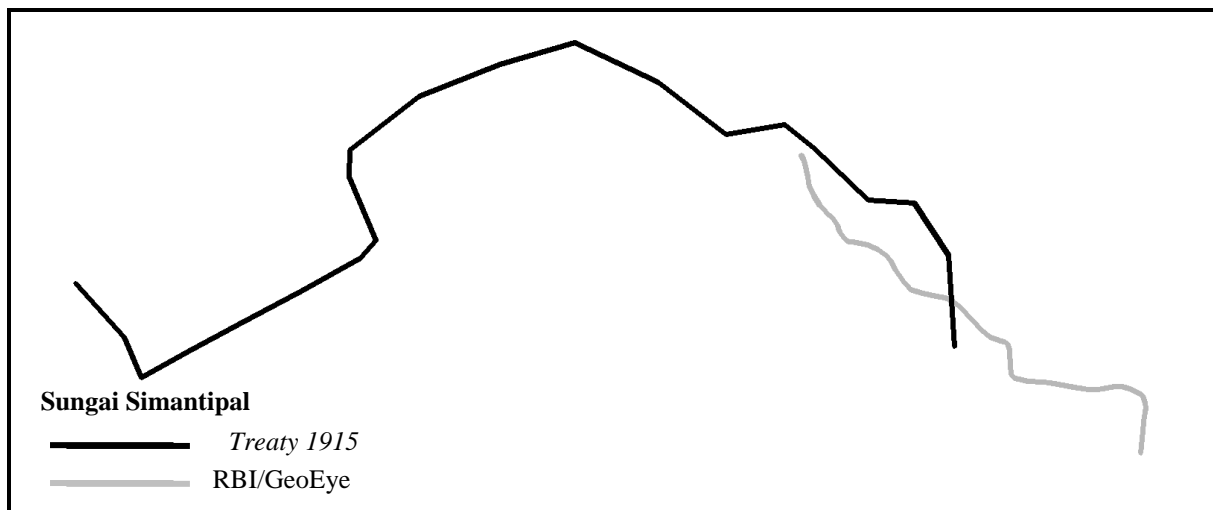


Figure 5. Simantipal River in RBI, Map Appendix Treaty 1915 and GeoEye Imagery

- 4) Similar results were obtained at the meeting of 3 (three) rivers namely Sedalir River, Rivers and River Sembakung Pesiangan. As a systematic error, the third position on the river flow and the RBI Map GeoEye Satellite Image shifted along to the west on the Map Appendix Treaty 1915. The third pattern shows the same shape and direction (Figure 6).
- 5) The last object that is the watershed of Simantipal River eastward to the River Sinapad. The object's position remains the same as the previous object that does not overlap but there are differences in the pattern and direction of the watershed before and after Sinapad River estuary. Sinapad River estuary to the west indicates the direction and the same pattern between existing watershed in 1915 with the Treaty Appendix Map Map RBI and GeoEye Satellite Imagery. While Sinapad River estuary to the east on the Map Appendix Treaty in 1915 in the form of a straight line and is different to that of the Map RBI and GeoEye Satellite Imagery (Figure 7).

The results of the comparison object pattern on the Map Appendix Treaty in 1915 with Map RBI / GeoEye Satellite Imagery shows that the object on the Map Appendix Treaty in 1915 is divided into two segments, namely:

1. Segment Sinapad estuary to the east shows the pattern of stream and watershed are almost the same, some differences due Map Appendix Treaty in 1915 in a smaller scale with the technology and methods are more ancient.
2. Segment Sinapad estuary to the east showed a different pattern of watershed. Pattern depicted on the Map Appendix Treaty in 1915 in the form of straight lines and different from the pattern in the Map RBI / GeoEye Satellite Imagery. The analysis is taken from the segment is not carried out the survey.

