

# The Analysis of Geospatial Information for Validating Some Numbers of Islands in Indonesia

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**Abstract** This article discusses a comparison of various numbers of islands in Indonesia; and it addresses a valid method of accounting or enumerating numbers of islands in Indonesia. Methodology used is an analysis to compare the different number of islands from various sources. First, some numbers of Indonesian islands were derived from: (i) Centre for Survey and Mapping- Indonesian Arm Forces (Pussurta ABRI) recorded as 17,508 islands; (ii) Agency for Geospatial Information (BIG) previously known as National Coordinating Agency for Surveys and Mapping (Bakosurtanal) as national mapping authority reported with 17,506 islands (after losing islands of Sipadan and Ligitan); (iii) Ministry of Internal Affairs published 17,504 islands. Many parties have referred the number of 17,504 islands even though it has not yet been supported by back-up documents; (iv) Hydrographic Office of Indonesian Navy has released with numbers of 17,499; (v) Other sources indicated different numbers of islands, and indeed will imply to people confusion. In the other hand, the number of 13,466 named islands has a strong document (Gazetteer). Second, enumerating the total number of islands in Indonesia can be proposed by three ways: (i) island census through toponimic survey, (ii) using map, and (iii) applying remote sensing images. Third, the procedures of searching valid result in number of islands is by remote sensing approach - high resolution satellite images. The result of this work implies the needs of one geospatial data source (including total numbers of islands) in the form of 'One Map Policy' that will impact in the improvement of Indonesian geographic data administration.

**Keywords:** number of Indonesian islands, island definition, method for counting islands.

**Abstrak** Makalah ini mengungkapkan perbandingan angka jumlah pulau Indonesia yang beragam dan mendiskusikan teknik penghitungan yang valid tentang jumlah pulau di Indonesia. Metodologi yang digunakan adalah kajian perbandingan angka jumlah pulau dari berbagai sumber. Pertama, Perbandingan angka jumlah pulau di Indonesia yang diperoleh dari: (i) Pusat Survei dan Pemetaan ABRI (Pussurta ABRI) mencatat sebanyak 17.508 pulau; (ii) Badan Informasi Geospasial (BIG) yang dulu bernama Badan Koordinasi Survei dan Pemetaan Nasional (Bakosurtanal) sebagai lembaga nasional yang memiliki otoritas dalam bidang informasi geospasial, pernah melaporkan angka 17.506 (setelah hilangnya P. Sipadan dan P. Ligitan); (iii) Kementerian Dalam Negeri yang memunculkan angka 17.504 yang sering dijadikan acuan banyak pihak walaupun juga belum ada data pendukung yang kuat sebagai 'back-up'; (iv) Dinas Hidro-oseanografi TNI-AL yang merelease angka 17.499 pulau; (v) Sumber lain menunjukkan angka yang berbeda, dan tentu saja dapat membingungkan masyarakat. Sementara angka 13.466 pulau bernama yang dihasilkan dari survei toponimi pulau, memiliki dokumen kuat berupa 'Gazetteer'. Kedua, penghitungan angka jumlah pulau diusulkan dapat dilakukan dengan tiga cara: (i) sensus pulau melalui survei toponimi, (ii) pemanfaatan peta, dan (iii) penggunaan citra penginderaan jauh. Ketiga, hasil penelusuran yang valid terhadap angka jumlah pulau adalah dengan pendekatan penginderaan jauh beresolusi tinggi yang terkoreksi secara geometrik. Hasil kajian ini mengimplikasikan perlunya satu sumber data geospasial (termasuk angka jumlah pulau) dalam bentuk 'One Map Policy' yang berdampak dalam perbaikan administrasi data geografi wilayah NKRI.

**Kata kunci:** jumlah pulau Indonesia, definisi pulau, metode penghitungan pulau.

## 1. Introduction

Number of islands in Indonesia is usually become an interesting topic to be discussed by many scholars, experts and others. Indonesia as an Archipelagic States, and particularly as Maritime Country has own land including areas and islands that extend and distribute all over the country. Such distributed islands need also to contribute people prosperity. Island inventory

is important to determine number of island and its resource potential in Indonesian situation. In this case potency of life and non-life resources that are owned by islands need to be properly managed, inventoried and mapped [Abidin, 2015]. Mapping works and geospatial information sometimes are not used properly.

The Minister of Marine and Fishery Republic of Indonesia, Susi Pudjiastuti stated that so many variety of resources (including islands) and broad coverage of the sea that are managed without map [BIG dan IGI, 2015]. As an archipelagic state and maritime country,

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Indonesia has to prove the owner of more than 17,000 islands. To become a big and strong maritime country, Indonesia has to manage its territory very well [Pailah, 2009, Lemhannas, 2015] while some assets in the form of islands distributed in Indonesian waters has not been formally determined yet. The number of island is not only limited to the recognition and claims but also need to have a fix number based on accounting supported by legal documents and proves for public in national or international level. Certainly, Indonesia has owned numbers of island and should declare as the same as he recognized.

The importance of island number here is due several interests involved in: (a). National development, that needs all areas including islands are the object to be built and managed, (b). Defense and security, to provide ascertain of all national territory, both land and water, sea and together with existing islands; and (c). Boundary demarcation of Indonesian territory to fix the total area and existing islands including the outer islands that are part of the area. Existing islands in Indonesian territory is an integrated part of archipelagic state or maritime country [Sebastian, 2015; Mangan, et al., 2013].

This paper analysis data on the various numbers of island in Indonesia at the present time. This is because there has been no research or analysis done to report the fixed number of island supported by its method of reenumeration. Indonesian people has right to know the number of island as public information. It's time for the Government to provide information about the number of island as his responsibility for the public. Center Bureau of Statistics or Badan Pusat Statistik (BPS) that has to be responsible for all statistical data in Indonesia, has not provided figure of number of island, even in the latest report of National Census 2010. The reason is that BPS is responsible for all statistical data in the country, but not geospatial data which is responsibility of BIG. Figure on island number is geospatial data. Meaning that, the accountability of counting process is not part of the BPS tasks, but when data become an output to be reported then BPS will take responsibility.

Unfortunately, geospatial data on island number have not been centrally published and declared. Many people wanted to know the actual number of island because the figure of number of island is important to know. The figure or number of islands is required for the national statistics that will benefit for country administration. For the national leaders and candidates of national leaders, the figure of island in Indonesia should become an important geographical statistics to understand the whole Indonesian geography. The first President of the Republic of Indonesia, Soekarno on the event of opening speech in launching Lemhannas in May, 20, 1965, stated:

*"In National Defense Institute that I approved,*

*given lectures to all followers, in order to really understand, our fatherland, geography of our fatherland, constellation of our fatherland, our people origin, our people mentality, our economy, our culture, all of these will process to become material for formulating and determining our national defense".*

The speech delivered by President Soekarno was a reflection of Djuanda Declaration in 1957. President Soekarno urged all Lemhannas participants (at that time the name was used as *Lembaga Pertahanan Nasional*), or National Defense Institute, (not Resilience) to remind and follow the example of founding father in struggling for the independence. Founding father emphasized that with all other aspects, geography and geographic constellation needed to be understood and be part of the national defense. Furthermore, geography of Indonesia has to be pay attention as national awareness, and one of the geographical awareness is the concern on the islands. The continuation of such struggle values should be inherited from generation to generation and aware of the importance of Indonesian geography [Martha, 2012, 2014]. In other words, from the beginning geography is considered to be important, therefore to learn Geography, map is an important tool to understand. Therefore, to read Indonesian map is needed to understand Indonesian territories [Martha, 2013]. Geographical awareness can be improved after seeing, visiting many different areas in Indonesia. This off course, field observation and study tour will improve regional knowledge and hopefully can improve geographical awareness. Geographical awareness of the nation is considered to be low [Suradinata, 2005]. Therefore, it can be improved through understanding of Indonesian geography, including Indonesian boundaries and geographical potency including existing number of islands [Martha, 2013]. The question is how to validate the different figures of island numbers.

## 2. The Methods

Methods used in this analysis are:

- (1) Literature study to obtain data on island number in Indonesia.
- (2) Analysis is conducted by comparative test, that compares all numbers of islands. Analysis is also done towards the variety differences of island number in Indonesia - derived from various sources.

The phase of analysis includes collection of data or number of islands from various sources, then it composed in the form of Comparison Table on Table 1 as sources of analysis. Furthermore, at the end of analysis, discussion will come to propose some alternative ways to calculate the number of islands.