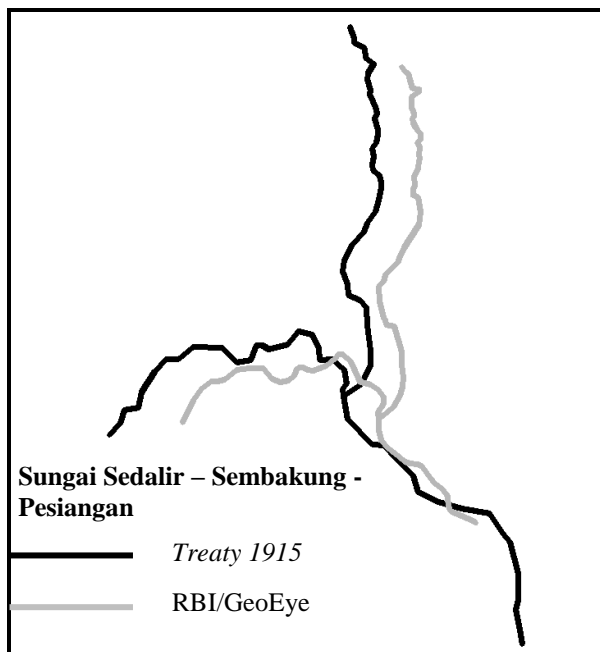


Figure 6. Fork in the river-Sembakung- Sedalir Competition in RBI, Map Appendix Treaty 1915 and GeoEye Imagery

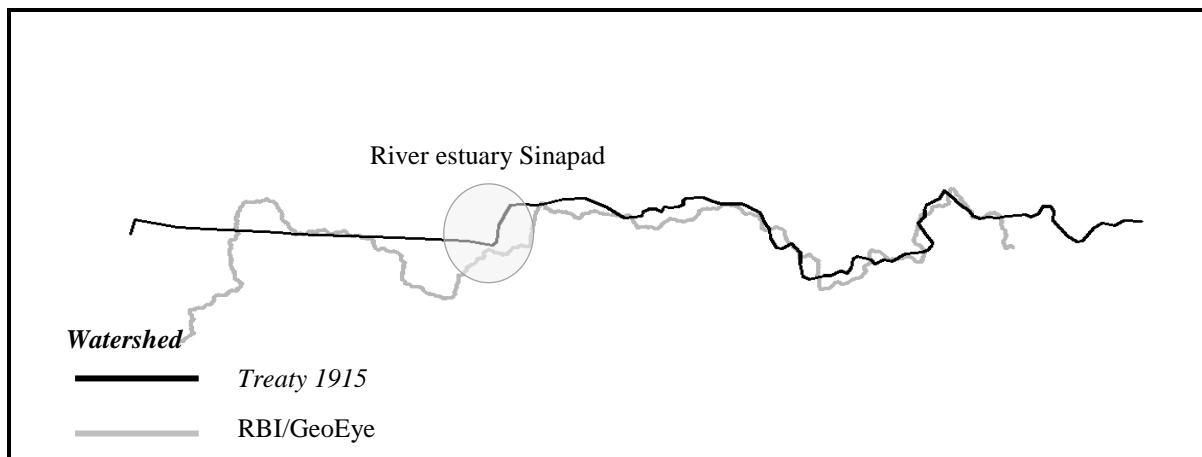


Figure 7. Directions watershed in RBI, Map Appendix Treaty 1915 and GeoEye Imagery

4. CONCLUSIONS

Based on the assumption is made that the 1915 Treaty Appendix Map an Astronomical maps with reference ellipsoid Bessel in 1841 obtained the following conclusions:

- 1) A registration method maps the 1915 Treaty attachment assumes that the map coordinates applying Astronomy and refers to the Bessel ellipsoid 1841 is not entirely appropriate.
- 2) The views of the object pattern shown, Map Appendix Treaty 1915 is adequate maps.

- 3) In the Map Appendix Treaty 1915terdapat segments not implemented the survey, namely the segment east estuary Sinapad. Therefore accuracy depiction on a map be not accurate enough.

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