In this analysis, data sources are media or

publication come from Governmental agencies or private sectors. Media sources that report the number of island Gazetteer from Bakosurtanal [1982], Analysis of satellite images- National Institute of Aeronautics and Space / LAPAN [2002], Indonesian Institute of Science (LIPI) Publication [1972], Report on Regional Government/ *Laporan Pemerintah Daerah* [2004], The United Nation Groups of Experts on Geographical names (UNGEGN) Report [1987], Circular of Chief Hydro-Oceanography Division - Indonesian Navy or *Kadishidros TNI-AL* (2012), and Report on Geography and Toponymy Survey, National Committee on Topographic Names Standardization or *Panitia Nasional Pembakuan Nama-nama Rupabumi* [PPNR, 2010]. Such data sources published the number of island based on some citations from competent institutions, or based on the direct counting through research, like LAPAN. Then, the author compiles the numbers of islands in the form of Tables 1 as material for analysis.

Before doing analysis, the definition of island according to United Nation Convention on the Law of the Sea (UNCLOS) should become a reference. *Article 121, Regime of Islands*, the definition of island as follows:

1. An island is a naturally formed area of land, surrounded by water, which is above water at high tide.
2. Except as provided for in paragraph 3, the territorial sea, the contiguous zone, the exclusive economic zone and the continental shelf of an island are determined in accordance with the provisions of this Convention applicable to other land territory.
3. Rocks which cannot sustain human habitation or economic life of their own shall have no exclusive economic zone or continental shelf.

Based on definition of UNCLOS 1982, island is natural landform surrounded by waters (sea) above the sea level rise on the high tide. It means that in the highest sea tide, an island must be on the position of above water (always appeared and not sink land). For this context, to determine an island, sea level data are important. Geographical landforms that is sometimes appeared in surrounding waters and sometimes drowned, cannot be categorized as islands, according UNCLOS, and these would not impact to the international law.

### 3. Result and Discussion

As previously mentioned, the number of island in Indonesia, published from various sources and media are vary. This affect the difficulty for researches

and analysts in finding the figures to be referred. The question is the variability of figure or numbers of island, which one is reliable. Several numbers of islands can be shown in Table 1.

Table 1 indicates that data sources derived from Ministry of Internal Affairs in the year 2004 [Departemen Dalam Negeri, 2004] published the figure of island number in Indonesia 17,504 islands. In 1987 Centre for Survey and Mapping - Indonesian Military Forces or *Pusat Survei dan Pemetaan ABRI* (Pussurta ABRI) published a number of 17,508 islands. Besides, Bakosurtanal, LIPI and Provincial Government still referred on the total figures that had been published so far. They just mentioned about the named and no-named islands. Figure of named islands based on LIPI in 1972 were 6,127 islands, and after ten years, Bakosurtanal had reported the total number of 6,489 named islands (in the year of 1982).

LAPAN analyzed Landsat data to Indonesia to report that 18,108 islands were existed in the whole Indonesian territory [Kompas 5/3/2003] while as mentioned in Table 1 were 18,306 islands. However, this number is still verified because the limitation of remote sensing system to record objects in the earth surface, and also the interpretation can also be mistaken. In manual interpretation, besides as an important key of interpretation, shadow (from cloud) can sometimes deceive image interpreter in knowing island performance on satellite images.

The total island figure of 17,508 is calculated in the time of normal condition of sea level point. The present time, in fact, sea level rise tends to increase as impacted by many factors. Meaning that the decrease number of islands is not always taken or claimed by other country. In other word, the figure of 17,508 as a total number of Indonesian island may not be completely true [Kompas, 9/4/2015]. Even other opinion said that total figure of 17,508 islands is not true. Based on that reason, it was presented a new figure of 13,487 islands. The reason was that there was about 4 thousands of islands escaped based on the rule of international law of the sea (UNCLOS). The author has not found the reason of figure 13,487 islands. As known, in previous stage of calculation, and also done by LAPAN [2002] all appeared lands around the waters including sandbanks were counted as island. While, present calculation was based on the UNCLOS definition of island. Referring to UNCLOS, sandbanks cannot be classified as island so that the total numbers of island will be decreased about four thousand islands. To avoid different statements regarding on the numbers of total islands, Board of Geospatial Information (BIG) as a national authority should announce the national standard data on number of island. In 2017, BIG declared with 16.506 islands for Indonesia [Badan Informasi Geospasial /BIG, 2017].

Table 1. Comparative Figure of Total Number of Island in Indonesia

Data Sources and Year	Information on Island Number			Media/ Source of Publication	Remarks
	Island number	Named	Un-named		
Depdagri 2004	17,504				
	17,508	7,870	9,634	-	
Pussurta ABRI, 1987	17,508	5,707			Including 337 island names in the river.
Bakosurtanal, 1982		6,489		Gazetteers	Including 374 island names in the river.
LAPAN, 2002	18,306			Satellite image analysis	Indocommunity-blogspot.com
LIPI, 1972		6,127		Publication	
Regional Government, 2004		7,870	9,634	Reports from Governors, Bupatis and City Mayors .	
Bakosurtanal, (mentioned by National Geographic Indonesia (NGI)	17,506 (minus two islands: Sipadan and Ligitan)			www.Google.co.id (mentioned as official data)	
Bakosurtanal and the University of Indonesia (UI)		11,013		NGI	Verified by Bakosurtanal
	17,508 – 18,306	8,844		Wikipedia.org	922 permanent islands - inhabited.
	17,504		About 6,000 islands un-inhabited		
CIA World Fact Book	17,508				
Ministry of Defence	17,504				
Ministry of Marine and Fishery (MoMF), 2011	+/- 13,000			Verified by MoMF	Director General Marine, Coastal and Small Islands (KP3K), Sudirman Saad, when visited Antara News.
Administrator Forum NGI, 2011	17,508 (possibility)	5,707			Refer to UNGEGN Report, 1987
Th. Susatyo	Someone said 17,000 and someone else said 13,000.				Media mentioned that Indonesia has not agreed yet.
Division of Hydro-Oceanography, Indonesian Navy (TNI-AL)	17,499	13,466	4,033	Circular Ka-Dishidros No. SE/1241/ IV/2012.	Also referred by <i>Investor Daily</i> , Thursday September, 18 2014, time : 17:21
National Committee on Topographic Names Standardization (PPNR)	17,504	13,466	The rest can be coral reef, atoll etc.	Field Verification and Inventory result. (Report on Geographical survey and toponimy in 2010)	Released at Kompas at: 8-2-2012 source: PPNR: Kemendagri, Kemenhan, KKP, Kemendiknas and Bakosurtanal.
Board of Geospatial Information (BIG)		16.056		UNCSGN and UNGEGN Meeting in New York, Agustus 7-18, 2017	All 16.056 islands were reported as having names and coordinates, and the numbers are possible to increase in the future.

Compiled by Author - from various sources [2017]

All recorded data and information related to islands should also be available in data base. Such island data base together with annotated bibliographic information are important to support the application of geographical information systems for the country's development [Martha, 1985, 1988].

Among various figures on island number mentioned on Table 1 above, the interesting figure 17,499 islands was published by Navy - Dishidros TNI-AL [Kurnia, 2015]. From the aspect of competences and the duty, the figure was officially supported by Circular or *Surat Edaran Kadishidros* No. SE/1241/IV/2012 [Dishidros TNI-AL., 2012]. The statement of Admiral Marsetio, Past Chief of Indonesian Navy Staff concerning Indonesian island strengthened the number of island mentioned [Lemhannas RI, 2015]. At least, this Circular bounded in the circle of Indonesian Army (TNI-AL) and Military Headquarter (*Mabes TNI*). Therefore, if the figure of 17,504 islands as result of National Committee on Topographic Names Standardization or *Panitia Nasional Pembakuan Nama-nama Rupabumi* (PPNR) which was formed through Presidential Decree or *Perpres* No. 112/2000, equipped by Ministerial Decree (*Permendagri*), still need to be harmonized with other institutions. Socialization and publication by one appointed Ministry or Authority are needed to avoid the differences of island number.

The big number of total islands indicates one of the main reason for Indonesia to be a strong, prosperous and developed maritime country. Indonesia has a total number of 17,504 islands (only 13,466 islands have been

named and reported to UN) has a coastal line 95,181 km. along (the second longest after Canada), and 75% of the whole territory is sea area

(5,8 million square km) including Indonesian Exclusive and Economic Zone (EEZ) (*Geography dan Toponimy survey result*, 2010).

The figure above becomes important due to the total number of island as an empirical number if kept and managed properly, it will contribute prosperity for the people [Dahuri, 2014]. The big figure on island number does not mean automatically become big country, as far as the figure or number of islands does not have a basic calculation and having good documentation and strong legal bases. Related to managing all islands, the number of island with their names has to be clearly identified and statistically informed. After establishment of Department of Marine and Fishery (DoMF) become Ministry of Marine and Fishery (MoMF) with Directorate General of Management of Small Islands, number of islands and also the outer islands where will have impacts for the national security should be paid into attention. The problem is related to the existing number of island has not yet been well documented. The good documentation in the form of Gazetteer and maps will help in avoiding many varieties of island number. National policy since the era of President Soesilo Bambang Yudhoyono, '*one-map policy*' has strengthened one geospatial data source, and will result in one same figure about island number in Indonesia [Dishidros-TNI-AL, 2014].

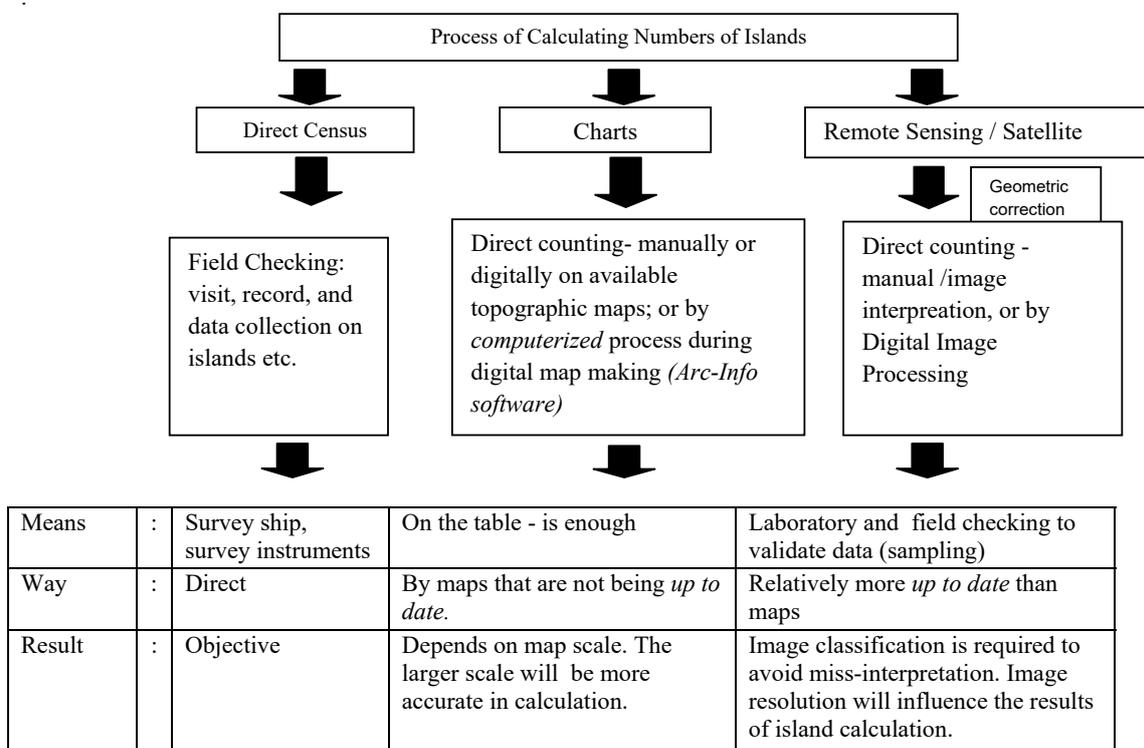


Figure 1. Proposing the Estimation of Island Numbers

The different numbers of island from various sources indicate the impacts of minimum socialization and question for the existing data reliability. Next, if compared, which figure can be reliable and how can calculate and obtain the accurate number of island in Indonesia. If President Jokowi will do field checking 'on the spot' every day for only one island for instance, having islands more than 17 thousands, the President needs more than 40 years to visit all. He has only limited time for 4 years of his presidency, or maximum 8 years if he will be re-elected. It means that there will be no enough time to visit all islands, as assets and part of the national territory. Therefore, the best way is to use technology like remote sensing in counting the number of islands.

The author proposes the estimation of total number of Indonesian islands can be conducted by three ways. Firstly, by direct census or counting islands by field or marine survey. Secondly, by calculating with the assistance of chart (map of the sea) as tool. Thirdly, by applying remote sensing imagery (Figure 1)

The first way, is actually the most accurate approach in collecting and counting total number of islands - by direct census with expensive cost and required many manpower to do that. This way should have a proper survey design to avoid the possibility in miss-counting, or double counting.

The second way, is to estimate the total number of island in Indonesia - by map assistance, particularly a reliable chart (map of the sea) with proper scale. Map/ chart users here involve with their capability in map reading. The old book of Erwin Raisz [1948], *General Cartography* discussed about 'Map Reading', as a part of the Chapter; even though it presented more on contour and *land-use*, Being used for the curriculum objectives in Hongkong, and presented samples of maps, graphic, pictures, diagrams that are more interesting because using description of 2 languages, English and Chinese, for understanding higher knowledge and detail (Cheung dan Cheung, 1980). However, the disadvantage of estimation on total number of islands through map is the availability of basemap itself related to islands. Map of National Marine Environment or *Lingkungan Laut Nasional* (LLN) published by BIG may not be enough as a tool for island estimation. Map of Coastal Environment of Indonesia or *Lingkungan Pantai Indonesia* (LPI) may also be the same as map of LLN. Large scale Charts or map of the sea published by Dishidros-TNI-AL can probably be used as a tool to count the island number. The larger scale of the map or chart, the better possibility to estimate total number of islands. In the contrary, the smaller scale of map or chart used, the smaller possibility in finding number of island. This is because maps with larger scale will perform of more detail island information.

The third way, is applying a vertical high resolution imagery. By using this remotely sensed data, the figures of island number will be obtained more accurately.

This is because satellite image can portrait all national territories seen as it is. This last way is considered as the most effective approach. This needs requirements, what is the real definition of island (according to *United Nation Convension Law of the Sea/UNCLOS-1982*), or in other terms that meaning of islands has to meet a definite criteria.

In 2002, LAPAN estimated the total number of island in Indonesia by using and analyzing remote sensing imagery. The study resulted total figure of Indonesian islands were 18.306. All objects visually seen on image including sandbanks are classified as island. For visual image interpretation, clouds cover can also be possibly miss-interpreted as island. As mentioned before, this way is the most effective method. The changes of existing islands can be monitored (if number of island is increased or decreased by high tide). Therefore, UNCLOS regulation can be accommodated with this approach. Off course, satellite image used has to be in high resolution and geometrically corrected so that remote sensing images have functioned properly to detect and count total number of island in Indonesia.



Karim [2009] with some modification.

Figure 2. Various numbers of Island, and which figure can be reliable?

From the above explanations and considering efficiency factor, the valid method to reanumerate or calculate the number of island is by high resolution remote sensing approach. Images that can be used to calculate number of island must be geometrically corrected so that the image will have similar scale with map. This method is valid because images can perform the real natural condition of island. The date of image recording can be known so that sea level rise in the condition of the low and high tide can also be known. Therefore, this way is the most effective and efficient (because the work does not require the direct visit or island census). This will provide the clear picture because vertical and high resolution image, as regulated by Presidential Instruction (Inpres) No. 6/ 2012 [Republik Indonesia, 2012]. From the comparison of

figures - island number which is disseminated in many publication so far, the author concludes that a figure of islands number in Indonesia is 17.504 (13.466 named islands) is the best figure that can be as a reference. This figure can be used until the national agreement will find the better solution figure as a result of unanimous decision. Such figure is actually as a result of works of *Panitia Nasional Pembakuan Nama-nama Rupabumi* (PPNR) as mandate of Perpres no. 112 tahun 2000 [Republik Indonesia, 2000]. The member of PPNR consists of many Ministries or Institutions involved, including Ministry of Internal Affairs, Ministry of Defense (MoD), MoMF, Ministry of Education and Culture and Bakosurtanal (now well known as Geospatial Information Agency or *Badan Informasi Geospasial* / BIG). Because of limited socialization and publication, It recommends that PPNS should meet with all stakeholders - all members, and to involve Ministry of Agraria and Spatial Planning, LAPAN, Dishidros-AL and Lemhannas RI to re-committed and re-confirm and agree with only one figure or number of Island in Indonesia.

#### 4. Conclusion

From this analysis, it concludes that one of the reliable approaches to validate some numbers of islands in Indonesia is analyzing geospatial information. The valid result in investigating the number of island depends on how accurate calculation of using high resolution geometrically corrected satellite imagery. This image has to perform as record product in the time of high tide condition. Therefore, the final result of islands counting will be relatively acceptable and can meet the island defined by UNCLOS 1982.

*One Map Policy* will be very important instrument in solving various geographical data and information problems in Indonesia. In this context, one geospatial data source, including number of island, can be act as one gate to release any data. In this case, one geospatial data source including the number of islands can be obtained from one map. For example, National Committee on Topographic Names Standardization or *Panitia Nasional Pembakuan Nama-nama Rupabumi* (PPNR) that BIG acts as Executive Secretary (Perpres No. 112/2000).

By one map policy, information related to various number of islands can be solved through a process of agreements among Department/ Institution involved and declared as one decision of formal and bounded governmental regulation.

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